SUBJECT **PRESSURE VESSEL AND SYSTEMS (PVS) CERTIFICATION COMPLIANCE PROCEDURE**

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PURPOSE

This procedure defines the NNK08OC01C Base Operation & Spaceport Support (BOSS) process for maintaining Pressure Vessel Certification requirements on the assigned Government-furnished Pressure Vessel Systems identified in Tech Exhibit 4.3.1.1-1, BOSS PVS Database per the Performance Work Statement (PWS) General Requirements Section 4.3.1.1. The execution of this process provides for compliance with the NASA Procedural Requirement (NPR) 8715.1 C “KSC Safety Procedural Requirements” and the NASA-STD-8719.17 “NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS)” technical standard.

SCOPE AND APPLICABILITY

This procedure is applicable to all BOSS personnel at the Kennedy Space Center (KSC) who perform inspections, testing, analysis, operations, maintenance, and administration functions to ensure compliance of the PVS certification program.

This procedure is applicable for all National Aeronautics and Space Administration (NASA) owned systems under BOSS responsibility which require certification per Kennedy NASA Procedural Requirements (KNPR) 8715.3 “NASA General Safety Program Requirements”. This includes NASA owned systems physically located on the Cape Canaveral Space Force Station (CCSFS). Systems excluded from certification, which require tracking, are also covered by this procedure as provided in NASA-STD-8719.17C, Paragraph 4.2. The PSM has the authority to determine applicability of any Category Exclusion to specific PVS.

PVS consist of pressurized tanks, vessels, or systems designed to operate at pressures above 15 psi (zero psi for systems containing hazardous or lethal fluids). PVS components include but are not limited to tanks, vessels, valves, relief valves, piping, and gauges required to maintain the systems at the required pressures. Systems include facility compressed air, mobile compressors, and gaseous nitrogen (GN2) regulator panels/distribution, in addition to facility boilers.

When conflicts exist between this document and the National Consensus Standard (NCS), the NCS shall take precedence, except in those cases where the NCS is invoked by an applicable Government regulation. When conflicts exist between this document and a NASA Standard, the NASA standard shall take precedence. Conflicts between NASA-STD-8719.17 and other requirements documents shall be resolved by the responsible KSC Pressure Systems Manager (PSM) in accordance with NASA-STD-8719.17.

PROCESS

1. PVS CERTIFICATION PROCESS

NASA’s requirements for Certification and Recertification of Ground-Based Pressure Vessels and Systems across all Centers are specified in NASA-STD-8719.17. These requirements are levied on KSC and Contractors through KNPR 8715.3. These requirements were developed through the Centers’ Pressure System Manager(s) (PSM)s

derived from industry experts as they pertain to the continuing “qualification” of aging vessels and systems.

All facility related PVS which are not excluded shall be certified and recertified in accordance with American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section VIII, Divisions 1 or 2, ASME Code for Power Piping, B31.1, Process Piping, B31.3, and National Board Inspection Code, ANSI/NB-23.

Additionally, all fixed pressure vessels and pressurized systems shall comply with KSC design requirements as stated in KNPR 8715.3. All Certified PVS shall be safe to operate and be subject to In-Service Inspection (ISI), Half Life Pressure Vessel NDE, Relief Valve functional testing, and periodic recertification to maintain personnel and equipment safety.

1.1. PVS Certification & Recertification Criteria

1.1.1. General Requirements

The following criteria apply for PVS Certification’s and Recertification’s:

- All new PVS shall be designed, fabricated, installed, operated, maintained, and certified in accordance with the applicable codes, standards, and guides.
- Recertification of PVS that do not conform to these codes, standards, and guidelines require that supplemental analyses, tests, and examinations be performed to ensure that the safety of personnel, equipment, and facilities is not compromised.
- Periodic inspection and maintenance activities shall be specified and documented throughout the usage history of the PVS. Inspection procedures shall be developed on the basis of established codes and standards or as the result of an engineering evaluation.
- Vessels and systems that are on standby/contingency status, either with or without pressure, shall be viewed as if they are in continuous service, and the certification of these PVS shall be maintained to conform to the normal service conditions.
- Piping shall be analyzed for stress levels at the operating condition, ensuring they meet the requirements of KSC-STD-Z-0005 “Design of Pneumatic Ground-Support Equipment, Standard for Engineering Development Directorate” and/or American Society of Mechanical Engineers (ASME) B31.3, “Chemical Plant and Petroleum Refinery Piping.” Flanges and other connections shall be evaluated to comply with applicable American National Standards Institute (ANSI), ASME, or manufacturer’s standards.
- Material shall be evaluated to comply with KSC-STD-Z-0005, ASME B31.3, Chapter III, “Materials”, and ASME Section II.
- System components like relief valves, regulators, valves, rupture disk, etc. shall be analyzed to verify proper flow characteristics and capacity. The pressure and flow characteristics of components as determined through analysis shall fall within the Maximum Allowable Working Pressure (MAWP) and Maximum Operating Pressure (MOP) limits for each system.

- Components shall meet the requirements of the following standards as applicable: KSC-STD-Z-0005; ASME B31 Chap. 4, “Standards for Piping Component,” Manufacturer’s Data; and/or NASA Component Specification Pressure Ratings.
- All discrepancies identified from PVS inspection shall be documented and resolved per the latest revision of ENG-P-0027 “Technical Anomaly Event Disposition Process” procedure.

1.1.2. Documentation Requirements

The certification process is based on field inspections, testing, analysis, and reviews of operational and technical documentation to ensure that the PVS meets operational requirements and is technically safe to operate. The final product of the process is the Certification Report that is approved by the KSC PSM and stored in NASA TechDoc as a historical record.

All discrepancies identified during the inspection shall be noted in the ISI and a EWR shall be written to correct the discrepancies.

The official start time for the repair/replacement shall be when the respective Electronic Work Request (EWR) and/or Task Orders (TO)s are approved by NASA for funding. Special circumstances may occur requiring extensions beyond the original due date of repair, however, to satisfy the intent of the contract language a documented approval from the KSC PSM shall be required in advance.

1.1.2.1. Assessment Reference Sources

The Certifying Engineer shall review the applicable system documentation for the PVS including but not limited to configuration drawings, manufacturers data catalogs, prior Certification Reports, and maintenance and repair records (TAL1, TAL2, TAL3 work orders) for performing their assessment. The documentation utilized for the certification assessment is stored and accessed from one or more of the following databases:

- The OMEU database identifies systems by facility, baseline or work unit code and includes links to related drawings, construction data packages, etc.
- Certification reports are stored for historical reference in NASA TechDoc based on work unit code, program model number, baseline or facility.
- Maximo database contains system asset numbers and tracks work orders for maintenance issues, repairs or upgrades.

1.1.2.2. Configuration, Fabrication and Other Documentation Review

System documentation shall be reviewed prior to an inspection. The configuration documentation shall be used to verify the actual field configuration during the visual inspection. For configured systems or components, the field configuration shall match that of the drawing.

The BOSS PSM or PVS engineer shall ensure that low pressure systems that are not considered configured per the Operations, Maintenance, Engineering, and User (OMEU)

database but contains hardware not excluded from Pressure Vessel System Certification (PVSC) is tracked by maintaining a listing of all hardware requiring certification and manage it within the organization as configured. Changes to hardware requiring PVSC shall be documented and recorded for historical reference.

Configuration drawings shall include but not be limited to the following:

- A mechanical schematic, showing operating pressures of particular components (vessels, regulators, pressure gauges, etc.,) safety device set pressures and tolerance, tube and pipeline sizes and wall thicknesses, and Grayloc hub sizes where applicable.
- A schedule of vessels, if included in the system, detailing manufacturer, date of manufacture, details of construction including critical dimensions (e.g. head and shell thicknesses, overall length, Inside Diameter (ID) and Outside Diameter (OD),) design operating conditions (MAWP, temperature, service media), corrosion allowance, materials and material properties (tensile and yield strength and impact properties,) weld joint efficiencies, Non Destructive Examination (NDE) performed, and pressure tests performed. This information shall also be included in the Certification or History Report along with design calculations, manufacturer's data report, inspection, examination and test records and a facsimile of the stamped nameplate. Any additional manufacturer's data shall be released in the Vessel Data Manual (including operating instructions, test records, etc.)
- A component list with part numbers traceable to the manufacturer. If existing PVS has missing or illegible part numbers and the configuration drawing does not identify them, then fabrication drawings and maintenance documentation shall be checked to verify a satisfactory component is installed.
- Where there is value added, a diagram of vessel marking shall be included.
- System fabrication documentation shall be reviewed if the configuration drawing is lacking information and the initial field inspection walk-down fails to identify the specific information. The fabrication documentation shall resemble the as-built condition unless design upgrades have been implemented.
- Where upgrades have been incorporated, the drawing changes shall either be incorporated on a new drawing or recorded in a manner where they are traceable for future reference as a latest revision for configuration purposes. Manufacturer's drawings shall be either certified shop drawings or as-built drawings.
- Additional documentation may include the System Documentation List, the Spare Parts Analysis, the System Assurance Analysis, Operation and Maintenance Instructions, Operations and Maintenance Controlled Requirements (OMCR), Operations and Maintenance Requirements and Specification Documents (OMRSD), and Vendor Manuals. Changes impacting any OMCR or OMRSD system requirements shall be reviewed and processed per the latest revision of ENG-P-0033 "BOSS OMRS and OMCR Process Procedure".

1.1.2.3. Component Documentation Review

Manufacturer's documentation, including KSC component specifications shall be reviewed to verify pressure rating, materials of construction for metallic and nonmetallic components, flow parameters, operating characteristics, and relief device capacity to maintain system pressure within ASME Code allowable limits.

The data sheets or component specs shall indicate the components meet National Consensus Standard (NCS), have been hydrostatically tested, burst tested or undergone alternate acceptable qualification testing.

Safety-related pressure indicating devices shall meet a NCS such as ASME B40.100, UL-404, or MIL-G-18997. They shall also meet minimum acceptable accuracy as identified in the appropriate NCS.

View ports shall be pressure tested as installed in accordance with the code of construction for the PVS in which it is installed. They shall be analyzed for fluid compatibility.

1.1.2.4. Configuration Change Management Review

Documentation related to configuration changes shall be reviewed prior to an inspection. The documentation shall be used to verify the field configuration matches the respective configuration drawings as observed during the visual inspection. Examples of changes that shall be incorporated on drawings shall include but not be limited to the following:

- Design upgrades or modifications.
- Alterations or repairs to vessels under an R-1A or similar report in accordance with National Board Inspection Code (NBIC), NB-23.
- Repairs or adjustments to systems that alter the field configuration under a design Work Order Number (WON), field change notice, other directive (e.g. Information Request (IR)) or maintenance or TAL WON.
- Any design changes shall be incorporated into the configuration drawing. If a design proposal is in planning, but has not been funded or completed, an Engineering Order (EO) may be in place which shall only be incorporated upon the completion of the work. If the vessel repair results in any change to the vessels operating characteristics, the vessel schedule on the configuration drawing shall be updated. Any derating of a vessel shall be identified on the respective drawing. All configuration changes on configured systems shall be processed through the BOSS Configuration Control Board per ENG-P-0002 "Configuration Management of Facilities/Systems/Equipment/Utilities (FSEU)" procedure.

1.1.3. Engineering Assessment

The recertification process continues with an engineering assessment of existing vessel and system conditions to ensure that the PVS complies with documentation and code requirements. Certification of new vessels shall be dependent on the evaluation of the design documentation.

1.1.3.1. History and Initial Service Life Review

Based on the system work order review in Maximo, the BOSS Engineer shall interview the respective system engineer on the operating and maintenance history. A review of the system or vessel service life shall be addressed as well. Typical areas emphasized during the certification assessment include but are not limited to the following:

- Verification that operating parameters documentation is accurate.
- Determination of personnel exposure during operating hours for use in the risk assessment.
- Review of component repair/replacement issues, in particular gauges, relief valves, or regulators where reliability may be in question.
- Review of technical anomaly events TAL1, TAL2, TAL3, or safety related events.
- Review of design upgrades or system modifications since prior certification and their effects on operations.
- Review of vessel pressurization cycles for life expectancy determinations.
- Obtain a baseline NDE Ultrasonic Thickness Testing (UTT) on all new receivers & vessels.

If a major problem is found during the PVS inspection, then the SE shall be notified, and the issue will be discussed at the next SHARP meeting. For minor problems, the PVS engineer shall submit a EWR (see Section 1.1.3.3 – Field Inspection Requirements).

1.1.3.2. Personnel Safety Hazards and Related Mitigation Actions

Prior to site visits and/or field inspection, identify any hazardous conditions or operations for the area. Where hazardous conditions or operations exist, ensure proper mitigations are in place prior to entry. Some examples for consideration are as follows:

- Condition - Systems located around hypergolic, hydrogen or other flammable, toxic and corrosive materials.

  Mitigation - Verify whether an area clear is required by Environmental Health & Safety; Use the buddy system; Use a safety badge exchange board.

- Condition - Systems used to perform transfers of hazardous materials.

  Mitigation - Contact the operations desk to verify location is safe to enter.

- Condition - Systems located in confined spaces.

  Mitigation - Undertake and maintain confined space entry certification; Coordinate confined space entries with the confined space entry supervisor.

- Condition - Other temporary situations where personnel safety may be jeopardized.

  Mitigation - Do not perform inspections until conditions are favorable for a safe inspection.

1.1.3.3. Field Inspection Requirements

The PVS engineer shall perform the field certification inspection utilizing the latest revision of the PVSC inspection form ENG-F-PVS1 as a checklist to ensure all requirements of the certification process are addressed properly to satisfy NASA-STD-8719.17 and NBI Code NB-23. All non-compliances noted during the inspection shall be identified in the "Remarks" column of the respective row where the non-compliance is observed. Each non-compliance shall have a Maximo Technical Anomaly Level (TAL) work order or EWR initiated by the respective System Engineer (SE) or PVS Engineer and the associated Work Order Number (WON) shall be input beside the discrepancy description noted in the "Remarks" column where it applies. All fields of the inspection form shall contain an entry.

