



National Aeronautics and  
Space Administration

**John C. Stennis Space Center**  
Stennis Space Center, MS 39529-6000

**SSTD-8070-0069-PIPE**  
**Revision A-2**  
**FEBRUARY 2016**

# COMPLIANCE IS MANDATORY

## **John C. Stennis Space Center Standard Low Pressure Vacuum Jacketed Pipe**

### **Original signed by**

Scott Olive  
NASA SSC Center Operations  
Project Management Division

6-30-14  
Date

Bartt J. Hebert  
NASA SSC Engineering &  
Test Directorate

6-27-14  
Date

### **Issued by**

Issued CEF  
Central Engineering Files

7-1-14  
Date

This is an uncontrolled document when printed. Verify that the document is current before use.



**Documents**  
Document Sharing Hub

|                                                                                    |                     |                   |
|------------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE | A-2               |
|                                                                                    | <i>Number</i>       | <i>Rev.</i>       |
|                                                                                    | Effective Date:     | February 11, 2016 |
|                                                                                    | Review Date:        | July 1, 2019      |
| Page 2 of 35                                                                       |                     |                   |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                                |                     |                   |

## Document History Log

| Revision | Date     | Originator/<br>Phone | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|----------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Basic    | 11/21/08 | D. Dike,<br>x8-2803  | <p><b>John C. Stennis Space Center (SSC) Central Engineering Files (CEF) Archive Note: This standard supersedes: COE Contracts 1544, Section 47; 1550, Section 54; 1580, Section 4; 2090, Section 49; 2876, Section 51; and 2899, Section 27.</b></p> <p>Initial release of standard in document format corresponding to Stennis Document Numbering System (SDNS) and Stennis Space Center Procedural Requirement (SPR) 1400.1, <i>John C. Stennis Space Center Document Preparation, Numbering, and Management Procedural Requirements</i>. This standard supersedes SSC STD 47-044 Rev. A. Added/specified sections per SPR 1400.1 where appropriate throughout the document. Updated documentation references to reflect current SSC Standards and SPRs. Updated type/size of materials and testing requirements as needed.</p>                                                                                                                                                                                                                                                                                                                                                           |
| A        | 7/01/14  | D. Dike,<br>x8-2803  | <p>Regular five year review. References updated. Added "limits specified by the EJMA Standard. Where liners are required, they shall be designed and fabricated in accordance with the EJMA Standard" to 5.1.4o. Added "[This required surface finish is smoother than the 63 micro-inch roughness required by ASME B16.5.]" to 5.1.5d. Added "Class 2 is permitted if the minimum service media temperature is no less than -325°F or if minimum temperature of stud/bolt material is determined to be no less than -325°F by FEA and in accordance with ASME B31.3 Paragraph 301.3.3. Otherwise Class 1 stud/bolt material is required. [Fluids other than cryogenic hydrogen and helium have minimum service temperatures that are -325°F or higher. Liquid and slush hydrogen and helium have minimum service temperatures below -325°F.] Stud/bolt torqueing or tensioning sequence and procedures shall be developed and used in accordance with ASME PCC-1 for each flange joint size and type to assure proper joining of flanges without overstressing studs/bolts." to 5.1.7a. Added 5.1.12.5 Inner Pipe Leakage Tests. Deleted "All inner pipe segments, sections, and spools</p> |

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                |                     |                   |
|--------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                            | SSTD-8070-0069-PIPE | A-2               |
|                                                                                | <i>Number</i>       | <i>Rev.</i>       |
|                                                                                | Effective Date:     | February 11, 2016 |
|                                                                                | Review Date:        | July 1, 2019      |
| Page 3 of 35                                                                   |                     |                   |
| Responsible Offices: NASA/Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                            |                     |                   |

