Revision H changes are detailed in the Revision History on page two.

January 20, 2010 –An Interim Policy letter was signed by the Center Director on April 9, 2009 and sent to all KSC Senior Management. The requirements will be included in the next revision of this document, but have been applicable to all applicable personnel since April 9, 2009:

1. Nonroutine Hazardous Operations/Tests Requirements: Defines requirements for identifying Nonroutine Hazardous Operations/Test, assigns responsibility for these activities, defines hazard analysis requirements, establishes requirements for review boards, details the approval process for these activities, and establishes operational requirements.

Kennedy NASA Procedural Requirements

Effective Date: **July 13, 2009**

Expiration Date: **July 13, 2014**

Responsible Office: **Safety and Mission Assurance**

KSC Safety Practices Procedural Requirements

Revision History for Revision H

The primary goals of Revision H were to eliminate Shuttle-specific requirements in preparation for future programs, capture existing Shuttle-specific requirements for use through the end of the program, capture International Space Station-specific requirements not affected by Rev H revisions, incorporate pending Document Change Requests where concurrence has been reached, and revise the formatting/numbering of some sections in need of clarification.

Hyperlinks were corrected/inserted throughout and some sections were renumbered or reformatted to meet current KNPR guidelines. Where content was not changed, this process was not noted in this Revision History.

Chapter 18 was created to capture all existing Shuttle-specific Requirements. Where requirements within the body of the KNPR were "generalized," a reference and hyperlink to Chapter 18 was provided which states:

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

The original Shuttle Requirements, as presented in Revision G of KNPR 8715.3, are contained within Chapter 18. All sections of the KNPR are represented in Chapter 18. Where the basic requirements presented in the rest of the KNPR apply to Shuttle, the term SABD (same as basic document) appears. Where Shuttle-specific requirements were generalized, the original requirements are presented and supersede the generalized requirements in the other chapters of the KNPR. Some sections of the KNPR are noted as "Reserved" to preserve identical numbering between Chapter 18 and the rest of the KNPR. The goal was to maintain the applicability of this KNPR to the Shuttle program without developing a second document while simultaneously making the KNPR available to non-Shuttle programs such as the Constellation Program.

Chapter 19 captures International Space Station-specific requirements that were generalized in the rest of the KNPR (only occurred in section 13.8.3, Flight Vehicle Vessels and Systems). Where this occurs, a reference and hyperlink to Chapter 19 was provided which states:

International Space Station Requirements for this section are contained in Chapter 19 .

Upon completion of the Shuttle Program, Chapter 18 and all references to Chapter 18 will be deleted, leaving a non-program-specific KNPR.

To identify the changes made during this revision, a change matrix detailing Revision H changes has been provided.

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

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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 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. 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.

c. 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 8710.2, NASA Safety and Health Policy

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

c. NPR 8715.3, NASA General Safety Program Requirements

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

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

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

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

h. 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 8720.2, KSC Reliability and Maintainability Procedural Requirements

r. KNPR 8730.2, Quality Assurance Procedural Requirements

s. KHB 1700.7, Space Shuttle Payload Ground Safety Handbook

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

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

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

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

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

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

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

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

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

jj. LSP-PLN-365.01 Rxxxxx, Mission Specific NASA Launch Services Program Mishap Preparedness and Contingency Plan

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

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

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

nn. GP-14-2, Facility Utilization Charts

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

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

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

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

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

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P.5 CANCELLATION/SUPERSESSION

This document supersedes KNPR 8715.3, Rev. G, KSC Safety Practices Procedural Requirements; KNPR 8715.4, Rev. Basic-1, KSC Lockout/Tagout Procedural Requirements; and KNPR 8715.5, Rev. Basic-1, KSC Personal Protective Equipment Program (PPE).

Shannon D. Bartell
Director, Safety and Mission Assurance

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CHAPTER 1: GENERAL REQUIREMENTS

1.1 GOAL

a. From a safety perspective, the primary goals of NASA/KSC and this document are to provide the 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 SA-G, 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 (SA) 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.

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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. 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

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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 Kennedy Handbook (KHB) 1700.7, Space Shuttle Payload Ground Safety Handbook.

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, 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

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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

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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

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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:

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(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

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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).

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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.”

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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.

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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 on-going 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.

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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.

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

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Safety Specialist will be required to accompany each tour group that includes underage children.

e. Mobility Restrictions

1. 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.

2. Special accommodations to allow disabled individuals access to Hazardous Facilities or Hazardous Processing areas may be made due to special circumstances such as providing crew family members access to the LCC roof viewing site. This requires approval of NASA-KSC External Relations, NASA-KSC Safety and Mission Assurance and the Center Director or designee.

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:

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(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 Chief Test Conductor (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.

RELEASED - Printed documents may be obsolete; validate prior to use.

(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 Chief Test Conductor 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).

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(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 internal KSC Intranet (http://trainingrecords.ksc.nasa.gov/) or from hard copies available from the KSC S&MA Directorate Business and Administrative Office (SA-A). The Protective Services Office shall not issue permanent access badges until certification of training has been completed. Supervisors shall ensure that employees are familiar with designated facilities where they work or routinely visit. All training will be automatically recorded in the System for Administration, Training, and Educational Resources for NASA (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.

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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.

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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 (PDR)/Center Declared Emergancy (CDE)]

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(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).

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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 .

RELEASED - Printed documents may be obsolete; validate prior to use.

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

RELEASED - Printed documents may be obsolete; validate prior to use.

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, SA-E2, 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 (SA-E).

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, and action(s) being taken to minimize the number of deviations.

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.

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CHAPTER 4: CONTROL AREAS

4.1 GENERAL

4.1.1 Impact limit lines shall be as established by the 45th Space Wing for Cape Canaveral Air Force Station (CCAFS) and 30th Space Wing for Vandenberg Air Force Station.

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

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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 TOOLS

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

5.3 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.

RELEASED - Printed documents may be obsolete; validate prior to use.

5.4 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.

5.5 HEAT-PRODUCING DEVICES

5.5.1 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.

5.5.2 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.

5.5.3 ROOFING OPERATIONS

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

RELEASED - Printed documents may be obsolete; validate prior to use.

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

5.5.4 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.

5.6 USE OF PHOTOGRAPHIC EQUIPMENT

5.6.1 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.

5.6.2 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.

5.6.3 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.

RELEASED - Printed documents may be obsolete; validate prior to use.

5.7 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 operations involving explosives or pyrotechnics.

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).

5.8 ATMOSPHERIC MONITORING SYSTEMS

5.8.1 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. If an ODMS malfunctions, the affected area shall be cleared. Work may resume in the affected area provided a portable oxygen detector is used and confirms an acceptable oxygen level.

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.

5.8.2 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.

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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.

5.8.3 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.

5.8.4 HYPERGOL VAPOR DETECTION

5.8.4.1 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.

5.8.4.2 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.

5.9 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.

5.9.1 CRYOGENIC SKIN EXPOSURE FIRST AID PROTOCOL

This section provides instruction for delivery of first aid for individuals involved in a cryogenic exposure related incident. This instruction is applicable to cryogenic workers and first aid care providers that may deliver immediate assistance for a cryogenic material skin exposure injury in the field at KSC/CCAFS.

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5.9.1.1 Immediate Response

In the event of any cryogenic liquid/gas exposure to the skin, immediate response by first aid providers is required to limit the extent and severity of cryogenic burns to exposure victims. First Aid consists of the following steps:

a. If necessary, remove the victim from contact with the cryogen to a safe location.

b. Notify the Emergency Medical Service (EMS) system (call 911 or 867-7911 by cell phone).

c. Follow basic life support guidelines: the ABC's (airway, breathing, circulation, and c-spine control).

d. Thaw tissue as soon as possible, situation permitting (see below).

e. Immobilize the affected area with a splint, if applicable, and loosely wrap with a blanket or similar dry clothing.

> *NOTE: Do not attempt to rub skin or remove any frozen clothes or articles since they may be adherent to the skin and could result in damage to the skin if forcibly removed.*

5.9.1.2 Thawing Procedure:

The best method used for thawing of frozen tissue depends upon the resources available at the scene of the accident and shall be based on a credible mishap scenario. These methods are listed in order of preference to minimize the severity and extent of resulting cryogenic burn injuries:

a. ***First option*** is to immerse the affected area in a prestaged basin of tepid water (105 degrees F/40-42 degrees C) until the affected area is thawed. If tepid water is not available then;

b. ***Second best option*** is to immerse the affected area of the body in a prestaged basin of water that is at a temperature comfortable to normal tissue (assistant's hand). If not available then;

c. ***Third best option*** is to pour water or use very gentle irrigation (do not spray or squirt) with water that is at a comfortable temperature. If not available then;

d. ***Fourth best option*** is to wrap the affected area of the body with a blanket.

