MPR 8710.1
REVISION B-1
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MARSHALL PROCEDURAL REQUIREMENTS

QD01

MSFC REQUIREMENTS FOR GROUND-BASED PRESSURE VESSELS AND PRESSURIZED SYSTEMS (PVS)

With Change 1 (10/7/19)

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DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Change/ Revalidation/ Canceled)	Document Revision/ Change	Effective Date	Description
Revision	A	10/3/2014	Complete document rewrite. Updated MWI 8710.1 to an MPR. Changed title from "Inspection and Certification Process For Pressure Vessels And Systems (PVS)" to "MSFC Requirements For Ground-Based Pressure Vessels And Pressurized Systems (PVS)." Internal certification team requirements are moved to an Organizational Issuance. Forms are included by reference only. The Procurement Certification Requirements Documentation Matrix is moved to DRD-STD/SA-PVDD. Added new chapter to address configuration management and preventive maintenance requirements for pressure system Owners.
Change	1	4/24/2017	On 4/24/17, at the request of the OPRD, removed references to obsolete MAF Form 4311, "MAF Pressure Vessel or System Certification." Clarified definition of Facility Distribution Category by revising paragraph 2.6.1.c. Clarified definition of Test Systems Category by revising paragraph 2.6.2.b. Clarified definition of Process and Laboratory Equipment by revising paragraph 2.6.4. Clarified Pressure Systems Reporting Tool contents by deleting paragraphs 2.8.i and 2.8.j. Added SharePoint as an electronic storage point for information and documentation by clarifying paragraphs 2.8.2 and adding 2.8.2.a and 2.8.2.b. Revised paragraph 2.9.3.d to show SharePoint instead of PSRT as storage point for Memorandums of Understanding. Changed paragraph 2.10.2.c to show SharePoint instead of PSRT as the electronic location where technical information shall be archived. Revised paragraph 3.3 to add the title of the SMA Pressure Systems OI, QD-PS-001, "Pressure Systems Inspection and Certification Process." Revised title of Table 6.2 to include "Owner" to clarify that these inspection guidelines are exclusively for the Owner. Added the definition of "Laboratory Space" to Appendix A Definitions. Added the definition of "Technical Space" to Appendix A Definitions. Revised Appendix D Records to replace PSRT with SharePoint as the location of electronic records after 2015.
Revision	B	9/24/2019	General revision to clarify requirements and improve alignment with NASA-STD-8719.17. Numerous editorial and formatting changes made throughout document. Add reference to SAE ARP 1658B in P.4. Add note for Special Test Equipment definition in 2.6.2. Add definition of Lab Pressure System in 2.6.5. Remove repeated references to "Documentum" as noted in 2.8.2. Updated steps for Certification Process in 3.1. Add statement that RVs and vessels are never excluded from certification in 4.1. Update Table 4.1 by rewording criteria in column 2 for clarification and revising column 2 heading. Revise title for Manager, SMA in Table 4.2. Revise paragraph in 5.6.1 regarding ASME certified RV with allowance for no ASME stamp for RVs operating above 6000 psig when not commercially available. Revise and reformat information on use of tubing/piping flow resistance to size RV in 5.6.2. Reworded paragraph related to PSM authority to extend RV service intervals in 5.6.4. Rewrite section 5.7 on Flexible Hose Requirements to better define requirements and applicable hose types including the addition of Table 5.1. Remove the words "by welding or brazing" in Paragraph 5.7.3.e. Add requirement to tag Type 1 hoses that are permanently installed and not retested in Section 5.7.4. Add requirement for 6" vessel clearance in 5.8.1. Add requirement

			regarding no procurement of DOT portable vessels in 5.8.4. Reworded Section 5.8.5 to better clarify that air compressors are the primary focus for requirements including the addition of the note related to "homeowner" air compressors which are not ASME code stamped. Add paragraph related to pressure gauge dial indication for pressure systems (as opposed to vessels) in 5.9.1. Delete requirement for labeling of non-calibrated equipment to better align MPR 8730.5. Revised paragraph to clarify that Industrial Safety Branch is separate from the EEOH office. Change title to Chapter 6 to include the words "PVS Owner Responsibilities For". Add note for OSHA PSM program in 6.2. Deleted requirement for Owners to record findings in 6.3.6. Deleted paragraph for PM Inspection Findings in 6.3.6. Made changes to information related to equipment and added row for Lab Pressure Supply Systems requirements in Table 6.1. Add last retest date to Flex Hose section in Table 6.1. Add parenthetical note related to relief valves for COTS equipment in Table 6.1. Reworded Note 8 for Table 6.1. Revised definitions for Air Receivers, Documentum and Mobile Pressure Vessels in Appendix A. Added "road gear" to definition for Portable PVS and added SharePoint definition in Appendix A. Corrected acronym definition for TPS in Appendix B. Reworded numerous paragraphs in Appendix F to better clarify the focus on "air compressors" and applicable requirements. Replaced numerous occurrences of "are to be" with "shall be" in Appendix F. Revised wording of Appendix G to make it consistent with DRD Revision A language.
Change	1	10/7/2019	On 10/7/19, at the request of the OPRD, administrative change is being made to correct the third to the last and last sentences in the Document History Log description for Revision B above: Air Receiver Requirements moved from Appendix F to Chapter 5.8.5. New Appendix F is DRD Example and is now consistent with DRD Revision A language. Corrected the title of STD/SA-PVDD at P.4 o.

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PREFACE

P.1 PURPOSE

This MPR establishes minimum requirements for the management, maintenance, and certification of MSFC owned Pressure Vessels and Systems (PVS) in accordance with the requirements of NPD 8710.5, and NASA-STD-8719.17.

P.2 APPLICABILITY

a. This MPR applies to Center personnel, programs, projects, and activities, including contractors and resident agencies to the extent specified in their respective contracts or agreements. ("Contractors," for purposes of this paragraph, include contractors, grantees, Cooperative Agreement recipients, Space Act Agreement partners, or other agreement parties.)

b. This MPR applies to Michoud Assembly Facility.

c. This MPR applies the following: all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms: "may" or "can" denote discretionary privilege or permission; "should" denotes a good practice and is recommended, but not required; "will" denotes expected outcome; and "are/is" denotes descriptive material.

d. This MPR applies the following: all document citations in this MPR are assumed to be the latest version unless otherwise noted.

e. This MPR applies to ground-based PVS, code and non-code pressure vessels (including vacuum vessels and boilers) that are MSFC-owned or -operated, temporary or permanent, and non-MSFC-owned contractor or tenant-operated PVS on MSFC property if those PVS are determined to pose a risk to MSFC personnel, facilities, or equipment.

f. This MPR is applicable to pressure systems physically located at MSFC and those located at remote locations owned and/or managed by MSFC (e.g. the KSC Booster Fabrication Facility (BFF) and Hanger AF).

g. This MPR is not intended to identify all pressure system hazards or define the safety and training requirements for performing pressure system operation or maintenance.

h. NPD 8710.5 and NASA-STD-8719.17 are implied where the term "Agency requirements" is used throughout this MPR unless otherwise noted.

i. NASA-STD-8719.17 shall take precedence where conflict exists between requirements in this MPR and the NASA standard.

P.3 AUTHORITY

NPD 8710.5, Policy for Pressure Vessels and Pressurized Systems

P.4 APPLICABLE DOCUMENTS AND FORMS

a. OSHA General Industry Regulations, 29 CFR 1910

b. OSHA Basic Program Elements for Federal Employees, 29 CFR 1960

c. OSHA Compressed Gas and Compressed Air Equipment, 29 CFR pt.169

d. Hazardous Materials Transportation, 49 CFR 100 pt.185

e. Occupational Safety and Health, 29 U.S.C. § 652 (9) Title 29. Labor; Chapter 15

f. NRRS 1441.1, NASA Records Retention Schedules (NRRS)

g. MPR 1440.2, MSFC Records Management Program

h. MPR 8715.1, Marshall Safety, Health, and Environmental (SHE) Program

i. MPR 8730.5, Control of Inspection, Measuring, and Test Equipment

j. MWI 8715.15, Ground Operations Safety Assessment Program

k. MWI 8715.17, Hazardous Operations Readiness Review Program

l. NASA-STD-6001, Flammability, Off-gassing, and Compatibility Requirements and Test Procedures

m. NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS)

n. DOD Material Inspection and Receiving Report, DD Form 250

o. STD/SA-PVDD, ASME Section VIII Pressure Vessel Data and Documentation

p. MSFC Form 4311, Pressure Vessel or System Certification

q. MSFC Form 4527, MSFC/MAF Safety Variance Request (SVR) Ground-Based Pressure Vessels and Systems

Note: The following documents are national consensus standards (NCS)

r. ANSI/AIAA G-095-2017, Guide to Safety of Hydrogen and Hydrogen Systems

s. ANSI/NB-23, National Board of Boiler and Pressure Vessel Inspectors, National Board Inspection Code (NBIC)

t. ASME A13.1, Scheme for the Identification of Piping Systems

u. ASME B31.1, Power Piping

v. ASME B31.3, Process Piping

w. ASME B40.100, Pressure Gauges and Gauge Attachments

x. ASME Section I, Boiler and Pressure Vessel Code (BPVC), Rules for Construction of Power Boilers

y. ASME Section IV, BPVC, Heating Boilers

z. ASME Section VIII, Division 1 – Rules for Construction of Pressure Vessels
Division 2 – Alternate Rules for Construction of Pressure Vessels

aa. ASTM-MNL-36, Safe Use of Oxygen and Oxygen Systems: Handbook for Design, Operation, and Maintenance

bb. National Board Inspection Code (NBIC), Part 2, Inspection

cc. API 570, Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems

dd. API 576, Inspection of Pressure Relieving Devices

ee. UL 404, Standard for Safety Gauges, Indicating Pressure, for Compressed Gas Service

ff. CGA G5.5, Hydrogen Vent Systems

gg. CGA P-1, Safe Handling of Compressed Gases

hh. SAE ARP 1658B, Hose Assemblies, Installed, Visual Inspection Guide For

ii. ET01-PRO-OWI-024, Process Safety Management (PSM) Program for Liquid Hydrogen and Liquid Methane

P.5 Measurement/Verification

N/A

P.6 Cancellation

MWI 8710.1 Revision A-1, Inspection and Certification Process for Pressure Vessels and Systems (PVS), October 3, 2014

Electronically approved by

Jody Singer
Director

CHAPTER 1

RESPONSIBILITIES

Specific and detailed responsibilities of the Center Director, the Pressure System Manager (PSM), the PVS Owner (or Management of the Organization responsible for the PVS), the Contracting Officer, Center or Component Facility Safety Directors, the Office of Procurement, and the Safety and Mission Assurance (SMA) Directorate are provided in NPD 8710.5. Responsibilities that are unique to MSFC owned or managed pressure systems are addressed below.

1.1 The PSM

The PSM has overall responsibility for ensuring that MSFC owned pressure systems are managed, maintained and certified in a manner to ensure safe and reliable operations in accordance with Agency requirements and applicable national consensus standards (NCS). The PSM performs the following functions:

a. Serves as the MSFC Technical Authority on NCS that apply to ground-based PVS.

b. Interprets or clarifies this MPR, PVS NCS, or applicable Agency standards to provide technical guidance or resolve conflicts which may exist for ground-based PVS.

c. Provides oversight of PVS certification programs for MSFC owned PVS at MSFC, Kennedy Space Center (KSC) and Michoud Assembly Facility (MAF), and any MSFC PVS transported to or on loan to another site, to ensure that MSFC PVS are managed, maintained, and certified in accordance with applicable Agency requirements.

d. Inspects, evaluates and certifies PVS for service by approving the MSFC Certification Certificate MSFC Form 4311.

e. Ensures that there is a process established and implemented to document, classify and track PVS deficiencies which prevent compliance with applicable MSFC and Agency standards.

f. Evaluates and reviews Owner Configuration Management and Preventive Maintenance (CM/PM) Plans.

g. Evaluate designs of PVS that are excluded from certification where necessary to ensure compliance with applicable NCS.

h. Ensures a process is established that provides scheduling and implementation of PVS certification, recertification and in-service inspection activities.

i. Ensures a process is established for documenting and maintaining certification reports, PVS data and approved Safety Variances.

j. Serves as the Chair of the Pressure Systems Committee.

k. Serves as the Office of Primary Responsibility Designee for this MPR.

l. Approves any tailoring or customizing of the Data Requirements Description DRD STD/SA-PVDD that may be needed for a specific pressure vessel procurement.

1.2 <u>The Owner or Management of the Organization responsible for the PVS</u>

a. Have overall responsibility for pressure system safety, maintenance, upkeep, configuration control, compliance with Agency requirements, and securing funding necessary to meet these responsibilities.

b. Retain overall responsibility for the pressure system even in cases where the Owner is not the pressure system user (operator) and in cases where the Owner procures maintenance, repair or configuration management services from another MSFC organization or third party.

c. Ensure all PVS are certified prior to operation and the certification status is maintained by operating PVS within the certification parameters.

d. Promptly report any PVS anomalies or incidents to the PSM.

e. Ensure only trained, certified and qualified personnel are allowed to operate PVS.

f. Provides personnel protective equipment (PPE) appropriate for the pressure system hazards involved.

g. Submit designs, design analysis, or procurement specifications for new PVS or modifications to existing PVS for review and evaluation by the PSM, or designee, in accordance with this MPR. This requirement may be fulfilled by PSM involvement in the design or procurement review process.

h. Include STD/SA-PVDD in the procurement specifications for new pressure vessels and modifications or repair of existing pressure vessels per the requirements of this MPR.

i. Obtain concurrence from the PSM for any proposed tailoring or customization of STD/SA-PVDD (see Appendix F).

j. Establish, implement and obtain PSM approval for a CM/PM Plan that meets the requirements of this MPR.

k. Ensure that the CM/PM Plan is periodically reviewed and updated to properly address any changes in PVS owned by the organization or changes in center PVS requirements.

l. Concur with PVS certification deficiencies by signing the certification certificate (MSFC Form 4311) included with the Interim Certification Report.

m. Promptly correct all certification deficiencies and/or non-compliances or initiate a Safety Variance to obtain approval for continued operation of PVS with known deficiencies or non-compliances.

n. Correct open deficiencies or non-compliances within the time constraints defined within the approved Safety Variance Request.

o. Compile and retain engineering information and data as defined in Chapter 6 of this MPR.

p. Collaborate with the PSM to identify and establish pressure system categories and functional interfaces (i.e., special test equipment (STE) and test article interfaces).

q. Use the procurement process to notify SMA of proposed PVS procurements (excluding commercial off the shelf (COTS) items) to ensure NCS quality assurance requirements are identified in the procurement documentation.

r. Ensure that the organization is sufficiently represented at the Pressure System Committee by assigning a point of contact (POC) and alternate POC to represent the organization.

s. Provide concurrence/approval for organizational SMEs to support the Pressure System Committee as standing members when requested by the PSM.

1.3 The Office of Center Operations

The MSFC Office of Center Operations has additional responsibilities as shown below which are in addition to the “Owner/Management” responsibilities cited above.

a. Ensure that MSFC and MAF steam generation, condensate return, and fire protection systems, facilities and associated equipment are operated and maintained in accordance with the applicable NCS.

b. Ensure that fired boiler and heating boiler systems are designed and constructed to ASME Section I and Section IV, respectively, and are inspected in accordance with State and local boiler and pressure vessel statutes.

c. Maintain copies of the National Board of Boiler Inspectors (NBBI) and State inspection documentation and certificates.

d. Is the Owner of PVS during construction or installation for Construction of Facilities (CoF) projects until formal transfer of a certifiable facility or system to the new Owner is completed. The CM/PM requirements of this MPR become mandatory at facility/system turn-over.