|     |          |                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|----------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |          |                                | <p>which have surfaces precision-cleaned to RPTSTD-8070-0001 shall be packaged and preserved at their specified cleanliness levels in accordance with NASA/SSC Drawing 54000-GP11 <i>Packaging and Preservation of Cleaned Components</i>. All hardware that is precision cleaned to RPTSTD-8070-0001 Cleanliness Levels 1, 1X, 1XX, 1XXX, or 2A shall be treated as LO/GO components with respect to packaging requirements (section 3.3 of NASA/SSC Drawing 54000-GP11 applies). All hardware that is precision cleaned to RPTSTD-8070-0001 Cleanliness Levels 2, 2X, 2XX, or 4 shall be treated as NON-LO/GO components with regards to packaging requirements (section 3.4 of NASA/SSC Drawing 54000-GP11 applies) from 5.1.13. Multiple changes to 5.2.14.5 Outer Pipe Leakage Test including adding sections f-i. Added “For vacuum jacketed pipe sections and spools fabricated, inspected, and tested by a commercial manufacturer at a facility outside of NASA/SSC, the field joints of the inner pipe shall be tested for leakage in accordance with Section 5.1.12.5 prior to installation or connection of the field-installed vacuum closures. The field-installed vacuum closures shall then be leak tested in accordance with the above paragraph or in accordance with Section 5.2.14.5, Parts b. through I” to 5.2.14.7. Reworded 5.3a to say: “Unless stated otherwise in contract specifications or drawings, the contractor/vendor shall furnish the Contracting Officer with information included in Table 2 below and in accordance with requirements shown on this table. Where there is a conflict between requirements of Table 2 and those of contract specifications or drawings, the latter requirements govern.”</p> |
| A-1 | 7/8/14   | D. Dike<br>x8-2803             | Administrative changes for formatting issues.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| A-2 | 02.12.16 | R. Carol<br>Wolfram<br>x8-1164 | Administrative change. Replaced “FOSC” with “SACOM” throughout document.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|     |          |                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|     |          |                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                |                     |                   |
|--------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                            | SSTD-8070-0069-PIPE | A-2               |
|                                                                                | <i>Number</i>       | <i>Rev.</i>       |
|                                                                                | Effective Date:     | February 11, 2016 |
|                                                                                | Review Date:        | July 1, 2019      |
| Page 4 of 35                                                                   |                     |                   |
| Responsible Offices: NASA/Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                            |                     |                   |

## Table of Contents

|            |                                                                    |          |
|------------|--------------------------------------------------------------------|----------|
| <b>1.0</b> | <b>PURPOSE.....</b>                                                | <b>6</b> |
| <b>2.0</b> | <b>APPLICABILITY.....</b>                                          | <b>6</b> |
| <b>3.0</b> | <b>REFERENCED DOCUMENTS.....</b>                                   | <b>6</b> |
| <b>4.0</b> | <b>RESPONSIBILITIES.....</b>                                       | <b>8</b> |
| <b>5.0</b> | <b>REQUIREMENTS.....</b>                                           | <b>8</b> |
| 5.1        | Inner Pipelines.....                                               | 8        |
| 5.1.1      | Inner Pipeline General Requirements.....                           | 8        |
| 5.1.2      | Inner Pipe.....                                                    | 8        |
| 5.1.3      | Inner Pipe Fittings.....                                           | 9        |
| 5.1.4      | Inner Pipe Flexible Convolute Sections.....                        | 9        |
| 5.1.5      | Inner Pipe Flanges.....                                            | 11       |
| 5.1.6      | Inner Pipe Flange Gaskets and Seals.....                           | 12       |
| 5.1.7      | Inner Pipe Flange Bolting.....                                     | 12       |
| 5.1.8      | Inner Pipe Boss Connections.....                                   | 13       |
| 5.1.9      | Inner Pipe Boss Connection Seals.....                              | 13       |
| 5.1.10     | Inner Pipe Standoffs.....                                          | 14       |
| 5.1.11     | Inner Pipe Welding and Weld Joints.....                            | 14       |
| 5.1.12     | Inner Pipe Inspections and Tests.....                              | 15       |
| 5.1.12.1   | Inner Pipe Visual Inspections.....                                 | 15       |
| 5.1.12.2   | Inner Pipe Radiographic Inspections.....                           | 15       |
| 5.1.12.3   | Inner Pipe Dye-Penetrant Inspections.....                          | 16       |
| 5.1.12.4   | Inner Pipe Pressure Tests.....                                     | 16       |
| 5.1.12.5   | Inner Pipe Leakage Tests.....                                      | 17       |
| 5.1.13     | Inner Pipe Precision Cleaning.....                                 | 18       |
| 5.2        | Outer (Vacuum Jacket) Pipelines and Vacuum Annuluses/Closures..... | 18       |
| 5.2.1      | Outer Pipeline General Requirements.....                           | 19       |
| 5.2.2      | Allowed Heat Leakage.....                                          | 19       |
| 5.2.3      | Outer Pipe.....                                                    | 20       |
| 5.2.4      | Outer Pipe Fittings.....                                           | 21       |
| 5.2.5      | Outer Pipe Flexible Convolute Sections.....                        | 21       |
| 5.2.6      | Vacuum Annulus/Closure Gettering System.....                       | 22       |
| 5.2.7      | Thermal Insulation.....                                            | 23       |
| 5.2.8      | Outer Pipe Mechanical Closures.....                                | 23       |
| 5.2.9      | Outer Pipe Mechanical Closure Seals.....                           | 24       |
| 5.2.10     | Boss Connection Vacuum Closures.....                               | 25       |
| 5.2.11     | Evacuation and Vacuum Measurement System.....                      | 25       |
| 5.2.12     | Outer Pipe Standoffs.....                                          | 26       |