> *NOTE 1: Decontamination/thawing times will vary depending on the extent of the frozen injury.*
>
> *NOTE 2: Thawing of frozen tissue is generally associated with a lot of discomfort from the victim. Encourage the victim to continue the thawing process via the 'water bath method' as described above until the affected part is completely thawed.*

5.9.1.3 After Thawing:

a. Gently remove all wet and constricting clothing.

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b. Gently wrap the affected area in a dry blanket or clothing.

c. Keep the affected area clean, do not apply pressure to the site, except for bleeding control, and do not puncture any blisters.

d. Immobilize the affected area.

e. It is recommended that no weight bearing occur on any affected areas.

f. Arrange for Emergency Medical Services transport to the nearest appropriate medical facility.

5.9.1.4 REPORTING

Following the procedure implementation, documentation of the event shall be accomplished in accordance with Chapter 10, Mishaps and Close Calls herein.

NOTE: For additional information on cryogen first aid, contact the KSC Aerospace Medicine and Occupational Health Office.

5.10 HAZARDOUS OPERATIONS SUPPORT REQUIREMENTS

5.10.1 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.

5.10.2 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.

5.10.3 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.

5.11 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.

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

5.12 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.

5.12.1 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.

5.12.2 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:

EMERGENCY SITUATION EXISTS
CLEAR AREA IMMEDIATELY

b. Warning signs adjacent to amber lights shall read as follows:

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.

5.13 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.

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5.14 HAZARDOUS OPERATIONS EMERGENCY POWER

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

5.15 CONCURRENT OPERATIONS

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

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

5.15.2 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.

5.16 EMERGENCY SHOWER/EYEWASH REQUIREMENTS

5.16.1 The preservation of sight, and the minimization of the effects of chemical exposure, are the most important aspects of the policies of section 5.16. 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.

5.16.2 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:

5.16.2.1 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.

5.16.2.2 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.

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5.16.2.3 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: Inspections shall be documented on KSC Form 20-202/KSC Emergency Eyewash/Shower Inspection, and affixed to the unit.

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.

5.16.3 <u>Personal eyewash (bottles) will not be used as Emergency Eyewash</u>; 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

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29 Part 1910.268(b)(2)}. If batteries require servicing, i.e., adding electrolytes, fully functioning EE&SE equipment is required per this policy.

5.16.4 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.

5.16.5 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.

5.16.6 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.

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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.

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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.

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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).

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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.

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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)

8.1.2 OVERALL PPE PROGRAM PREQUIREMENTS

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

a. Conduct of 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.

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

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

e. General PPE selection guidelines are provided in Figure 8-1 of this KNPR, Personal Protective Equipment Hazards Consideration/Selection Checklist.

f. Guidelines for selection of specific PPE for chemical protection may be found in "Recommendations for Chemical Protective Clothing – A Companion to the NIOSH Pocket Guide to Chemical Hazards" (http://www.cdc.gov/niosh/ncpc/ncpc2.html).

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.

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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	Safety glasses with side shields or safety glasses covered by a full-face shield
Grinding/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 or safety glasses with side shields covered by a full-face shield
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	Goggles, safety glasses with side shields or face shield (face shield required for heavy grinding)
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	Nomex 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	Nomex coveralls
High voltage	Safety shoes
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

RELEASED - Printed documents may be obsolete; validate prior to use.

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.”

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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 CORRECTIVE LENSES/GLASSES

a. Contact lenses: Personnel attired in Self-Contained Atmospheric Protective Ensemble (SCAPE), toxic vapor suits, or full-face respirators shall not wear contact lenses.

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

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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

*

TABLE 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

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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 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 PROGRAM

Lockout/Tagout 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.

a. Mandatory Lockout/Tagout Conditions

Lockout/tagout requirements are mandatory when the following conditions are present:

(1) During equipment/machinery setups or preoperational activities.

(2) Whenever equipment/machinery guards, safety switches, or other safety devices are removed or bypassed in order to perform:

(a) Maintenance

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(b) Troubleshooting (if feasible)

(c) Repairs or servicing

(3) When any part of an employee's body may be placed in a possible danger zone.

b. Lockout/Tagout Exemptions

Lockout/tagout is not required under the following circumstances:

(1) 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.

(2) 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.

8.5.1 POTENTIAL ENERGY SOURCES

a. All energy sources must be identified, isolated, and controlled by locking and tagging out disconnects, valves, and other similar items before work is conducted.

b. Energy is typically classified as either potential (stored energy) or kinetic (energy in motion). Different types of workplace energy include:

(1) Chemical energy (corrosives, flammables, reactants, toxins, asphyxiants).

(2) Electrical energy.

(3) Gravitational energy (movement caused by weight or position).

(4) Hydraulic energy (generated by liquids under pressure).

(5) Mechanical energy (spring-driven equipment, clutches, cams).

(6) Pneumatic energy (generated by pressurized gas or air).

(7) Thermal energy (extreme heat or cold).

8.5.2 LOCKOUT/TAGOUT DEVICES

a. Both a lock and a tag are required when performing lockout/tagout procedures.

b. An authorized employee's Supervision (or designee) shall issue all lockout/tagout devices, either individually or in a kit form (e.g., centralized locker).

c. Each authorized employee shall be issued locks, tags, multiple lock hasps, or other lockout/tagout devices as deemed necessary, either individually or in a kit form (e.g., centralized locker).

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d. Additional locks, hasps, tags, and lockout devices, if required, may be obtained from the authorized employee's Supervision (or designee).

e. Locks and tags issued for use shall be traceable from the using employee back to the issuing employer.

f. The issuing employer shall maintain an accountability log of all issued and returned devices.

g. The exception to these requirements 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 (tag) device (only) may be implemented based on the procedure specified in section 8.5.4 of this KNPR.

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

8.5.2.1 Locks

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

a. Durable.

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

c. Substantial enough to prevent easy removal.

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

e. Keyed padlocks which are keyed individually.

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

f. Designated solely for lockout/tagout purposes.

8.5.2.2 Tags

Tags alert workers regarding equipment/machinery status. KSC Form 20-195, Lockout/Tagout Tag (see **Figure 8-3**) is the only tag authorized for use at KSC. Tags must (be):

a. Durable and printed so that they remain legible.

b. Standardized according to print and format.

c. Clearly identify the employee who applied them.

d. Include the signal word "DANGER" to warn against hazardous conditions if the equipment/machinery is energized, and must include messages such as "DO NOT OPERATE" and "LOCKOUT/TAGOUT".

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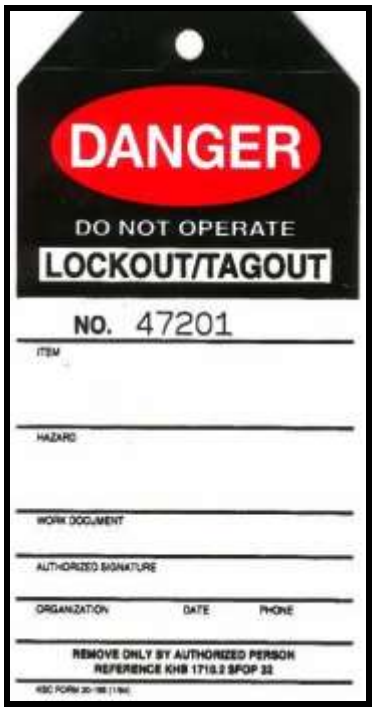

FIGURE 8-3: KSC FORM 20-195, LOCKOUT/TAGOUT TAG

8.5.2.3 Means of Attachment

The means of attachment for various lockout/tagout devices must 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.

8.5.3 LOCKOUT/TAGOUT PROCEDURES

Procedures for the application of lockout/tagout (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). An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of the equipment/machinery stoppage.

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

c. Authorized employees shall affix lockout/tagout devices to each energy-isolating device.

d. Tagout devices shall be affixed in such a manner as will clearly indicate 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 lockout/tagout 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 a “zero energy state” and that energy has been isolated and that the equipment/machinery has been de-energized.

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.

8.5.4 GROUP LOCKOUT/TAGOUT

8.5.4.1 Usage

Group lockout/tagout procedures may be used if there are multiple locks required for a single piece of equipment/machinery, and several employees are involved in maintenance and servicing activities.