For the three-year In-Service Inspection (ISI) requirement, the checklist shall be saved in a file for verification that the requirement has been satisfied. Photographs taken during the ISI shall be stored with the report for objective evidence. The checklist shall be named/stored with the standard convention "KSC(PVSC Document Number)VE(date)". As an example, KSC-12587 performed on June 27, 2018, would be stored as KSC-12587VE6.27.18.

The inspection results recorded on the checklist shall be utilized for the final certification report but is not considered part of the report. The form shall be saved as a historical record as an attachment to the report. The Certification Field Inspection covers four specific areas as noted on the ENG-F-PVS1 inspection form as shown in Figures 1 through 4 that follows. Add additional inspection forms as necessary per the PVSC of the inspected system (e.g. Vessel 2, Component 2, etc.). If components and/or vessels are missing CAIR, PVSC and/or No Calibration Required label(s), apply new label(s) out in the field or submit an EWR to have new label(s) applied. Write down corrective actions to be taken and EWRs submitted in the general remarks section of the inspection form. Once ISI is complete, update DRDs, fiscal year and performance standards spreadsheets noting when the ISI was completed and when the next ISI (in 3 yrs. time) is due.

FIGURE 1: COMPONENT INSPECTION FORM

Item No.	Component Installation Inspection Requirement	Y	N	N/A	Remarks
1	Do the components match the drawing?	☐	☐	☐	
2	FOR PANELS: Is the configuration and approximate location of components, tubing and direction of flow identified on the front of the panel face?	☐	☐	☐	
3	FOR PANELS: Is the panel face marked with Panel Title, Drawing Number, PMN, MAWP, Media and Component Find No.'s?	☐	☐	☐	
4	Is there any component damage or leaks?	☐	☐	☐	
5	Are all vent and relief valve exhaust directed away from personnel, supported, and side wall RV's zero thrust tee and screened?	☐	☐	☐	
6	*Are all relief valves marked/labeled with: A. Set Pressure in psig B. Date valve was set or calibrated? C. Due date of next calibration? D. Manufacturer's Nameplate?	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	
7	Are the relief valves that protect pressure vessels ASME stamped?	☐	☐	☐	
8	A. Are the relief valves installed vertically? **B. Is there a reducer on the relief valve inlet?	☐ ☐	☐ ☐	☐ ☐	
9	*Are all pressure gages marked/labeled with: A. Date gage was set or calibrated? B. Due date of next calibration? C. Part Number?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	
10	*Are all Transducers marked/labeled with: A. Date valve was set or calibrated? B. Due date of next calibration? C. Part Number?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	
11	*Are all pressure switches in current calibration?	☐	☐	☐	
12	* Are all flowmeters in current calibration?	☐	☐	☐	
13	Does the system have electrical grounding and bounding?	☐	☐	☐	

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* If not in current calibration and there is not a "NO CAL REQD" sticker affixed, write a TAL work order at this time.

** If there is a reducer on the relief valve inlet, write a TAL work order to remove it.

FIGURE 2: SYSTEM PIPING INSPECTION FORM

Item No.	Tube & Pipe Installation Inspection Requirement	Y	N	N/A	Remarks
1	Are there any conspicuous cracks, defects, or flaws in the assemblies or their welds?	☐	☐	☐	
2	Are there any signs of corrosion or leaking?	☐	☐	☐	
3	Are all the assemblies free of dents, irregular bends, or any other noticeable irregularities?	☐	☐	☐	
4	Are the tube assemblies supported per KSC-SPEC-Z-0008, Table 10	☐	☐	☐	
5	Do the stainless steel tube assemblies have ID tags indicating their test pressure, pressure test date, direction of flow and size?	☐	☐	☐	
6	Do the interconnecting/distribution piping & tubing have ID tags indicating commodity, direction of flow, and normal operating pressure?	☐	☐	☐	
7	For pipe and tube supports: (a) Are there any conspicuous cracks, defects, or flaws in the supports or their welds? (b) Are there any signs of corrosion?	☐ ☐	☐ ☐	☐ ☐	
8	If insulated, does the insulation show any signs of deterioration or damage? Are there signs of water (or other fluid) intrusion under the insulation?	☐	☐	☐	
9	Is the tubing / piping adequately protected from mechanical damage (such as impact from tools, equipment, etc.)?	☐	☐	☐	

FOR REFERENCE ONLY

FIGURE 3: PRESSURE VESSEL INSPECTION FORM

Item No.	Pressure Vessel Inspection Requirement	Y	N	N/A	Remarks
1	Is the vessel ASME Stamped?	☐	☐	☐	
2	Is the vessel is physically identified with the correct find number?	☐	☐	☐	
3	Does the vessel have a manufacturer's nameplate with the following: MAWP or DP, Temp Range, Capacity, Material, Media, Model No. or Serial No.?	☐	☐	☐	
4	Is the MAWP or MOP and Name of Service Fluid displayed on the vessel in a conspicuous location (visible from 50 ft)?	☐	☐	☐	
5	Does each pressure vessel have the KSC PV/S Certification Program Sticker/Label?	☐	☐	☐	
6	Is vessel protected by an RV with a set pressure not exceeding vessel MAWP?	☐	☐	☐	
7	Can RV be isolated from vessel?	☐	☐	☐	
8	For uninsulated vessels, are vessel welds free of cracks or corrosion?	☐	☐	☐	
9	For painted vessels: A. Is there any evidence of deterioration or flaws? B. Is there any evidence of deterioration or flaws in vessel supports?	☐ ☐	☐ ☐	☐ ☐	
10	For unpainted and uninsulated vessels: A. Is there any evidence of deterioration, flaws or corrosion? B. Is there any evidence of deterioration or flaws in vessel supports?	☐ ☐	☐ ☐	☐ ☐	
11	Are all telltales/vent/weep holes free of plugs or covers?	☐	☐	☐	
12	Is the vessel adequately protected from mechanical damage (bollards)?	☐	☐	☐	
13	Is the condensate drain functional?	☐	☐	☐	
14	For insulated vessels: A. Is the insulation free of damage and deterioration? B. Are there any signs of leaking from the vessel through the insulation? C. Are there signs of water intruding under the insulation?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	

FOR REFERENCE ONLY

FIGURE 4: FLEX HOSE INSPECTION FORM

Item No.	Flex Hose Installation Inspection Requirement	Y	N	N/A	Remarks
1	Does the flex hose identification information on the hose agree with the SMS & LRU parts list?	☐	☐	☐	
2	Is a tag/s affixed to the flex hose which contains the following data: (a) Maximum rated working pressure? (b) Date of fabrication? (c) Hydrostatic pressure test date? (d) Current, visual inspection and next due date? (e) KSC or vendor part number? (f) Serial Number? (g) Find Number? (h) Service media? (Only for dedicated system fluid hoses in support of any oxygen, hydrocarbon or hypergolic liquid systems.)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
3	Is the rated working pressure of the flex hose greater than or equal to the system operating pressure shown on the SMS?	☐	☐	☐	
4	Are flex hoses with operating pressures above 150 psig constrained in accordance with 80K51846?	☐	☐	☐	
	Is flex hose rubbing on any surface causing wear or abrasion?	☐	☐	☐	
5	Are there any hot spots? (Note: it is normal for the SST braid to turn a uniform golden-brown color after exposure to high temperatures. However, isolated patches of color are not normal.)	☐	☐	☐	
6	Is the flex hose's outer surface free of corrosion, deterioration, deformation, flattened areas, or cut braid?	☐	☐	☐	

FOR REFERENCE ONLY

1.1.3.4. System NCS Assessment

The certifying engineer shall review the existing calculations and determine if they are still valid, require recalculation, or a verification of parameters is needed.

For Code PVS

- Historical data, physical measurement and the condition assessment shall be used to complete the Integrity Assessment indicating if the PVS meets the requirements of the original construction Code. If changes in Code requirements require re-rating, re-rate shall be provided per the new requirement as applicable.
- PVS that does not meet the original construction Code, repair the PVS per Code requirements, re-rate to a lower pressure to meet Code requirements, recertify as non-Code PVS or remove from service. Any Code PVS which are recertified as non-Code PVS shall be clearly marked per NCS to indicate the new condition status.

For Non-Code PVS

- PVS which has an equivalent code in an NCS, any changes in the equivalent code shall be reassessed for impacts on the non-Code PVS. All other assessments shall meet the equivalent NCS.
- The factor of safety per the original code of construction shall be maintained.
- A case-by-case probability assessment shall be performed.

1.1.3.5. Material of Construction Evaluation

The certifying engineer shall review the existing materials of construction for code-compliance or commodity suitability by identifying the alloys used, material tensile properties, and impact properties. Additional assessments include the following, but are not limited to:

- The material shall be listed per code and be compatible with the commodity (e.g. stainless steel is only acceptable under certain conditional limits in oxygen service.) Any non-compliant components or questionable service usage shall be evaluated separately.
- Any non-code specified materials are acceptable provided their adequacy for the intended application can be demonstrated and approved by the KSC PSM.
- If the actual material composition is not known, utilize conservative assumptions regarding material characteristics.

1.1.3.6. Initial Integrity Assessment

Integrity assessments shall be performed per the applicable NCS. The assessment shall include an inspection plan to address credible failure mechanisms. Identify most likely failure modes, including fatigue, and most likely locations for accumulated service-related damage. A Non-Destructive Examination (NDE) Test plan shall be implemented to identify typical failure mechanisms. The NDE Test Plan requires approval of the KSC PSM. View ports shall have their cyclic life and ambient noise effects assessed to determine the appropriate inspection cycle.

Additional items to consider include, but are not limited to:

- Evaluate major energy and toxic material sources supplying and/or affecting the system.
- Perform worst case wall thickness calculations in both stress and stability.
- Perform nozzle reinforcement calculations where applicable.
- Perform analysis of high stress areas such as nozzles, supports, or other significant discontinuities.
- Verify material thickness and other aspects of configuration to ensure applicability of analysis.
- Identify critical welds or welds most likely to experience degradation for performance of volumetric inspections with quantity and location subject to the approval of the KSC PSM. These areas shall be identified on the NDE plan.

1.1.3.7. System Condition Assessment

Perform visual inspections of overall PVS condition, including such items as critical weld configuration, condition and quality, corrosion, erosion, or other system deterioration. Identify any visible damage mechanisms and include NDE to evaluate suspect areas. Corrosion rates shall be identified in the PVS integrity assessment. Several references for evaluation of corrosion types include ASTM G46, CGA C-6, and URL https://www.corrosionclinic.com/.

1.1.3.8. Integrity Requirements Findings Assessment

Assess the findings from inspections, operational review, and documentation to develop the detailed integrity assessment. Discrepancies shall be documented and managed per the latest revision of ENG-P-0027 on a Maximo TAL work order. Root/problem causes and corrective actions shall be documented on the respective TAL work order. The discrepancies shall be recorded on the final Certification Report along with the corresponding Maximo TAL Work Order Number (WON). Evaluate ISI plan to determine if increased inspections are warranted.

1.1.3.9. Remaining Service Life Evaluation

Evaluate remaining service life limitations based on pressure or thermal cycles. The remaining life shall be calculated based on comparing the design thickness to the latest minimum UTT measurement thickness along with determining a corrosion rate. The minimum UTT measurement thickness can be within 6% tolerance of the ordered (design) thickness as per ASME BPVC to be deemed acceptable. Using the corrosion rate, the remaining life is calculated by comparing the existing thickness to the minimum design thickness and dividing by the corrosion rate. If the cyclic history cannot be verified through history files or logs, a conservative estimate shall be determined.

If the remaining service life is less than the recertification interval for the vessel in question, then the vessel shall be considered for de-rating to a lower MAWP. De-rating a vessel to a lower MAWP will require the procurement of the vessel's U-1A form from the National Board of Boiler and Pressure Vessel Inspectors (NBBI) along with employing

ASME BPVC equations to determine the minimum required wall thickness at the lower specified MAWP. Procuring the vessel's U-1A form requires submitting form WCC-F-2001A to procurement along with the vessel's nameplate data that states the vessel's unique NB number. Once the U-1A form has been procured, a vessel can be de-rated based on the minimum required wall thickness along with the remaining life at the lower specified MAWP. The de-rated vessel shall be presented to KSC PSM for approval to remain in service.

1.1.3.10. Pressure Relief Devices (PRDs) and Vent System Assessment

Identify parts of the system requiring over-pressure protection and verify relief device protection (relief valve, burst disk, etc.) is installed per applicable NCS. This is typically required for vessels, regulated pressure circuits, etc. Consideration for fire-sizing of any protective devices should include an evaluation of service conditions, location of the vessel, and other factors which may expose a vessel to fire conditions. Pressure relief requirements are detailed in UG-125 through UG-137 of ASME BPVC Section VIII, Division 1. Also, evaluate the discharge vent lines to determine if backpressure build-up is acceptable. American Society of Heating, Refrigeration, and Air-Conditioning Engineering (ASHRAE) 12 calculations are acceptable in determining allowable vent line lengths for most service media.

Overpressure relief devices shall also be installed to protect parts of the system which operate at lower pressures than that upstream of pressure regulators. Pressure regulators shall not be used to provide overpressure protection. When use of a PRD is determined not feasible, with approval from the KSC PSM, a regulator satisfying the requirements of CGA E-4 may be used to protect the downstream system.

For PRDs set below 15 PSIG, the ASME "UV" stamp is not required, but they shall still be qualified to the maximum set pressure by burst testing and shall have sufficient relieving capacity. They shall also be periodically retested per NBIC retest guidelines.

PRDs shall be evaluated for both flow and pressure. In a compressed air system, the PRD shall have a minimum flow rate greater than or equal to the maximum flow rate of the compressor that supplies the compressed air. For a PRD that is located downstream of a regulator, the PRD shall have a minimum flow rate greater than or equal to the maximum flow rate of the regulator should the regulator fail open. BOSS maintains standardized Excel spread sheets that performs the calculations. For flow comparison BOSS maintains Excel spread sheets that converts Actual Cubic Feet per Minute flow rate (ACFM) to Standard Cubic Feet per Minute flow rate (SCFM).

1.1.3.11. Initial Risk Assessment Development

The initial risk assessment should include an evaluation of the personnel exposure (hours of operation exposed to the pressurized system or vessel), hours system or vessel is pressurized, system size and vessel code (if vessels are used in system). This information shall be used to determine an initial Risk Assessment Code (RAC).