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                |                     |                   |
|--------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                            | SSTD-8070-0069-PIPE | A-2               |
|                                                                                | <i>Number</i>       | <i>Rev.</i>       |
|                                                                                | Effective Date:     | February 11, 2016 |
|                                                                                | Review Date:        | July 1, 2019      |
| Page 5 of 35                                                                   |                     |                   |
| Responsible Offices: NASA/Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                            |                     |                   |

|            |                                                 |           |
|------------|-------------------------------------------------|-----------|
| 5.2.13     | Outer Pipe Welding and Weld Joints.....         | 27        |
| 5.2.14     | Outer Pipe Inspections and Tests.....           | 27        |
| 5.2.14.1   | Outer Pipe Visual Inspections.....              | 27        |
| 5.2.14.2   | Outer Pipe Radiographic Inspections.....        | 27        |
| 5.2.14.3   | Outer Pipe Dye-Penetrant Inspections.....       | 27        |
| 5.2.14.4   | Outer Pipe Pressure Tests.....                  | 27        |
| 5.2.14.5   | Outer Pipe Leakage Tests.....                   | 28        |
| 5.2.14.6   | Outer Pipe Bake-Out/Vacuum-Retention Test.....  | 29        |
| 5.2.14.7   | Outer Pipe Field Vacuum Retention Test.....     | 29        |
| 5.2.15     | Vacuum Annulus/Closure Contaminant Removal..... | 30        |
| 5.2.16     | Outer Pipe Marking.....                         | 30        |
| 5.3        | Submittal Documents.....                        | 31        |
| 5.4        | Preparation for Shipment.....                   | 32        |
| 5.5        | Shipping.....                                   | 34        |
| <b>6.0</b> | <b>RECORDS AND FORMS.....</b>                   | <b>34</b> |
| <b>7.0</b> | <b>ACRONYMS AND ABBREVIATIONS.....</b>          | <b>35</b> |

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                    |                     |                   |     |
|------------------------------------------------------------------------------------|---------------------|-------------------|-----|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE |                   | A-2 |
|                                                                                    | Number              | Rev.              |     |
|                                                                                    | Effective Date:     | February 11, 2016 |     |
|                                                                                    | Review Date:        | July 1, 2019      |     |
|                                                                                    | Page 6 of 35        |                   |     |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |     |
| SUBJECT: Low Pressure Vacuum Jacketed Piping                                       |                     |                   |     |

## 1.0 PURPOSE

This John C. Stennis Space Center (SSC) standard (SSTD) specifies materials and construction criteria for the inner and outer piping for cryogenic service vacuum jacketed piping. The nominal size range for the inner piping is ½-inch through 16-inches. The maximum internal operating/service pressure for the inner piping is 275-psig.