8.5.4.2 Process

In addition to all other requirements, the following process must be adhered to when applying group lockout/tagout devices:

a. An authorized employee applies the equipment locks.

b. The authorized employee places keys to equipment locks in a master lock box and applies their personal lock.

c. The authorized employee places their personal lock key in a separate lock box; members of the crew, including the authorized employee, apply their personal lock.

d. All lockout/tagout procedures (section 8.5.4 of this KNPR) are followed until the job is complete.

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e. Specific procedures shall be utilized during shift or personnel changes to ensure the continuity of lockout/tagout protection. This shall include provision for the orderly transfer of lockout/tagout 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.

8.5.5 LOCKOUT/TAGOUT DEVICE REMOVAL

8.5.5.1 Under normal circumstances, before lockout/tagout device(s) are removed and equipment/machinery energy is restored, authorized employees shall implement the following procedures and actions:

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

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

c. After lockout/tagout devices have been removed and before equipment/machinery is started, affected employees shall be notified that the lockout/tagout devices have been removed.

8.5.5.2 If the authorized employee is unavailable to remove their lockout/tagout device, it may be removed under the direction of the authorized employee's Supervision provided all the following conditions are met:

a. At least one attempt is made to contact the authorized person who applied the device(s), or to verify the authorized employee who applied the device is not at the facility.

b. The person who performed the lockout/tagout is notified that the device(s) have been removed prior to their return to work.

c. The authorized employee's Supervision and another authorized employee must be present.

d. A determination is made that it is safe to startup the equipment/machinery prior to removing the lockout/tagout device.

8.5.6 PERIODIC PROGRAM INSPECTIONS

Annual lockout/tagout program inspections will be conducted and documented:

a. An annual inspection must be conducted in order to ensure the lockout/tagout program is meeting the requirements of 29 CFR 1910.147, and to correct any identified deviations or inadequacies.

b. An authorized and properly trained employee must 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.

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

d. Documentation certifying the completion of the inspection must 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.

8.5.7 TRAINING/RESPONSIBILITIES

8.5.7.1 Training

Training will be conducted and documented to include the following:

a. Employees will receive initial training or instruction in lockout/tagout to ensure that the purpose and function of the lockout/tagout (energy control) program are understood. The employer will ensure employees acquire the knowledge and skills required for the safe application, usage, and removal of the energy controls. Employees will be trained in lockout/tagout requirements in accordance with their level of responsibility.

b. The employer shall certify that employee training has been accomplished and is being maintained current. The certification shall contain each employee's name and dates of training.

c. Authorized and affected employees will 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 lockout/tagout procedures change and/or when an inspection indicates a lack of knowledge or deficiency in work practices.

8.5.7.2 Responsibilities

Levels of responsibility for lockout/tagout procedures and activities include:

a. Authorized employees – Those employees who service or maintain equipment and perform lockout/tagout procedures. Authorized employees must be trained to be able to:

(1) Distinguish the various types of hazardous energy sources

(2) Identify the hazardous energy sources present in the workplace

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(3) Understand dangers presented by workplace energy sources

(4) Understand and follow workplace lockout/tagout procedures

b. Affected Employees – 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. Affected employees must receive training in order to:

(1) Recognize when lockout/tagout procedures are being implemented

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

c. Other Employees – Those employees who may have reason to enter or work in the area where lockout/tagout may be implemented must be instructed regarding the purpose of lockout/tagout procedures, and be informed of the prohibition against restarting or re-energizing equipment that is locked and/or tagged out.

8.5.8 RECORDKEEPING

a. An initial documented survey, of all equipment/machinery that is covered by lockout/tagout, must be conducted to identify and categorize energy sources and control methods

b. Organizations shall develop and document energy control procedures for machinery and equipment. One procedure may be developed for multiple pieces of equipment/machinery with similar energy sources and controls.

c. Organizations must maintain inventory records of locks and tags. NASA organizations shall utilize KSC Form 28-912, Lock Control Record (Figure 8-4) for locks and KSC Form 28-915, Tag Control Record (Figure 8-5) for tags. Contractors may utilize these or other forms, provided that the data elements in Forms 28-912 and 28-915 are addressed.

d. All training and annual inspections must be documented and available for review.

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Lockout/Tagout LOCK CONTROL RECORD			
Number of Locks on Hand	Lock Numbers Issued Out	Locks Issued to (Name)	Lock Numbers Lost or Destroyed

Lockout/Tagout CONTROL RECORD (for KSC Form 20-195)			
Tag Numbers Received	Tag Numbers Issued Out	Tags Issued to (Name & Shop/Facility)	Tag Numbers Lost or Destroyed

KSC FORM 28-915 NS (07/02)

FIGURE 8-5: KSC FORM 28-915, TAG CONTROL RECORD

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8.6 DANGER TAGS

8.6.1 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.

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

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

8.7 BATTERY HANDLING

8.7.1 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.

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

8.7.3 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.

8.7.4 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.

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

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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 8-6 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.

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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.

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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).
Metal Roof	A roof with metal surface that engineering has determined is load bearing or is a structural support surface.
Mechanical Equipment	All motor or human propelled wheeled equipment used for roofing work, except wheelbarrows and mop carts.
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.

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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.
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.

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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

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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

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(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

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(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 and shall be retrained a minimum of once every three (3) years.

g. 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.

h. 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

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(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, man-holes, 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.

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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.”

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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.

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:

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(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) 15 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) 15 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.

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8.9.10 SAMPLE SITE SPECIFIC FALL PROTECTION PLAN

Figure 8-6 illustrates an example site specific fall protection plan that satisfies the fall protection requirements of this KNPR and applicable OSHA and ANSI standards.

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FIGURE 8-6: 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.

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FIGURE 8-6: 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.

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FIGURE 8-6: 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.

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CHAPTER 9: TECHNICAL OPERATING PROCEDURES (TOPs) (SUPPLEMENTS NPR 8715.3, NASA GENERAL SAFETY PROGRAM REQUIREMENTS)

9.1 GENERAL

9.1.1 Space Shuttle Program/International Space Station (SSP/ISS) payload organizations shall comply with the requirements of KHB 1700.7, Space Shuttle Payload Ground Safety Handbook, in lieu of the requirements in this chapter.

9.1.2 Laboratory operations shall comply with 29 Code of Federal Regulations (CFR) 1910.1450 in lieu of the requirements of this chapter.

9.1.3 TOPs provide a written communication that identifies and directs 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.

9.1.4 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.

9.1.5 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.

9.1.6 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.

9.1.7 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.

9.1.8 TOPs shall be prepared in clear, precise language that can be readily understood by personnel involved in the operation.

9.1.9 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 A cover identifying the TOP as either hazardous or non-hazardous.

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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. These notes shall immediately precede the step that directs the activity. For multiple steps for related work within a TOP, the WARNING/CAUTION shall immediately precede 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 contained within the document with uniquely identifiable pages; eg. distinctive border or cut corners.

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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.

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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

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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.

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(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 13.13.10 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.

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9.9.2 A written 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 written 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 a written approved deviation. For emergency or time-critical (real-time) situations, operations may continue with the deviation written 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 a written 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 at Vandenberg Air Force Base (VAFB), or involving hazardous operations for NASA Launch Services Program (LSP) at the Cape Canaveral Air Force Station (CCAFS), shall be forwarded to the LSP S&MA Division.

9.9.5 All TOPs/changes/deviations involving hazardous operations for NASA payloads (KSC or CCAFS) shall be forwarded to the ISS/Payload Processing S&MA 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

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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.

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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.

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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.

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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

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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.

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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.

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(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 program/project or directorate S&MA organization 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.

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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 in accordance with KDP-KSC-P-1473, KSC Mishap Reporting and Investigating.

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.

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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

Corrective action(s) shall be determined and implemented in order to prevent recurrence of similar events. Within 45 working days of the mishap or close call (or approval of the report in the case of mishap board investigations), the responsible program/project or directorate organization shall develop the Corrective Action Plan (CAP) (or further develop the proposed CAP in the case of MIBs) and enter it into the NASA IRIS database. The CAP shall provide corrective action(s) for the root cause(s) identified, and for all other contributing factors to the mishap or close call. 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). In the case where there

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are no corrective actions that could reasonably be taken, a statement stating this shall be entered into the NASA IRIS database. The program/project and NASA KSC S&MA Division is responsible for monitoring corrective actions activities for mishaps and close calls, and to determine if they are carried out according to plan.

10.8 LESSONS LEARNED

All mishaps and close calls shall be evaluated for any lessons learned. 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. 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 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. 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.