The Abbreviated Integrity and Risk Assessment (AIRA) Worksheet DES-F-0005 is used to find any design, operational or maintenance conditions which may pose a high risk to operating personnel.

1.1.4. Nondestructive Testing Requirements Review

Recertification of existing PVS requires a review of the code of construction. Original test and inspection requirements shall be repeated. If original results are available, these shall be compared with the new results to determine any damage mechanisms which may be active (or inactive.)

The following actions shall be performed to develop the Nondestructive Testing (NDT) Plan:

1.1.4.1. Original Code of Construction Review

The original code of construction identifies testing and inspection requirements. Typically for ASME Section VIII Division 1 vessels, there shall be some level of radiography of the welds required (the level should be identified on the ASME U-1A form or similar report). The same level should be performed at recertification. Other NDT methods required could involve UTT for corrosion mechanism, dye penetrant and magnetic particle inspections for surface defects of welds. All new pressure vessels shall have an initial baseline NDE performed. BOSS PVS Engineering shall identify the testing points.

1.1.4.2. NDT Plan Processing

Prior to requesting the NDE support an assessment shall be performed to determine the scope of the task. The NDT requirements identified in the code review shall be documented in advance to ensure scope of task and resource requirements are understood prior to requesting NDE support. Request for NDE support shall be initiated at the Laboratory Support Services and Operations (LASSO) contract link Home Page - Labs Portal (nasa.gov).

The original code of construction, typically B31.3 for systems or ASME Section VIII, Division 1, 2 or 3 for vessels, is identified along with the required NDT methods. If any methods were performed recently and can be credited to the recertification, the date performed shall be listed and a description of the results included. The next test that shall be performed, if not at the next recertification, shall be identified in the ISI plan within the Certification Report.

Damage mechanisms include but are not limited to macroscopic corrosion (pitting, line, uniform, under insulation, galvanic), erosion (crevice, exfoliation, selective leaching), fatigue, creep, fracture, cyclic service history, bulges/blistering, carbon steel graphitization and intergranular carbide precipitation. Damage mechanisms specific to KSC include severe corrosion on vessel Grayloc hubs. NDE used to identify damage mechanisms include but are not limited to VE, Depth Gauge Measurements, IR, Neutron Backscatter, UT, RT, MT, PT & MFL.

A visual inspection shall be evaluated during the NDT Plan development. A review of system related Maximo TAL work orders shall be performed to identify recurring

conditions which may require specific attention. Photos shall be included that may be helpful for the NDT personnel to accomplish the tasks.

For pressure vessel mid-life NDEs if the vessel is not part of a critical system and can be taken offline, a visual internal inspection (VI) shall be performed first to search for any corrosion inside the vessel. If no corrosion is found inside the vessel, then an Ultrasonic Thickness Test (UTT) shall be performed to determine the remaining service life of the vessel. If corrosion is found inside the vessel, a VI report shall be submitted to the KSC PSM to determine if the vessel should be replaced or a UTT can proceed to determine the remaining service life of the vessel.

After the NDT plan is completed, it shall be submitted to the KSC PSM for approval.

1.1.4.3. NDT Implementation Plan

After approval of the plan, a NDT implementation Plan meeting shall be scheduled to identify any safety issues, inspection requirements (e.g. removal of paint from welds), shop support (e.g. low-pressure purges and removal of hubs for internal vessel inspections), etc. Acceptance criteria shall be identified, such as minimum thickness requirements or previous weld radiograph indications (including size and location if available). Personnel reviewing the plan shall include but not be limited to the system PVS engineers, Operations and Maintenance (O&M) System Engineer (SE), NDT representatives, safety representatives, and end user representatives. All stakeholders shall be included in the meeting invite including NASA SI Operations Engineer (OE) counterpart.

1.1.5. Identification of Inspection and Test Requirements

NDE personnel shall be trained and certified per ASME Section V for the particular testing they are performing. All variations to ASME requirements shall be documented and approved by the KSC PSM.

1.1.5.1. Coordination of Support Activities for NDE

Testing and required support shall be coordinated with the respective SE. The scope of the NDE task shall be identified initially in order for the SE to schedule supporting activities such as paint removal and recoating.

1.1.5.2. NDE Operational Safety Assessment

Safety procedures shall be identified prior to performing the NDT taking into account height above ground level and health hazards associated with radiography. Precautions shall be taken to provide a safe working environment. The systems shall be assessed for safing requirements, such as reducing the pressure levels or removing hazardous materials form the system. NDT operations conducted from elevated position shall require proper scaffolding and fall protection.

1.1.5.3. Volumetric Inspection of Welds

Volumetric inspections shall be performed on critical welds or those welds deemed likely to experience degradation. These inspections shall be performed in accordance with the approved NDT plan. These welds are category A and B welds.

1.1.5.4. Additional Inspection/Tests

Magnetic Particle and/or Liquid Penetrant tests may be performed on welds suspected of having surface flaws. These tests shall be performed in accordance with the approved NDT plan.

1.1.5.5. Welded Joint Inspections

Inspection of welded joints on connecting flanges, tube sheets or flat heads to main shell, formed heads, transitions in diameter, nozzles, and communicating chambers shall be performed by the appropriate inspection method specified in the approved NDE plan. Welded joints attaching non-pressure parts and stiffeners shall also be included. These types of welds are category C, D, and E welds.

1.1.5.6. Thickness Testing/Evaluations

Appropriate thickness inspections shall be performed as specified by the approved NDE plan. This inspection is required to establish rate of material thinning due to service conditions or caused by the environment. The NDE plan shall specify location and extent of inspection. Vessels in a cluster may be sample tested. For Recertification, Ultrasonic Thickness Testing (UTT) shall be performed in the same locations as prior tests where practicable.

1.1.5.7. Fatigue Inspections

Areas of high local (peak) stresses shall be inspected for vessels not exempted from the Fatigue Analysis requirement. The approved NDE plan shall identify the specific area(s) requiring inspection and the type of NDE to be employed.

1.1.5.8. NDE Documentation Requirements

The visual inspection results shall be documented in the certification report. The NDE inspection results shall be documented in appropriate NDE reports. A summarization of the NDE results shall be included in the certification report. The Engineering Documentation Report shall be updated with the new NDE reports and released into TechDoc. Also, the original NDE results shall be maintained in the BOSS system files for historical reference.

1.1.5.9. NDE Test Plan Revision

The approved NDE plan shall be revised to show any redlined changes to the plan with the description of the change(s) along with the respective rationale (i.e., field condition, invalid requirement based on existing condition). Redlined changes shall be approved by the KSC PSM. All of the approved redlined tests shall then be performed.

1.1.6. Final Evaluation and ISI Initiation

1.1.6.1. Disposition Discrepancies and Perform Engineering Analysis

All NDE results that do not satisfy the initial design requirements shall require further engineering analysis to re-rate the pressure vessel, tubing, or piping.

The calculations performed for analysis are also used to address visual inspection results where material degradation has been observed. The pressure ratings of the individual

system components shall be verified. The system relief valve setting shall be revised to ensure that the component is not pressurized beyond its rated/de-rated MAWP where applicable. The component with the lowest pressure rating shall be used to establish the system MAWP. The allowable back pressure for the vent system shall be calculated and shall be the basis for establishing its hydrostat test requirement.

1.1.6.2. Remaining Service Life Determination

The Manufacturer's initial service life determination shall be documented. The remaining service life shall be determined based on a detailed integrity assessment of the PVS. The integrity assessment shall be based on the inspection of relevant failure modes such as fatigue, creep, corrosion, cyclic service history, and rates of degradation. The inspection methods shall consist of NDE, VE and analysis. The cumulative results of the inspections shall determine the remaining life of the PVs. The remaining life shall not exceed 40 years unless the original manufacture's design requirements indicated 40 plus years (reference NASA-STD-8719.17 Revision C, paragraph 4.8.2.7). Based on this standard, the replacement of a pressure vessel shall be recommended after 40 years of service unless there is documented evidence the design service life is different. Recommend replacement of a pressure vessel based on its advertised designed service life. SHARP team lead shall ensure replacement of pressure vessels is planned well in advance and listed on project list accordingly to ensure funding is available.

1.1.6.3. Follow-Up Analysis

For discrepant conditions, follow-up analysis shall be performed to determine if mitigation is required. Results shall be added to the Risk Assessment Matrix for tracking and RAC determination. All discrepant conditions identified during inspections shall be documented on Maximo TAL work orders per ENG-P-0027.

1.1.6.4. Disposition of PVS Results

Based on the results of the Final Evaluation the PVS can be certified, de-rated/re-rated for certification, re-evaluated, removed, replaced, deactivated, or abandoned. Safety related discrepancies require correction prior to issuing certification.

A vessel or system that has been de-rated shall be re-rated to the original or new operational parameters only after appropriate testing, examination, repair, alteration, modification, documentation, and engineering analysis has been performed and documented.

1.1.6.5. Evaluation of Risk Assessment Variables

The likelihood of a worst-case scenario and severity of the respective consequence shall be determined for each PVS. The probability of a mishap shall be based on the amount of time the system is in a pressurized state, the personnel exposure time and default probabilities of equipment failure per NASA-STD-8719.17 RAC Determination section. The probability of mishap is used to establish a level of likelihood of the consequence. The severity of the mishap is based on various conditions that may cause death or permanently disabling injury. Consequence severity is categorized into 4 classes: Catastrophic, Critical, Moderate, and Negligible. This is typically determined through Blast Pressure calculations. The worst credible consequence shall be considered in the

determination of the severity of consequence. For PVS certification, risk is based on the level of personnel injury potential and the likelihood of that injury occurring. As a special note, the typical failure mode established for a gaseous commodity pressure vessel is leak before burst.

Alternate methods of equipment failure probability may be used with the KSC PSMs permission. Also, when specific failure assessment is required, the principles in NASA Procedural Requirements (NPR) 8000.4 “Agency Risk Management Procedural Requirements” policy or conservative engineering judgment which is documented and approved by the KSC PSM shall be used. For example, Code Vessels with a factor of safety less than the original code factor of safety (due to degradation or fluid service changes,) require a case-by-case assessment.

For PVS with life limiting factors of fatigue or brittle fracture, the probability of failure shall be increased one level to account for the possibility of NDE missing existing flaws (i.e. a probability of 10^{-6} shall be increased to 10^{-3}).

1.1.6.6. Risk Assessment Code Determination

The level of risk is determined on the basis of the probability of a mishap and the severity of the consequence. The probability of mishap is assigned one of five probability letters, A-B-C-D-E. The letter A represents a mishap happening frequently, B represents Probable, C represents Occasional, D represents Remote, and E represents Improbable.

The four severity classes are assigned Roman numerals, I thru IV. The severity and probability are then used to determine the Risk Assessment Code (RAC) as shown in Figure 5, Risk Assessment Code Determination Matrix. A RAC greater than 4 is the criterion for a PVS system that can be certified and remain in service with PSM approval, otherwise a technical waiver shall be required. PVS certification non-compliances shall be addressed by options such as modification, repair, rerating the system, or the initiation of a technical waiver.

FIGURE 5: RISK ASSESSMENT CODE DETERMINATION MATRIX

	A Frequent	B Probable	C Occasional	D Remote	E Improbable
I Catastrophic	**1**	**1**	**2**	**3**	**4**
II Critical	**1**	**2**	**3**	**4**	**5**
III Moderate	**2**	**3**	**4**	**5**	**6**
IV Negligible	**3**	**4**	**5**	**6**	**7**

1.1.6.7. Technical Waiver

A technical waiver shall be used to address case-by-case variations from requirements of standard NAS-STD-8719.17. Any PVS that does not meet KSC requirements can be certified and allowed to operate provided a waiver is approved. PVS that does not comply with NCS, or federal regulations requires a waiver to the particular federal agency or Code committee. These shall be reviewed by NASA HQ prior to submittal to the particular authority. The technical waiver shall be used to address case by case variations such as allowing the use of PVS under non-compliant conditions. New non-coded PVS shall require a technical waiver prior to operation provided it meets all of the System Safety, Risk Assessment, Specific Component Requirements, Integrity Assessments, Remaining Service Life, and Inspection Requirements. An extension variance is also required for any overdue item prescribed under Specific Component.

The technical waiver shall be prepared in accordance with NPD 8710.5D, Policy for Pressure Vessels and Pressurized Systems, and NASA-STD-8719.17. Technical Waiver shall be reviewed and approved as shown in Figure 6, Technical Waiver Approval Matrix. Code design and construction techniques shall be used on non-code PVS to the extent possible, especially, Code Material, Listed Components, Code-certified welding procedures, and Code-equivalent factors of safety.

FIGURE 6: TECHNICAL WAIVER APPROVAL MATRIX

	RAC 1&2	RAC3+
Headquarters notification	X	X
Center Director Approval	X	
Safety and Mission Assurance Director Approval	X	X
PSM	X	X
Program Manager/Owner	X	X

1.1.6.8. Policy Waiver

A policy waiver shall be used when a Center policy varies from NPD 8710.5 or when Center policy varies from and “shall” statement in NASA-STD-8719.17. Policy waivers shall be approved in accordance with NPR 8715.3, NASA General Safety Program Requirements and NASA-STD-8709.20, Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements.

1.1.6.9. ISI Plan

Based on the results of the NDE an ISI plan shall be prepared to show inspection intervals for the system pressure vessel(s), tubing/piping and system components (gauges, relief valves, flex hoses). The ISI shall contain applicable technical information describing the present configuration of the system. ISI reports shall be issued to provide current and relevant PVS information to the KSC PSM. Subsequent use of the ISI shall be used to identify any discrepant condition of the system requiring corrective action by the O&M and to update system configuration information. The accuracy of PRDs and Safety

devices shall be periodically retested/calibrated in accordance with NBIC 23 with the following exceptions:

- CCSFS safety devices shall be retested annually, unless a waiver or variance is approved by 45th SW Safety.
- Rupture disks need not be replaced if the vent space is protected from restrictions. The maintenance job plan shall include provisions to inspect the vent space.