1.4 The Safety and Mission Assurance (SMA) Directorate

a. Recommend individuals to serve as PSM and, if appropriate, an Alternate PSM to perform the duties delineated in NPD 8710.5 and NASA-STD-8719.17.

b. Provide oversight of MSFC PVS certification process to ensure that PVS are evaluated and certified in accordance with NPD 8710.5, NASA-STD-8719.17 and this MPR.

c. Ensure that requirements to maintain all certification documentation, associated data packages, pressure system databases, and the Pressure System Reporting Tool are delineated in any contract involving PVS certification.

d. Industrial Safety shall monitor PVS construction activities to ensure contractor owned PVS is in compliance with applicable Occupational Safety and Health Administration (OSHA), Agency requirements and this MPR (also reference MPR 8715.1 Marshall Safety, Health, and Environmental (SHE) Program).

e. Industrial Safety shall inspect fire protection systems and fire extinguishers to ensure they are installed and maintained in accordance with OSHA, the applicable NCS and Agency safety requirements.

1.5 Pressure System Certification Team (PSCT)

a. Team members provide direct support to the PSM for pressure system certification activities and support pressure system program initiatives under technical direction of the PSM.

b. Identify and perform inspections and analyses to verify that MSFC PVS are designed, installed, managed, and maintained in compliance with applicable NCS and Agency standards.

c. Make recommendations to the PSM on the certification status for MSFC PVS.

d. Document the results of PVS certification inspections, assessments and analysis in Interim Certification Reports, Certification Reports, In-Service Inspection Reports, Safety Variances and related program documents to communicate PVS deficiencies, non-compliances and certification status to the PSM and PVS Owners.

e. Work directly with the PSM and PVS Owners as required to develop strategies for certification or disposition of pressure system non-compliances and deficiencies.

CHAPTER 2

PVS CERTIFICATION PROGRAM ADMINISTRATION

2.1 Certification Synopsis

2.1.1 Pressure system certification is a verification activity that determines pressure system structural integrity by ensuring that PVS are designed, installed, managed, and maintained in compliance with Agency requirements and applicable NCS (i.e., code compliance). The overall objective of this work is to ensure the safety and reliability of PVS throughout its lifecycle.

2.1.2 Code compliance is verified by the PSCT through review of drawings and engineering documentation, in-service inspection, application of nondestructive test and examination (NDT/NDE) techniques, and engineering analysis. The end product is an estimate of overall PVS operational risk, the remaining PVS service life and the required inspection intervals which are documented in the Certification Report.

2.1.3 The Certification Report establishes PVS certification status and identifies any constraints or limitations associated with operation of the certified PVS. Implementation of the Owner's PVS CM/PM Plan helps ensure PVS certification status is maintained until in-service inspection or recertification is required.

2.1.4 Safety Variances are used to justify continued operation of PVS when the PVS does not conform to Agency or MSFC requirements and operational risk is demonstrated to be acceptable.

2.2 Certification and Inspection Intervals

2.2.1 General certification intervals are established for all MSFC PVS based on damage mechanisms present (e.g., fatigue, corrosion) and hazard conditions (e.g., flammable, high pressure). The certification intervals are documented and maintained in the Pressure System Reporting Tool (PSRT) for general guidance only and may be changed by the PSM as circumstances dictate.

2.2.2 The PSM may change the certification interval, either extending or reducing the intervals, when circumstances indicate a need for change and adequate engineering rationale is documented in the Certification Report or other associated certification documentation. Circumstances for changing the certification intervals would include, but not be limited to, a change in overall hazardous conditions or operations, evidence of gross neglect for PVS maintenance, or service induced deterioration/degradation of PVS.

2.2.3 The in-service inspection is a certification maintenance activity to ensure that certification status or PVS conditions and hazard levels have not substantially changed, either through service induced degradation or configuration changes, since the last certification inspection. The in-service inspection will typically be performed midway through the certification interval as PSCT

priorities and resources allow. The in-service inspection is not as rigorous and detailed as the inspection performed for PVS recertification.

2.3 Certification Documentation

Various certification documents are used to describe the PVS, identify the overall inspection and certification approach, document and communicate pressure system findings and establish PVS risk and certification status. Certification documents include the information shown below and shall be approved (signed) by the PSM before release to PVS Owners or into the configuration management system for archiving.

a. Interim Certification Report: An Interim Certification Report will typically be issued when deficiencies or non-compliances are identified during the certification inspection and analysis process which prevent certification of the PVS. This report shall contain all the information required for the Certification/Recertification Report (addressed below) and identify open deficiencies which require elimination or mitigation prior to PVS certification. This report forms the basis for the final Certification Report once the Owner properly mitigates or eliminates hazards associated with the deficiencies.

b. Certification/Recertification Report: The Certification or Recertification Report provides the rationale for declaring that PVS can be certified and identifies any PVS operational limitations or special constraints. These reports shall include the results of the PVS integrity assessment, potential damage mechanisms, deficiencies (if any), initial service life, remaining service life, risk assessment and recertification due date. These reports may also include Safety Variances which were approved for mitigation of PVS deficiencies identified during the certification process.

c. In-Service Inspection Report: The in-service inspection is intended to keep the PSM and the PVS Owner informed of any significant PVS deficiencies or non-compliances *between* certification intervals that impact the certification status. The In-Service Inspection Report shall document any PVS findings and observations and is then provided to the PVS Owner by means of a signed memorandum.

d. Safety Variance Request (SVR): A Safety Variance Request shall be prepared by the PVS Owner to authorize PVS operation in cases where the PVS is not, or cannot be verified to be, in full compliance with the applicable NCS or Agency requirements (Refer to Chapter 4).

e. Signed Memorandum: The PSM may use signed memorandum, in lieu of a formal report, to communicate concurrence for use of PVS when formal certification documentation is not required or warranted. Examples would include, but not be limited to, In-Service Inspection Report, PSM concurrence on operation or design of excluded systems, acceptance of an assessed hazard exclusion, concurrence for minor modification to a certified system or to a change in the standard operation of specific PVS.

2.4 Pressure System Operational and Certification Status

2.4.1 PVS that are pressurized, in use, or regarded as operationally ready for use are considered to be “in-service” or “active.”

2.4.2 In-service pressure systems that are authorized for use shall be certified, excluded or covered under an approved Safety Variance.

2.4.3 The PSM shall have the authority to take active systems out-of-service when deficiencies or non-compliances exist that precludes safe operation of the system. In this situation, the PSM authorizes the system to be returned to active service once the owner corrects the deficiencies or properly mitigates all hazards and documents the mitigation plan by means of an approved Safety Variance.

2.4.4 A pressure system may be taken out of service either temporarily or permanently by the owning organization when there is no programmatic need for the system. “Out-of-service” or “inactive” pressure systems fall into one of following three categories:

a. Mothballed: PVS is temporarily out-of-service but is planned for future use. The system is depressurized, sufficiently isolated from pressure sources, and has all hazardous fluid media removed. The system may be maintained under a low pressure air or inert gas purge, operating up to 10% of maximum allowable working pressure (MAWP) but not to exceed 50 psig, to preserve its clean and dry state if the Owner so chooses.

b. Abandoned or Decommissioned: PVS is not intended for future use. The system is depressurized, physically disconnected from all potential pressure sources, and has all hazardous fluid media removed and is not purged.

c. Demolished: Abandoned or decommissioned PVS which is physically and permanently disassembled or removed.

2.4.5 Out of Service PVS shall be isolated from the pressure source(s) by a positive means adequate to ensure the system is not re-pressurized without preplanning and authorization.

2.4.6 Out-of-service pressure systems are not required to be certified or maintained under a CM or PM Plan and may have deficiencies that would otherwise prevent certification.

2.4.7 The system providing purge gas supply to an out-of-service system, if any, shall meet the requirements of this MPR including safety relief protection to prevent the out-of-service system from being over-pressurized.

2.4.8 PVS which will remain out-of-service more than 1 year but not physically removed (demolished) shall comply with the following:

a. The PVS shall have a prominent sign or placard designating the system "Out-of-Service" placed, as a minimum, near the point of system isolation.

b. Baseline drawings shall indicate that the PVS is out of service and clearly indicate the means of system isolation which prevents inadvertent pressurization (e.g., locked valve, physical disconnect).

c. Baseline drawings for PVS which are taken out of service due to known deficiencies shall include notes that clearly indicate the PVS has existing deficiencies which must be corrected before reactivation.

2.4.9 Out-of-service pressure systems shall be certified or placed under a Safety Variance prior to being re-pressurized and returned to active service.

2.4.10 Out-of-service pressure systems shall be placed under a CM/PM Plan in accordance with this MPR when returned to active service.

2.4.11 The PSM shall ensure that the operational and certification status of all items in the MSFC pressure system inventory are maintained in the PSRT and include the certification expiration date and in-service inspection date.

2.4.12 The PVS certification status shall be updated in PSRT when inspections and engineering analysis are completed and the Certification (or Recertification) Report is approved by the PSM.

2.5 Certification Non-Compliances and Deficiencies

PVS non-compliances and deficiencies are considered to be failures to meet Agency or NCS requirements thereby preventing certification.

2.5.1 The Owner shall be responsible for correcting PVS deficiencies and non-compliances in order to obtain or maintain certification status or prepare a Safety Variance Request in accordance with Chapter 4 of this MPR.

2.5.2 Typical PVS deficiencies and non-compliances are listed in PSRT and the associated deficiency codes are defined as follows:

a. Criticality Category 1: Represents an immediate hazard to personnel or property (e.g., under-rated components, inadequate relief valve capacity) and is sometimes referred to as “safety critical.”

b. Criticality Category 2: Represents a potentially hazardous situation to personnel or property.

c. Criticality Category 3: Represents a minimal hazard to personnel or property, but if left uncorrected, may present higher risk over time. Category 3 deficiencies are treated generally as "Observations" and do not prevent PVS certification.

2.6 Pressure System Categories

Pressure systems at MSFC can be categorized as defined below. The pressure system categories will ultimately determine the CM/PM requirements that are applicable to each PVS as later defined in Chapter 6.

2.6.1 Center Infrastructure – Pressure systems designed to transport, convey and distribute pressurized commodities to end use points at MSFC. These pressure systems provide basic utilities, center or facility capability where system outages or failures could have a broad or critical impact to multiple end-users, customers, projects or programs. Configuration changes are infrequent due to the nature and function of these systems. Three types of Center Infrastructure are defined by this MPR as follows:

a. Center Utilities – Pressure systems that provide basic center services for personnel comfort, convenience or protection such as steam, potable water, and fire protection which are owned and maintained by the Center Operations Directorate and have few, if any, user interfaces.

b. Facility Services – Pressure systems that originate at commodity storage areas or generating stations and which transfer or otherwise convey commodities to MSFC facilities. These pressure systems are owned by the organization which manages the Pressurant and Propellant Delivery Services (PPDS) contract at MSFC. Portable equipment and vehicles used to transport commodities to customer use points at MSFC (e.g., tankers, tube trailers, dewars, etc.) also fall into this category. In addition, storage vessels and accumulators (satellite vessels) owned by the PPDS managing organization but which are located at or near a user facility are included in this category.

c. Facility Distribution – The network of pressure systems within a facility or building, downstream of the Facility Services interface, which distribute the gas or liquid commodity to the use points within the facility. The interface between Facility Services and Facility Distribution systems shall be documented on baseline drawings.

2.6.2 Test Specific Pressure Systems – Pressure systems used specifically to support test or research activities and which are designed to meet specific test or research conditions and requirements. The four types of Test Specific Pressure Systems are defined below.

a. Special Test Equipment (STE) – Pressure systems intended specifically for test or research purposes, including both fixed and portable hardware, which are used for a specific test series or research activity and have a limited life cycle. In accordance with NASA-STD-8719.17, systems or equipment designated as STE may not be used repeatedly on different test or research programs. STE may be reclassified as a Test System in cases where the STE is needed on a

more permanent basis than originally intended and would then have to comply with requirements associated with Test Systems.

Note: As used in this MPR, the term Special Test Equipment applies only for pressure system installations and may not be consistent with STE definitions used by other disciplines or in other controlled NASA documents.

b. Test System – Systems, equipment, laboratory and technical spaces intended specifically for test or research purposes, including both fixed and portable hardware, that are not part of the Facility Distribution system and have a configuration that is subject to change depending on test project or research activity objectives. These systems, by definition, will have a life cycle longer than that of STE and may be used repeatedly for different test programs or research projects.

c. Test Articles – The hardware under test, examination or evaluation for the sole purpose of obtaining data related to the test hardware. This category also includes research articles when those articles are comprised solely or in part of pressure retaining components.

d. Ground Support Equipment (GSE) - Non-flight systems or equipment with a physical or functional interface with flight hardware necessary to support the operations of transporting, receiving, handling, assembly, inspection, test, checkout, servicing and launch of space vehicles and payloads at launch, landing, or retrieval sites. A typical application of GSE at MSFC would be servicing carts used to support flight hardware test operations.

2.6.3 Commercial Off-The-Shelf (COTS) Equipment - 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. Pressure systems and components that are installed to interface with COTS systems are not considered COTS.

2.6.4 Process and Laboratory Equipment – Equipment in this category includes fabrication, manufacturing, diagnostic, laboratory, and bench top test equipment which are comprised solely, or in part, of pressurized system or components. Examples include, but are not limited to, pneumatically assisted fabrication equipment and machinery, spray foam equipment, shop air, welding equipment, gas chromatograph, and pressure gauge calibration equipment.

2.6.5 Laboratory Pressure Systems – Systems within a laboratory setting which provide pressurized media using pressure sources other than site-wide facility distribution systems to conduct small-scale test or research. Typical pressure sources would be gas cylinders or cryogenic dewars.

2.7 Pressure Systems Committee

2.7.1 The Pressure Systems Committee is a SHE subcommittee chaired by the PSM to address pressure system related issues and keep the MSFC pressure system community involved in and aware of ongoing pressure system activities. The Pressure System Committee provides a two-way communication conduit between the individual pressure system owning organizations and the PSM.

2.7.2 The PSM establishes the committee meeting frequency and agenda, assigns actions, and ensures that meeting minutes, attendance and agenda are archived in SharePoint.

2.7.3 The Pressure System Committee membership is comprised of the PSM, Alternate PSM, specific members of the Pressure System Certification Team (PSCT), organizational POCs and SMEs.

2.7.4 Each organization that owns or operates pressure systems shall have at least one POC and one Alternate POC assigned by their management. The POC and Alternate are responsible for disseminating pressure system information to affected personnel in their home organization and supporting pressure system program activities.

2.7.5 Subject Matter Experts (SME) shall support and attend the Pressure System Committee meeting as requested by the PSM and provide specific expertise and knowledge required for decision making or to support specific program activities.

2.7.6 A current Pressure System Committee membership listing by name and organization is maintained in SharePoint.

2.8 Pressure Systems Reporting Tool (PSRT)

2.8.1 The PSRT is the primary electronic application for managing the extensive pressure system inventory at MSFC. The PSRT is maintained by SMA and provides a single point of entry for accessing pressure system certification information and engineering data for pressure systems and vessels. The PSRT is located at https://safety.msfc.nasa.gov/apps/psrt/ and either includes or provides electronic links to:

a. Pressure system certification status and certification due dates
b. Historical and current pressure system certification reports
c. Inventory of MSFC pressure systems and vessels and their operational status
d. Pressure system and vessel engineering data
e. Approved Safety Variance Requests
f. Searching and sorting of pressure system assets using flexible search engines
g. Organizational reporting, charts and metrics
h. Pressure system deficiency listing, status and disposition

2.8.2 Certification packages are stored in the MSFC Document Repository (Documentum) and linked to PSRT. Beginning in 2015, SharePoint became the MSFC server used for the storage of PVS information and documentation. SharePoint provides sharing and collaboration of information and documentation among the Pressure System Certification Team, PVS user/owners, and different user groups. In addition to the information provided by PSRT, SharePoint provides links to:

a. Technical reference information to the User/Owner community.
b. Pressure system ownership interface agreements

Note: From this point forward in the MPR, the generic term "PVS document repository" shall be used to refer to the official retention location for PVS records which is subject to change as MSFC sharing, collaboration and document retention electronic environments evolve. The specific location of PVS documentation is identified in the official Records Plan as described in Appendix D.