## 2.0 APPLICABILITY

This standard applies to all personnel at SSC involved with performing and/or supervising vacuum jacketed piping for cryogenic service-at service pressures that do not exceed 275-psig.

## 3.0 REFERENCED DOCUMENTS

All references are assumed to be the latest version unless otherwise indicated.

ASME BPV Code, *Boiler and Pressure Vessel Code, Sections II, V, VIII, and IX*

ASME B16.5, *Pipe Flanges and Flanged Fittings*

ASME B16.9, *Factory-Made Wrought Steel Butt welding Fittings*

ASME B16.20, *Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed*

ASME B16.20a, *Addenda to ASME B16.20; Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed*

ASME B16.21, *Non-Metallic Flat Gaskets for Pipe Flanges*

ASME B16.25, *Butt welding Ends*

ASME B16.28, *Wrought Steel Butt welding Short Radius Elbows and Returns*

ASME B18.2.1, *Square and Hex Bolts and Screws, Inch Series*

ASME B18.2.2, *Square and Hex Nuts*

ASME B31.3, *Process Piping*

ASME PCC-1, *Guidelines for Pressure Boundary Bolted Flange Assembly*

ASME PCC-2, *Repair of Pressure Equipment and Piping*

ASTM A182, *Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service*

ASTM A194, *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A240, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications*

ASTM A312, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes*

ASTM A320, *Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service*

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                    |                     |                   |     |
|------------------------------------------------------------------------------------|---------------------|-------------------|-----|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE |                   | A-2 |
|                                                                                    | Number              | Rev.              |     |
|                                                                                    | Effective Date:     | February 11, 2016 |     |
|                                                                                    | Review Date:        | July 1, 2019      |     |
|                                                                                    | Page 7 of 35        |                   |     |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |     |
| SUBJECT: Low Pressure Vacuum Jacketed Piping                                       |                     |                   |     |

ASTM A358, *Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications*

ASTM A403, *Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings*

DR 6-SA01, *Safety and Health Plan*

EJMA Standards, *Standards of the Expansion Joint Manufacturers Association, Inc. with Addenda*

MIL-I-24768, *Military Specification; General Specification for Insulation, Plastic, Laminated, Thermosetting*

MSFC-STD-3535, *Standard for Propellants and Pressurants used for Test and Test Support Activities at SSC and MSFC*

MSS SP-6, *Standard Finishes for Contact Faces of Pipe Flanges and Connections – End Flanges of Valves and Fittings*

RPTSTD-8070-0001, *Surface Cleanliness Standard of Fluid Systems for Rocket Engine Test Facilities of the NASA Rocket Propulsion Test Program*

SAE AS4395, *Fitting End, Flared Tube Connection, Design Standard*

SAE AS5202, *Port or Fitting End, Internal Straight Thread, Design Standard*

SNT-TC-1A, *ASNT's guideline to personnel qualification and certification in NDT*

SQP-5300-0016, *Certification of NDT personnel*

SPR 1400.1, *John C. Stennis Space Center Document Preparation, Numbering, and Management Procedural Requirements*

SPR 8715.1, *John C. Stennis Space Center Safety and Health Procedural Requirements*

SSTD-8070-0013-WELD, *Classes of Welding Inspection*

SSTD-8070-0017-WELD, *Joining Stainless Steel by GTAW Wire*

SSC Drawing 54000-GM00, *Flange Gasket, LO/GO Compatible*

SSC Drawing 54000-GM30, *Specifications for Material Used in LOX and GOX Service Exempt from Batch Test Requirements*

SSC Drawing 54000-GP11, *Packaging and Preservation of Cleaned Components*

SPR 1440.1, *Records Management Program Requirements*

SSTD-8070-0005-CONFIG, *Preparation, Review, Approval, and Release of SSC Standards (SSTD's)*

#### 4.0 RESPONSIBILITIES

Responsibilities for use and control of this standard and for the review and approval of revisions or cancellation of this standard shall be as specified in SSTD-8070-0005-CONFIG and the applicable documents referenced herein.