1.1.6.10. Documentation Archival

All available information shall be documented and released into TechDoc. Typical documentation released from the pressure vessel certification effort includes but is not limited to Engineering Data that contains all pressure vessel data, vessel drawings, vessel calculations, tube/pipe data and calculation, component data with cut sheets, and the Certification Report. Discrepancy work orders shall be referenced in the Certification Report and maintained as a record in Maximo.

1.1.6.11. Certification Reports

The Full Certification Report (FCR) (Template DES-F-0002B) and the Simple Certification Report (SCR) DES-F-0002C are two types of PVS reports BOSS utilizes for documenting the certification results for BOSS pressure vessels.

The SCR is recommended for low pressure compressed air systems as directed and approved by the KSC PSM.

BOSS SCR Form DES-F-0002C shall only be utilized with prior KSC PSM concurrence for performing certification/recertification under the following ground rules:

1) PVS RAC shall be 3 or greater
2) PVS operating at 150 PSIG or less which meet the following criteria:
   • Non-critical PVS
   • System not considered a constraint to other critical operations
   • System does not contain hazardous commodity
3) Air compressors with vessels and associated components shall meet the following criteria:
   • Operating pressure of 150 PSIG or less
   • Pressure vessels up to 30 ft3 (224 gallons)
   • ASME Code Stamped pressure vessel(s) only
   • Line sizes not to exceed nominal pipe size (NPS) 2"
   • Require annual inspections for external corrosion and damage
   • Ultrasonic Thickness Testing (UTT) shall be performed on the vessel(s) no later than 10 years from date of manufacture, or prior to certification for systems older than 10 years.
4) Pressurized panels (inert gas and compressed air systems) which meet the following criteria:
   • Operating pressure of 250 PSIG or less,
   • Designed per ASME B31.3 or KSC-DE-512-SM, and
   • Line sizes not to exceed NPS 2",
   • Require annual inspections for external corrosion and damage.

The BOSS SCR Form DES-F-0002C form shall be completed per the instructions on the form. Approval signatures are acquired in the order as shown on the form.

The Full Certification Report DES-F-0002B is typically utilized for high pressure inert gas systems but can be used for other systems as directed by the KSC PSM.

1.1.6.12. Certification/Recertification Report Approval Process

The final draft of the certification report shall be submitted to the KSC PSM for review and approval signature. PVS is not certified until approved by the PSM.

The NASA SI PVS representative shall coordinate, schedule, and facilitate quarterly progress review meetings where current progress status shall be provided to the KSC PSM. ***PVS Certification Tabletop Reviews shall also be performed during the quarterly meetings following the guidelines in KDP-KSC-P-3621 "Ground-Based Pressure Vessel and Pressurized Systems (PVS) Certification" process chart.*** All certification reviews shall be approved by the NASA SI PVS representative for the system prior to submittal to the KSC PSM. Completed PVS Certification Reports shall be approved and signed off at the quarterly meetings or through other arrangements as requested by the KSC PSM. Quarterly meetings should be scheduled one month prior to the end of a quarter so that any problems that need addressing prior to the end of the quarter can be resolved on time. This shall help to ensure that the items on the RBP are completed prior to the end of the waiver.

1.1.6.13. Final Approved Certification Report Processing

The completed signed off Certification Report and certification history report shall be released to TechDoc on a DRA. The DRA identifies the distribution listing for those receiving a full report and those receiving notification of release and report identification.

1.1.7. PVS Deactivation/Abandonment

A deactivation report shall be prepared providing instructions for deactivating or abandoning PVS. The SE shall take appropriate steps to deactivate or abandon the PVS per the report. A review of storage requirements, blanket pressures, and other requirements shall be performed in accordance with paragraph 1.3.5.1.

1.1.8. ISI Implementation

To ensure a safe operational system for the user the required inspection plans are expected to be executed on schedule.

1.1.8.1. Documentation Updates

The Certification Report shall be updated as required to provide continuity of system status. Design upgrades, configuration changes, etc. shall be evaluated and documented in the Certification Report. The PVS Change Notice Form DES-F-0002A (See Figure 7) shall be used to document minor changes between full certification dates when applicable. The PVS Change Notice Form shall be considered in line with the design Engineering Order policy utilized for configuration management on configured drawings. All Change Request Forms shall be attached to the respective parent PVS Certification

Report and incorporated in the next PVS Certification Report for the asset prior to the respective expiration date.

As noted on PVS Change Notice Form instructions, typos and repairs that are replacement of parts with like kind or equivalent shall only require the respective NASA Operations Engineer (OE), and the BOSS SHARP Team lead or respective System Engineer (SE) signatures on the completed form for approval of the change. All other type changes shall require the KSC PSM approval signature.

FIGURE 7: PVS CHANGE NOTICE FORM DES-F-0002A

Pressure Vessel Systems Change Notice Form

INPUT PVS DOC # IN HEADER

PVS CN FORM				
Change Notice Number:	Date:	☐ Repair ☐ Mod	☐ Typo ☐ Analysis	Attachments? ☐ Yes ☐ No
Requestor:		Organization:		
Facility Number:	OMEU Baseline No:		PMN:	
OMEU System Description:				
WON:				
Reason for Change/Acceptance Rationale:				
Description of Change:				
SIGNATURES				
BOSS PVS Engineer X		NASA SI Operations Engineer X		
NASA Pressure Systems Manager (PSM) X		BOSS Pressure Systems Manager X		

FOR REFERENCE ONLY

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1.2. In-Service Inspections

Inspections shall be performed to ensure PVS is maintained in a state of compliance with the PVSC requirements. ISIs may be performed at the time of routine preventive maintenance when feasible. ISIs shall be performed using checklist form ENG-F-PVS1. Shop personnel shall routinely inspect PVS assets for corrosion and other signs of degradation during normal operations and maintenance to ensure minor discrepancies are identified and resolved in a proactive manner between PVS certification intervals. PVS assets shall be maintained per the manufacturers' recommendations. System engineers responsible for PVS assets shall ensure adequate instructions are included in operations and maintenance preventative maintenance Job Plan(s) (JP)s to document and resolve problems proactively.

1.2.1. Inspection Requirements

Inspections shall be performed to obtain sufficient data to ensure that unanticipated forms or rates of degradation, service changes, or other factors have not changed the remaining life of the PVS. In-service corrosion rate thickness inspections shall be determined by the PVS integrity assessment. Records of inspection are maintained in an ISI Report. Personnel performing inspections and tests shall be appropriately qualified and certified as applicable in accordance with the appropriate NCS.

During inspections, survey the entire system, attached systems and other systems in the area to verify proper categorization in the PVS program (included or excluded, active or inactive, etc.).

Evaluate the cyclic usage history and adjust the remaining service life entry field where applicable.

1.2.2. Damage Mechanisms

Inspection intervals for all relevant damage mechanisms shall be specified in the inspection plan consistent with intervals recommended in the applicable NCS and this procedure.

1.2.3. Inspection Intervals

Inspection intervals shall be reviewed and adjusted throughout the life of a PVS to incorporate safety related Code changes, unanticipated rates of degradation, or other relevant factors.

1.2.4. Relief Devices, Vent Systems and Other Safety Devices

Relief valve exhausts and vents shall be inspected to ensure thrust load structural supports are adequate. In addition, thrust tees incorporation shall be verified. The vent system shall be verified to have sufficient flow capacity to meet system requirements. Relief valve and pressure indicating device locations, design operating parameters, last test date and due dates shall be verified and documented.

1.2.5. Integrity Assessment

Each PVS shall have an inspection plan that addresses credible damage mechanisms. The assessment shall be performed to ensure the PVS is maintained in compliance with

the certification requirements. Consideration shall be given for the applicability of NDE methods employed and the quality and/or fidelity of the effort (e.g. ultrasonic shear wave results based on calibration with non-compliant blocks).

1.2.6. Thickness Evaluations

Wall thickness calculations shall be performed to include both stress and stability for normal and worst-case conditions. Wall thinning due to the service effects or environmental conditions shall be determined by means of NDE methods. Respective adjustments shall be made to the estimated remaining life of the PVS.

Respective adjustments shall also be made to the inspection plans and certification/recertification based on the results and assessments. Vessels in a cluster may be sample tested. UTT shall be performed in the same locations as previous efforts where practicable.

1.2.7. Fatigue or Brittle Fracture

Inspections to determine the presence of fatigue or brittle fracture shall be performed no later than when the PVS has experienced one-half of the specified number of permissible load cycles. Also, brittle failure modes shall be evaluated using ASME rules for fracture toughness (ref. ASME Section VIII, Division 1, UCS-66) when the service temperature is below the Minimum Design Metal Temperature (MDMT).

View ports or windows shall be inspected annually for cracks, scratches or other imperfections or damage. Analysis of imperfections shall be performed to determine suitability of view ports for continued service.

1.2.8. Risk Assessment and RAC

Risks shall be assessed for all PVS based on the likelihood of mishap and on the severity of the consequence. A Risk Assessment Code (RAC) shall be determined for all PVS ranging from 1 considered the most risk to 7 the least per NASA-STD-8719.17 RAC Determination Table. The Risk analysis shall be performed to identify and reduce or eliminate the risk. The PSM has the authority to specify the method and detail of risk analyses and/or modify the risk investigation requirements. When a risk is unacceptable, the risk shall be mitigated in accordance with the risk reduction protocol.

The KSC PSM has the authority to modify failure probabilities, without processing a waiver for specific systems noted in NASA-STD-8719.17 provided one of the following conditions is met: (1) failure data exists that is more relevant to the particular PVS, (2) analysis is performed and documented consistent with the principles of risk management found in NPR 8000.4, Agency Risk Management Procedural Requirements, (3) informed and conservative engineering judgment based on information relevant to the particular facts and condition of the PVS in question is exercised and documented. In the event any risk is mitigated, the measures used to reduce the risk and risk classification shall be documented and tracked throughout the life of the PVS.

The PSM has the authority to de-certify and remove from service any PVS that is not safe to operate. A Technical Waiver may be approved to operate with a RAC score equal to

or greater than 3. RAC scores less than 3 require a technical waiver approved by the NASA center director in order for the system to remain in service.

1.2.9. Risk Mitigation

It is necessary to assess risks with respect to the impact on safety and health to properly support design and operational decisions. Risk management decisions shall use the results of the risk assessment as the basis for decisions to determine if the risk is at an acceptable level. All documentation shall be maintained in the PVS History Report.

1.2.9.1. Risk Reduction Protocol

- Eliminate accident scenarios (e.g., eliminate hazards or initiating events by design).
- Reduce the likelihood of accident scenarios through design and operational changes (hazard control).
- Reduce the severity of accident consequences (hazard mitigation).
- Improve the state-of-knowledge regarding key uncertainties that drive the risk associated with a hazard (uncertainty reduction to support implementation of the above strategies).

Note: Designs for hazard control, accident prevention, and mitigation should include considerations for the possibility of human errors. The level of hazard control should be based on the level of risk associated with the hazard. Examples of risk reduction strategies include control of system and operational characteristics, incorporation of safety devices, use of caution and warning devices, and the use of operational and management procedures and training. Some hazards may require a combination of several of these approaches for prevention, mitigation, and/or control. Providing protective clothing and equipment is considered an operational mitigation. The KSC PSM has authority to modify risk mitigation requirements or de-certify and remove unsafe PVS from service. Any change to KSC PVS requirements shall be identified by the KSC PSM for impact to baseline risks assessments. Any changes which require analysis, planning, tracking or controls shall be identified by the KSC PSM.

1.2.10. Track Mitigations

Measures used to reduce/eliminate risk and to reduce risk classification shall be documented in ISI and Certification Reports. Tracking shall be performed through-out the life of the PVS.

1.2.11. Revoking Certification

PVS certification shall be revoked when the PVS is deemed to be unfit for the intended service. The PVS shall be immediately removed from service. In the event that safety related components are not tested at prescribed intervals (ISI maintenance plans) the applicable PVS certification shall be revoked. Disregarding PVS inspections shall be cause for revoking the PVS certification. ***Portable unit's certifications shall be revoked if units are moved prior to notifying PVS engineer in advance to coordinate an inspection prior to placing unit in service.***

1.3. Miscellaneous

1.3.1. New Vessels/Systems

1.3.1.1. Design Approval

New PVS designs and design analysis shall be submitted to the KSC PSM for review and approval prior to start of construction. The PSM shall be notified of PVS design reviews.

1.3.1.2. Code Vessels and Piping

New pressure vessels, including heat exchangers and vacuum systems, shall be ASME Section VIII code stamped in accordance with the applicable division used to design the vessel. The vessel shall be registered with the National Board (NB). Heating boilers shall be ASME Section IV code stamped and registered with the NB.

New pressure vessels shall be ordered with their corresponding ASME U-1A form if it is readily available. This is not a hard requirement and shall not delay the procurement of the pressure vessel.

New relief valves shall be ordered with a Certificate of Compliance (CoC) stating the set pressure and the date of the functional test.

Process Piping shall meet B31.3 requirements. Other piping shall meet the appropriate B31 series (e.g. underground piping shall meet B31.8).

All new pressure vessels shall have an initial baseline UTT NDE performed. BOSS PVS Engineering shall identify the inspection points.

1.3.1.3. Non-Code Vessels

In the event non-code PVS is essential for mission success however does not meet all requirements of the applicable NCS, a technical variance shall be submitted to S&MA for approval. Vacuum vessels may be made by a shop that has an equivalent quality manual to ASME “U” or National Board Inspection Code (NBIC) “R” Symbol shops, as reviewed and approved by the KSC PSM.

For vessels in high vacuum or other extreme cases, where code stamping is not feasible, the following exceptions to the requirements in this document shall be allowed:

- No ASME “U” or NBIC “R” Stamp is required. All other documentation requirements still apply.
- The ASME or NBIC Data Report shall be completed, but not submitted to the National Board. It shall be signed by a NB certified inspector or the KSC PSM.
- Industry standard components shall be used in strict compliance with manufacturer’s recommendations and within the manufacturer’s ratings if rated for external pressure only. Any components operated above atmospheric pressure shall be analyzed per ASME code or other KSC PSM-approved methods.