2.8.3 Certification documentation for pressure systems owned or managed by MSFC at remote locations is not required to be included in the PSRT but shall be maintained in a manner approved by the PSM.

2.9 <u>Establishing Pressure System Ownership Interfaces (OI) (MSFC Center Only)</u>

2.9.1 The physical location in a pressure system where organizational ownership and financial responsibility changes is referred to as the "Ownership Interface" (OI). Pressure system ownership is established by formal agreement and baseline drawings which identify the pressure systems or portions of pressure systems for which Owners have responsibility.

2.9.2 The formalized OI agreement is between the two organizations owning the system on each side of the OI. In most circumstances, the agreement is between the MSFC Center Operations Facilities Management Office (FMO) and another User/Owner organization. In limited cases, the agreement is between two User/Owner organizations which does not include the FMO (multi-user facilities for example).

2.9.3 The OI shall be formally documented in a Memorandum of Understanding (MOU), or similar document format, which establishes the specific location of the OI and identifies Owner building/facilities which will be purchasing configuration management and preventive maintenance services through the FMO.

a. The MOU, and any subsequent revisions, shall be signed and dated by personnel representing the two Owning organization directorates and department/division management as a minimum (i.e., Owning organizations on each side of the interface).

b. The MOU shall be revised and re-approved by the affected organizations whenever there are changes to the pressure system ownership location.

c. Changes which only involve the buildings or facilities which will procure FMO services in a given fiscal year only require signature of the directly affected organizations. These signatures may be placed on an attachment, appendix or addendum to the MOU showing concurrence by the affected organizations.

d. The latest approved version of the MOU shall be maintained in SharePoint.

e. The MOU shall have a unique number assigned, and updated upon revision, for traceability.

f. Organizational responsibility for pressure systems managed by MSFC, but not physically located at MSFC, shall be clearly established but does not have to comply with the MOU process described above and does not have to be maintained in the PSRT.

2.10 PVS Requirement Interpretation and Clarification

2.10.1 The technical nature of this MPR and the many NCS and Agency standards that are referenced herein make it necessary at times to provide interpretation and clarification of technical requirements within this MPR or to address the application of technical requirements to specific or unique applications. In addition, changes to NCS and Agency standards, referenced within this MPR, may need to be disseminated to the pressure system owner community during interim periods between revisions of this MPR.

2.10.2 The PSM shall document and disseminate technical information as described below when the pressure system community is affected, or potentially affected, by technical interpretations, clarifications or changes in technical requirements:

a. The PSM shall formally document the technical information in a signed memorandum which clearly addresses the impact to existing pressure system engineering requirements or practices.

b. The PSM shall electronically route the signed document to all members of the MSFC Pressure System Committee, all MSFC Directors of organizations that own pressure systems, the MSFC SMA Director, and to managers of organizations responsible for pressure systems at remote locations managed by MSFC.

c. The technical information shall be archived in SharePoint for traceability and to allow access by the MSFC pressure system community.

d. The PSM shall ensure that subsequent MPR revisions include the updated technical information, interpretations or requirement changes as applicable at the time of the MPR revision.

CHAPTER 3

PVS CERTIFICATION PROCESS

The PVS certification process is defined in this chapter and, depending on the circumstances, may be initiated by the PVS Owner or the PSM. Typically, the PSM will initiate the certification process for existing PVS with an expiring certification. The PVS Owner will typically initiate the certification process when new PVS are installed, procured or when existing PVS are modified.

3.1 PVS Owner Role in Certification Process

a. The Owner notifies the PSM of the need for certification for new, modified or reactivated PVS in order to allow for planning and scheduling of the certification activities.

b. The Owner convenes a meeting with the PSM, Certification Lead Engineer, and the Hazard Analysis Lead to discuss the plans for or to review existing PVS hardware, system layout, general operation, and the associated hazards. The objective of this meeting is to determine STE and test article interfaces (where applicable), define the Hazards Analysis and certification scope, and schedule the certification inspection. This meeting is not required for projects, such as CoF, which have a formal design review process if the PSM is included in the design review.

c. The Owner is responsible for providing all information, data and system access to the PSCT to assist in the assessment, analysis and certification of the PVS. (See Engineering Data Retention Requirements in Chapter 6)

d. The Owner receives the Interim Report, after certification inspection and analysis have been performed, and signs the attached MSFC Form 4311 acknowledging receipt of the report which includes identified PVS deficiencies. An Interim Report is not required if there are no deficiencies identified.

e. Alternatively, for systems which are already in service, the Owner may receive an In-Service Inspection Report which provides findings from a certification maintenance inspection typically performed mid-way through the PVS certification interval.

f. The Owner prepares a deficiency correction work authorization document, as applicable, to correct any open deficiencies identified in either an Interim Certification Report or in an In-Service Inspection Report.

g. If requested by the PSM, the Owner prepares a Safety Variance in accordance with Chapter 4 if the deficiencies cannot be immediately corrected but can be mitigated to an acceptable risk level.

h. The Owner promptly notifies the responsible Certification Engineer, identified in both the Interim Report and in the deficiency database, of the plan and timeframe for correction of deficiencies identified in the Interim Report..

i. The Owner notifies the responsible Certification Engineer that deficiencies are corrected, or that other means were used to properly mitigate risk, so that the open deficiencies can be closed by the Certification Engineer in the deficiency database.

j. The Owner receives the final Certification Report and signs MSFC Form 4311 signifying closure of deficiencies and agreement to operate the associated PVS within the certification parameters and any operational limitations documented in the report.

k. The Owner receives notification from the PSM that the PVS is certified for service.

l. The Owner ensures that existing, new, modified or reactivated PVS are installed and maintained in compliance with the approved CM/PM plan.

3.2 PSM Role in Certification Process

a. The PSM establishes the PVS certification requirement priority.

b. The PSM requests the Certification Team to perform the in-service inspection, recertification or certification tasks.

c. The PSM approves the STE and Test Article interface(s) as applicable.

d. The PSM approves the Interim Report using MSFC Form 4311.

e. The PSM approves the Certification Report by signing MSFC Form 4311 indicating that the PVS is certified in accordance with applicable Agency standards.

3.3 PSCT Role in the Certification Process

The detailed internal PSCT work activities, methods and approach for PVS certification are not included in this MPR but are defined in SMA Organizational Instruction QD-PS-001, “Pressure Systems Inspection and Certification Process”. The following is a high level overview of the PSCT role in the certification process:

a. The PSCT performs the inspections and analysis required to verify that PVS are compliant with Agency and NCS requirements.

b. The PSCT prepares the certification documentation necessary to document the certification process and report results of the PVS assessments including identification of deficiencies and non-compliances.

c. The PSCT coordinates with the PVS Owner as required to schedule inspection activities, obtain current system data or drawings, communicate findings resulting from PVS assessment and verify that PVS deficiencies are eliminated or properly mitigated.

d. The PSCT ensures that all required signatures are obtained on certification documentation and that the documentation is properly archived upon completion of the certification activities.

CHAPTER 4

CERTIFICATION EXCLUSIONS AND SAFETY VARIANCES

NASA-STD-8719.17 makes allowance for pressure systems to be operated without undergoing certification when risk to personnel and facilities are low and when existing hazard assessment processes are used in lieu of the certification process. This chapter defines the criteria necessary for operation of pressure systems without certification.

4.1 Excluded PVS

4.1.1 Table 4.1 summarizes pressure systems excluded from certification, in accordance with NASA-STD-8719.17, and provides the criteria necessary for exclusion. The PSM has authority to require certification of these systems, on a case by case basis, if all criteria necessary for exclusion is not met or if extenuating circumstances exist that pose elevated risk to personnel or facilities.

4.1.2 Pressure relief devices and pressure vessels are never excluded from certification even when installed in an excluded system. Excluded system inspection will still be performed when required to ensure all applicable criteria for exclusion are met and for examination of relief devices and pressure vessels.

4.1.3 Excluded systems shall remain subject to all applicable OSHA, NCS and Agency safety requirements.

4.1.4 The owner may recommend systems for exclusion which are not specifically listed in Table 4.1 if the systems can be demonstrated to present negligible risk to personnel, facilities, and mission. These systems, if approved by the PSM, would fall into the “Assessed Hazard Exclusion” category identified in NASA-STD-8719.17, and the process would be as follows:

a. The owner shall provide rationale and engineering data necessary to justify the exclusion along with a MWI 8715.15 compliant hazard assessment which evaluates potential risks to personnel, facilities, and mission (program).

b. The PSM shall provide written notification to the Owner upon approval of the Assessed Hazard Exclusion. The PSM may document approval using a Safety Variance Request form if deemed appropriate. (See paragraph 4.3).

c. PVS excluded from certification using an Assessed Hazard Exclusion shall be included in PSRT along with all supporting documentation.

Table 4.1 Summary of PVS Excluded from Certification (reference NASA-STD-8719.17 for complete list of excluded systems and additional details)

General Category of PVS	Criteria to be Met for Exclusion
Water systems operating up to 160 psig	Surge is not a design consideration or is properly mitigated
Water deluge operating up to 250 psig	Negligible personnel hazards in event of failure
Shop air systems and inert gas systems operating up to 150 psig	Line size up to 2 inches *Note: Relief valves and pressure vessels (including Air Receivers) remain subject to certification requirements.*
COTS hydraulic systems	System operated within manufacturers placard limitations
COTS welding equipment	System operated in accordance with manufacturer recommendation
COTS lab equipment	Equipment must be operated at pressures no higher than, and adequately protected from pressures exceeding, the manufacturer's maximum operating pressure. *Note: Pressurization systems connected to COTS lab equipment remain subject to certification requirements.*
COTS Cryogenic Portable Dewars	Dewars operating at 15 psig or less, not modified or altered, operated in accordance with manufacturer's specifications, equipped with appropriate ASME certified relief device set no higher than dewar MAWP, appropriate pressure gauge(s), and appropriately anchored safety lanyards as recommended by manufacturer.
Vacuum vessel/system	Vessel/system capacity not exceeding 100 cubic foot water volume. *Note: Pressurization systems connected to the vacuum vessels/systems remain subject to certification requirements.*
Vacuum piping	Above ground piping up to 6 inch diameter (nominal pipe size) and all underground vacuum piping.
Building heat steam and condensate systems	Operating pressures up to 15 psig

4.2 Safety Variance

4.2.1 A Safety Variance is a request for relief from a specific requirement of this MPR or NASA-STD-8719.17 on a case by case basis. The Safety Variance involves 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 a requirement is not satisfied. The two types of Safety Variances are the Deviation and the Waiver as defined below.

a. A Deviation authorizes a project or program relief in advance from a specific requirement and is requested during the formulation/planning/design stages to address expected situations.

b A Technical Waiver authorizes relief after the fact from a specific requirement and is requested during the implementation of a project or operation to address situations that were unforeseen during design or advanced planning.

> *Note: NASA does not have approval authority to waive or deviate from Federal, State, or local regulations (e.g. OSHA) or from NCS that are prescribed as applicable by Federal regulations (e.g., ASME code).*

4.2.2 The Safety Variance shall document the deficiency or non-compliance, characterize and quantify the level of risk (assuming worst case credible event) in accordance with NASA-STD 8719.17, describe the modifications and controls necessary to eliminate or mitigate the risk, and clearly demonstrate that risk to personnel and facilities is acceptable.

4.2.3 The PVS Owner shall be responsible for preparing, routing, and obtaining approval of the Safety Variance Request using MSFC Form 4527.

4.2.4. The PSM shall determine the Safety Variance duration which is required on MSFC Form 4527.

4.2.5 The PVS Owner shall take steps to either bring the PVS into compliance or remove the PVS from operational service by the expiration date on the Safety Variance Request unless the Safety Variance is permanent.

4.3 Safety Variance Request Approval

4.3.1. The Safety Variance Request shall be approved in accordance with Table 4.2.

4.3.2 The approved Safety Variance Request shall be scanned into the PVS document repository and linked to PSRT.

Table 4.2 MSFC Signatures Required for Safety Variance Requests

Signature Authority	RAC 1 & 2	RAC 3+
NASA Headquarters Notification	X	X
Center Director Approval	X	
PVS Owner Directorate Approval	X	
Safety and Mission Assurance Director Approval	X	X
PSM or Alternate PSM	X	X
Manager, Safety and Mission Assurance	X	X
NASA PVS Owner or Management Organization	X	X

4.4 Safety Variance and PVS Operation

An approved Safety Variance Request shall be required to operate PVS which are not compliant with requirements of this MPR including operation of PVS with components which are past the prescribed service or test interval (i.e., delinquent components) except as noted below:

a. The PSM may extend a component certification not to exceed the lesser of 5% of the PVS safe remaining life or 180 days without an approved Safety Variance. This extension is based on demonstrated operational need or test constraints and shall not be in violation of any applicable external regulation (e.g., OSHA).

b. The Owner may operate PVS without certification or a Safety Variance for initial inspection, examination, and testing (i.e., pre-operational verification and checkout) when required by the applicable code or the inspection plan.

CHAPTER 5

PVS CERTIFICATION REQUIREMENTS

5.1 General Information

5.1.1 The requirements of this chapter are intended for the PVS Owner unless otherwise stated.

5.1.2 This chapter is not intended to provide an all-inclusive listing of NCS requirements but does address many of the typical pressure system design, test, installation, operation, and certification issues that are frequently encountered with MSFC pressure systems. Where specific NCS requirements are referenced in this chapter, the information should be considered the minimum requirements for the applicable NCS.

5.1.3 The Designer and/or Owner shall be responsible for identifying all applicable NCS requirements and ensuring that the applicable requirements are fully implemented in the design, fabrication, test, installation, operation and modification of PVS. A list of applicable NCS is provided in paragraph P.4.

5.1.4 Once the applicable NCS is established by the Owner, Designer or PSM for a given design, the requirements of the NCS shall be followed consistently and met in their entirety.

5.1.5 PVS shall comply with all applicable Federal laws and regulations (e.g., 29 CFR 1910, 29 CFR 1960).

5.1.6 The Owner or Designer shall ensure that all necessary Material Use Agreements (MUA) are prepared as required by NASA-STD-6001. MUA's are required when materials have not been previously approved by the MSFC Materials Lab for the media, service conditions or a specific use configuration.

5.1.7 Failure to comply with the requirements of this Chapter, including timely correction of deficiencies and servicing of components on the intervals identified, may prevent initial PVS certification or lead to revocation of certification.

5.2 General Certification/Recertification Requirements

5.2.1 New or existing PVS which is not excluded from certification per Chapter 4, including non-code PVS, shall be authorized for service with a Certification/Recertification Report or Safety Variance in accordance with Agency requirements and this MPR prior to operation.

5.2.2 The rules of the NBIC, ANSI/NB-23 shall be used for the repair and alteration of pressure-retaining items.

5.2.3 Configuration changes or modification to previously certified PVS are considered a system alteration and certification of the altered system shall be required prior to operation except as allowed below (see definition of "Configuration Change"):

5.2.3.1 Recertification is not automatically required when previously certified PVS are changed (altered) or repaired if the Owning organization is following a PSM approved CM Plan in accordance with Chapter 6 and the alterations do not involve changes to a vessel or piping.