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                    |                     |                   |      |
|------------------------------------------------------------------------------------|---------------------|-------------------|------|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE |                   | A-2  |
|                                                                                    | Number              |                   | Rev. |
|                                                                                    | Effective Date:     | February 11, 2016 |      |
|                                                                                    | Review Date:        | July 1, 2019      |      |
|                                                                                    | Page 8 of 35        |                   |      |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |      |
| SUBJECT: Low Pressure Vacuum Jacketed Piping                                       |                     |                   |      |

## 5.0 REQUIREMENTS

- a. Requirements for design, fabrication, inspecting, and testing of inner pipelines shall conform to ASME B31.3, except where stated otherwise in this standard, and all subsections under section 5.1 in this standard.
- b. Requirements for design, fabrication, inspecting, and testing of outer pipelines and vacuum closures/annuluses shall conform to ASME B31.3, except where stated otherwise in this standard, and all subsections under section 5.2 in this standard.

### 5.1 Inner Pipelines

Inner pipelines are defined as pipe, pipe fittings, pipe spools, tubing, and tube fittings that contain and convey the service media which in turn are enclosed by outer vacuum jacketing (outer vacuum jacket pipelines).

#### 5.1.1 Inner Pipeline General Requirements

- a. Allowed service media for the inner pipelines is cryogenic, slush, liquid and gaseous air, helium, hydrogen, methane, natural gas, nitrogen, and oxygen. Non-cryogenic liquid hydrocarbons may also be contained in and conveyed through inner pipelines in cases where minimal heat leakage from environment to service media is required.
- b. Inner line design pressure shall not exceed 275-psig, except where flange materials require down-rating of inner pipelines to 230-psig (reference section 5.1.5 below).
- c. Allowed service media temperature range is from -423°F to +130°F.

#### 5.1.2 Inner Pipe

- a. Inner pipe shall be seamless or seam welded Schedule 5S stainless steel in accordance with ASTM A312, TP 304L or TP316L, or ASTM A358, Gr. 304L or Gr. 316L.
- b. The surface finish on all internal, service media wetted surfaces and on all weld end preparations of pipe shall be 250 Root Mean Square (RMS) or smoother.

#### 5.1.3 Inner Pipe Fittings

- a. Inner pipe fittings shall be seamless or seam welded Schedule 5S stainless steel in accordance with ASTM A403, TP 304L or TP316L or ASTM A182 Gr. F304L or Gr. F316L.

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                    |                     |                   |
|------------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE | A-2               |
|                                                                                    | Number              | Rev.              |
|                                                                                    | Effective Date:     | February 11, 2016 |
|                                                                                    | Review Date:        | July 1, 2019      |
| Page 9 of 35                                                                       |                     |                   |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                                |                     |                   |

- b. Fittings shall be butt weld type with dimensions conforming to ASME B16.9 or ASME B16.28.
- c. Short radius elbow and return fittings per ASME B16.28 shall be used only where specified on pipe system or spool drawings.
- d. Schedule 10S fittings may be used instead of Schedule 5S fittings for cases where additional stiffness or strength is required or where material availability provides a viable option for cost or schedule savings. When and where Schedule 10S fittings are used, drawings shall show specific pipe spool and system locations where these fittings are used.
- e. Where Schedule 10S fittings are butt welded to Schedule 5S pipe and fittings, weld end transitions shall be provided at the effected butt weld end preparations of the Schedule 10S fitting so that these end preparations match those of the Schedule 5S fittings.
- f. Weld end transitions shall conform to requirements of ASME B16.25.
- g. The inside diameter counterbore at each transition shall have a 3-to-1 taper minimum (18.4-degree maximum included cone half angle).
- h. The surface finish on all internal, service media wetted surfaces and on all weld end preparations of pipe fittings shall be 250 Root Mean Square (RMS) or smoother.