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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

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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

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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

12.2.1 Three-phase power sequencing shall be verified in each KSC facility prior to connection, including after facility modification or outages.

12.2.2 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.

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CHAPTER 13: NASA KSC REQUIREMENTS FOR GROUND-BASED VESSELS AND PRESSURIZED SYSTEMS (PV/S)

13.1 PURPOSE

The purpose of this Chapter is to assign responsibilities and to ensure the structural integrity of PV/S through implementation of the minimum requirements for ground-based PV/S 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 (PV/S)-related definitions are included in Appendix A.

13.4 POLICY

It is KSC policy that all ground-based Pressure Vessels and Pressurized Systems (PV/S) which are not excluded per section 13.16 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 PV/S 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 PV/S shall be designed, fabricated, installed, operated, maintained, certified, and recertified in accordance with applicable codes, standards, and guides. For existing PV/S 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 PV/S. 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.

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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 PV/S are properly categorized and included or excluded in the PV/S certification program, as appropriate.

d. An inventory database is updated and maintained for pressure vessels and systems. This includes all PV/S that are inactive and active, and those that are exempt from the PV/S Certification Program. For systems excluded from the PV/S 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 PV/S 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 PV/S 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* KSC Procedural Requirements (KHB) 1700.7 *(STS/ISS payloads) or Eastern Western Range (EWR) 127-1 (1997)/ AFSPCMAN 91-710 V3 (ELV Payload GSE).*

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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 PV/S Certification Program, documentation should be maintained indicating the rationale for exclusion from certification.

b. Reviewing and approving PV/S 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 PV/S, 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 PV/S 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 PV/S certification and inservice inspection (ISI) reports.

13.6 PRESSURE VESSELS AND PRESSURIZED SYSTEMS (PV/S) 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 PV/S listed in section 13.17 shall be exempt from the certification requirements of this KNPR.

c. PV/S 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

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conflict between this document and applicable statutes or regulations, the statutes or regulations govern.

d. All PV/S 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 PV/S 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. PV/S 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 PV/S in accordance with section 13.9 or Figure 13-8 of this KNPR.

g. The original service life or remaining safe life of each PV/S 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. PV/S shall be pressurized only after initial certification is complete, with the exception of pressurization that may be required for initial integrity testing of the PV/S.

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. PV/S 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.

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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 PV/S shall be maintained to conform to expected service conditions.

o. A change in the service of a PV/S 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. PV/S 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. PV/S 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 PV/S within the certification parameters.

b. The owner shall maintain change and modification records of PV/S.

NOTE: This may be used to identify problem components or PV/S trends.

c. The owner shall report to the PSM any PV/S 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 PV/S 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.

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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 PV/S 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 PV/S 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.

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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.

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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 PV/S 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.

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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) PV/S 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) PV/S 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) PV/S 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 PV/S 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.

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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 PV/S 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 PV/S 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 PV/S integrity assessment.

p. PV/S whose service life is limited by fatigue or brittle fracture shall have fatigue inspections performed no later than when the PV/S 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 PV/S to incorporate safety related Code changes, unanticipated rates of degradation, change in service fluid, operating pressure or temperature, or other relevant factors.

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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 PV/S 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

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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 PV/S 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 PV/S 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

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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,

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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 of this section 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.

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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 PV/S INTEGRITY ASSESSMENT, REMAINING LIFE

13.11.6.1 PV/S INTEGRITY ASSESSMENT

a. Integrity assessment of each PV/S 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 PV/S integrity assessment shall include an inspection plan that addresses credible damage mechanisms for the specific PV/S.

d. Verification of integrity of each in-service PV/S shall be documented at each periodic inspection interval as specified in the inspection plan in compliance with the appropriate NCS.

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e. If at any time a PV/S is not fit for the intended service, the PV/S shall be immediately removed from service and the certification of the PV/S 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 PV/S 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 PV/S 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 PV/S 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 PV/S 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 PV/S 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 PV/S.*

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 PV/S 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:

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(1) Relevant characteristics of the PV/S 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 PV/S 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 PV/S risk assessment

13.12 DESIGN, REPAIRS, ALTERATIONS, OR MODIFICATIONS

13.12.1 GENERAL DESIGN REQUIREMENTS

a. The PV/S 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 PV/S 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.

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13.12.2 DESIGN AND CONSTRUCTION REQUIREMENTS FOR NEW PV/S

All new ground-based conventional (i.e., non-flight) PV/S 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.

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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.

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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 PV/S shall be documented in the PV/S configuration management system.

> *NOTE: Redundant PRDs used only for operational pressure control below the MAWP of the PV/S 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 PV/S shall be in accordance with the applicable NCS.

e. Overpressure protection devices for PV/S 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.*

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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 PV/S.

k. Pressure safety relief valves shall only be used in accordance with the applicable ASME code of construction.

l. PV/S 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 PV/S 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 PV/S 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).

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b. PV/S 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 PV/S 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 PV/S 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 PV/S 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.

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(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.

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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 PV/S (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 PV/S 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 PV/S 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 PV/S 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.

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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 PV/S, 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 PV/S that were not originally designed to meet DOT requirements and are used to transport material under pressure.

a. This type of PV/S 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 PV/S shall be evaluated as “non-Code PV/S” per section 13.12.16 of this document.

13.12.14 INTEGRITY ASSESSMENT OF EXISTING CODE PV/S

a. Existing Code PV/S shall be documented as meeting the requirements of the original construction Code by means of record collection and physical measurements and condition

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assessment. Original Code information, if available shall be released into the PV/S 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 PV/S in accordance with section 13.12.16 of this document, or removed from service.

c. Code PV/S 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 PV/S 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 PV/S.

h. Code PV/S that have been re-designated as non-Code shall be clearly and visibly marked to indicate the non-Code status.

i. For existing PV/S 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.

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(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 PV/S.

(14) Develop a plan and schedule for the full inspection and recertification of the PV/S, based on a ranking of risks and associated analyses, inspections, and mitigations, with schedule determined so as to minimize the overall risk.

j. If the full certification/recertification process in accordance with section 13.14 of this document for existing PV/S is not completed by the end of a five year period beginning on the original issue date of this document, the PV/S shall be removed from service.

13.12.15 TECHNICAL VARIANCE REQUIREMENTS FOR NEW NON-CODE PV/S

NOTE: This section does not endorse the purchase of new non-Code PV/S, but offers guidance for those rare cases where new PV/S 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 PV/S.

b. New non-Code PV/S 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 PV/S, in particular through the use of:

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(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 PV/S.

13.12.16 EXISTING NON-CODE PV/S (LEGACY)

a. Non-Code PV/S shall be documented and evaluated to the extent possible as meeting the requirements of the most applicable NCS.

b. Non-Code PV/S 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 PV/S 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 PV/S 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 PV/S.

d. The design and operational limits of existing non-Code PV/S 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 PV/S 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 PV/S 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 PV/S shall be removed from service.

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g. Code PV/S 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 PV/S. See section 13.12.12 for additional specific requirements for DOT vessels.

i. The provisions of sections 13.13.14.i and 13.13.14.j apply to existing non-Code PV/S that must be placed in service prior to certification or recertification in accordance with section 13.15 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**"

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p. Prior to inactive PV/S 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 PV/S are put into storage they shall be protected against exposure to adverse environments which could cause corrosion or other forms of material degradation.

b. PV/S 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. PV/S 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 PV/S is repairable, it should be repaired per the appropriate NCS.

c. If the PV/S 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 PV/S 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

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13.14.1 PV/S 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. PV/S 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 13.11 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.

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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 PV/S certification file.

d. Engineering Work Packages: Description of documentation issued for inspection and tests and description of any repairs and modifications required for PV/S 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 PV/S 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 PV/S 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. PV/S 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. PV/S 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 PV/S 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 PV/S.

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.

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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 PV/S 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.

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13.15 PRESSURE VESSELS/SYSTEMS DATABASE

The KSC Pressure Systems Manager shall maintain an inventory and certification status database of all ground-based PV/S 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 PV/S

a. Risks shall be identified and documented for all PV/S 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 PV/S.

b. Risks shall be assessed and Risk Assessment Code (RAC) determined for all PV/S 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 PV/S.

d. Planning of risk mitigation activities and residual risk analysis shall be performed and documented in the initial PV/S 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 PV/S 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. PV/S 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 PV/S.

h. The PSM has authority to modify risk mitigation requirements or de-certify and remove from service any PV/S that is not safe to operate.