- Intermittent welds on nozzles and reinforcing pads are allowed if an appropriate code analysis is performed.
- Nozzle reinforcement which does not follow standard ASME BPVC Section VIII illustrations may be used provided the configuration is analyzed per ASME code or equivalent testing.
- An internal pressure test (per ASME code) may be replaced with a vacuum test to 1.5 times the specified pressure differential, but not to exceed an external pressure of 14.7 PSIG. This exception shall not be used in those cases where proof test is used in lieu of analysis if an overpressure of 1.5 times the maximum allowable working (differential) pressure is not attained.
- Materials not listed in ASME Section VIII may be used if the adequacy can be demonstrated and approved by the KSC PSM. The allowable stresses shall be obtained using the approach and safety factors used to develop ASME BPVC Section VIII.
- Relief capacities shall meet ASME requirements, but the valve need not be “UV” stamped if the set pressure is below 15 PSIG. If the set pressure exceeds 2 PSIG, the vessel shell shall be analyzed for structural soundness per ASME Section VIII, Division 1.
- If the vessel relief is set for an external pressurization source, any bolting or fasteners shall be analyzed per ASME code or other PSM-approved methods. The relief protection shall be reviewed and approved by the KSC PSM.

1.3.1.4. Baseline Thickness

PVS which has wall thinning as a limiting damage mechanism shall be NDE tested to establish a baseline thickness prior to certification.

1.3.2. Evaluate PVS for Exclusion

1.3.2.1. General

The following listed PVS does not require certification provided they are covered under appropriate inspection and maintenance programs. (Refer to NASA-STD-8719.17, applicable section for full descriptions)

- Water Systems under 150 PSIG
- Water deluge systems less than 250 PSIG
- Control, instrument and shop air or inert gas systems less than 150 PSIG
    - Items not excluded are relief devices, pressure vessels, regulators, and components and pipe sizes larger than 2-inch diameter.
- COTS
- Fire protection systems
- Fire extinguisher covered by 29 CFR Part 1910, Subpart L
- Glove boxes
- Fuel storage PVS with licensed motorized vehicles and Department of Transportation (DOT) compliance
- Vacuum systems with volumes less than 100 cubic feet and less than NPS 6

- Temporary non-NASA owned equipment
- Atmospheric storage tanks
- Self-contained eye wash system
- DOT specification containers
- Natural Gas distribution system
- Flight weight PVS

1.3.2.2. Assessed Hazard Exclusions

The KSC PSM has the authority to exclude other PVS provided a risk and hazard analysis is performed and meets KNPR 8715.3, KSC General Safety Practices Requirements. In addition, the following requirements must be demonstrated:

- Operational risk or hazard to personnel under any foreseeable failure is negligible
- Technical variance is approved
- Other applicable NASA safety requirements are met
- Other applicable regulatory safety requirements are met

1.3.2.3. PVS Test Article Classifications

Test articles and test specific PVS reviewed and approved in accordance with KNPR 8715.3, KSC General Safety Practices Requirements are excluded. Test specific PVS shall demonstrate no risk to personnel and risk to the facility has been accepted by the KSC PSM. Equipment that is used repeatedly is not considered temporary test specific PVS.

1.3.2.4. Liquid Transport DOT Vessels

49 Code of Federal Regulations (CFR 100) thru 185 or ASME Boiler and Pressure Vessel Code (BPVC) Section XII shall apply to pressure vessels used to transport fluids under pressure. Department of Transportation (DOT) specification packaging shall be pressure tested per 49 CFR requirements.

1.3.2.5. PVS Inclusion Evaluation

1.3.2.6. Vessels Certified per DOT Regulations in Semi-Permanent or Permanent Installation

Pressure vessels originally designed and used for transportation of fluids under pressure may be used in semi-permanent or permanent installation provided they are recertified as ASME or non-code vessels if they are not maintained per DOT specification packaging requalification.

1.3.2.7. Non-DOT Vessel Transport Criteria

Non-DOT vessels shall only be transported at the lesser of 25 PSIG or 1/5 MOP. If a non-DOT vessel is used for transportation of fluids at pressures greater than the above limits, they shall be certified as non-code PVS.

1.3.2.8. DOT Vessels Certified as Non-Code Vessels

Certification shall be based on risk assessment with acceptance and approval through the variance process. DOT specification packaging which may be exempt from requalification testing shall be tested per a retest procedure developed by BOSS PVS or

HVAC engineers. Certification to ASME codes is generally difficult due to variances and uncertainties in the original DOT material specifications. Containers shall be certified based on the DOT requalification interval. Where ASME-equivalent derating can be accomplished, a Factor of Safety (FS) = 4 (or other appropriate FS based on time and material of construction) shall be met. Consideration shall be given for any change in service temperature and its effect on the material properties.

1.3.3. New System Certification Requirement

The PVS shall be certified before being placed into operation/service. Pressurization is allowed prior to certification only for inspection, examination and integrity testing as required by applicable NCS. This includes a one-time hydrostatic test for ASME vessels.

1.3.3.1. Vessels/Systems on Standby/Contingency

This PVS, either with or without pressure, shall be treated as if they are in continuous service, and the certification of such PVS shall be maintained to conform to expected service conditions.

1.3.3.2. Non-DOT Vessels Transported and Reactivated

Non-DOT vessels which are designed for permanent installation and are transported under low pressure blanket shall be recertified prior to activation or reactivation.

1.3.4. PVS Certification/Re-Certification Expectations

PVS shall be certified before entering service. PVS may be activated after a suitable initial operating safety assessment has been performed and documented.

1.3.4.1. One-Half Service Life Recertification

PVS shall be recertified on or before one-half the documented initial service life or one half the recertified remaining life.

1.3.4.2. Service Change Recertification

Recertification shall be performed when the PVS service changes (e.g., commodity, design parameters such as increase in temperature or design pressure, location, and orientation). This shall also require recertification if a change results in a new inspection interval.

1.3.4.3. PVS Repair or Alteration Recertification

Recertification shall be performed if any repair that affects the integrity or configuration of the system occur or for any modifications that are made to the PVS.

Recertification is required if a pressure vessel is replaced, or the configuration is modified. If the configuration is modified the ISI PSM shall evaluate if the PVS certification requires a revision. Replacement of like for like components shall not require recertification.

1.3.4.4. Recertification per PSM Request

Recertification shall be performed as directed by the PSM in the case of NCS changes that reduce the estimated remaining life or increase the known risk of continued operation.

1.3.4.5. Recertification for PVS Service Degradation

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

1.3.4.6. Recertification Requirements for Other Situations

Recertification shall be performed if a vessel being reactivated has not been previously certified or the previous certification has expired. This also applies if the PVS has been repaired or altered to a degree that invalidates prior certification.

1.3.5. Inspector Qualifications

Inspections are performed by engineers (Inspectors) with appropriate degrees and who are knowledgeable of the engineering principals used in PVS design. Inspectors are supported by specialist knowledgeable of NDE testing. The specialist shall perform the NDE testing, interpret and document the results. Inspections shall always be conducted as a minimum in the presence and under the supervision of an experienced inspector. The knowledge base of the inspectors shall be maintained through continuing education by formal training courses, on-site orientation where actual conditions are noted and evaluated, and round table technical discussions where experience is shared.

1.3.5.1. Inactive Systems

The KSC PSM shall be notified within 90 days of any systems removed from service. The following information is required to accompany the notice and be maintained in the PVS History File:

- Facility Location (name and number)
- Service commodity
- PVS drawing number
- Manufacturer’s name and date of manufacture
- Vessels’ serial numbers
- MAWP or design pressure
- PVS Responsible O&M organization
- Vessels’ capacities
- Code stamping
- Certification date
- Certification report number
- System baseline number
- Normal operating pressure, temperature, and pressure cycles

Inactive vessels shall be tagged, “Inactive – Certify Before Reuse”

When PVS is placed into storage, they shall be protected from exposure to the environment and mechanical damage. If placed in a storage fixture, the induced stresses shall be minimized. Prior to placing the PVS in storage, it shall be drained, inerted, and maintained with a blanket purge.

An engineering analysis shall be performed to identify a down-moded ISI Plan for periodic inspections to verify the above requirements are met.

1.3.5.2. Unsafe Systems

When a vessel is deemed to be unsafe for continued use, it shall be removed from service. If repairs are implemented to bring it back into compliance with all safety requirements, then they shall be made per the appropriate post-construction code. An unsafe vessel awaiting repair shall be locked out/tagged out until repaired and deemed as certified by the inspector. If not repairable or too costly to meet program requirements, it shall be decommissioned per KNPR 4000.1, Supply Support Manual.

Unsafe and unrepairable vessels shall be stenciled “NOT USABLE – FOR DISPOSAL ONLY.” If unsafe, unrepairable, and not movable, the vessel shall be stenciled “NOT USABLE – ABANDONED IN PLACE.”

Disposal procedures shall be developed and forwarded to the KSC PSM for review and approval. The procedure shall include:

- Disposal method (excessing, marking, disabling method, etc.)
- Method for flushing and disposing of any hazardous liquids
- Vessel manufacturer’s nameplate data, baseline number, drawing number, and/or other identifying nomenclature.
- Submittal of Maintenance Action Request (MAR) to decommission asset in Maximo database

1.3.5.3. PVS Asset Replacement Determination

Where engineering economic analysis indicates a PVS asset replacement is the most feasible option based on the system age, condition, failure rate, NDE cost, engineering administration/analysis cost, repair/modification cost, it shall be replaced. A standard recommendation for replacement shall be if the asset is over 10 years old with procurement cost ≤ $2,000, and NDE and/or repair cost is over 50% of procurement cost, the asset shall be replaced.

For assets greater than $2,000, if asset age is greater than 75% of design service life, and NDE cost, engineering administration/analysis cost, repair/modification cost is over 50% of procurement cost, the asset shall be replaced. The final decision for NDE, repair, or replacement shall be determined by SHARP team vote.

1.4. PVS Operation and Maintenance

1.4.1. Operation and Maintenance

PVS shall be operated and maintained within the parameters of the certification by qualified and experienced personnel. PVS shall be operated and maintained in accordance with prescribed OMDs. PVS shall not be operated unless it is certified, excluded from certification or has an approved variance on file. PVS which is not certified, excluded nor has an approved variance shall only be operated for specific inspection, examination or testing required for certification. The MOP for these items shall be determined by BOSS Design/PVS Engineers.

1.4.1.1. General Requirements

System maintenance requiring disconnection of any tubing or flex hoses shall be done only after depressurization of the system. PVS maintenance shall include component manufacturer's recommendations in addition to maintenance required due to operating or environmental conditions.

1.4.1.2. General Boiler Requirements

Boiler maintenance shall follow manufacturer's recommendations. Additional maintenance shall be performed if conditions warrant.

1.4.2. Records

Any changes in system operation or maintenance shall be maintained by updating the appropriate report, i.e., ISI and Certification. Modification records shall be noted in the applicable report and the applicable drawings shall be released to the KEDS. Changes to PVS between scheduled certification dates that do not require a system recertification shall be documented on PVS Change Notice Form DES-F-0002A in accordance with the form instructions. All change notice forms shall be maintained as a historical record for incorporation of change content into the next scheduled recertification report.

1.4.3. Data

Data such as pressure cycles, corrosion, erosion and creep shall be collected for certification reports. The operator/maintainer shall comply with inspection findings which require corrective action. Problems shall be documented on Maximo TAL work orders per ENG-P-0027 to ensure problem history on assets is maintained for trending information.

1.4.4. Incidents/Anomalies

Any incidents or anomalies that occur on PVS shall be reported to the KSC PSM and documented per ENG-P-0027. Corrective action shall be authorized by the KSC PSM.

1.4.5. Weld Rod and Braze Material

Weld rod and braze materials recommended by the manufacturer for on-site repair or maintenance shall be maintained on center. Repair and/or alteration of pressure retaining parts are permitted only if the repair organization has or obtains a National Board Certificate of Authorization to use the "R" Symbol Stamp. Repair of systems by replacement with new components may be accomplished by BOSS shops if code-welding is not required.

1.4.6. Repairs and Alterations

System repairs and alterations shall be accomplished only after the system is depressurized. After repairs or alterations, the system shall be pressure and leak tested. Any leaks found shall only be repaired after the system is depressurized again. Repairs to lethal service vessels shall have 100% radiography of new welds.

1.5. BOSS PVS Database

The BOSS PVS database is maintained on the BOSS Shared directory currently on an Excel spreadsheet and transitioning to Maximo. The database includes all known RBP inventory and normal Inventory PVS with all required tracking information including but

not limited to Certification dates/due dates, component calibration expiration dates, ISI dates/due dates and other related information that is monitored and updated by the BOSS Pressure System Representative.

1.5.1. Documentation

Documentation numbers for certification reports, in-service inspection reports, configuration drawings, assessed hazard exclusion reports, and certification history reports/data packages are maintained in the database.

1.5.2. Quarterly DRD Reports

A quarterly report containing both Data Requirement Description (DRD) and an Inventory Flat File shall be provided to the KSC PSM at the PVS Committee quarterly meeting.

The DRD shall be submitted 5 days prior to the end of the quarter to the NASA Customer Portal Submitted DRD - DRD List (nasa.gov).

● Leads are responsible for monitoring and uploading the DRD documents within one week of the DRD due dates. Refer to PMO-REF-0001 for instructions for uploading the DRD documents to the NASA Portal.

● As soon as the DRD documents are uploaded to the NASA Portal, the Lead is to send an email to the Design Engineering Manager, the Lead Engineer for Mechanical Engineering, the Project Controls Analyst and the BOSS Engineering Division Manager – to let them know that the DRD due date has been met.
A backup copy shall be kept in the working PVS folder. The DRD shall be updated each time a task (PVSC, ISI, NDE) is performed. The report shall include:

1.5.2.1. Systems

Certification report number, revision, Change Notice Numbers, release date, KNPR revision, description, location, baseline, station set, program model numbers, system status, original certification date, current certification date, expiration date, service fluid, design pressure, certifying organization, O&M organization, ISI plan in place, configuration drawing numbers, number of vessels, number of relief devices, number of gauges, number of flex hoses, last ISI date and additional comments.

1.5.2.2. Vessels

Vessel find number, program model number, description, installation drawing number, manufacturer, manufacturer's drawing number, manufacturer's serial number, ASME code stamp, code of construction, year built, fluid media, status, water volume, certified MAWP at design temperature, original MAWP at design temperature, minimum design metal temperature at design pressure, and additional comments.