Note: One primary objective of the Owner PM Plan, addressed in Chapter 6, is to ensure that PVS configuration changes are made in a manner to maintain certification status.

5.2.4 When configuration changes, or repairs, involve pressure vessels or piping, the Owner shall notify the PSM to determine if PVS recertification is necessary and to identify the scope of recertification required prior to operation even if the Owner has an approved CM Plan.

5.2.5 Re-evaluation of PVS certification status by the PSM shall be required when PVS service conditions change including, but not limited to, changes in fluid commodity, operating pressure or temperature, and location or orientation of the system.

5.2.6 Recertification shall be required, as directed by the PSM, in the case of a NCS change that reduces the estimated remaining life or increases the known risk of continued PVS operation.

5.2.7 Recertification shall be required, if any unanticipated damage or degradation is identified that reduces estimated service life, changes the probability of failure or failure modes, or changes the PVS risk assessment.

5.2.8 All PVS, equipment and components shall be operated and maintained in accordance with manufacturer's recommendations and with a suitable CM/PM Plan (Ref Chapter 6) to ensure continued certification compliance.

5.3 <u>Piping and Tubing</u>

a. Piping and tubing shall meet the design, construction and test requirements of the applicable ASME B31 Code for Pressure Piping.

b. NCS requirements, where available, take precedence over vendor catalog pressure ratings for piping and tubing. NCS do not typically address ultra-high pressure applications, generally greater than 6,000 psig, and in these situations only vendor data may be available.

c. Fluid conduit shall be labeled in accordance with ASME A13.1 and the guidance of Appendix E. Proper labeling should be considered as a contract deliverable for new system procurements or construction when practical.

d. Piping and fitting materials shall be compatible with the service conditions and media.

e. Weld filler rod and braze material shall be maintained by the Owning organization in accordance with manufacturer recommendations.

f. Fasteners shall be compatible with the joint material.

g. Where dissimilar materials are being joined, fasteners that minimize corrosion shall be selected.

h. Design considerations for installation of new (or modification to existing) cross country distribution systems shall include electrical isolation at building/facility entrances.

i. Bolted connections should be fully engaged (male to female thread) but shall be acceptable if lack of complete engagement is not more than one thread. (API 570)

j. Adequate clearance around piping, tubing and components shall be provided for maintenance, inspection and to minimize corrosion from moisture.

5.4 General PVS Components

a. The requirements of this section shall apply to all PVS components but there are additional requirements specifically for relief valves, flexible hoses and instruments which are each addressed separately in this chapter.

b. Components used in flammable, toxic or oxidizer service shall meet the requirements as described in “Special Fluid System Considerations.”

c. Components that meet a listed standard in the applicable piping construction code (e.g., ASME B31.3) shall be selected for use in construction or fabrication of a piping system. Other (unlisted) components can be used, provided they are evaluated and substantiated based upon the criteria of the applicable piping construction code (e.g., ASME B31.3).

d. The PVS Owner is responsible for providing component data to the PSCT when information on the component is not legible or is non-existent. (Reference Chapter 6 for component database requirements.)

e. Components shall not be exposed to pressures in excess of their MAWP except as allowed during Code required leak testing or as expressly allowed by the governing piping code.

f. Each component of a pressure system shall be legibly marked or tagged (to the extent practical) to indicate the part/model number, manufacturer and maximum working pressure.

g. Pressure system components installed in systems requiring baseline drawings per Chapter 6 shall have a unique identification number affixed which is traceable to the baseline drawing. Tagging of the fluid conduit (piping/tubing) and associated fittings is not required.

5.5 Special Fluid System Considerations

The materials that comprise the fuel and oxidizer "wetted" surfaces of valves and other components shall be approved for use by the MSFC Materials and Processes Laboratory. Application for Materials and Processes Laboratory approval is through the MSFC Valve and Component Shop.

Note 1: Fuel and oxidizer valves and other components are assigned a "V" number by the MSFC Valve and Component Shop, traceable to a specific component manufacturer model or figure number. A parts list is provided for each valve or other component to the MSFC Materials and Processes Laboratory for review and approval. Once approved, the valve or other component is entered into the MSFC Valve and Component Shop database along with the "V" number approval sheet.

Note 2: As fuel and oxidizer valves and other components are serviced by the MSFC Valve and Component Shop, a "VC Sheet" is generated. This "VC Sheet" is assigned a number and lists the valve or other component individual parts and records any parts serviced or replaced. The "VC Sheet" is the official record of each individual valve or other component being serviced.

5.6 Safety Relief Devices

5.6.1 General Safety Relief Device Requirements

a. All PVS, including those operating at pressures less than 15 psig, which can be pressurized above the MAWP for any reason either by an internal or external pressure source shall have appropriate overpressure protection in accordance with this MPR and the applicable NCS.

b. The primary safety relief device for all PVS shall be ASME code stamped except in cases when the relief device set pressure does not exceed 15 psig or when no ASME code stamped relief devices are commercially available due to very high set pressures required (typically for set pressures above 6000 psig).

c. Relief valves shall have a permanent tag (or tags) affixed indicating the component identification number, the set pressure, rated flow capacity, and last service or test date as a minimum. Information shown on the manufacturer tag, which is accurate and legible, does not have to be repeated on the owner affixed tag.

(1) When a relief valve is installed as-received directly from the manufacturer without post-procurement servicing (air and inert service only), the "last service or test date" in the requirement above shall be interpreted to mean the earlier of the manufacturer documented test date or the date of relief valve delivery from vendor.

Note: See "Special Fluid System Considerations" for components installed in fuel or oxidizer service.

d. The primary relief device set pressure shall not exceed the lowest MAWP of any component in the system being protected by the relief valve. (See definition of "MAWP")

e. Pressure reducing valves and similar mechanical or electrical control instruments shall not be used as the primary safety relief device. (ASME BPVC, Section VIII, Division 1, UG-125).

f. Code stamped burst or rupture disks may be used in lieu of, or in conjunction with, pressure relief valves.

5.6.2 Safety Relief Device Set Pressures and Sizing Requirements

a. The Owner is responsible for identifying all potential sources of overpressure and determining the worst case flow rate for relief valve sizing calculations taking into account normal operating conditions, upset conditions, relevant failure scenarios, fluid phase change and sources of external heat (such as fire) as applicable to the specific operation or installation environment.

b. Relief valve sizing calculations to verify flow capacity shall be performed per the applicable design code and retained in accordance with the engineering data retention requirements of Chapter 6. Flow capacities provided by ASME or NBIC relief device suppliers are acceptable.

c. ASME provides specific guidance for relief valve sizing, installation and other pertinent considerations in the codes and sections shown below. The PSM may also be consulted for guidance on relief valve sizing and installation.

(1) Section VIII Division 1 UG-125 thru UG-140 and Appendix M
(2) Section VIII Division 2 Part 9 and Annex 9-A
(3) B31.1 Appendix II

d. Overpressure protection devices shall be installed downstream of pressure regulators unless the downstream system is designed for the maximum pressure possible upstream of the regulator.

e. Relief devices downstream of a regulator or other flow rate restriction shall be sized on the assumption that the pressure source is flowing at upstream relief valve set pressure with flow restriction (e.g., regulator, orifice, valve) at its maximum opening.

f. Tubing or piping flow resistance may be taken into account by the Designer or Owner to calculate maximum system flow rate if the following requirements are met:

(1) An established engineering calculation approach is used, calculation margin of error is taken into account to ensure conservatism and calculations are retained in accordance with engineering data retention requirements of Chapter 6

(2) The baseline drawings include notes to indicate that the required relief valve flow capacity is based on tubing/piping flow resistance and not solely based on primary flow control device (typically a pressure regulator).

(3) A tag or label is applied to the tubing or piping, where practical, to indicate that the tubing/piping size is being used to determine the required relief valve flow capacity (this requirement is intended to minimize inadvertent change to the tubing/piping without reassessment of required relief valve capacity).

5.6.3 Safety Relief Device Installation Requirements

a. Pressure systems shall be designed and installed with no intervening fluid components between the pressure source and the relief device that can inhibit proper operation or overly restrict the relieving device.

b. Discharges from vents, relief devices, and gage blowout ports shall be located or directed away from personnel and equipment (ASME B31.1, 122.6.2).

c. The opening through all pipe and fittings between a pressure vessel or piping system and its relief device shall:

(1) Have at least the flow area of the relief device inlet, and

(2) Be installed such that the pressure drop will not reduce the relieving capacity below that required or adversely affected proper operation of the relief device (ASME Section VIII Division 1 UG-135).

> *Note: ASME Section VIII Division 1 Appendix M-6 recommends an accumulated inlet pressure loss not to exceed 3% of relief device set pressure.*

d. The opening in relief device discharge pipe and fittings shall:

(1) Be at least as large as the relief device outlet opening (NBIC Part 2 Section 2), and

(2) Be installed such that accumulated backpressure will not reduce the relieving capacity below that required or adversely affect operation of the relief device (ASME Section VIII Division 1 UG-135).

> *Note: ASME Section VIII Division 1 Appendix M-6 recommends an accumulated backpressure not to exceed 10% of relief device set pressure.*

e. Relief device outlets shall be protected to ensure that dirt, water, or other debris (such as insect nests) cannot block the vent path. Typically, this is accomplished by providing a bug eliminator

at the outlet to atmosphere. Relief device outlets located indoors or in an enclosed panel are considered protected.

f. Relief devices shall be installed to withstand reaction loads at their rated flow rate and pressure using balanced thrust vent tees and structural supports where appropriate.

g. Relief devices shall be installed in accordance with manufacturer's recommendations and in a manner that allows access for inspection and replacement (ASME Section VIII UG-125(d)).

h. Relief valves shall be installed in the upright vertical position (spindle vertical, disk or piston moves upward as valve opens) unless other orientations are expressly allowed by the manufacturer and the conditions of ASME BPVC Section VIII Division 1 Appendix M are satisfied (API 576).

5.6.4 Safety Relief Device Servicing and Replacement

a. ASME Code stamped relief valves shall only be repaired or altered by National Board (NB23) certified organizations (for example "R" and "VR" stamp holders) in strict conformance with an approved code compliant quality manual.

b. Servicing, adjustment or repair to relief valves which are not ASME code stamped shall comply with the applicable code to the extent possible.

c. Relief valves shall be serviced (or replaced) on the intervals shown in Table 5.1. Service media examples are provided for reference purposes only and other applications may exist in each category which are not specifically identified.

Table 5.1 Relief Valve Service Intervals

Service Category	Examples of Service Media	Retest Interval (years)
Toxic, corrosive, flammable (except for general hydrocarbons)	Hydrogen, hydrogen peroxide, TEA TEB	2
General Hydrocarbons	Propane, RP1, Hydraulic Oil, Methane, Butane	5
Gas Systems with MAWP Above 200 psig (non-corrosive, non-flammable, non-toxic)	Air, nitrogen, oxygen, argon, helium	3
All Others (e.g., high purity air and inert gases operating at or below 200 psig and inert liquids at any pressure) *Note: Does not apply to relief valves on Air Compressors.*	High Purity air, nitrogen, oxygen, argon, helium (liquid or gas) Deionized water	5
Relief Valves in parallel with rupture disks	All media	5

d. As objective evidence is collected on the operation of a specific relief valve in a specific service, the relief valve periodic retest may be extended as approved by the PSM, but to a total of no more than five years, or reduced.

e. Table 5.1 does not apply to burst or rupture disks. Burst or rupture disks are susceptible to fatigue failures and shall be included in the Owner PM Plan and replaced per the manufacturer's recommendations (ASME BPVC, Section VIII, Division 1, UG-127).

f. Pressure relief devices installed on Department of Transportation (DOT)-certified PVS require set pressure verification in accordance with DOT regulations.

g. Vacuum annulus relief devices (e.g., relief devices for the vacuum jacket on piping or vessels) shall be visually inspected per the Owner PM Plan but do not require set-pressure verification.

h. Non-conventional relief devices protecting PVS with MAWP less than 15 psig shall be included in the Owner PM Plan to ensure the relief device is functional (for example, ensuring that lift plates are unobstructed).

i. Inspection and test of relief valves for boilers and steam systems is the responsibility of the FMO and shall be in accordance with NBIC Part 2.

j. Hydraulic pump discharge pressure relief valves are acceptable for use as the primary safety relief device if sized to relieve maximum possible flow from the hydraulic pump while set no

higher than system MAWP, are verified to be functional, and are tested on at least a 5 year interval to verify no set point change.

5.7 Flexible Hose Assemblies

There are three primary types of flexible hose assemblies addressed in this section as identified below. Hoses which do not fall into these general category descriptions shall be approved for use by the PSM.

Type 1: Stainless steel hose with steel braided overwrap for both high and low pressure applications and which may contain non-metal linings (Teflon lining for example).

Type 2: Reinforced hose commonly used for moderate to high pressure gas and hydraulic service many of which are manufactured and tested to either SAE or ISO standards

Type 3: Unreinforced non-metal hose commonly used for lower pressure shop or laboratory applications (plastic, silicone, rubber, nylon, polyvinyl chloride (PVC), polyurethane, etc.)

5.7.1 General Requirements Applicable to All Flexible Hose Types

a. Flexible hose shall not be subjected to pressures above manufacturer recommended MAWP.

b. Flexible hose shall only be used in accordance with manufacturer recommended fluid media and service life requirements.

c. The ratio of burst pressure to MAWP for flexible hoses shall be at least 4:1 (factor of safety).

d. Flexible hose for which the rated working pressure is unknown or cannot be established (for example by hose procurement records, manufacturer markings or previous pressure test records) shall be destroyed.

e. Flexible hose materials used in flammable or oxidizer service shall have approval by the Materials and Processes Laboratory (EM) (see section on Special Fluid System Considerations).

> *Note: Flex hoses in oxidizer service should be avoided when possible due to potential problems with adiabatic compression leading to a rapid temperature rise which could lead to catastrophic hose rupture. Stainless steel rigid tubing should be used in place of flexible hoses whenever possible to avoid this potential problem.*

f. Flexible hoses shall be assembled, installed, maintained, inspected and operated in accordance with manufacturer recommendations.

g. Flexible hose shall not be used on a permanent basis in lieu of rigid fluid conduit (piping/tubing) unless the system design must accommodate vibration, thermal movement, or other motion and flexibility which would be impractical with rigid conduit. Flexible hoses may also be used to support strictly temporary operations (e.g., trailer or tanker hookup, proof test, heating, drying).

h. Flexible hoses shall be inspected for damage prior to installation and periodically during operation using criteria found in SAE ARP 1658B.

i. Flexible hoses exhibiting major defects as classified in SAE ARP 1658B shall be removed from service and destroyed.

Note: SAE ARP 1658B was written specifically for installed hoses, however, the inspection criteria in SAE ARP 1658B are applicable to newly purchased and existing installed hoses.

j. Flexible hoses shall be protected from damage due to personnel traffic and moving equipment.

5.7.2 Flexible Hose Initial Proof Testing

Type 1 and Type 2 flexible hoses shall have an initial proof test at 1.5 times MAWP and must be performed prior to the hose being placed in operational service and only after the hose end fittings are attached. Initial proof test by the manufacturer or distributor is acceptable when a proof test certificate is provided. The exceptions to this requirement are as follows:

a. Type 2 flexible hoses which are manufactured and marketed specifically for air hose applications and which are being used for general shop (or similar industrial area) air service do not require initial proof test as long as manufacturer pressure rating is not exceeded.

b. No initial proof test is required for Type 3 hoses where manufacturer rated working pressure is clearly established.