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i. The PSM shall serve as the System Safety Manager with respect to PV/S in accordance with paragraph 2.8.2 of NPR 8715.3 for PV/S.

j. System safety documentation shall be as specified throughout this document and shall be maintained within the PV/S configuration management system.

k. The PSM shall identify each PV/S change that potentially affects the baseline risk assessment throughout the life of the PV/S 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.

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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 recovere d	> 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 1:. The values and ranges are considered default values and ranges and may be adjusted based on actual data.

FIGURE 13-2: SEVERITY DETERMINATION TABLE

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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 PV/S.

(2) Without further information on a specific PV/S 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 PV/S, (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 PV/S in question is exercised and documented.

(4) PV/S 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.

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Example 1: Small bore piping system with personnel exposure 2 hours/24 hour work day, 5 day work week; PV/S 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 PV/S.

Example 2: Small bore piping system PV/S 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 PV/S 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

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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 PV/S 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 PV/S 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 PV/S 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 PV/S FAILURE RATES PER YEAR (MEDIAN VALUES) FOR CERTIFIED PV/S

Item	PV/S 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				$>10^{-6}$	

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Item	PV/S 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.

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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 PV/S variances will be processed in accordance with KNPR 8715.3, Section 1.6, Safety Variance Processing.

c. For KSC PV/S, 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 PV/S 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

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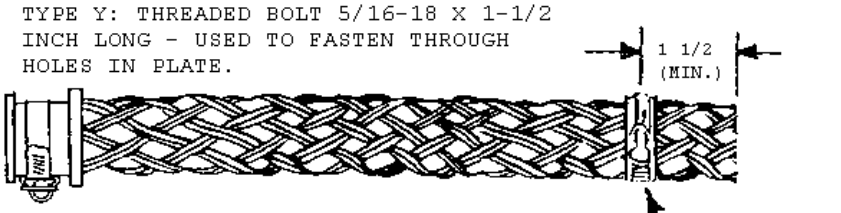
TYPE E: DOUBLE EYE GRIP - USED WHERE FASTENING IS MADE WITH EYE BOLTS OR SIMILAR ANCHOR TERMINATIONS.

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.

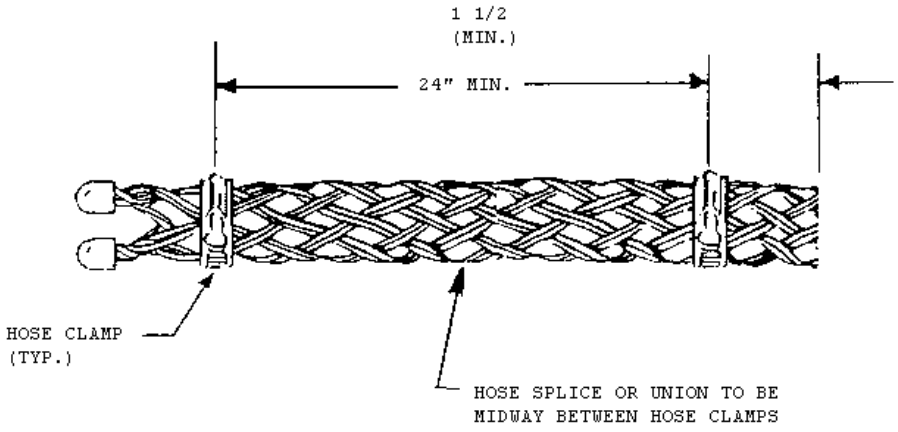


TYPE F: SPLIT FITTING TO FIT AN818 NUTS. FITTING IS POSITIONED OVER NUT AND LOCATED WITH INTERNAL FLANGE. A HOSE CLAMP IS FURNISHED AND REQUIRED TO CORRECTLY POSITION FITTING.

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

RELEASED - Printed documents may be obsolete; validate prior to use.



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

RELEASED - Printed documents may be obsolete; validate prior to use.

(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

RELEASED - Printed documents may be obsolete; validate prior to use.

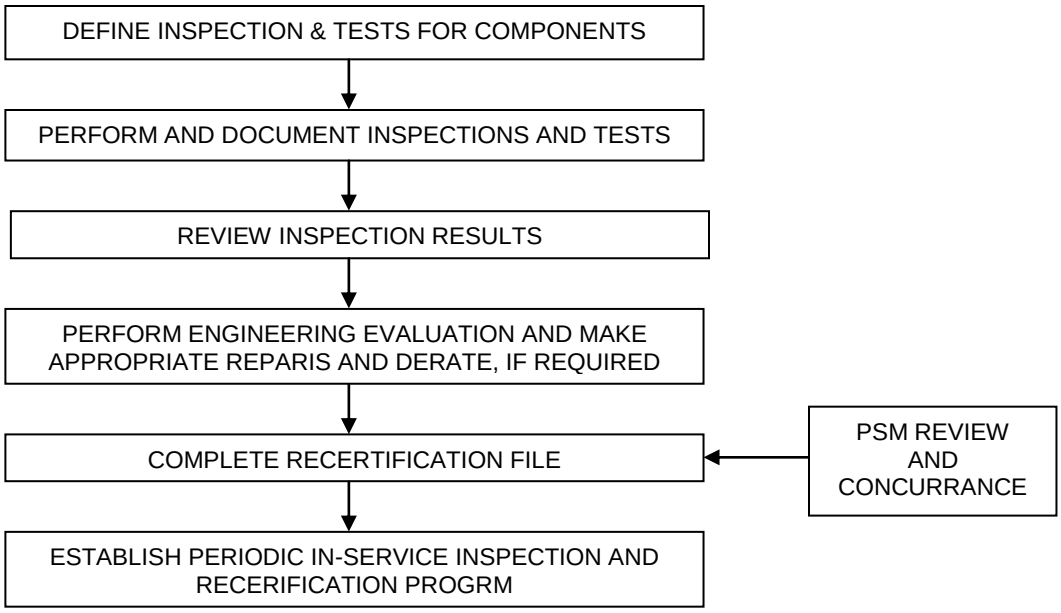


FIGURE 13-9: RECERTIFICATION PROCEDURE FOR INSERVICE EQUIPMENT

RELEASED - Printed documents may be obsolete; validate prior to use.

(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

RELEASED - Printed documents may be obsolete; validate prior to use.

(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

RELEASED - Printed documents may be obsolete; validate prior to use.

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 PV/S[12]

PV/S	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

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PV/S	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		
Liquified 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

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13.17 ITEMS EXCLUDED FROM CERTIFICATION

The following PV/S 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 PV/S that supply the lower pressure PV/S.

13.17.5 Fuel storage PV/S 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) PV/S

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.

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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 PV/S, 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.

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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 PV/S 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 PV/S 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 PV/S 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 PV/S EXCLUSIONS

a. Test article PV/S 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 PV/S (e.g., special test equipment (STE)) are excluded if risk assessment has been performed in accordance with NPR 8715.3, NASA General Safety

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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.

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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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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:

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(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.

d. 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)

The appropriate program/project or directorate NASA KSC S&MA organization shall approve ETE. The submitting organization shall provide the following data:

a. Model number

b. Mechanical/electrical engineering drawings and specifications

c. System safety analysis

d. A valid calibration seal shall be maintained on all approved ETE.

e. 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.

f. Section 14.4 contains the list of currently approved ETE.

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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

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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

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

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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.

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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

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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.

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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.

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14.3.7.13 HANDLING AND TRANSFER OF HYDRAZINE (N_2H_4)/MONOMETHYL HYDRAZINE (MMH)/NITROGEN TETROXIDE (N_2O_4)

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.

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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.

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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 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, 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, shall be in the transfer aisle.

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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://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,

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(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.

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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://www-ph.ksc.nasa.gov/sma/KSC_LDE_files/slide0001.htm

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.

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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.

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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:

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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 concurrently with the design process, with the safety and reliability design requirements provided at the project design kickoff meeting. Draft copies of analyses should be included in design review packages (i.e., 30/60/90%) distributed for review.

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.

e. Residual risks (hazards and critical items) not eliminated through the design process shall be formally documented and presented to management for risk disposition.

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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.

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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.

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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 Chief Test Conductor (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)

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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:

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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.

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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 5.5.3 - SABD

5.5.4 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;

5.6 through 5.8.1.a - SABD

5.8.1.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.

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5.8.2 - SABD

5.8.3 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.

5.8.4 - SABD

5.9 CRYOGENICS

5.9.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.

5.9.b through 5.9.d - SABD

5.9.1 through 5.10 - SABD

5.11 Handling of Flammable/Combustible Liquids near flight hardware

5.11.1 Containers used for liquids, flammable/combustible or not, shall be labeled to specify the contents.

5.11.2 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.