1.5.2.3. Metrics

PVS Engineering shall report status monthly to the Performance Standards Spreadsheet, PWS Section 4.3.1.2 -1 PVS located at METRICS_WLIs - All Documents (nasa.gov). A

backup copy shall be kept in the working PVS folder. The Performance Standards spread sheet shall be updated each time a task (PVSC and ISI) is performed.

PVS Engineering shall update the current fiscal year spreadsheet keeping track of PVSC recertifications, NDEs, ISIs, On-Hold and Task Order PVSCs making sure recertifications, NDEs and ISIs are completed before their respective expiration date. Update the completed date for each PVSC recertification, NDE and ISI listed once each item is completed. Update On-Hold and Task Order PVSCs tabs as necessary when a CAIR project is forthcoming.

FIGURE 8: CERTIFICATION / RE-CERTIFICATION PROCESS FOR INSERVICE EQUIPMENT

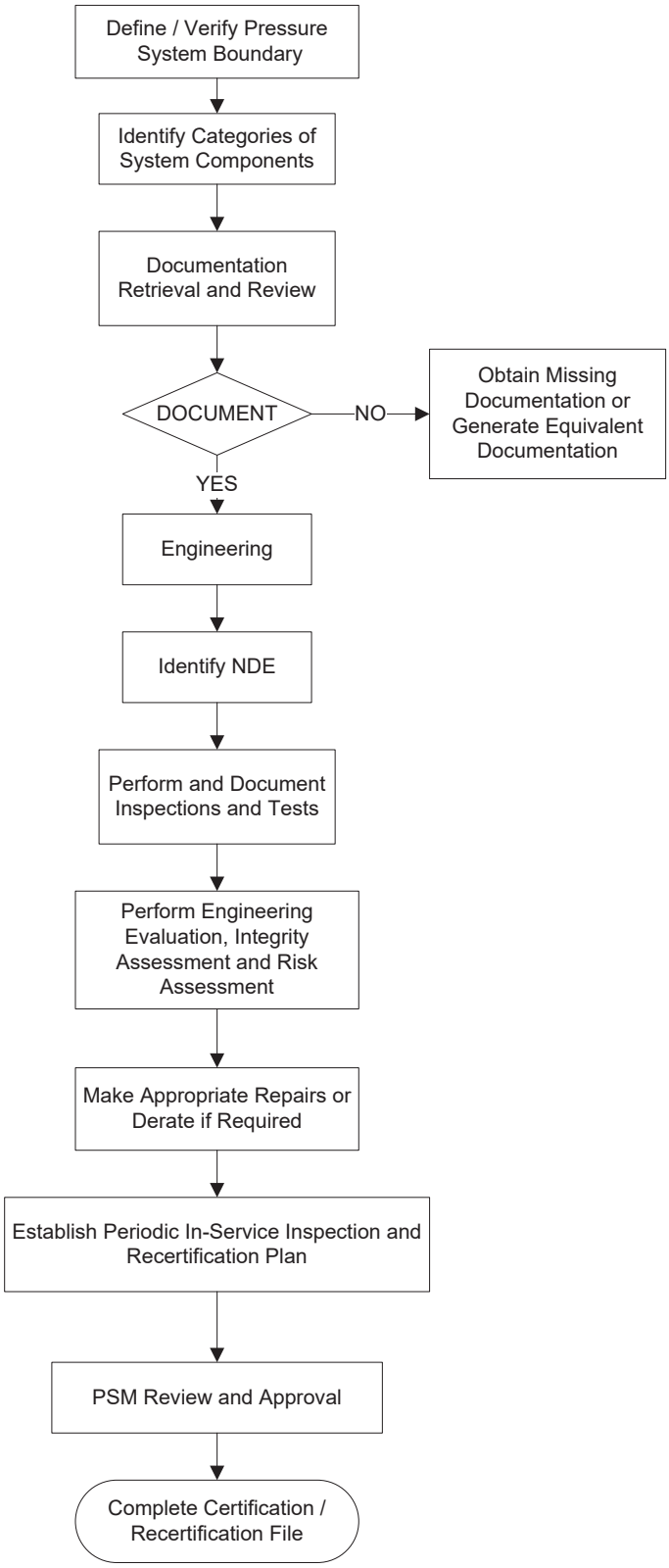
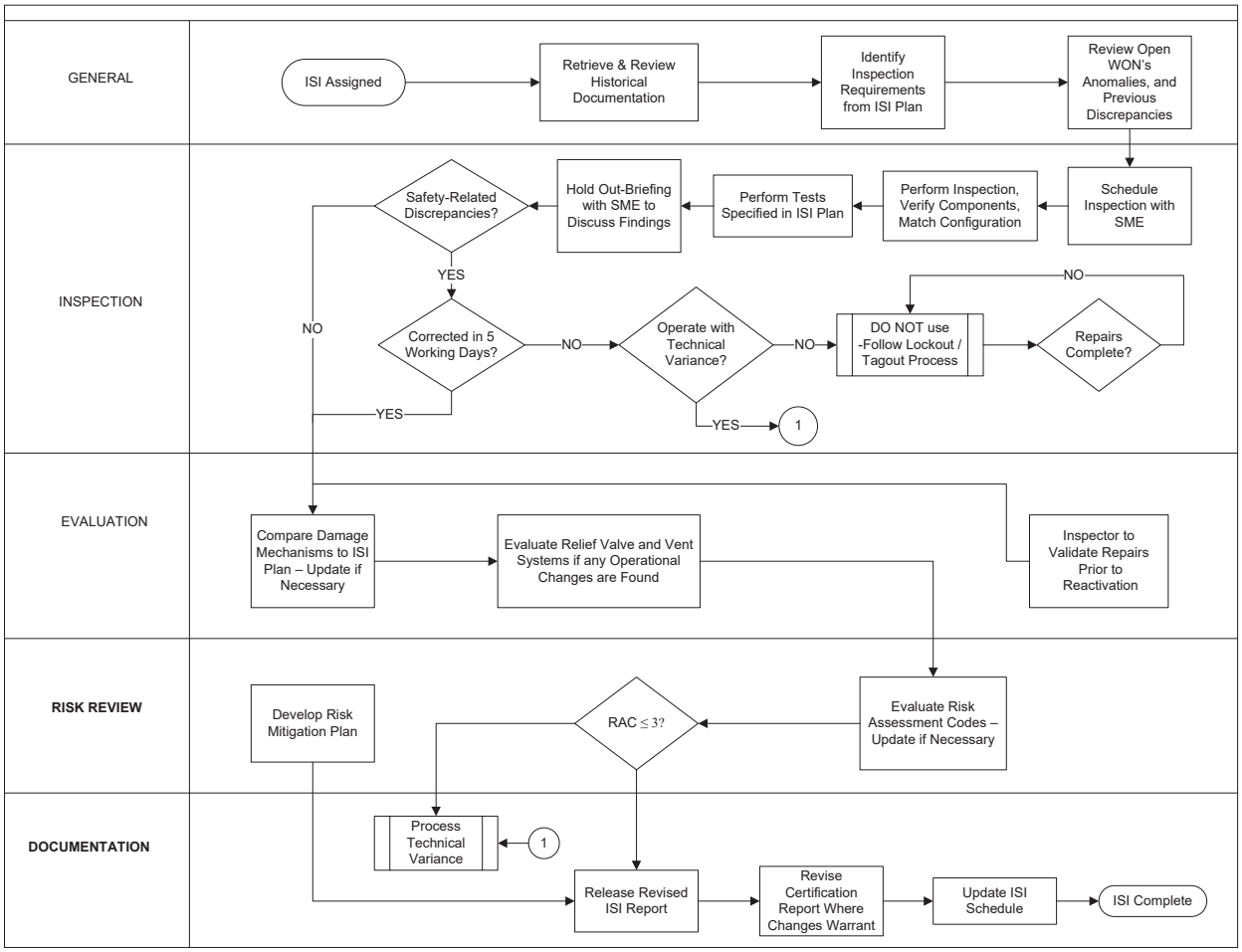
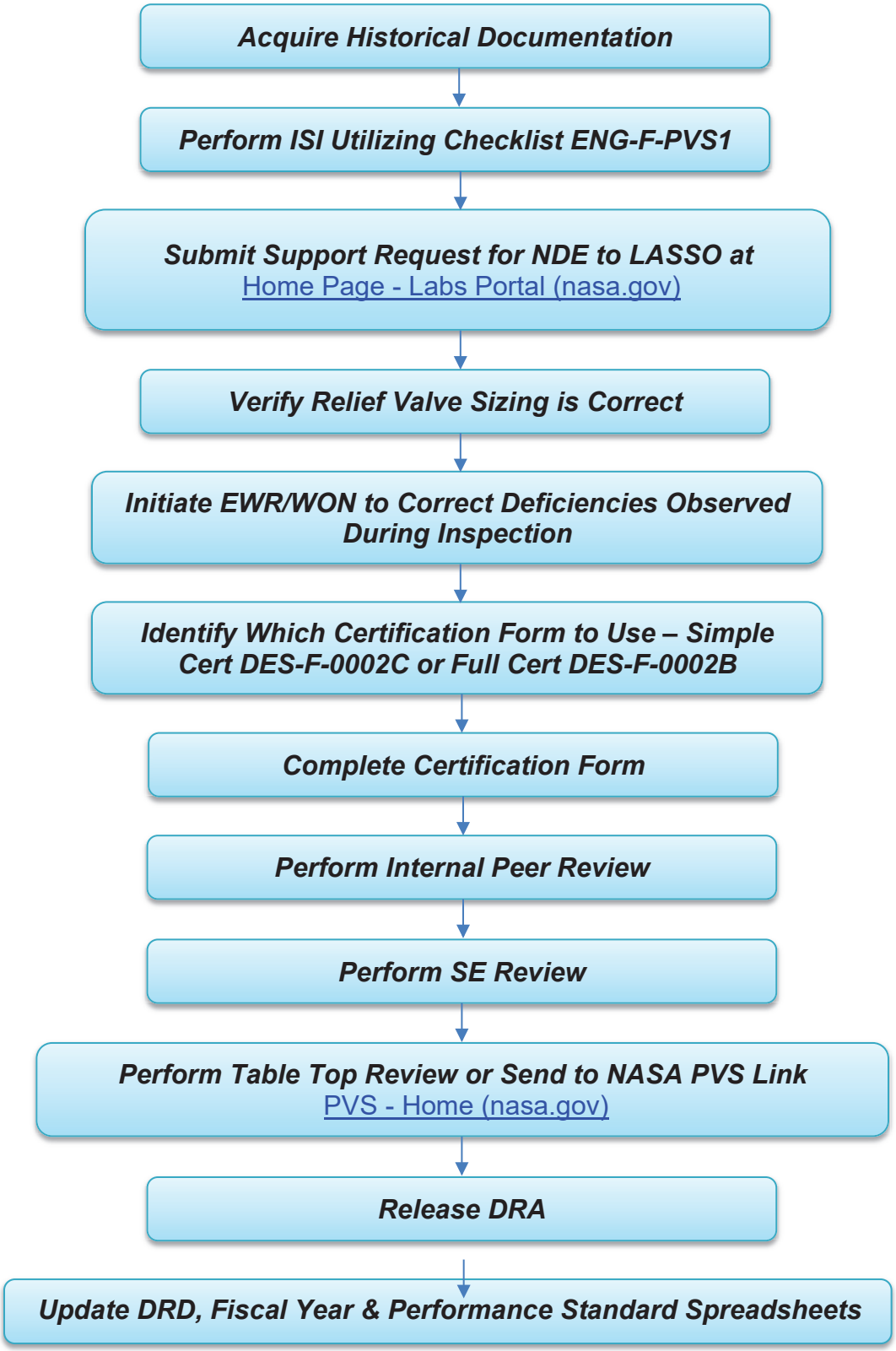