5.7.3 Flexible Hose Periodic Inspection and Pressure Re-test

a. All flexible hoses in operational service, including hoses installed by welding or brazing, shall be included in the Owner PM Plan and inspected using criteria found in SAE ARP 1658B on an annual basis as a minimum.

b. Type 1 hoses shall be re-tested at either the hose rated MAWP, or the MAWP of the system in which the hose is installed (if system MAWP is less than hose MAWP), on an interval not to exceed 5 years.

c. Type 2 and Type 3 hoses are exempt from retest requirements as long as manufacturer rated working pressure is clearly established.

d. Any hoses operating at not greater than 20% of the hose rated MAWP are exempt from the re-test requirement as long as all other requirements specified herein are met.

e. Flexible hoses which are permanently installed are exempt from pressure re-test but shall be re-tested if ever removed with intention to reinstall at a later date (see tagging requirements below).

5.7.4 Flexible Hose Tagging Requirements

a. Flexible hose tags, where required, shall be metal with required information etched, stamped or printed on the tag which is attached to the hose with safety wire or metal banding.

b. Type 1 hoses shall have a tag containing hose MAWP, initial proof test pressure and proof test date which remains permanently attached to the hose.

c. Type 1 hoses shall have a tag which contains the most recent hose retest pressure and retest date. This tag is temporary and can be replaced with a new tag at each subsequent retest interval.

d. Type 1 hoses, which are permanently installed and not periodically re-tested per the allowance of Section 5.7.3, shall have a tag that states the following (or similar) wording: "Permanent installation. No retest required unless removed." This tagging requirement does not apply to hoses which physically cannot be removed due to being welded or brazed in place.

e. Type 2 hoses do not require tagging if manufacturer MAWP is clearly indicated on hose.

f. Type 3 hoses do not require tagging.

Table 5.2 Summary of Flex Hose Requirements (see applicable paragraphs for complete requirements)

Flex Hose Type	Initial Proof Test	Periodic Re-Test	Service Media	Tagging	Notes
Type 1	1.5 times MAWP	Every 5 years at MAWP (see notes)	Use in flammable or oxidizer service requires Materials and Processes Laboratory (EM) approval	Yes	Hoses operating at pressures $\leq$ 20% of MAWP are exempt from retest Hoses permanently attached by welding/brazing are exempt from retest
Type 2	1.5 times MAWP (see note)	Not Required	Use in flammable or oxidizer service requires EM approval	Not Required (see note)	Initial proof test not required for general service "air hoses" within manufacturer rated working pressure and being used in air service at pressures up to 300 psig. Tagging not required as long as manufacturer MAWP is clearly indicated on hose
Type 3	Not Required (see note)	Not Required (see note)	Use in flammable or oxidizer service requires EM approval	Not Required	Manufacturer pressure rating must be clearly established

5.7.4 Flexible Hose Restraint Requirements

a. Flexible hoses used in systems operating above 150 psig with a length exceeding 2 feet, and which do not meet the exclusion criteria herein, shall be properly restrained as described below. The preferred method of restraint is wire mesh style grips which do not rely on the hose end fitting remaining in place.

(1) Flexible hoses with a length between 2 feet and 6 feet shall be secured at both ends.

(2) Flexible hoses greater than 6 feet in length shall be secured at both ends and in the middle.

(3) Flex hose restraints shall be securely attached to a substantial anchor point capable of securing the hose in the event of failure. Adjacent piping or tubing is not an acceptable anchor point.

(4) Gas tube trailers shall be provided with anchoring points for flexible hose harnesses.

b. The following flexible hoses are excluded from hose restraints

(1) Flexible hoses installed on equipment or test apparatus that require free translation or rotation shall be exempt from restraint requirements if risk of personnel injury is negligible.

(2) Flexible hoses which are enclosed, restrained or contained by or within equipment or test apparatus and pose negligible risk to personnel when pressurized are exempt from restraint requirements.

(3) Type 2 hoses used in liquid (incompressible) service are exempt from restraint requirements.

(4) Type 2 flexible hoses which are manufactured and marketed specifically for air hose applications and which are being used for general shop (or similar industrial area) air service at pressures up to 300 psig are exempt from restraint requirements.

5.8 Pressure Vessels

5.8.1 Code and Non-Code Pressure Vessels

The generic term “pressure vessel” refers to code and non-code pressure vessels, autoclaves, heat exchangers, and composite overwrapped pressure vessels (COPV) unless otherwise denoted and the requirements are as follows:

a. Non-code vessels shall comply with the detailed requirements of NASA-STD-8719.17.

b. All pressures vessels under the scope of ASME shall be ASME stamped and NBIC registered.

c. Code design and construction techniques shall be utilized on new non-code PVS to the extent possible.

d. Design and procurement specifications for pressure vessels shall meet the requirements specified in Chapter 6 “PVS Procurement”.

e. The Owner shall provide the PSM with pressure vessel drawings and procurement deliverables which will then be archived in the PVS document repository and linked to the PSRT (Reference Chapter 6 and Appendix G for vessel procurement deliverables).

> *Note: PSRT will not contain vessel records which have not been provided by the Owner or records for heritage vessels for which documentation is not available.*

f. Repairs and alterations shall be performed in accordance with ANSI/NB-23 and conform to the section and edition of the construction standard or specification most applicable to the work planned (see RC-1020 in ANSI/NB-23).

g. All vessels shall be labeled in accordance with ASME A13.1 and the guidance of Appendix E. Proper labeling should be considered as a contract deliverable for new vessel procurements when practical.

h. To facilitate cleaning of large, fixed pressure vessels, low-point drain(s) shall be included in the design.

i. Adequate clearance around pressure piping and components shall be provided for maintenance and inspection purposes. Clearance should allow direct visual inspection of individual system components and facilitate removal of components for servicing.

j. A minimum of 6” clearance shall be provided around all pressure vessel surfaces (heads, shell section, nozzles, manways, etc.) to allow installation and use of inspection equipment for examination of vessel walls and welds (12” clearance preferred). Vessels which are installed without sufficient room for inspection may require Owner to remove vessel for inspection.

5.8.2 Portable and Mobile Pressure Vessels

a. This section pertains to portable and mobile vessels which were originally designed and constructed to either ASME or DOT requirements and are used for transport of liquids and gases. Portable vessels include compressed gas bottles and laboratory sized cryogenic dewars. Mobile vessels include bulk cryogenic tankers and high capacity multi-tube gas trailers.

b. Certification documentation for NASA owned portable vessels shall be maintained in the PVS document repository and linked through the PSRT.

c. Pressure systems and components installed downstream of portable and mobile pressure vessels shall be certified in accordance with the applicable requirements of this MPR.

5.8.3 Mobile Pressure Vessels

a. DOT specification vessels or cylinders shall be operated, inspected and maintained in accordance with the appropriate DOT regulations and a MSFC approved procedure.

b. NASA owned non-DOT specification vessels or cylinders shall be operated, inspected and maintained as specified by an MSFC approved procedure and (re)certified prior to (re)filling.

c. NASA owned non-DOT specification vessels or cylinders may be used to transport pressurized commodities on Redstone Arsenal but shall not be used to transport pressurized commodities outside the arsenal on public thoroughfares or waterways.

d. An engineering evaluation shall be performed to ensure that non-DOT specification vessels or cylinders used as mobile vessels meet the static and dynamic load requirements associated with use as a mobile vessel.

5.8.4 Portable Vessels

General information on procurement, storage, handling or installation of portable vessels (e.g., compressed gas cylinders, bottles, cryogenic dewars) may be obtained from the PSM or the Industrial Safety Branch. The requirements listed below are applicable to both leased (rental) and NASA owned portable vessels. Portable vessels are not certified by the PSCT.

a. Portable high pressure DOT gas cylinders (such as k-bottles) shall not be purchased, unless specifically approved by the PSM, but may be rented or leased. (This allows responsibility for meeting DOT pressure test requirements to reside with the rental/lease company. NASA owned DOT gas cylinders will be removed from service and delivered to Property Disposal unless specifically approved in writing by the PSM. This requirement does not apply to lecture bottles.)

b. The Owner or User shall ensure that portable vessels are stored, installed, handled, operated, maintained, retested and equipped with safety relief devices in accordance with applicable NCS and manufacturer (or supplier) recommendations. Reference CGA P-1.

c. Refilling of an expired DOT approved vessel is prohibited.

d. All portable vessels shall be inspected prior to installation for any visible damage including, but not limited to, dents, gouges, or excessive corrosion that may affect the mechanical integrity of the vessel and removed from service and returned to Owner/Supplier if such damage is observed.

e. All portable vessels shall be included in the Owner PM Plan and inspected for damage or deterioration including dents, gouges or significant corrosion resulting in metal loss (wall thinning).

f. Leased portable vessels found to have damage or significant corrosion shall be immediately taken out of service and returned to the Supplier/Owner for repair or decommission.

g. Portable vessels owned by NASA which are found to have damage or significant corrosion shall be immediately taken out of service and reported to the PSM.

h. The requirements stipulated in "Flammable, Toxic, and Asphyxiate Fluid Systems" later in this chapter shall also apply to portable vessels.

i. All portable vessels shall be legibly marked with either the chemical or trade name of the gas or liquid.

5.8.5 Air Receivers (Accumulator Vessels on Air Compressors)

Air Receivers are addressed separately from other vessels in this MPR because air compressors can be obtained as COTS items from numerous distributors by personnel that are otherwise unfamiliar with pressure vessel code requirements. Air receivers are especially susceptible to internal corrosion from condensed atmospheric moisture. In addition, air receivers are susceptible to vibration induced weld stress cracks due to loads imparted by the motor/compressor into the vessel wall.

5.8.5.1 General Air Receiver Requirements

a. Requirements for operating and maintaining Air Receivers shall be the responsibility of the Air Receiver Owner unless specifically stated otherwise.

b. Air Receivers which have an internal diameter of 6 inches or greater, whether hard mounted to a surface (i.e., fixed) or portable, are required by OSHA to be ASME code stamped (the ASME certification is typically found on a stamped metal plate attached directly to the vessel wall or vessel attachments).

> *Note: Many air compressors sold in retail outlets are sold without an ASME code compliant accumulator vessel. These compressors are sold for "homeowner" use which is outside the scope of OSHA regulation and are not acceptable for use in the workplace unless the accumulator vessel inside diameter is less than 6".*

c. Air Receivers having an internal diameter less than 6 inches do not require ASME code stamp but shall comply with all other requirements stated herein.

d. All Air Receivers shall have a properly sized ASME code stamped relief valve, integral with pull ring or lever, to protect the vessel from over-pressurization.

e. Air Receivers shall have a functional UL-404 or ASME 40.100 compliant pressure gauge that reads tank typical operating pressure at approximately gauge mid-scale.

f. Air Receivers shall have a low point drain valve or port for draining water from the vessel (ASME Section VIII Division 1 UG-25(f)).

g. Air Receivers which are hard-mounted to the floor or other fixed support surface shall have vibration isolation pads installed between the vessel and the fixed surface to minimize vibration induced stress.

h. Air Receivers shall be operated, maintained and inspected in accordance with manufacturer recommendations including, but not limited to, recommendations for testing relief valve, periodically draining water from the vessel and adherence to the service life of the vessel.

i. Owners shall notify the PSM of the purchase of any air compressors, or any air compressors identified without a visible asset number, so that vessel inventory information can be updated.

j. Owner shall remove Air Receivers from service and notify PSM if the vessel wall shows signs of damage or distortion.

k. Owners shall notify the PSM when air compressors are removed from service so that vessel inventory information can be updated.

5.8.5.5 Air Receiver Removal from Service

Air Receivers are subject to immediate removal from service for any of the following reasons:

a. Air Receiver cannot be conclusively confirmed to be an ASME code stamped vessel (does not apply to accumulators vessels less than 6” inside diameter)

b. No code stamped relief valve is installed

c. The relief valve is improperly sized or non-functional

d. Indication of air receiver internal or external corrosion (pitting/metal loss)

e. Indication of damage to the vessel pressure boundary (e.g., dents, gouges)

f. The manufacturer recommended service life has been exceeded

g. Evidence of weld defects, vessel damage or internal corrosion as determined during periodic NDE inspection.

h. Air Receivers removed from service for any of the reasons above shall not be approved for return to service until the condition has been corrected and the PSM deems the air receiver safe for continued use.

i. Air Receivers removed from service due to expired service life shall not be put back into service. PSM can be consulted for disposal of air receivers with expired service life.

5.8.6 Vacuum Vessels

a. Vacuum vessels shall meet the detailed requirements of NASA-STD-8719.17.

b. Vacuum vessels shall be ASME Section VIII code stamped and registered with the National Board except as allowed per NASA-STD-8719.17.

c. Vacuum vessels which meet the code stamp exclusion allowances of NASA-STD-8719.17 shall be authorized for use through an approved Safety Variance.

d. Vacuum vessels (and interconnected vacuum system) having a capacity of 100 cubic feet or less are excluded from certification but remain subject to the CM/PM requirements of Chapter 6.

e. All vacuum vessels, including those which are excluded from certification which may be pressurized above 2 psig either from an internal or external source shall contain a pressure relief device.

5.8.7 Boilers and Boiler Piping

Boilers and boiler piping shall comply with the following requirements:

a. PVS shall meet the requirements of State and local boiler and pressure vessel statutes unless exclusive federal jurisdiction applies. In the event of a conflict between this MPR or NASA-STD-8719.17 and applicable statutes or regulations, the statutes or regulations govern.

b. Boilers shall be operated and maintained in accordance with recommendations of the boiler manufacturer, including water quality.

c. All power boilers shall be ASME BPVC Section I code stamped and registered with the National Board.

d. Boiler external piping and non-boiler external piping (power piping), as defined by ASME BPVC, shall comply with the requirements of ASME B31.1.

e. A copy of the manufacturer’s data report(s) shall be retained in accordance with the CM requirements of Chapter 6.

f. All heating boilers shall be ASME Section IV code stamped and registered with the National Board.

g. Repair or alterations shall be performed in accordance with ANSI/NB-23, and conform to the section and edition of the construction standard or specification most applicable to the work planned (see RC-1020 in ANSI/NB-23).

h. Boilers shall be inspected, repaired or altered in accordance with ANSI/NB-23.

5.9 Pressure and Temperature Indicating Devices

The pressure-sensing element in most gauges is subjected to high internal stresses, and applications exist where the possibility of catastrophic failure is present. Pressure regulators, diaphragm (chemical) seals, pulsation dampers (snubbers), siphons, and other similar items are available for use in these potentially-hazardous systems. The hazard potential increases at higher operating pressure. See ASME B40.100 for more information.

a. Pressure or temperature indicating devices which are essential to personnel safety, are used to control critical or hazardous operations, provide program critical data, or used to measure pressure during code required pressure tests shall be considered “safety critical” instruments.

b. Safety critical instruments shall have accuracy verified prior to use. (See additional requirements below for pressure gauge calibration.)

5.9.1 Pressure Indicating Device General Requirements

a. The PVS Designer or Owner shall consider potential risk to personnel from catastrophic failure of a pressure indicating device and take precautions to mitigate any associated hazards.

b. The PVS Owner or Designer shall consider instrument material compatibility with the fluid media when selecting a pressure gauge and the consequences of system contamination in the event that the instrument fails.

c. Pressure gauges which could result in personnel injury in the event of catastrophic failure shall meet an appropriate NCS such as ASME B40.100 or UL 404 and be equipped with a pressure relief case. Maximum personnel protection is provided by a gauge design which contains a solid front and blowout back to prevent projection of parts outward through the front of the gauge.

d. For pressure vessels, pressure gauge full scale range shall be at least 25% above the corresponding relief device set pressure and should generally indicate nominal system operating pressure at gauge mid-scale (NBIC Part 1, Section 4 and ASME B40.100).

e. For tubing and piping systems, the nominal system operating pressure should occur in the middle half (25-75%) of full scale range (ASME B40.100) but in no case shall the pressure gauge full scale range be less than the relief valve setting.