5.11.3 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.

5.11.4 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).

5.12 through 5.17 - SABD

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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

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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

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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.

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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 (PV/S)

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.

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(5) A logbook shall be maintained for each PV/S 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) PV/S 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) PV/S 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) PV/S 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 (CPOVS)

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

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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

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

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14.2.4.2 The Space Shuttle Vehicle (SSV) [i.e., the Orbiter, External Tank (ET), SRB, Payload with in 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.

RELEASED - Printed documents may be obsolete; validate prior to use.

(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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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 Shuttle S&MA organization.

(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.

RELEASED - Printed documents may be obsolete; validate prior to use.

(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, al 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).

RELEASED - Printed documents may be obsolete; validate prior to use.

(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)

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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.

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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.

RELEASED - Printed documents may be obsolete; validate prior to use.

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

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(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

RELEASED - Printed documents may be obsolete; validate prior to use.

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

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16.2.2 There are several system safety analyses that can be used to identify hazards. There 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.

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(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 LH2 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.

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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.

Safe to start ET LH2 preparations for drain.

e. Closeout crew is proceeding to the white room.

f. White Room O_2 atmosphere is acceptable.

g. Flight crew egress has begun.

h. Flight and closeout crews are clear of the BDA.

i. Safe to start ET LH_2 drain.

j. Securing teams may proceed to BDA.

k. 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.

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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 LH2 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

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concurrence of the KSC Launch Director, S&MA Shuttle 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 GH2 venting or gas supply during aft entry. If work is to be performed within four (4) feet of the aft interior side of the LH2 T-0 umbilical, a cover must be installed to protect the exposed PRSD GH2 line, or the PRSD GH2 system shall be safed by isolating/terminating the GH2 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 LH2 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 LH2 TSM access is permitted during active ET LH2 tank venting through the TSM or during LH2 tank inerting. Access between tank vents is permitted but must be coordinated with Safety and ET LH2 engineering.

(2) ECS GN2 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.

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(5) Acceptable O2 levels must be verified prior to entry and O2 and H2 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) LO2 and/or LH2 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.

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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.

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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) Crew Transport Vehicle moved away from Orbiter

(3) Successful completion of upper level assessment.

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.

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(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 5.0j.

(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 5.0j.

(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

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k. A 25-foot radial control area shall be maintained around the T-0 S70-1214/1215 prior to initiating controlled PRSD venting.

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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.

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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.

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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 13.9.9, 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 13.9.3 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, 13.9.3 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 13.9.2 - SABD,"** indicates that the entire document from Preface through 13.9.2 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 13.9.2 - SABD

13.9.3 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.

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(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 PV/S 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) PV/S 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) PV/S 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) PV/S 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.

13.9.4 through Chapter 17 - SABD

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APPENDIX A - DEFINITIONS

A.1 **1% H2:** A measure of hydrogen by volume in air

A.2 **Acceptance:** Formal documentation of accepting an increased level of risk.

A.3 **Accepted Risk**: A hazard whose risk is not controlled (i.e., hazard controls have some limitations) and whose residual risk has been accepted by the appropriate approval authority.

A.4 **Affected Employees**: 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.

A.5 **Alteration:** (PV) 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 shall be considered an alteration. A reduction in minimum temperature such that additional mechanical tests are required shall also be considered an alteration. See ANSI/NB-23, Chapter 1, Glossary of Terms.

A.6 **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.

A.7 **Approval:** Formal documentation of agreement and authority to proceed as documented, as long as the appropriate authority accepts any increase in risk.

A.8 **Authorized Employees**: Those employees who service or maintain equipment and perform lockout/tagout procedures.

A.9 **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.

A.10 **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.

As an example, for the Space Shuttle vehicle with a full load of propellants this area is within a 4485-foot radius centered on the space vehicle including the pad.

A.11 **Breathing Escape Unit (BEU):** Used only for escape from a hazardous environment.

A.12 **Buddy System:** The buddy system requires two people be designated to be concerned with each other's safety in a hazardous situation. 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.

A.13 **Category I SCAPE:** PHE with backpack. Operating time from air on to air off is 120 minutes.

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A.14 **Category IV SCAPE:** Same as Category I with hose-line breathing in lieu of the backpack.

A.15 **Category VI SCAPE:** 'Chemturion' CPS - "blue suit" with hose-line breathing.

A.16 **Caution:** A notation before an operational step, etc., which, if not adhered to or observed, could result in damage to equipment

A.17 **Certification:** (PV) 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.

A.18 **Cleared Area:** An area where a hazardous condition exists or a hazardous operation is in progress; personnel are prohibited from entering.

A.19 **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.

A.20 **Code PV/S:** (PV/S) 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

A.21 **Commercial Off the Shelf (COTS)**: (PV/S) 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.

A.22 **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.

A.23 **Concurrence**: Formal documentation of agreement, but with no authority to approve or accept risk.

A.24 **Consequence (Severity)**: An assessment of the worst-case credible potential result(s) of a risk, without any controls in place. The table below below is an example of consequence classifications definitions.

Consequence Risk Attribute Definitions						
Level		**1**	**2**	**3**	**4**	**5**
Consequence		**Very Low**	**Low**	**Moderate**	**High**	**Very High**
Safety	Personnel Safety	A condition that could cause the need for minor first aid	A condition that may cause short-term, minor injury, impairment, or incapacitation	A condition that may cause long-term, severe injury, impairment, or incapacitation	A condition that may cause permanent severe injury, impairment, or incapacitation	A condition that may cause loss of life
	Facilities/Equipment	A condition that subjects facilities, equipment, or flight hardware to more than normal wear and tear	A condition that may cause minor property damage to facilities, systems, equipment, or flight hardware	A condition that may cause moderate property damage to facilities, systems, equipment, or flight hardware	A condition that may cause major property damage to facilities, systems, equipment, or flight hardware	A condition that may cause destruction of critical facilities on the ground, major systems, or vehicle during ground

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						operations
	Environmental	Negligible environmental Impact; negligible OSHA/EPA violation – non-reportable	Minor environmental Impact ; minor reportable OSHA/EPA violation	Moderate environmental Impact ; moderate OSHA/EPA violation which requires Immediate remediation	Major environmental Impact; major OSHA/EPA violation causing temporary stoppage	Catastrophic environmental Impact; serious or repeat OSHA/EPA violations resulting in termination
Mission Success	Meeting requirements, program/project and institutional services support	Negligible Impact to requirements and program/institutional services goals and objectives	Minor Impact to requirements and program/Institutional services goals and objectives	Moderate Impact to requirements and program/Institutional services goals and objectives	Major Impact to requirements and program/Institutional services goals and objectives	Failure to meet requirements and program/Institutional services goals and objectives Impact
Supportability	Capabilities flexibility for workforce, facilities, infrastructure	Negligible Impact to capability/flexibility of workforce, facilities, or Infrastructure	Minor Impact to capability/flexibility of workforce, facilities, or Infrastructure	Moderate Impact to capability/flexibility of workforce, facilities, or Infrastructure	Major Impact to capability/flexibility of workforce, facilities, or Infrastructure	Failure of workforce, facilities, Infrastructure to meet activity goals or objectives Impact
Cost	Based on allocated yearly budget for project/element/item	≤ 2% (Negligible Impact to budget)	> 2% but ≤ 5% (Minor Impact to budget)	> 5% but ≤ 10% (Moderate Impact to budget)	> 10% but ≤ 15% (Major Impact to budget)	> 15% (Catastrophic program Impact or potential activity cancellation
Schedule	Ability to support activity milestones	Negligible schedule Impact	Minor overall schedule Impact (Accommodate with reserve, no Impact to critical path)	≤ 1 month Impact to critical path/milestones	>1 and ≤ 6 month Impact to critical path/milestones	> 6 month Impact to critical path/milestones or possible program/activity cancellation

A.25 **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.

A.26 **Control Point:** The area or place where the task leader and any other support groups direct and monitor the operation.

A.27 **Controlled (Risk) Hazard:** The likelihood of occurrence or severity of the associated undesirable event has been reduced to an acceptable level through the imposition of appropriate, readily implementable, verifiable controls, resulting in minimal residual risk.

A.28 **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.

A.29 **Credible:** A condition that can occur and is reasonably likely to occur. Failures of structure, pressure vessels, and pressurized lines and fittings are not considered credible failure modes if those elements comply with the applicable requirements.