FIGURE 9: IN-SERVICE INSPECTION PROCESS

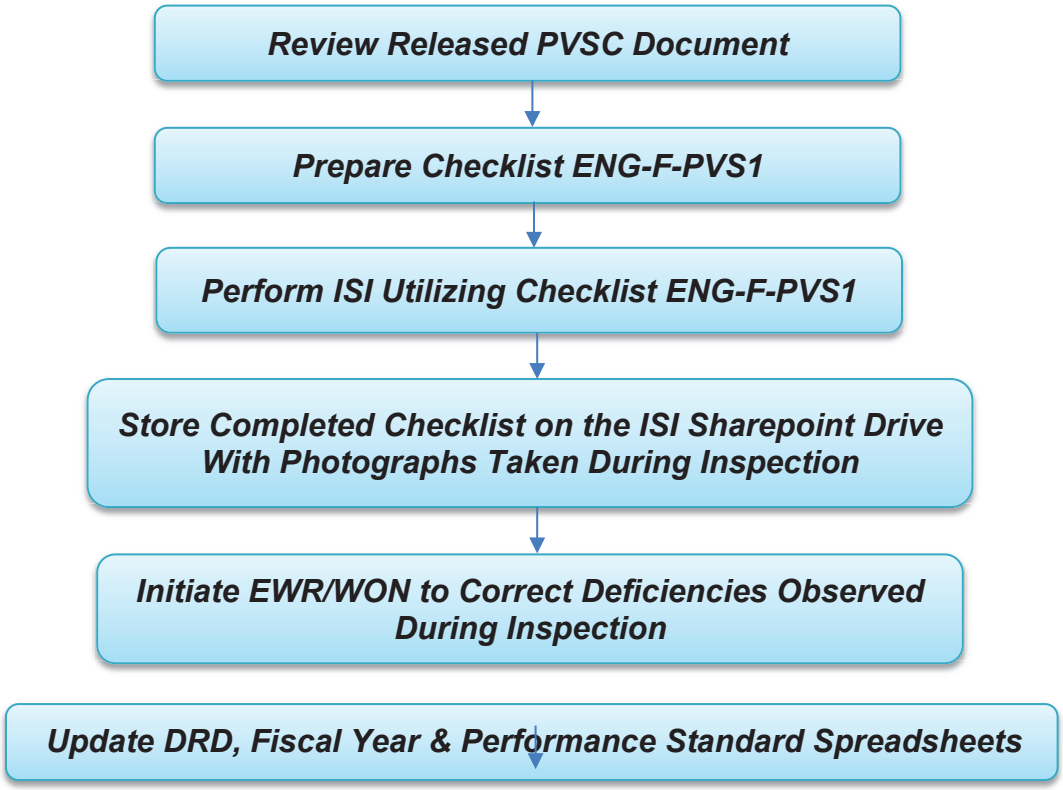


APPENDIX A: GENERAL PVS INSPECTION PROCESS FLOWS

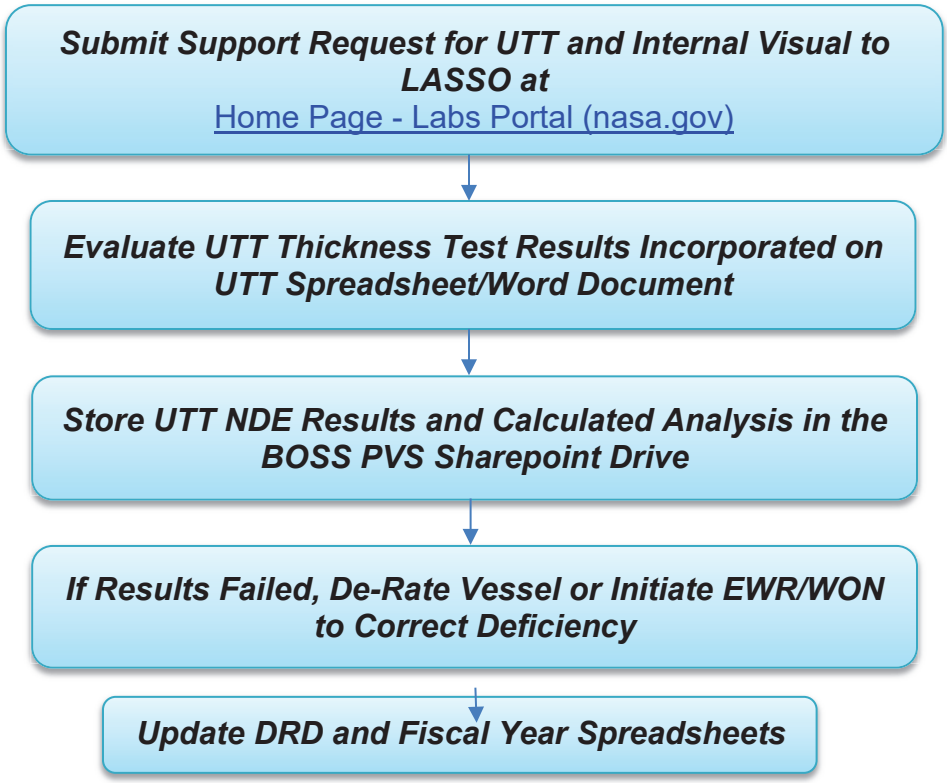
PVS GENERAL CERTIFICATION PROCESS FLOW



PVS GENERAL THREE YEAR ISI PROCESS FLOW



PVS GENERAL MID-LIFE UTT PROCESS FLOW



RECORDS

The following records are retained by the organizations listed below:

Record	Responsible Organization
PVS In-service Inspection Reports	BOSS Engineering Services Division
BOSS PVS Database (located on BOSS Shared Drive)	BOSS Engineering Services Division
NDE Reports (As provided – copies in PVS System File)	BOSS Engineering Services Division
NDE Film (X-rays – Associated NDE Report #s as provided)	BOSS Engineering Services Division
PVS Change Notice Form (DES-F-0002A)	BOSS Engineering Services Division
Full Certification Report Form (DES-F-0002B)	BOSS Engineering Services Division
Simple Certification Report Form (DES-F-0002C)	BOSS Engineering Services Division
Technical Variances	BOSS Engineering Services Division/SMA
KSC Visual Examination Report (ENG-F-PVS1)	BOSS Engineering Services Division

AFFECTED DIVISIONS/OFFICES

Engineering Services
FSEU and OM&E
Laboratories

MANAGEMENT ROLES AND RESPONSIBILITIES

Design Engineering (DE):

- Designate a representative for the BOSS PVS Certification Program and notify the KSC PSM in a letter assigning the representative to the Center PVS committee.
- Manage and implement the BOSS PVS Certification and In Service Inspection (ISI) program to comply with the KSC PVS Certification Program (ref. KNPR 8715.3.)
- Track resolution of discrepancies identified during PVS certifications, re-certifications, field audits/walk-downs and In-Service Inspections.
- Review and approve each certification report (including revisions.)
- Ensure that copies of all certification reports are provided to the PSM for review and approval.

FUNCTIONAL ROLES AND RESPONSIBILITIES

Design Engineering (DE):

- Maintain the BOSS PVS database.
- Identify and schedule PVS Certification/Re-certification Reports that require development or updating.
- Request through the IMCS Duty Office any NDE tests required to complete certifications and ISIs.
- Evaluate new, existing, and modified equipment and systems which fall under the KSC PVS Certification Program for compliance with National Consensus

Standards.

- Notify KSC PSM of any new, existing, and modified equipment and systems which fall under the KSC PVS Certification Program.
- Prepare (or update) and maintain PVS Certification/Re-certification, In Service Inspection (ISI) and Certification History Reports
- Update configuration documentation during in-service inspections, certifications and re-certifications.
- Peer review each certification report (including revisions)
- Coordinate with Configuration Management to issue through appropriate DRA.

Non-Destructive Evaluation (NDE) Organization:

- Perform any required NDE inspections requested by DE through WON assigned by the IMCS Duty Office for both pressure vessels and systems in support of PVS Certification and ISIs.
- Provide Reports and Test Result Media to requestor in DE.

Configuration Management:

- Implement and maintain configuration control of equipment and systems that fall within the guidelines of the KSC PVS Certification Program per *ENG-P-0002*.
- Implement and maintain configuration accounting of new, existing and modified equipment and systems that fall within the guidelines of the KSC PVS Certification Program.
- Coordinate with DE and support the processes associated with maintaining the PVS Certification History in the Engineering Documentation Center.
- Issue Certification, In-service Inspection, and Certification History Reports through appropriate DRA.

REFERENCE DOCUMENTS

The following documents are referenced in this procedure:

Document Number	Title
AFSPCM 91-710	Range Safety User Requirements Manual
ASME B31.1	Power Piping
ASME B31.3	Process Piping, MIL-G-18997
ASME B40.100	Pressure Gauges and Gauge Attachments
29 CFR	Code of Federal Regulations KSC-DE-512-SM
49 CFR	Code of Federal Regulations
ENG-DOP	Engineering Services Division Operating Plan
ENG-P-0002	Configuration Management of Facilities/Systems/Equipment/Utilities (FSEU)
ENG-P-0027	Technical Anomaly Event Disposition Process

Document Number	Title
ENG-P-0033	BOSS OMRS and OMCR Process Procedure
KDP-KSC-P-3621	“Ground-Based Pressure Vessel and Pressurized Systems (PVS) Certification
KNPR 8715.3	KSC Safety Practices Procedural Requirements
KNPR 4000.1	Supply Support Manual
KSC-DE-512-SM	Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements
KSC Form 16-12	NASA KSC Technical Report Cover Sheet
KSC Form 21-68	KSC Document Release Authorization (DRA)
KSC-2011-011	KSC Safety Variance Request Waiver
NASA-STD-8709.20	Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements.
MIL-G-18997	Military Specification, Gauge Pressure, Dial Indicating
NASA-STD-8719.17	NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS)
NB-23	National Board Inspection Code (NBIC)
NNK08OC01C	Institutional Services Contract, PWS 3.4-1
NPD 8710.5	NASA Safety Policy for Pressure Vessels and Pressurized Systems
NPG 1441.1D	NASA Records Retention Schedules
NPR 8000.4	Agency Risk Management Procedural Requirements
PMO-P-0014	BOSS Control of Records
QMS-QP	BOSS Quality Plan
SHP-P-0146	Confined Space Program
SMA-SHP	BOSS Safety and Health Plan
TDC-P-0001	BOSS Document Control
UL-404	Underwriters Lab Standard for Gauges, Indicating Pressure, for Compressed Gas Service
WCC-P-0004	BOSS Work Management Procedure

ACRONYMS

AET	ACOUSTIC EMISSION TESTING
AIRA	ABBREVIATED INTEGRITY AND RISK ASSESSMENT
ANSI	AMERICAN NATIONAL STANDARD INSTITUTE
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR CONDITIONING ENGINEERING
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASNT	AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BAIR	BREATHING AIR

BOSS	BASE OPERATIONS & SPACEPORT SUPPORT
CA	CORROSION ALLOWANCE
CAIR	COMPRESSED AIR
CCSFS	CAPE CANAVERAL SPACE FORCE STATION
CFR	CODE OF FEDERAL REGULATIONS
COC	CERTIFICATE OF COMPLIANCE
COTS	COMMERCIAL OFF THE SHELF
CUI	CORROSION UNDER INSULATION
DE	DESIGN ENGINEER
DOT	DEPARTMENT OF TRANSPORTATION
DRA	DOCUMENT RELEASE AUTHORITY
DRD	DATA REQUIREMENT DOCUMENT
EDC	ENGINEERING DOCUMENTATION CENTER
EWR	ELECTRONIC WORK REQUEST
FK01	FLUIDS MANAGEMENT COMMODITY TRACKING DATABASE
FPC	FIXED PRICE CONTRACT
FS	FACTOR OF SAFETY
GN2	GASEOUS NITROGEN
ID	INNER DIAMETER
IR	INFRARED RADIATION
ISI	IN-SERVICE INSPECTION
JE	WELD JOINT EFFICIENCY
JP	JOB PLAN
KEDS	KSC ENGINEERING DOCUMENTATION SYSTEM
KNPR	KENNEDY NASA PROCEDURAL REQUIREMENTS
KSC	KENNEDY SPACE CENTER
LASSO	LABORATORY SUPPORT SERVICES AND OPERATIONS
MAR	MAINTENANCE ACTION REQUEST
MAWP	MAXIMUM ALLOWABLE WORKING PRESSURE
MDMT	MINIMUM DESIGN METAL TEMPERATURE
MFL	MAGNETIC FLUX LEAKAGE
MOP	MAXIMUM OPERATING PRESSURE
MT	MAGNETIC PARTICLE TESTING
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NB	NATIONAL BOARD
NBBI	NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

NBIC	NATIONAL BOARD INSPECTION CODE
NCS	NATIONAL CONSENSUS STANDARD
NDE	NONDESTRUCTIVE EVALUATION
NDT	NONDESTRUCTIVE TESTING
NPR	NASA PROCEDURAL REQUIREMENT
OD	OUTER DIAMETER
OE	OPERATIONS ENGINEER
O&M	OPERATIONS AND MAINTENANCE
OMEU	OPERATIONS, MAINTENANCE, ENGINEERING, AND USER
PR	PROBLEM REPORT
PSIG	POUNDS PER SQUARE INCH (GAUGE)
PSM	PRESSURE SYSTEMS MANAGER
PRD	PRESSURE RELIEF DEVICE
PT	LIQUID DYE PENETRANT TESTING
PVS	PRESSURE VESSELS AND PRESSURIZED SYSTEMS
PVSC	PRESSURE VESSEL SYSTEM CERTIFICATION
PWS	PERFORMANCE WORK STATEMENT
RAC	RISK ASSESSMENT CODE
RBP	RISK-BASED PLAN
RT	RADIOGRAPHIC TESTING
SAE	SOCIETY OF AUTOMOTIVE ENGINEERS
SCC	STRESS CORROSION CRACKING
SCR	SIMPLE CERTIFICATION REPORT
SE	SYSTEMS ENGINEER
SF	SAFETY FACTOR
SHARP	SYSTEM HEALTH AND READINESS PROGRAM
SMA	SAFETY AND MISSION ASSURANCE
STD	STANDARD
TAL	TECHNICAL ANOMALY LEVEL
TO	TASK ORDER
UT	ULTRASONIC TESTING
UTS	ULTIMATE TENSILE STRENGTH
UTT	ULTRASONIC THICKNESS TESTING
VE	VISUAL EXTERNAL INSPECTION
VI	VISUAL INTERNAL INSPECTION
WON	WORK ORDER NUMBER
YS	YIELD STRENGTH

DEFINITIONS

Alteration: Change that affects the pressure containing capability of a pressure vessel. Nonphysical changes such as an increase in the maximum allowable working or design pressure (internal or external) or design temperature of a pressure vessel shall be considered an alteration. A reduction in minimum temperature such that additional mechanical tests are required shall also be considered an alteration.

Applicable Codes, Standards, Guides: Any national consensus code, standard or guide, or any NASA KSC accepted design code, standard or guide for the design verification of pressure vessels, systems or their components.

Buddy System: The buddy system requires two people be designated to be concerned with each other's safety in a hazardous situation. The system does not demand shoulder-to-shoulder contact, but rather visual contact and a proximity that allows each buddy to help the other in an emergency.

Certification: Documentation qualifying a vessel or system to operate in its particular service.

Certificate of Compliance: Relief valve factory test certificate stating the associated relief valve has been tested to a set pressure verifying no valve leaks according to the manufacturer’s specifications. Test certificate is dated showing when the relief valve was tested.

Code PVS: Pressure vessels and pressurized systems that are designed, fabricated, installed, Code stamped, and maintained in strict conformance with the requirements of the national consensus code or standard.

Commercial Off the Shelf (COTS): Commercial items that require no unique Government modification or maintenance over the life cycle of the product to meet the needs of the procuring agency. A commercial item is one customarily used for non-Governmental purposes that has been or shall 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.

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

De-Rating: The lowering of the maximum allowable working pressure or narrowing of the allowable operating temperature range of a pressure vessel or system.

Design Burst Pressure: The theoretical pressure, at which a vessel or other pressurized component would burst, based on calculations using accepted formulas and material

properties. Vessels and systems to be placed in service are never subjected to a burst pressure test.

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

Design Temperature: The metal temperature used in the design of a vessel or system for determining the minimum required thickness of the components, and for selecting the maximum allowable stress for the materials used in the vessel or system.