Note: Pressure gauges are often less accurate at the upper and lower end of the scale than at mid-scale. Engineering evaluation is required when selecting a gauge that will not be operated at mid-scale. Consult ASME B40.100.

f. The pressure retaining boundary (body) of a pressure transducer shall be designed for a MAWP no less than the corresponding relief valve set pressure and the transducer full-scale pressure range should span the relief valve set pressure. Engineering judgment should be used when selecting a transducer indication range that does not span the relief valve set pressure.

5.9.2 Pressure Indicating Device Calibration and Labeling

a. Pressure indicating devices which are essential to personnel safety, are used to control critical or hazardous operations, provide program critical data, or used to measure pressure during code required pressure tests shall be calibrated per MPR 8730.5 and compliant with ASME B40.100.

b. Calibration of gauges shall be performed on an interval no less frequent than that required for pressure relief devices installed in the same system.

c. Labeling of calibrated gauges shall be compliant with MPR 8730.5.

d. Pressure gauges which do not require calibration, per MPR 8730.5, shall be periodically inspected as part of the Owner PM Plan to ensure proper function.

e. UL-404 compliant pressure gauges used as general purpose equipment gauges, pressure regulator gauges and compressed gas bottle gauges and which are not calibrated, do not require labeling but shall be included in the Owner PM Plan for periodic inspection.

5.10 MSFC In-House Custom Design/Fabricated Equipment and Specialty Items

a. Wherever practical, custom in-house MSFC designed, fabricated, repaired or altered, pressure system equipment and components shall have the MAWP and work authorization number (e.g., Test Preparation System (TPS) number) stamped, engraved, or etched on the item or affixed with a tag. This requirement does not apply to individual sections of piping or tubing.

b. A copy of the engineering calculations, proof test records, heat treat records and other associated design documentation shall be attached to the work authorization document and retained in accordance with “Engineering Documentation Retention” requirements of Chapter 6.

c. Specialty or unique items may be used in PVS if supported by engineering analysis and adequate margin of safety is demonstrated.

d. A 4:1 factor of safety based on ultimate strength, for ductile materials only, shall be used if possible when personnel exposure is involved. Approval of the PSM, and in some cases, the Industrial Safety Office is required for a factor of safety less than 4:1.

e. Brittle materials shall have a factor of safety of 10 and require special consideration by the PVS Designer or Owner to ensure personnel safety under all operational scenarios.

5.11 Pressure Regulators Orifices and Similar Flow Limiting Devices

a. The Owner shall ensure that any flow limiting devices such as orifices and venturies are clearly identified to minimize the possibility that the device is inadvertently removed and not replaced during maintenance operations or system modification.

b. Flow limiting devices shall be designed and fabricated for the MAWP of the system in which the device is installed including the capability to withstand a differential pressure equal to the MAWP in the event of orifice partial or complete obstruction (i.e., clogging).

c. The type of device and internal diameter shall be identified on system drawings and a tag attached to the device to allow verification of flow rate through the device. Drawings do not require update to identify internal diameters of orifice and venturi type devices that are frequently removed and replaced for test operational purposes.

d. Pressure regulators and similar pressure reducing devices shall be clearly tagged or labeled with the internal orifice size or manufacturer orifice designation.

e. Maximum possible orifice diameter or flow coefficient for a given manufacturer component model or series shall be assumed when determining maximum flow rate for relief valve sizing in cases where the actual orifice diameter or flow coefficient is not identified or is not known.

5.12 View Ports in PVS (including sight glasses and liquid level indicators)

This section addresses viewports and liquid level indicators which are made from brittle materials (i.e., glass, sapphire, etc.) and therefore subject to fail catastrophically.

a. The Designer or PVS Owner shall take fluid compatibility into account to ensure all hazards are identified and properly mitigated.

b. These devices are regarded as hazardous and steps shall be employed to ensure the safety of personnel from brittle failures during system operation.

c. The code equivalent factor of safety on breaking strength for view ports shall be 10 or as recommended by the manufacturer subject to approval by the PSM.

d. A view port shall be initially pressure tested in accordance with the applicable Code for the PVS in which it is installed using a fixture, or similar means, to duplicate the installed loads during test.

e. View ports shall have an engineering assessment performed, including view port cycle life and ambient noise effects, to determine the appropriate inspection and re-test interval to ensure continued safe operation.

f. View ports shall periodically be re-tested as determined appropriate through the engineering assessment.

g. View ports shall be included in the Owner PM Plan and inspected visually for cracks, scratches, or other imperfections on the interval identified in the engineering assessment or annually, whichever is shorter.

h. View ports with damage or deterioration shall be immediately removed from service until replaced or justified for continued use through a documented engineering assessment.

5.13 Flammable, Toxic, and Asphyxiate Fluid Systems

a. Flammables, toxic fluids and asphyxiates shall be vented to safe areas outside of buildings unless otherwise authorized by the MSFC Industrial Safety Branch and the Environmental Engineering and Occupational Health Office. This includes any components that could potentially discharge inside the building (e.g., self-venting regulators, relief valves, system vent valves).

b. Hydrogen PVS shall meet the requirements of ANSI/AIAA, G-095-2017.

c. CGA G-5.5 shall be consulted for guidelines and recommendations on design of hydrogen vent systems.

d. Oxygen systems should follow guidelines established by ASTM-MANUAL-36. Contact the MSFC Materials and Processes Laboratory for guidance on the safe handling of oxygen and oxidizer systems.

CHAPTER 6

PVS OWNER RESPONSIBILITIES FOR CONFIGURATION MANAGEMENT AND PREVENTIVE MAINTENANCE (CM/PM)

6.1 General

NPD 8710.5 requires that organizations owning pressure systems establish a configuration management (CM) system to document and control engineering changes and to develop inspection and maintenance procedures for PVS. An effective CM/PM process will address the entire life cycle of the PVS from initial system fabrication, installation and activation through de-activation and final retirement of the system. This chapter establishes the CM/PM requirements to ensure safe and reliable operation and compliance with applicable Agency pressure system requirements.

6.2 Pressure System CM/PM Plan

a. The level of detail required in the CM/PM Plan shall be based on the specific pressure system categories which are defined in Chapter 2. The six fundamental elements of pressure system CM/PM to be addressed are: 1) work authorization; 2) system drawings; 3) component data; 4) engineering documentation retention; 5) procurement; and 6) preventive maintenance. These elements are required to properly manage, maintain, provide traceability and facilitate the certification process.

b. The Owner, or organization providing CM/PM services for PVS that they do not own, shall establish a CM/PM Plan compliant with Table 6.1 and the CM Plan Elements outlined below.

c. The Owner shall formalize the CM/PM Plan in an up-to-date controlled document.

> *Note: The CM/PM Plan may be consolidated into a single document addressing both configuration control and maintenance or may be included in more than one controlled document. Revision of existing organizational documents to include CM and PM processes*
> *is also acceptable.*

> *Note: There may be additional pressure system CM/PM requirements for facilities that are subject to OSHA Process Safety Management requirements per CFR 1910.119. Reference MSFC document ET01-PRO-OWI-024.*

d. PSM approval of the Owner CM/PM Plan(s) shall be required.

6.3 CM/PM Plan Elements

The individual CM/PM Elements are addressed below and shall be used in conjunction with, and

to the extent defined by, Table 6.1. The pressure system owning organization may include additional information and rigor in the CM/PM plan if needed to address unique operational considerations or to comply with programmatic requirements.

6.3.1 Work Authorization

a. A Work Authorization process shall be established to ensure that only authorized maintenance, repair and configuration changes are performed on PVS and to document new fabrication work.

b. The Work Authorization process shall identify the approval authority required for performing PVS fabrication, maintenance, repair, and configuration changes.

c. The Work Authorization process shall identify means by which work related documentation is maintained for future reference and traceability. (See note in Engineering Documentation Retention section below).

d. The Work Authorization process shall provide for a technical review of engineering calculations or analysis to ensure work is accurate, engineering approach and assumptions are valid and that applicable NCS requirements are met.

6.3.2 Baseline Drawing Process

MSFC uses a number of different types and formats of pressure system drawings for different purposes. Drawing types range from design and construction drawings and building baseline drawings to process flow drawings (flow schematics) used for test operations. The requirements in this section are intended to be the minimum baseline drawing requirements to assist the PSCT during the certification inspection. Additional requirements may be stipulated by the Owning organization for organizational or programmatic purposes.

a. A drawing baseline process shall be established and documented to ensure drawings are maintained accurate, current and controlled.

b. The drawing baseline process shall establish a process for drawing review, redline, field verification, update, approval and archiving.

c. Drawings shall be maintained in an electronic format readily accessible by the PSCT to facilitate the certification process.

d. Drawings shall clearly identify any organizational pressure system ownership interface (OI) that exists.

e. Drawings shall include all primary pressure retaining components and items including vessels, valves, filters, regulators, instruments, and safety devices along with the unique identification number assigned to each component. Standard pipe and tube fittings and connections are not

required to be included on drawings.

f. Drawings shall indicate the MAWP of pressure vessels regardless of vessel RV setting at the time the drawings are updated. (For example, a vessel may have a MAWP of 1000 psig although the RV may be set less than 1000 psig to meet a specific test requirement.)

g. Drawings shall identify set pressure for all safety relief devices and set point for pressure switches and temperature switches.

h. Drawings shall identify full scale pressure range of all pressure gauges.

i. Drawings should generally identify nominal pipe and tubing sizes and wall thicknesses.

j. Drawings shall include notes to indicate when system maximum flow rate capacity (for relief valve sizing purposes) is not based solely on the primary flow control device (see Chapter 5.6.2 “Safety Relief Device Set Pressures and Sizing Requirements”).

k. A legend showing the symbols used for all pressure system components on the baseline drawings should be included as part of each drawing set or be immediately available for reference when needed.

l. Drawings shall show a complete revision history, to the extent possible, that is traceable to the work authorizing document that initiates a configuration change and subsequent drawing revision.

m. Drawings shall differentiate between different fluid media types where necessary to avoid potential confusion or misidentification by maintenance or operations personnel.

n. Drawing approval signature authority shall be specified in the Owner CM/PM Plan and include the Designer (where applicable) and an Owning organization representative as a minimum.

6.3.3 Pressure System Component Data

a. Component data for all primary pressure retaining components, other than fittings, shall be maintained in an orderly and searchable electronic format readily accessible by the PSCT to facilitate the certification process. Insufficient component data may delay or prevent PVS certification.

b. Primary pressure retaining components shall include valves, regulators, filters, instruments, pumps, compressors, safety devices and any unique components or equipment connected to or installed in the system which contains the system pressure.

c. Minimum component data to be maintained shall include component identification number (traceable to affixed component identification tag), service media, manufacturer, model number, design pressure rating, operating pressure, set pressure of relief devices and full scale range of pressure gauges.

d. Component data shall also include orifice sizes for both safety relief devices and flow limiting devices (e.g., orifices, regulators, venturies) to allow verification that relief devices are properly sized.

e. Data for critical components requiring periodic service shall include the last service date along with a means of tracking the components to prevent service due date delinquencies. Critical components include relief valves, pressure gauges, flex hoses and any specialty items requiring periodic service.

> *Note: "Last service date" for relief valves installed directly from the vendor without post-procurement servicing will be the earlier of the manufacturer documented test date or the date of relief valve delivery from vendor.*

f. Pressure gauges which are included in the MSFC Calibration Facility recall system (MPR 8730.5 Category 1 items) shall be included in the component data listing but responsibility for tracking calibration due dates will remain with the Calibration Facility.

g. Air Receivers data shall be maintained to track remaining service life and ensure that PM inspections are being performed in accordance with Appendix F.

h. Component data shall include the baseline drawing and sheet number where the component is schematically shown in the system.

6.3.4 Engineering Documentation Retention

Engineering documentation shall be retained as described below. This information is required to validate the PVS design, construction, inspection and test, to demonstrate compliance with applicable standards, and to provide traceability.

> *Note: Insufficient engineering documentation for a given pressure system or vessel may prevent or delay system certification or authorization for operation.*

a. The Owner PM/CM Plan shall identify how the requirements for documentation retention are satisfied.

b. The engineering documentation retention requirements shall be in addition to the baseline drawing and component data requirements addressed previously in this chapter.

c. The Owner shall be responsible for providing engineering documentation, when requested,

to support system certification, safety assessments, hazard analysis or readiness reviews even in cases where documentation or data is stored in areas or on electronic systems not managed directly by the Owner organization (e.g., component service data stored on Valve and Component Lab system).

Note: The Owner's work authorization process, addressed earlier in this section, may be used to satisfy some or all of the documentation retention requirements of this section (e.g., documentation and data may be collected, stored and verified as part of the work authorization process).

d. Engineering documentation shall be maintained as described in Appendix D and identified in the Owner Record's Plan in accordance with NRRS 1441.1 and MPR 1440.2.

e. Engineering documentation to be retained for all new PVS and existing PVS (where available), regardless of pressure system category, shall include engineering calculations, proof test records, cleanliness verification records, and service and maintenance records, as applicable.

f. Documentation for new pressure vessels (including vacuum vessels and autoclaves), existing vessels where available, and repair or alteration of vessels shall include procurement specifications, drawings, welder qualifications, welding procedure specifications, welding procedure qualification records, welding consumable certifications, certified material test reports, inspection and NDE records, manufacturer's data report, heat treat records and proof test records (reference Appendix G).

g. The Owner shall provide the PSM all pressure vessel documentation identified above which will then be archived in the PVS document repository and linked to the PSRT.

h. Documentation for PVS which are owned/managed by MSFC but which are physically located at another center or facility shall be maintained at those sites and readily available to the PSM.

i. COTS system documentation shall include drawings, component listing, design specifications, operating capabilities and limitations, certified proof test reports, setup and operating instructions, and maintenance manuals, as applicable.

6.3.5 PVS Procurement

PVS procurements shall be processed as follows:

a. Procurement of standard off-the-shelf pressure retaining components including valves, regulators, filters, safety devices, fittings, connectors, piping and tubing do not require approval of the PSM.

b. Design specifications for procurement of vessels, heat exchangers, autoclaves and packaged pressure systems shall be provided to the PSM for review prior to release of procurement. This

requirement may be fulfilled by PSM, or designee, participation in the design and procurement review process.

c. Procurement specifications for vessels shall include the tailored or customized DRD STD/SA-PVDD to ensure that appropriate analyses, inspections and tests are performed and the appropriate documentation is identified for submittal in the procurement package. An example of the DRD is shown in Appendix G.

> *Note: Use of the DRD is not required for organizations that have an established process for purchasing pressure vessels and ensuring that code required forms and documentation are properly identified in the procurement specification.*

d. Tailoring or customization of STD/SA-PVDD shall be approved by the PSM.

e. The procurement document for vessels shall specify that a technical acceptance inspection be performed at destination to verify that all deliverable data has been received.

6.3.6 Preventive Maintenance (PM) Plan

The PM Plan shall establish the specific preventive maintenance activities required to maintain the mechanical integrity and certification status of pressure systems throughout the life cycle of the system.

a. PM Inspection: The PM Plan shall establish a process for scheduling and implementing a routine periodic visual inspection of pressure systems to identify damage or degradation that could lead to unsafe operating conditions, premature failure or system disruption.