A.30 **Critical Function**: A function which, if lost or improperly performed, could result in a critical or catastrophic hazard. The loss of or improper operation of any GSE/GS function that results in loss of life, loss of vehicle or damage to a vehicle system (loss of mission).

A.31 **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

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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.

A.32 **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.

A.33 **Critical System:** A system that has at least one critical function.

A.34 **De-Rating:** (PV) The lowering of the maximum allowable working pressure or narrowing of the allowable operating temperature range of a pressure vessel or system.

A.35 **Design Burst Pressure:** (PV) 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.

A.35 **Design Pressure:** (PV) 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 shall 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).

A.36 **Design Temperature:** (PV) 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.

A.37 **Deviation (1):** 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.

A.38 **Deviation (2):** 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 is used for this purpose.

A.39 **DOT Service:** (PV/S) Those uses of PV/S covered by the regulations contained in 49 CFR 100 – 185, Pipeline and Hazardous Materials Safety Administration.

A.40 **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.

A.41 **Eliminated Hazard:** A hazard that has been eliminated by completely removing the hazard causal factors.

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A.42 **Emergency Instructions:** Written 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.

A.43 **Emergency Life Support Apparatus (ELSA):** Used only for escape from a hazardous environment.

A.44 **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.

A.45 **End Item:** A final combination of end products, components, parts or materials that is ready for its intended use.

A.46 **Essential Personnel:** The number of personnel required within the control area to perform a particular operation.

A.47 **Exception:** A variance that authorizes permanent relief from a specific requirement and may be requested at any time during the life cycle of a program/project.

A.48 **Excluded PV/S:** (PV/S) A PV/S 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 PV/S configuration management system. Excluded PV/S are subject to all applicable laws, regulations, safety requirements, NASA requirements, and appropriate NCS and must be maintained in accordance with applicable NCS.

A.49 **Existing PV/S**: (PV/S) PV/S shall be considered to be “Existing PV/S” if installed no later than 6 months from the date of original issue of this document.

A.50 **Explosive Test Equipment:** Electrical circuit test equipment used for testing explosives items, pyrotechnic devices, or circuits connected to those items before or after installation.

A.51 **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.

A.52 **Facility:** A location where equipment/machinery resides (e.g., buildings, labs, shops, processing areas).

A.53 **Factor of Safety (FOS):** (COPV) Ratio of design burst pressure to maximum ground processing pressure.

A.54 **Factor of Safety (FS)**: (PV/S) 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.

A.55 **First Aid:** (Ref. 29CFR 1904.7(b)(5)(ii)) "First Aid" means the following:

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(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.

A.56 **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

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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.

A.57 **Flight Hardware Processing Facilities:** Buildings and areas, to include their respective perimeter fence, where flight hardware is processed.

A.58 **Flight Termination System:** A radio commanded airborne system whose purpose is to detonate explosives installed on the flight vehicle to end the vehicle's flight.

A.59 **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.

A.60 **Fracture Mechanics:** An engineering concept used to predict flaw growth and fracture behavior in materials and structures containing cracks or crack-like flaws.

A.61 **Ground-based PV/S:** (PV/S) All PV/S, including PV/S based on barges, ships, or other transport vehicles, not specifically excluded in this document. Flight weight PV/S 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 PV/S converted to ground use are included.

A.62 **Ground Support Equipment (GSE):** Ground-based equipment used to store, transport, handle, test, checkout, service, and control aircraft, launch vehicles, spacecraft, or payloads.

A.63 **Ground System (GS):** Ground-based systems used to transport, handle, test, checkout, service, and control aircraft, launch vehicles, spacecraft, or payloads

A.64 **Hazard:** Existing or potential condition that can result in or contribute to a mishap.

A.65 **Hazard Analysis:** Identification and evaluation of existing and potential hazards, and the recommended mitigation for the hazard sources found.

A.66 **Hazardous Fluids:** (PV) 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
d. Liquefied Petroleum Gases (Propane, Butane, as defined in NFPA 58)
e. Liquid Air
f. Liquid Hydrogen
g. Liquid Nitrogen

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h. Liquid Oxygen
i. Monomethylhydrazine
j. Nitrogen textroxide
k. Trichloroethylene

A.67 **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.

A.68 **Hazardous Operation (Hazardous Tasks):** Any operation involving materials or equipment that has a high potential to result in loss of life, serious injury to personnel, or damage to systems, equipment or facilities.

A.69 **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.

A.70 **Hazardproof:** Prevention of an explosive atmosphere penetrating electrical fixtures where sparking or arcing could occur.

A.71 **Hydrostatic Test:** (PV) 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.)

A.72 **Hydraulics:** (PV/S) 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.

A.73 **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.

A.74 **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.

A.75 **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

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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.

A.76 **Impact Limit Line:** A line defining a limit beyond which a missile/spacecraft or specified portions thereof will not be allowed to impact.

A.77 **Inactive Vessels/Systems:** (PV) 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.

A.78 **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.)

A.79 **Inservice Inspection (ISI):** (PV) A periodic inspection of a vessel or system while in service. If required, the vessel or system will be inoperative during the inspection.

A.80 **Inservice Inspection (ISI) Plan:** (PV) The plan is a list of inspections and tests and the frequency to be performed on the pressure vessels and/or pressurized systems.

A.81 **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.

A.82 **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.

A.83 **Job Cards:** A Category I TOP designed for computer release through work control.

A.84 **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.

A.85 **Lethal Fluids:** (PV) 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

A.86 **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.

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A.87 **Likelihood (Probability):** 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. Likelihood (probability) takes into account that the hazard controls are in-place and effective. The table below is an example of probability classification definitions.

Likelihood (probability) Classification Definitions		
Level	**Likelihood**	**Definition**
Level 1 (Very Low)	Highly unlikely	Existing controls are strong and very likely to prevent this risk scenario.
Level 2 (Low)	Unlikely	Existing controls have minor limitations and/or uncertainties and usually are sufficient to prevent this risk scenario; some additional actions may be required.
Level 3 (Moderate)	Could happen	Existing controls have some limitations and/or uncertainties and may prevent this risk scenario; additional actions may be required.
Level 4 (High)	Likely	Existing controls have significant limitations and/or uncertainties and cannot prevent this risk scenario; additional actions will be required.
Level 5 (Very High)	Highly likely	Existing controls have little or no effect and cannot prevent this risk scenario; no alternative controls are available.

A.88 **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.

A.89 **Lock:** Lockout/tagout device that physically prevents the use of equipment or machinery.

A.90 **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.

A.91 **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.

A.92 **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.

A.93 **Manloading:** The maximum number of personnel permitted to occupy a defined area at a single time.

A.94 **Maximum Allowable Stress Value:** (PV) The maximum unit stress permissible for any specified material that may be used in the design formulas.

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A.95 **Maximum Allowable Working Pressure (MAWP):** (PV) 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.

A.96 **Maximum Operating Pressure (MOP):** (PV) 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.

A.97 **Maximum Work Time Deviation:** An authorized exceedance of the MWT provisions that is documented and approved prior to the exceedance.

A.98 **Maximum Work Time Violation:** Exceedance of MWT limits without preapproval.

A.99 **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.

A.100 **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.

A.101 **National Consensus Standard:** (PV) 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.)

A.102 **Non-Code PV/S**: (PV/S) 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 PV/S that were fabricated from non-Code materials by non-Code processes or organizations.

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A.103 **Non-Safety-Related Discrepancy:** (PV) 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.

A.103 **Nondestructive Examination**: (PV/S) 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.

A.104 **Open Grain:** Exposed solid propellant.

A.105 **Operating or Working Temperature:** (PV) The metal temperature that will be maintained in the part of the vessel or system under consideration during normal operation.

A.106 **Operating Pressure:** (PV) The gage pressure at which a vessel (top of the vessel) or system normally operates. For a vessel, it shall not exceed MAWP/design pressure, and for a system, it may not exceed the design pressure.

A.107 **Operations Planning Sheets:** A form used for repetitive TOPs, which is released for documentation and control of a single performance of a TOP.

A.108 **Other Employees:** Those employees who may have reason to enter or work in the area where lockout/tagout procedures may be implemented

A.109 **Owner**: (PV/S) The management of the organization responsible for the PV/S as defined in NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems.

A.110 **Personal Protective Equipment**: Portable equipment that provides a barrier between an individual employee and hazardous materials or agents in the workplace.

A.111 **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.

A.112 **Phase 2 Lightning Warning:** Lightning observed or thunder heard within 5 nautical miles, or forecaster determines the threat of lightning is immediate.

A.113 **Photographic Equipment:** Cameras, still and video, and electronic and/or enclosed flash assemblies.