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

Excluded PVS: A PVS that is not required to meet the certification (or recertification) requirements of NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems, and need not be included in the PVS configuration management system. Excluded PVS are subject to all applicable laws, regulations, safety requirements, NASA requirements, and appropriate NCS and must be maintained in accordance with applicable NCS.

Factor of Safety (FS): Unless otherwise noted, this refers to the material design factor of safety on structural failure and is equal to the lesser of the material strength divided by the material stress under anticipated loading or the actual buckling load divided by the anticipated buckling load.

Flexhose: There are two basic types of flexhoses – those constructed entirely of metal, herein described by the term “metal hose”, and those constructed of elastomeric material or a combination of elastomeric material and metal, herein described by the term “nonmetallic hose”.

> **Metal Hose:** A metal hose consisting of a flexible metal pressure carrier tube surrounded by an outer layer of wire braid (some low-pressure metal hoses do not utilize an outer layer of wire braid). The flexible metal pressure carrier tube and the wire braid are attached to the hose end fittings by welding, silver-soldering, or brazing (some metal hoses used for cryogenic applications utilize an inner and outer flexible metal tube with a vacuum in the space between the inner and outer flexible tubes).
>
> **Nonmetallic Hose:** A nonmetallic hose consists of a polytetrafluoroethylene or other flexible elastomeric material pressure carrier tube reinforced by fabric or wire braid with metal end fittings attached by mechanical means such as swaging or crimping.

Fracture Control: Fracture control is a set of policies and procedures involving the application of analysis and design methodology, manufacturing technology, and operating procedures to prevent structural failure due to the initiation of and/or propagation of flaws or crack-like defects during fabrication, testing, and service life.

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

Ground-based PVS: All PVS, including PVS based on barges, ships, or other transport vehicles, not specifically excluded in this document. Flight weights PVS used for their intended purpose aboard active air or space craft, even though on the ground, are not included in this definition, but flight weight PVS converted to ground use are included.

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

Hazardous Material: Any solid, liquid, or gaseous material which meets the hazard reporting requirements of 29CFR 1910.1200. This includes commodities that, under foreseeable conditions, are toxic, carcinogenic, cryogenic, explosive, flammable, pyrophoric, water-reactive, corrosive, an oxidizer, a compressed gas, a combustible liquid, or are chemically unstable.

Hydrostatic Test: The test of a pressure vessel or system during which the vessel or system is filled with a liquid (usually water) and pressurized to a designated level in a manner prescribed in the applicable code. (Reference Paragraph UG-99, ASME Code, Section VIII, Division 1 or Article T-3, ASME Code, Section VIII, Division 2.)

Hydraulics: Hydraulic systems using commercially available hydraulic fluid.

Note:

Associated pneumatic storage, actuation devices, or components that are used in a hydraulic system are not considered hydraulics. Pressurized hydraulic fluid containing devices are included if the system is included.

Inactive Vessels/Systems: These are vessels/ systems which are not in service because of changes in program requirements and have no current planned usage but have not been determined to be unsafe.

In-service Inspection (ISI): Periodic inspections and tests performed on PVS to ensure that discrepancies identified during the certification process, possible safety violations, and deterioration due to age and environmental factors are evaluated on an ongoing basis. If required, the vessel or system shall be inoperative during the inspection.

In-service Inspection (ISI) Plan: The plan is a list of inspections and tests and the frequency to be performed on the pressure vessels and/or pressurized systems.

Maximum Allowable Stress Value: The maximum unit stress permissible for any specified material that may be used in the design formulas.

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

Maximum Operating Pressure (MOP): The highest pressure at which a vessel or system component normally operates. This pressure is based on operating requirements and may not exceed the MAWP or design pressure. MOP is synonymous with MEOP (Maximum Expected Operating Pressure) or maximum working pressure.

National Consensus Standard: Any standard, or modification thereof: (1) adopted or promulgated by a nationally recognized standards-producing organization using procedures that demonstrate to the Secretary of Labor for Occupational Safety and Health that those persons interested in or affected by the standard have reached substantial agreement on its adoption; (2) formulated so that an opportunity existed for diverse views to be considered; and (3) designated by the Secretary or the Assistant Secretary, after consultation with other appropriate Federal agencies. (NOTE: A standard, as defined, requires appropriate conditions or activities to provide a safe and healthful employment environment.)

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

Non-Safety-Related Discrepancy: Any discrepancy that does not increase the potential for injury or death to personnel or damage to hardware. The following are considered non-safety-related discrepancies (others may be added at the discretion of the KSC PSM):

- Panels/systems not properly identified.
- Stainless steel piping or tubing not coated for corrosion protection.
- Missing or illegible identification tags on components (except for relief devices, pressure gauges, and flex hoses).
- Discrepancies between documentation and hardware.
- Minor corrosion of vessels, piping, components, or supports.

Nondestructive Examination (NDE): The application of technical methods to examine materials or components in ways that do not impair future usefulness and serviceability in order to detect, locate, measure, and evaluate flaws; to assess integrity, properties, and composition; and to measure geometrical characteristics.

Operating or Working Temperature: The metal temperature that shall be maintained in the part of the vessel or system under consideration during normal operation.

Operating Pressure: The gauge pressure at which a vessel (top of the vessel) or system normally operates. For a vessel, it shall not exceed MAWP, and for a system, it may not exceed the design pressure, except for occasional variations in design pressure.

Owner: The management of the organization responsible for the PVS as defined in NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems.

Pneumatic Test: A test of a pressure vessel or system in which a gas is introduced and pressurized to a designated level in a manner prescribed in the applicable code. (Reference Paragraph UG-100, ASME Code, Section VIII, Division 1, or Article T-4, ASME Code, Section VIII, Division 2, and Paragraph 345.5, ASME B31.1.)

Pressure Cycle: The initiation and establishment of new pressure levels followed by a return to the conditions that prevailed at the beginning of the cycle. Two types of pressure cycles are considered:

- **Full Pressure Cycle:** Pressure as one of its extremes and normal operating conditions (not exceeding vessel MAWP/design pressure) as its other extreme.
- **Partial pressure (normal operating) cycle:** Any pressure cycle within the full pressure cycle, which is required for the vessel or system to perform its intended purpose.

Pressure Relief Device (PRD): A pressure relief device designed to actuate on inlet static pressure and to reclose after normal conditions have been restored. This includes relief valves, safety valves, and safety relief valves [Note: this definition is that of ASME PTC 25-2001.]

Pressure Relief Device Set Pressure: The pressure at which a pressure relief device is set to operate. Set to operate means the set pressure of a relief valve or spring-loaded non-reclosing device, the bursting pressure of a rupture disk device or the breaking pressure of a breaking pin device. (Reference Paragraphs UG-125 and UG-134, ASME Code, Section VIII, Division 1, and Part AR, ASME Code, Section VIII, Division 2.)

Pressure Vessels and Systems (PVS): An assembly of components under pressure, including vessels, piping, valves, relief devices, pumps, expansion joints, gauges, etc. This includes systems containing hazardous or lethal fluids at any pressure above 0 MPa (gauge) (0 lb/in2 (gauge)) and systems containing nonhazardous or nonlethal fluids

above 0.1 MPa (gauge) (15 lb/in2 (gauge)), unless otherwise specifically excluded in KNPR 8715.3, or excepted by direct approval from the PSM.

Pressure Systems Manager (PSM): The individual designated by the KSC Center Director who is responsible for the overall management of the KSC Pressure Vessel/Systems (PVS) Certification Program. The KSC PSM is a member of the Propellants and Life Support Branch of the Spaceport Services Directorate.

Pressure Test: See Hydrostatic Test and Pneumatic Test.

Pressure Vessel: Any vessel used for the storage or handling of gas or liquid under positive pressure. Included in this definition are components of systems (e.g., heat exchanger shells and drying towers, and other shell structures) for which the rules of the ASME Code, Section VIII, would apply. Vessels containing hazardous or lethal fluids at any pressure above 0 MPa (gauge) (0 lb/in2 (gauge)), and vessels containing nonhazardous or nonlethal fluids above 0.1 MPa (gauge) (15 lb/in2 (gauge)) are included unless otherwise specifically excluded.

Proof Tests to Establish Maximum Allowable Working Pressure: Pressure test which establishes the maximum allowable working pressure of a vessel, system, or component thereof, may be used: (1) When the strength cannot be computed with a satisfactory assurance of accuracy; (2) When the thickness cannot be determined by means of the design rules of the applicable code or standard; or (3) When the critical flaw size to cause failure at the certified pressure cannot be identified by other nondestructive test methods. This test is to be performed in a manner equivalent to one of the methods specified in Paragraph UG-101 of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition. Proof tests may be performed only upon approval of the KSC PSM.

PVS Representative: The individual(s) assigned to represent an organization in all matters relating to PVS and shall be identified to the PSM.

Quality Management System (QMS): The set of management and operational processes and procedures which affect the quality of products and services, including those processes required by ANSI/ISO/ASQ Q9001-2000.

R-1 and R-1A Forms: An NBIC form identifying repairs or alterations, respectively, on code stamped vessels or power piping.

Recall System: A system which tracks selected components subject to periodic calibration, inspection, or test. Components included in recall systems are relief valves, pressure gauges, and flex hoses.

Recertification: The procedure (appropriate tests, inspections, examinations, analyses, and documentation), which qualifies a previously certified vessel or system to continue or be returned to operation at a designated pressure.

Recertification Interval: The time between recertification when a certified status is maintained through documented periodic examinations and inspections to determine acceptable vessel or system condition. This time period must be determined when the ISI plan is developed, and the length of this period shall depend on the results of the initial and subsequent inspections, tests, risk assessment, remaining life and engineering analyses.

Repair: The work necessary to restore a pressure vessel or system to a safe and satisfactory operating condition provided there is no deviation from the original design.

Rerated Vessel or System: (1) A vessel or system judged to be unsafe, unsuitable, or unnecessary for continued operation at its original design pressure and/or temperature limits. (2) A vessel or system recertified to operate at a lesser or greater pressure and/or temperature limit relative to its original designs.

Risk (Safety) Assessment: Process of qualitative risk categorization or quantitative risk (safety) estimation, followed by the evaluation of risk significance.

Risk Assessment Code: A numerical expression of comparative risk determined by an evaluation of both the potential severity of a condition and the probability of its occurrence causing an expected consequence.

Safety-Related Discrepancy: Any hardware discrepancy that could increase the potential for injury or death to personnel or damage to hardware. The following are considered safety-related discrepancies:

- Primary relief device set above the certified MAWP or design pressure.
- Relief device with insufficient flow capacity.
- Relief device past due for calibration.
- Relief device with missing or illegible identification tag.
- Pressure gauge out of calibration or past due.
- Obvious physical damage (e.g., crushed or kinked flexhose, dented or nicked piping/tubing/vessels, or heavy corrosion of vessels/piping).
- Not labeling the vessel's MAWP/service fluid.

Safety-Relief Device Set Pressure: The pressure at which a pressure relief device is set to operate. Set to operate means the set pressure of a relief valve or spring-loaded non-reclosing device, the bursting pressure of a rupture disk device or the breaking pressure of a breaking pin device. (Reference Paragraphs UG-125 and UG-134, ASME Code, Section VIII, Division 1, and Part AR, ASME Code, Section VIII, Division 2.)

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

System Certification Pressure: The maximum pressure that has been applied to a system; however, no system element can have its MAWP exceeded when the certification pressure has been applied.

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

Temporary equipment (PVS): Non-government owned equipment that is not required to meet the certification (or recertification) requirements of NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems or NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS). Temporary equipment is subject to all applicable laws, regulations, NASA safety requirements, OSHA requirements, and appropriate NCS. This typically includes contractor supplied rental equipment leased from an offsite location.

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

Test Specific PVS: PVS used to perform testing of a specific test article. PVS used on a permanent or repeated basis or built up of components used repeatedly for testing different hardware or configurations are not part of this category.

Unsafe Vessels or Systems: These are vessels or systems, which have been determined to be unsafe for service.

Vacuum System: An assembly of components under vacuum (internal pressure less than that of the surrounding atmosphere) including vessels, piping, valves, relief devices, pumps, expansion joints, and gauges.

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

Welded Joint Categories: Category “A” welds primarily consist of longitudinal welds within the main shell, any welded joint in a sphere, and circumferential welds connecting hemispherical heads to the main shell. Category “B” welds primarily consists of circumferential welds within the main shell or nozzles and circumferential welds connecting formed heads to the main shell. Category “C” welds primarily consist of connecting flanges on the main shell and formed heads. Category “D” welds primarily consist of nozzles connecting to the main shells or spheres. Category “E” welds primarily consist of non-pressure parts and stiffeners. An expanded description is included in Part UW-3 of ASME BPVC Section VIII, Division 1.

REVISION RECORD

The following revisions have been applied to this document:

Revision Number	Change Description	Date
0	Initial Release	04/28/00
1	Complete revision to incorporate organizational changes; and updates to In-Service Inspection requirements and Certification procedure.	06/22/04
2	Complete revision to delineate certification processes.	06/01/06
3	This revision removes the SGS Company Proprietary-JBOSC Competition Sensitive statement.	05/28/07
4	This revision updates entire procedure to be compliant with KNPR 8715.3, Rev. G.	12/14/09
5	Minor Revisions; Update Template & Records Table. No Formal Review Required per QPO	06/21/11
6	Page 21 Section 1.2, added reference to In-Service Inspection form ENG-F-PVS1. Page 64, updated signature block & Records Table	10/20/16
7	Complete revision required to address obsolete content and changes to process to add efficiencies.	02/04/2019
8	Converted document from ISC to BOSS format	03/11/2020
9	Updated Section 1.5.2 Quarterly Reports and Metrics Page 41. Incorporated minor changes.	12/23/2021
10	Added Baseline UTT NDE for new pressure vessels. Updated Section 1.3.1.2 to include vendor forms when ordering new relief valves and pressure vessels. Added Internal Visual Inspections for pressure vessel Mid-Life NDEs. Incorporated minor changes.	4/22/2022
11	Added Baseline UTT for initial service life. Corrected hyperlinks and TAL process with EWR. Removed Full Service Certification requirements along with Risk Based Plan. Remove appendix regarding damage mechanisms and NDE used for identification along with associated references. Added additional acronyms. Added the process of de-rating a vessel.	12/19/2023

DOCUMENT APPROVALS

X

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