> *Note: Periodic visual inspection is a critical part of a general preventive maintenance plan and should not be confused with the more rigorous nondestructive test or examination (NDT/NDE) inspection performed during the certification process by a certified specialist.*

b. PM Inspection Interval: The PM Plan shall establish a system inspection interval, not to exceed one year, with consideration to system operating conditions, operating environment, failure modes, damage mechanisms and risk to personnel, facilities and equipment.

c. The PM Plan shall be developed with consideration to damage factors resulting from service induced conditions (general wear and tear). Specific service conditions for consideration include fluid media, operating pressure and temperature extremes, consequences of mechanical failure or system outage, and history of usage.

d. Special consideration shall be given to systems with limited life cycle, susceptibility to failure based on operating conditions and severity of service, and those exposed to cyclic service (pumps, compressors, etc.).

e. The PM Plan shall be developed with consideration to degradation resulting from general environmental factors such as corrosion, erosion, ultraviolet (UV) exposure, and other environmental considerations unique to the system installation or operation environment.

f. PM Inspection Record: An inspection log, or similar means defined within the PM Plan, shall be used to document completion of the periodic PM inspection. Minimum information to be included in the PM log includes inspection date, personnel performing inspection and the specific PVS inspected.

g. The PM Plan shall include verification that critical components requiring periodic service are not overdue for service (delinquent). Critical components include relief valves, pressure gauges, flex hoses and any specialty or unique items requiring periodic service or calibration.

h. The PM Plan shall include inspection requirements for Air Receivers as shown in Appendix F.

i. Table 6.2 is provided as a guide to facilitate the development of a PM Plan. The Owner shall be responsible for ensuring that all maintenance items are included in the PM Plan as necessary to address specific pressure system hardware, operations and hazards involved.

j. Obvious disregard for maintenance or inspection shall be cause for revocation of PVS certification at the discretion of the PSM.

Table 6.1 CM/PM Requirements By Pressure System Category (Refer to Chapter 2 for System Category Definitions)

Pressure System Category	Authorization for Use	Work Authorization System	Controlled Baseline Drawings	Component Data	Preventive Maintenance (PM) Plan	Engineering Documentation Retention
Center Infrastructure						
Facility Services	Certification Package or Variance	Section 6.3.1	Section 6.3.2	Section 6.3.3	Section 6.3.6	Section 6.3.4
Facility Distribution	Note 1					
Test Specific Systems and GSE						
Test Systems (permanent)	Note 1	Note 4	Section 6.3.2	Section 6.3.3	Note 9	Section 6.3.4
Special Test Equipment (temporary)	Note 2		Note 5	Note 8		
Test/Research Articles			Note 6			Per Program Requirements
Ground Support Equipment (GSE)						
Commercial, Shop and Laboratory						
Commercial-Off-The-Shelf (COTS) Equipment	Note 3	Not Required	Note 7	Not Required	Maintenance & Inspection per manufacturer recommendations	Section 6.3.4
Fabrication, Process and Lab Equipment						
Laboratory Pressure Supply Systems	Note 1	Not Required	Note 7	Note 8	Note 9	Section 6.3.4

Table References

1. Certification required unless system meets exclusion criteria identified in Chapter 4 Table 4.1

2. Certification not required provided systems are authorized for use by a MWI 8715.15 compliant safety assessment and an MWI 8715.17 compliant readiness review process.

3. Certification not required provided that the system is operated within the manufacturer's design (placard) limitations and maintenance and inspection are performed in accordance with the manufacturer's recommendations.

4. Work authorization process is required except in cases where an MWI 8715.15 compliant safety assessment has determined that work on these systems represents minimal risk to personnel and facility.

5. Drawings or engineering sketches (uncontrolled drawings) required as necessary to support the MWI 8715.15 compliant safety assessment process and the MWI 8715.17 compliant operation readiness review process.

6. GSE/Test Article owning organization is responsible for Baseline Drawings which shall be provided as necessary to support the MWI 8715.15 compliant safety assessment process and the MWI 8715.17 compliant operation readiness review process.

7. Baseline drawings are required unless system is of such low hazard and complexity that the Owning organization management authorizes operation without controlled procedures. Manufacturer's drawings are acceptable in lieu of baseline drawing.

8. Components requiring periodic service per this MPR shall have configuration management as required to track service due dates and prevent service delinquency. Component data shall be provided as necessary to support the safety assessments and operation readiness review process.

9. PM performed by either a PM Plan or by operational procedure(s) as necessary to maintain safe and reliable operation.

Table 6.2 Owner Guidelines for Preventive Maintenance Inspection

Inspection Item	Guidelines for Inspection
Pressure Vessels Including Vacuum Jacketed Vessels	Relief valve is set no higher than vessel MAWP Vessel is ASME code stamped and ASME data plate is present and legible Vessel is properly labeled with service media and maximum operating pressure No flange leakage No damage to vessel or supports No degradation/damage of paint or insulation No significant external surface rust No corrosion causing pitting and wall thinning Verify layered vessel weep holes contain grease No vegetation growth near vessel (which can promote corrosion and present fire hazard)
Vacuum Vessels	Vessel is ASME code stamped and ASME data plate is present and legible Verify free and unobstructed lift plates No damage or degradation of paint or insulation No damage to vessel or supports No damage or degradation of entryway seals or seal surfaces No corrosion/damage to vacuum annulus relief devices No unusual frosting of vacuum jacket for cryogenic vessels
Air Receivers (Accumulators on Air Compressors)	No significant external surface rust No external corrosion causing pitting or wall thinning Ensure accumulator vessel is drained of water regularly Relief valve is ASME code stamped with pull ring or lever installed Verify relief valve functions using pull ring or lever (use necessary safety precautions for air release) Verify pressure gauge functional with operating pressure between 25%-75% full scale range Ensure fixed air receivers have vibration dampers installed between vessel and fixed surface Ensure belt guards properly installed (where applicable)
Relief Valves (RV)	Verify ASME date plate is present and legible Relief valves installed upright/vertical (except where manufacturer allows other orientations) Service due date has not expired Tagged to indicate earlier of manufacturer test date or delivery date (for RV's installed directly from vendor without post-procurement servicing) Discharge is unobstructed Discharge directed safely away from personnel and work areas Thrust tees installed where required and appropriate RV adequately supported to resist thrust load Inlet line flow area no smaller than RV inlet port flow area Discharge line flow area no smaller than RV outlet port flow area RV outlet bug screens installed for outdoor installations Flammables and asphyxiates vent outside building except where approved for indoor venting
Rupture Disks	Verify ASME data plate is present and legible Verify unobstructed vents No signs of Leakage No damage or distortion of disk (where possible to visually inspect)

Flex Hoses	Verify hoses retested on required interval as defined in this MPR Verify tag indicates hose MAWP, proof test date and last re-test date, where applicable Ensure hoses are properly restrained Inspect for damage/degradation using criteria found in SAE ARP 1658B Ensure hoses protected from foot and vehicle traffic
Piping/Tubing	Verify proper labeling to indicate service media and operating pressure No corrosion No damage/distortion No fitting leakage Adequate pipe/tube supports Verify unobstructed vent lines No unusual frosting of vacuum jacket for cryogenic systems Verify sufficient thread engagement on flanges and fittings (all female threads fully engaged to be acceptable) No vegetation growth near system (which can promote corrosion and present fire hazard)
Pressure Gauges	Calibrated gauges: Verify calibration label attached and due dates have not expired Pressure gauge glass not cracked or otherwise damaged and is legible Pressure gauge not under-rated for the service condition
Filters	Verify cleaning performed in accordance with due date (if any) No signs of leakage Verify fasteners properly engaged
Regulators	Manufacturer rated for service media and pressure conditions Manufacturer data plate is present and legible (manufacturer name, model/type, part number, etc.) Regulator in flammable or oxidizer service has label/tag to indicate servicing for specific media Regulator orifice size is indicated on the body of the regulator
General Components	Components rated by manufacturer for media and pressure conditions Manufacturer data present and legible (Manufacturer name, model/type, part number, etc.) Component identification tags installed Components in flammable, toxic or oxidizer service have legible service sticker/tag indicating component serviced for the appropriate media Verify component properly supported Sufficient thread engagement on flanges or component body (all female threads fully engaged to be acceptable) No signs of packing or fitting leakage No damage or corrosion Properly installed lockout devices (where applicable)
COTS Systems	No signs of leakage No signs of hose damage or degradation using criteria found in SAE ARP 1658B Inspections and maintenance performed per manufacturer's recommendations (including relief valve test or replacement)
Gas Bottles and Laboratory Dewars	No significant corrosion No obvious damage or degradation No Leakage Proper safety relief protection Proper separation distances (e.g., fuels and oxidizers)

	Proper storage and signage Proper venting location
Viewports	Verify factor of safety of 10:1 for brittle materials (glass, sapphire, etc.) No signs of damage (scratches, cracks, deterioration, etc.) No signs of seal leakage No deterioration which prevents adequate visibility through viewport
Pumps & Compressors	No signs of leakage from unit or the attached fluid conduit All attached gauges or switches in proper working condition No unusual vibration or noise during operation No unusual frosting of vacuum jacketed cryogenic systems Service performed in accordance with maintenance schedules or manufacturer recommendations

APPENDIX A

DEFINITIONS

Air Receiver. The accumulator vessel connected directly to a fixed or portable air compressor and used only in air service.

Alteration. Any change in the item described on the original Manufacturer's Data Report that affects the pressure-containing capability of the pressure-retaining item or a change to previously certified PVS.

Certification. The process that uses inspection and analysis to ensure that pressure vessels and systems are safe to operate. PVS structural integrity and safety is assessed through implementation of requirements in accordance with NPD 8710.5, NASA-STD-8719.17, applicable Federal Regulations, and national consensus codes and standards.

Certification Interval. The interval at which a PVS is scheduled for Recertification.

Certified PVS. PVS that has been deemed compliant with applicable code and Agency standards and received certification in accordance with this MPR.

Code PVS. Pressure vessels and pressurized systems that are designed, fabricated, installed, code stamped, and maintained in strict conformance with the requirements of the NCS specified as applicable by the PSM.

Commercial Off the Shelf (COTS). Commercial items that require no unique Government modification or maintenance over the life cycle of the product to meet the needs of the procuring agency. A commercial item is one customarily used for non-Governmental purposes that has been or will be sold, leased, or licensed (or offered for sale, lease, or license) in quantity to the general public. An item that includes modifications customarily available in the commercial marketplace or minor modifications customarily made to meet NASA requirements is still a commercial item.

Configuration Change. A change (e.g., alteration, modification) made to PVS that affects the form, fit or function of the system.

Configuration Management. The identification, control, accounting, and verification of requirements and implementation documentation for formal orderly control of the PVS configuration.

Critical Components. Critical components include relief valves, pressure gauges, flex hoses and any other pressure system components requiring periodic service, test or verification including all items designated as "safety critical."

Cryogenic Fluid. A liquid with a normal boiling point below -150 °C (-238 °F) at standard pressure.

Data Package. The collection of schematics, specifications, manufacturer's submittal documentation (i.e., data reports, calculations, drawings and material certifications), component information, hydrostatic/pneumatic test, cleanliness certifications, material compatibility certifications, and User/Owner calculations and drawings that are pertinent to the PVS.

Deficiency. A failure to meet or comply with applicable National Consensus Codes and Standards (NCS), drawings, specifications, critical processes or Agency requirements.

Department of Transportation (DOT) Service. Those uses of PVS covered by the regulations contained in 49 CFR 100 – 185, Pipeline and Hazardous Materials Safety Administration.

Design Pressure. The pressure used to design an individual component or system based on system owner or user need. For individual components, the manufacturer design pressure is typically equivalent to the maximum allowable working pressure (MAWP) of the component.

Deviation. A Safety Variance that authorizes a project or program relief in advance from a specific requirement and is requested during the formulation/planning stages of a program/project operation to address expected situations.

Documentum. The official MSFC repository for PVS documentation until 2015 when replaced by SharePoint. (Pre-2015 PVS records still reside in Documentum)

Engineering Evaluation. A detailed analysis and examination of a PVS supported by objective documentation to determine the system integrity verification required prior to the PVS being submitted for certification.

Engineering Sketches. Any form of drawing that does not have engineering or administrative controls (as opposed to controlled baseline drawings).

Excluded PVS. PVS that does not require certification per NASA-STD-8719.17.

Finding. A conclusion, positive or negative, based on facts derived during an inspection or investigation.

Hydraulic Systems. Those systems that use an incompressible fluid as the pressure media to perform work. These systems normally include pumps, piping, pressure safety valves, and accumulators.

In-Service Inspection (ISI). Post-construction inspections, examinations, or tests which are performed as an integral part of the certification process to assess the overall condition and structural integrity of PVS.

Interface. The functional or organizational boundary or connection point in a pressure system established primarily for administrative and management purposes.

Laboratory Space. Work areas in which electronic, chemistry, life sciences, medical, bioscience, physics, photographic, or other research, development, evaluation, or test activities are conducted using specialized equipment. Laboratory spaces are generally single story environmentally controlled areas with limited pressurants and propellants.

Leased (Rental) Vessels. Includes pressure vessels (and packaged vessel systems) which are not owned by NASA but are obtained for use on NASA property by agreements, contracts, loans, memoranda of agreement, or joint use agreements. This term also includes vessels on NASA property for tenant operations.

Maximum Allowable Working Pressure (MAWP). The maximum pressure that can be sustained without exceeding code allowable stress at design temperature and with consideration given to corrosion allowance where applicable.

Mobile Pressure Vessels. Vessels with attached road gear designed for travel on streets and highways; e.g., tube trailers, rechargers, and other vessels mounted on trailers or trucks.

National Consensus Standard (NCS). In accordance with 29 U.S.C. § 652 (9) [Title 29. Labor; Chapter 15. Occupational Safety and Health]: Any occupational safety and health standard or modification thereof which (1), has been adopted and promulgated by a nationally recognized standards-producing organization under procedures whereby it can be determined by the Secretary that persons interested and affected by the scope or provisions of the standard have reached substantial agreement on its adoption, (2) was formulated in a manner which afforded an opportunity for diverse views to be considered and (3) has been designated as such a standard by the Secretary, after consultation with other appropriate Federal agencies.

Non-Code PVS. Any pressure vessel that is not stamped with the appropriate symbol and documented as complying with the original applicable construction Code or any pressure piping system that does not meet the requirements of the appropriate fabrication code (e.g., ASME Section VIII, B31.1, B31.3), including PVS that were fabricated from non-Code materials by non-Code processes or organizations.

Non-compliance. The failure to comply with a documented requirement. The non-fulfillment of an agency or MSFC directive, national consensus code, or published standard.

Nondestructive Testing/Examination (NDT/NDE). The development and 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.

Owner. The NASA organization responsible for managing a pressure system and ensuring that the system meets the intent of this MPR and applicable Agency and consensus standards.

Portable PVS. PVS easily transported from one location to another but without mobile gear (road gear) attached. Examples include Department of Transportation (DOT) compressed gas cylinders, Hoke bottles, and portable Dewars.

Pressure Relief Devices (PRD). An automatic pressure relieving device which includes pressure relief valve, safety relief valve, rupture disc, or other similar device.

Pressure System. This MPR uses the term “pressure system” and “system” synonymously and these terms also include pressure vessels unless specifically stated otherwise.

Pressure System or PVS Owner. (See definition of “Owner”)

Pressure Systems Certification. A systematic and technically independent evaluation to determine whether pressurized systems and associated physical hardware complies with established requirements. This evaluation is documented in a Pressure Systems Certification or Recertification Report and becomes an official record when signed by the PSM.

Pressure System Certification Team (PSCT). The personnel under technical direction of the PSM responsible for PVS inspection, engineering analysis and documentation necessary for PVS certification.

Pressure Systems Reporting Tool (PSRT). The database used for accessing PVS data and tracking the status of MSFC Pressure Systems and is available through the Pressure Systems Web page at https://safety.msfc.nasa.gov/apps/psrt/.