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A.114 **Physical Agent:** Any environmental factor, such as noise, temperature extremes, vibrations, etc., which may cause harm or injury to personnel

A.115 **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.

A.116 **Pneumatic Test:** (PV) 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.)

A.117 **Pressure Cycle:** (PV) 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.

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.

A.118 **Pressure Relief Device (PRD)**: (PV/S) 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.]

A.119 **Pressure Relief Device Set Pressure:** (PV/S) 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.)

A.120 **Pressure System:** (PV) 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.

A.121 **Pressure Systems Manager (PSM):** (PV) The individual designated by the KSC Center Director who is responsible for the overall management of the KSC Pressure Vessel/Systems (PV/S) Certification Program. The KSC PSM resides in the Institutional S&MA Division.

A.122 **Pressure Test:** See Hydrostatic Test and Pneumatic Test.

A.123 **Pressure Vessel:** (PV) 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.

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A.124 **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.

A.125 **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.

A.126 **Processing Mishap/Close Call:** A mishap or close call, which occurs during the act of ground processing of flight hardware.

A.127 **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.

A.128 **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.

A.129 **PV/S Representative:** (PV) The individual(s) assigned to represent an organization in all matters relating to PV/S and shall be identified to the PSM.

A.130 **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.

A.131 **Radio Frequency (RF) Silence:** A period of time where RF transmitters/emitters, either fixed-in-place or transient, shall not emit RF energy in a specified area. It is acceptable for approved RF transmitter/emitter to be located outside of this zone and emit RF energy.

A.132 **Rated Load:** The static weight the basic equipment can safely support or lift.

A.133 **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.

A.134 **Recall System:** (PV) 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.

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A.135 **Recertification:** (PV) 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.

A.136 **Recertification Interval:** (PV) 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 me 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.

A.137 **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.

A.138 **Repair:** (PV) 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.

A.139 **Rerated Vessel or System:** (PV) (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.

A.140 **Residual Risk**: Risk that remains from a hazard after all mitigation and controls have been applied.

A.141 **Revision:** A modification of information contained in an approved existing TOP.

A.142 **Risk:** A future event characterized by the combination of the probability (qualitative or quantitative) that an activity will experience an undesired event (e.g., safety mishap, cost overrun, schedule slippage, inability to achieve goal or objective) and the consequence, impact, or severity of the undesired event, were it to occur. All risks must be actionable.

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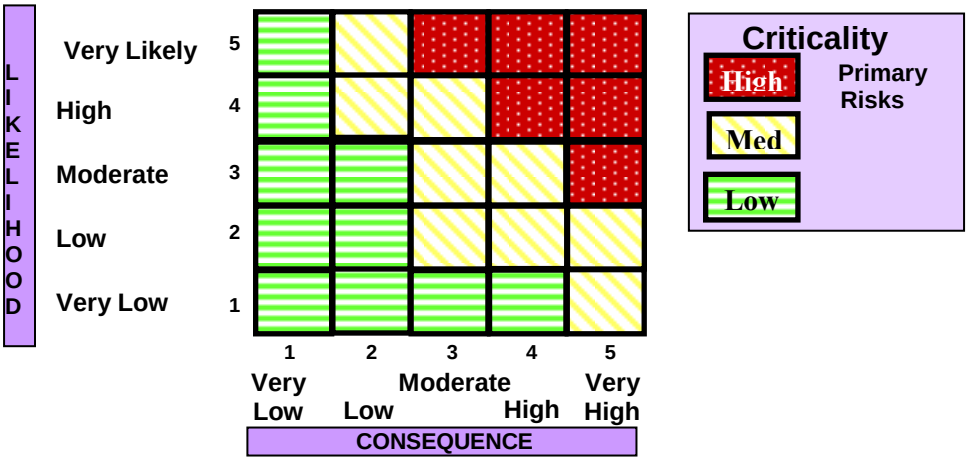
A.143 **Risk (Safety) Assessment:** Process of qualitative risk categorization or quantitative risk (safety) estimation, followed by the evaluation of risk significance. The standardized KSC 5 x 5 risk matrix is shown below.

NOTE: Program-accepted 5 x 5 risk matrices whose definitions of likelihood (probability) and consequences (severity) differ from the example KSC definitions contained herein may be used, if the program definitions of likelihood and consequence categories are provided within their risk assessment.

Standardized KSC 5 X 5 Risk Matrix



A.144 **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.

A.145 **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.

A.146 **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 shall be 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.

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A.147 **Safety Critical:** Any condition, event, operation, process, equipment, or system that could cause or lead to severe injury, major damage, or mission failure if performed or built improperly, or if allowed to remain uncorrected, results in loss of life.

A.148 **Safety Factor:** The ratio of a load that predicts a failure to a rated load.

A.149 **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 shall be responsible for determination of equally qualified personnel. Safety Specialists, Representatives, and Inspectors shall have competence to recognize Safety and/or health hazards in the workplace.

A.150 **Safety-Related Hardware Discrepancy:** (PV) 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.

A.151 **Safety-Relief Device Set Pressure:** (PV) 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.)

A.152 **Safety or Safety Representative:** The term Safety is used without context to contractor or NASA personnel. When the phrase "NASA S&MA" is used, it shall be construed to mean a Government Safety representative only.

A.153 **Shall:** A mandatory S&MA requirement. Noncompliance with a "shall" statement requires approval of a variance.

A.154 **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.

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A.155 **Software:** Computer programs developed to operate, control, service, or check out flight (including payload systems/subsystems) and/or ground support systems/ equipment hardware.

A.156 **Splash (KSC Vapor Suit):** Two-piece garment consisting of a hooded pullover blouse and trousers with boots and lightweight, long gauntlet gloves.

A.157 **Sub-task TOP:** A procedure used to perform work when called up by another TOP (usually an integrated TOP).

A.158 **Sub-task-only TOP:** A procedure preplanned to be performed only as a subtask to a controlling procedure and may contain limited Safety controls.

A.159 **System Certification Pressure:** (PV) 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.

A.160 **System Safety:** Application of engineering and management principles, criteria, and techniques to optimize risks within the constraints of operational effectiveness, time, and cost throughout all phases of the system life cycle.

A.161 **Tag:** Lockout/tagout device that alerts workers regarding equipment/machinery status.

A.162 **Tagout Device**: KSC Form 20-195, Lockout/Tagout Tag.

A.163 **Task Leader:** A person who has been trained and certified/stand boarded by his organization for a particular task.

A.164 **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 shall not be used to change or replace Category I procedures.

A.165 **Temporary equipment (PV/S)** (PV/S) 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 (PV/S). 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.

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A.166 **Test Article PV/S**: (PVS) A PV/S object(s) being tested for the sole purpose of obtaining data (other than integrity data) on the object(s).

A.167 **Test Specific PV/S**: (PV/S) PV/S 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.

A.168 **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.

A.169 **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.

A.170 **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.

A.171 **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.

A.172 **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.

A.173 **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.

A.174 **Unprotected Heights**: Personnel exposure to within 6-feet of an unprotected-leading edge from which there is a drop of more than 4-feet.

A.175 **Unsafe Vessels or Systems:** (PV) These are vessels or systems, which have been determined to be unsafe for service.

A.176 **Vacuum System:** (PV) 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.

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A.177 **Vacuum Vessel:** (PV) A vessel in which the internal pressure has been reduced to a level less than that of the surrounding atmosphere.

A.178 **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.

A.179 **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.

A.180 **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.

A.181 **Warning:** A notation which if not adhered to or observed could result in loss of life, personal injury, or exposure.

A.182 **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.

A.183 **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.

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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
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/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
CPS	Chemical Protection Suit
CT	Crawler Transporter
DBP	Design Burst Pressure
DC	Direct Current
DCR	Document Change Recommendation
DMES	Dimethylethoxsilane
DO	Duty Officer
DOD	Department of Defense

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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
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
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
GUCP	Ground Umbilical Carrier Plate

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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
IT	Intertank
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
LOMS	Left OMS
LO_2	Liquid Oxygen
LOX	Liquid Oxygen
LP	Liquefied Propane

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LSC	Linear Shape Charge
LSP	Launch Support Program
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
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

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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
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
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
PV/S	Pressure Vessel/Systems
PVT	Pressure Volume Temperature

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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
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/N	Serial Number
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

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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
TSM	Tail Service Mast
TTL	Task Team Leader
TVC	Toxic Vapor Check
UFGS	Unified Facilities Guide Specifications
UHF	Ultra High Frequency
UL	Underwriters Laboratories
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

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