Pressure Vessel. A vessel designed for the containment of gases or liquids at pressures (either internal or external) other than ambient.

PSM. The Center Director’s designated individual who provides oversight and technical management of certification efforts and serves as the primary point-of-contact for all MSFC certification activities as required by NPD 8710.5, NASA-STD-8719.17 and this MPR.

PVS. An assembly of components or sub-assemblies, designed for either internal or external pressure that includes but is not limited to vessels, tubing, piping, couplings, valves, relief devices, pumps, expansion joints, gauges, etc.

Recertification. The renewal of a previous certification with adjustments as necessary to accommodate new information, configuration or operating parameter changes, or PVS degradation.

Records. All documentary materials, regardless of physical form or characteristics, required to be preserved as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities due to the informational value of the data within them.

Relief Valve (RV). An automatic pressure-relieving device actuated by the static pressure upstream of the valve which opens to relieve system pressure when the static pressure reaches the set pressure of the relief valve. Also referred to as a "Pressure Safety Valve."

Repair. Work necessary to restore a pressure-retaining item to the applicable ASME code of construction.

Rupture Disk Device. A non-closing pressure relief device that is actuated by inlet static pressure designed to remain open after operation. The device performs its function by bursting a pressure-containing disk.

Safety Critical. A system or component whose failure or malfunction may result in: (1) death or serious injury to people, (2) loss or severe damage to equipment, or (3) environmental harm.

Safety Relief Device. A relief device characterized by rapid opening (pop action) to quickly relieve system pressure and prevent over pressurization.

Safety Variance Request. The written and approved authorization to operate PVS with a known non-compliance. The two types of Safety Variances are the Deviation and the Waiver. (Also referred to as a "Variance.")

Set Pressure. The pressure measured at the pressure relief valve inlet, at which there is a measurable lift, or at which discharge of a fluid becomes continuous.

SharePoint. A web-based collaborative platform used since 2015 for PVS document retention replacing Documentum.

Special Test Equipment (STE). Hardware designed and built to support test activities on a temporary basis only. STE may not be used repeatedly to support multiple test projects or programs.

System Integrity Verification. A methodology whereby the remaining life of a PVS is assessed during an engineering evaluation to determine if the PVS meets or exceeds the most applicable ASME code of construction.

Technical Space. Work areas in which assembly, instrumentation, test, checkout, data reduction, computer, calibration or similar activities are conducted. Technical spaces are typically characterized by environmentally controlled multistory or high-bay features with limited quantities of pressurants and propellants.

Test Article. A pressurized component or assembly of components, including MSFC-governed remote locations, used exclusively for the purpose of being tested.

Test Specific Pressure Systems. PVS used to perform limited 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.

Test System. PVS designed and built specifically for test or research purposes which is intended to be permanent and may be used for different projects or programs.

Test Preparation Sheet (TPS). The electronic Test Preparation Sheet is used for work authorization and configuration management by various organizations across MSFC. The electronic system is maintained and managed by the Engineering Directorate.

Vacuum Vessel. A vessel operated with the internal pressure reduced to a level less than that of atmospheric pressure.

Variance. See Safety Variance Request.

Verification. Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled.

Vessel. A closed container used to hold gases or liquids at a pressure substantially different than atmospheric pressure. The term “vessel” describes tanks, heat exchangers, accumulators, vacuum vessels, and autoclaves unless specifically stated otherwise in this MPR.

Waiver. A Safety Variance that authorizes relief after the fact from a specific requirement, and is requested during the implementation of a project or operation to address situations that were unforeseen during design or advanced planning.

APPENDIX B

ACRONYMS

AIAA American Institute of Aeronautics and Astronautics

ANSI American National Standards Institute

API American Petroleum Institute

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials

ASNT American Society for Nondestructive Testing

BFF Booster Fabrication Facility

BPVC Boiler and Pressure Vessel Code

CAD Computer Aided Design

CFR Code of Federal Regulation

CoF Construction of Facilities

CGA Compressed Gas Association

CM Configuration Management

CMTR Certified Mill Test Report

COPV Composite Overwrapped Pressure Vessel

COTS Commercial Off-the-Shelf

DOD Department of Defense

DOT Department of Transportation

DRD Data Requirements Description

EM MSFC Materials and Processes Laboratory

FMO Facilities Management Office

GSE Ground Support Equipment

ISI In-Service Inspection

ISO International Standardization Organization

KSC Kennedy Space Center

MAF Michoud Assembly Facility

MAWP Maximum Allowable Working Pressure

MCL Metrology and Calibration Laboratory

MOU Memorandum of Understanding

MPR Marshall Procedural Requirements

MSFC Marshall Space Flight Center

MUA Material Usage Agreement

MWI Marshall Work Instruction

NASA National Aeronautics and Space Administration

NB National Board

NBBI National Board of Boiler Inspectors

NBIC National Board Inspection Code

NCS National Consensus Codes and Standards

NDE Nondestructive Examination

NDT Nondestructive Test

NPD NASA Policy Directive

NPR NASA Procedural Requirement

NRRS NASA Records Retention Schedule

OI Ownership Interface

OI Organizational Instruction

OSHA Occupational Safety and Health Administration

PE Professional Engineer

PM Preventive Maintenance

POC Point of Contact

PPE Personnel Protective Equipment

psig pounds per square inch gauge

PPDS Pressurant and Propellant Delivery Service

PRD Pressure Relief Devices

PSM Pressure Systems Manager

PSCT Pressure System Certification Team

PSRT Pressure Systems Reporting Tool

PTFE Polytetrafluoroethylene

PVDD Pressure Vessel Documentation and Data

PVS Pressure Vessels and Systems

RAC Risk Assessment Code

RP1 Rocket Propellant-1 (or Refined Petroleum-1)

RV Relief Valve

SA Safety Category (data category for DRD)

SAE Society of Automotive Engineers

SMA	Safety and Mission Assurance
SME	Subject Matter Expert
SHE	Safety Health & Environmental
SOW	Statement of Work
STD	Standard
STE	Special Test Equipment
SVR	Safety Variance Request
TPS	Test Preparation Sheet
TEA TEB	Triethylaluminum-Triethylborane
UG	User Guide
UL	Underwriters Laboratories
UV	Ultraviolet
V	Valve Certification (as in “V number” used by MSFC Valve and Component Lab)
VC	Valve Control (as in “VC number” used by MSFC Valve and Component Lab)

APPENDIX C (Reserved for Verification Matrix)

N/A

APPENDIX D

RECORDS

The records generated or required by this MPR are identified in the table below and are retained in accordance NRRS 1441.1 and MPR 1440.2.

Record Description	Record Custodian	Record Location	Record Retention Schedule (See Note)	Record Retention Period (See Note)
Original Certification Data Packages (paper)	Certification Lead Engineer	PVS Certification Team Files	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination.
Certification Data Packages (electronic)	MSFC Documentation Repository	Documentum with link through PSRT (after 2015) SharePoint	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination
Pressure Vessel Documentation (paper) (code required forms, design specification, drawings, test records, procurement specifications)	Certification Lead Engineer	PVS Certification Team Files	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination
Pressure Vessel Documentation (Electronic) (code required forms, design specification, drawings, test records, procurement specifications)	Certification Administrator	Documentum with link through PSRT	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination
Original Variances (paper)	PVS Owner	PVS Owner Paper Record Files	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination

Variances – Electronic Files (Official Record)	Certification Administrator	Documentum with link through PSRT	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination
Pressure System Committee member roster, minutes, agenda and attendees list	Certification Administrator	SharePoint	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination
Records resulting from execution of pressure system CM/PM Plan, including work authorization, system drawings, component data, engineering documentation, procurement specifications, and preventive maintenance records related to specific PVS.	PVS Owner	PVS Owner Records Retention Areas	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination
Records for MSFC Owned PVS at Locations Remote to MSFC (e.g., MAF, KSC)	Certification Contractor/Operation Contractor	Contractor Records Retention Areas at Location	NRRS 8/103	Destroy/delete between 5 and 30 years after program/project termination

Note: NRRS 1/118/A deals with Ground-based Pressure Vessels. However, the current retention for that schedule is to destroy the records when they are 25 years old. A revision to NRRS 1/118/A has been proposed that will lengthen the retention to "Retire to Federal Records Center when related pressure vessel has been disposed of by NASA; destroy 5 years after disposal." Until the proposed revision is approved, the MSFC Records Manager has recommended that NRRS 8/103 be used for all long-term temporary ground-based pressure vessel records. For purposes of this document, "program/project termination" means when the pressure vessel or system has been destroyed and/or disposed of by NASA.

APPENDIX E

PRESSURE VESSEL AND FLUID CONDUIT LABELING FOR HAZARD IDENTIFICATION

The information below provides guidance for pressure vessel and fluid conduit labeling which meets the intent of ASME A13.1 "Scheme for the Identification of Piping Systems" and clarifies how ASME A13.1 will be applied to MSFC specific fluid media. ASME A13.1 does not provide specific guidance for all fluid categories used at MSFC or at MSFC managed facilities.
The table below provides information for fluid categories not specifically defined in ASME A13.1 or provides additional clarification for fluid categories that are identified in ASME A13.1. The labeling color schemes shown in the table below will be used, along with those specifically identified in ASME A13.1, except as noted below in the paragraph "Use of Existing Labeling Schemes."

Fluid Category	Typical MSFC Fluid Services (liquids and gases as applicable)	Background/Lettering Color
Inert/Asphyxiate Fluids	Nitrogen, helium, argon, etc.	Safety White/Black
Air	compressed or missile grade air	Safety Blue/White
Oxidizers	Oxygen	Safety Brown/White
Vacuum	(same as air)	Safety Blue/White

Note 1: Reference Table 2 in ASME A13.1-2007 for additional fluid categories and the associated labeling schemes

Note 2: The color scheme for a "combustible" fluid in ASME A13.1 is safety brown/white which is shown above for oxygen. Although oxygen is not classified as a combustible fluid, the safety precautions necessary for a combustible fluid system are generally the same as those for oxygen (i.e., no smoking, no welding, no open flames, etc.).

Use of Existing Labeling Schemes: ASME A13.1 does allow the system owner to use existing labeling schemes for identifying fluid hazards, however, A13.1 requires that these labeling schemes be identified in writing and communicated to affected personnel. Therefore, existing labeling color schemes which do not comply specifically with A13.1 Table 2 and the table above may be used provided that:

- The labeling schemes include legends that specifically identify the fluid media, pressure and flow direction as required by ASME A13.1
- The labeling scheme is properly communicated to all affected personnel and is identified in an approved and controlled organizational document
- The labeling scheme makes clear distinction between fluids of different hazard categories (e.g., flammables vs. asphyxiates vs. oxidizers, etc.)
- The labeling scheme is standardized and consistent within an organization or within a given facility so as not to create confusion among operations personnel

There will be no exceptions or custom tailoring of labeling schemes for fire quenching fluids which are to have safety red background and white lettering per ASME A13.1.

APPENDIX F

DRD Example Only (Official Record Copy Maintained at the DRD web-site)

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **DPD NO.**: XXX **ISSUE**: Revision A
2. **DRD NO.**: **Example A**
3. **DATA TYPE**: 1
4. **DATE REVISED**: 8/3/17
5. **PAGE**: 1/2

6. **TITLE**: ASME Section VIII Pressure Vessel Data and Documentation

7. **DESCRIPTION/USE**: To provide specifications for American Society of Mechanical Engineers (ASME) Section VIII, Boiler and Pressure Vessel Code (BPVC) compliant metallic pressure vessels (or procurement of vessel repair/modification services) including autoclaves, heat exchangers and vacuum vessels to identify and ensure delivery of appropriate engineering information and documentation (data, analyses, inspection results, certified reports and forms) as contract submittals in accordance with the associated Statement of Work (SOW).

8. **OPR**: QD10 9. **DM**: QD10

10. **DISTRIBUTION**: Per Contracting Officer's letter

11. **INITIAL SUBMISSION**: The following shall be submitted in the Offeror's initial proposal/offer: approved ASME Code compliant Quality Assurance Plan; proposed vessel material specifications; proposed deviations or exceptions to the SOW; other initial submittals as specified in the SOW.

12. **SUBMISSION FREQUENCY**: In accordance with requirements of Section 15.3 below.

13. **REMARKS**: The use of the term "Code" in this DRD refers to ASME Section VIII Boiler and Pressure Vessel Code unless otherwise noted. New pressure vessels shall be registered with the National Board of Boiler and Pressure Vessel Inspectors.

14. **INTERRELATIONSHIP**:

15. **DATA PREPARATION INFORMATION**:

15.1 **SCOPE**: The data submitted by the Offerer as required by this DRD provides the basis for work acceptance by the government and shall be in accordance with the associated SOW and ASME Section VIII BPVC.

DRD Continuation Sheet

TITLE: ASME Section VIII Pressure Vessel Data and Documentation **DRD NO.**: **Example A**
DATA TYPE: 2 **PAGE**: 2/2

15. **DATA PREPARATION INFORMATION (CONTINUED)**:

15.2 **APPLICABLE DOCUMENTS**:
NASA-STD-8719.17 *NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS)*
ASME Section VIII *Boiler and Pressure Vessel Code (latest version unless otherwise specified in SOW)*

15.3 **CONTENTS**: The Offerer shall provide the following technical information and documentation per the schedule identified in Section 12.

a. Certifications, Records and Drawings (15 days prior to beginning fabrication)
   1. Certified Mill Test Reports (CMTRs) for all base metals, raw materials and vessel components
   2. Weld filler metal certifications
   3. Nondestructive test (NDT) technique sheets
   4. NDE/NDT personnel certifications
   5. Weld procedure specifications (WPS)
   6. Weld procedure qualification records (PQR)
   7. Welder/Welding Operator qualification records.
   8. Engineering design calculation package
   9. Shop fabrication drawings with weld details and parts list

b. Procedures (5 days prior to performing heat treatment):

   1. ASME Code compliant heat treatment procedures.

c. Final Engineering Package Deliverables (5 days prior to delivery of vessel or at completion of repair/modification):
   1. National Board Form compliant with Code of construction (or repair).
   2. Professional Engineer (PE) certified design calculation package (Section VIII Division 2 or 3 only)
   3. Hydrostatic test records/reports
   4. NDT inspection reports and radiographs (as applicable per Code requirements)
   5. Heat treatment data, charts and reports
   6. Vessel name plate photograph or facsimile
   7. Approved non-conformances, waivers and deviations (if any)

15.4 **FORMAT**: Contractor format is acceptable except where mandated by ASME Section VIII Code requirements.

15.5 **MAINTENANCE**: None required

NOTE to STD/SA-PVDD

ASME Section VIII Pressure Vessel Data and Documentation

Applicability Instructions: The requirements, limitations and exceptions for use of this DRD are addressed in MPR 8710.1, MSFC Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS).

This DRD applies to the procurement of new ground-based metallic ASME Section VIII pressure vessels including vacuum vessels, autoclaves and heat exchangers to the extent specified in MPR 8710.1. The DRD also applies to the procurement of modification or repair services for ground-based pressure vessels.

This DRD applies to procurements related to ground-based pressure vessels at NASA MSFC and MAF.

Note 1: When conflicts arise between this requirement and either MPR 8710.1 or NASA-STD-8719.17, NASA Requirements for Ground Based Pressure Vessels and Pressurized Systems (PVS), NASA-STD-8719.17 shall take precedence.

Requirements for ground-based pressure vessel documentation or data, in addition to those listed in this DRD, may be required and should be identified in either the tailored DRD or the SOW.

Statement of Work words: "The contractor shall provide pressure vessel documentation and data within the time constraints identified in DRD STD/SA-PVDD."

NOTE:
These applicability instructions on this DRD are not a part of the DRD and should not be included in a DPD.