#### 5.1.4 Inner Pipe Flexible Convolute Sections

- a. The use of flexible convolute sections (bellows) on inner piping shall be used only where design constraints on pipe routing, length, or pressure drop precludes the use of other methods to prevent overstress conditions due to thermal displacements and strains of pipe systems and sections.
- b. The design and fabrication of each convolute section shall conform to all applicable requirements of Expansion Joint Manufacturers Association, Inc. (EJMA) standards and rated for no less than 5000 cycles at the full rated axial, lateral, and angular displacements expected for the respective convolute section.
- c. All convolute sections shall be made of Type 321 stainless steel in accordance with ASTM A240, ASTM A312, or ASTM A358.
- d. Single or multi-ply convolute sections may be used, but the multi-ply sections shall have no less than three plies.

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                    |                     |                   |
|------------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE | A-2               |
|                                                                                    | Number              | Rev.              |
|                                                                                    | Effective Date:     | February 11, 2016 |
|                                                                                    | Review Date:        | July 1, 2019      |
| Page 10 of 35                                                                      |                     |                   |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                                |                     |                   |

- e. Convolute sections shall have butt weld ends and be butt welded to pipe and pipe fittings in accordance with section 5.1.11.
- f. The inside diameters, outside diameters, and wall thickness of the convolute section stub ends shall match those of the adjoining pipe or pipe fitting within required dimensional tolerances.
- g. All tube, pipe, or cylinders with longitudinal seam welds used for the fabrication of convolute sections shall have these welds 100% radiographically inspected in accordance with ASME B31.3 prior to forming the convolutes.
- h. These welds and inspection of these welds shall fully conform to ASME BPV Code section VIII and IX requirements.
- i. The seam welds shall be planished after welding to within 10% of the original sheet/wall thickness.
- j. The surface finishes on all tube, pipe, or cylinders used for the fabrication of flexible convolute sections shall be 125 RMS or smoother.
- k. Convolutions shall be "U" shaped and formed with uniform pitch and matching height.
- l. Convolute sections shall be provided and installed into the pipe system, section, or spool in the as-formed condition.
- m. Where determined by calculations and manufacturer data as being needed, sections of pipelines containing flexible convolute sections shall be equipped with external supports, such as tie rods, to contain axial loads applied to the convolute section that result from internal service media pressure.
- n. Circumferential welds joining one convolute section to another are not permitted.
- o. Convolute sections shall be equipped with internal flow liners when fluid line flow velocities are expected to exceed limits specified by the EJMA Standard. Where liners are required, they shall be designed and fabricated in accordance with the EJMA Standard.
- p. Convolute section liners shall be equipped with external ports having SAE AS5202 thread connections, internal drain holes, and dimensional clearances that enable pressure spray and complete gravity draining of solvents used for precision cleaning of all surfaces in annular region between each liner and convolute section.
- q. External ports, if provided, shall be of sufficient length to penetrate through the outer (vacuum jacket) piping.

This is an uncontrolled document when printed. Verify that the document is current before use.

|                                                                                    |                     |                   |
|------------------------------------------------------------------------------------|---------------------|-------------------|
| Stennis<br>Standard                                                                | SSTD-8070-0069-PIPE | A-2               |
|                                                                                    | Number              | Rev.              |
|                                                                                    | Effective Date:     | February 11, 2016 |
|                                                                                    | Review Date:        | July 1, 2019      |
| Page 11 of 35                                                                      |                     |                   |
| Responsible Offices: NASA SSC Center Operations and Engineering & Test Directorate |                     |                   |
| <b>SUBJECT: Low Pressure Vacuum Jacketed Piping</b>                                |                     |                   |

- r. For each convolute section equipped with a liner, the adjacent pipe or pipe fitting butt welded to each end of the convolute section shall be permanently marked with a flow direction arrow.
- s. For each flexible convolute section, the manufacturer shall provide calculations in accordance with EJMA standards as proof that the respective convolute section fully conforms to requirements in this section.

### 5.1.5 Inner Pipe Flanges

- a. Unless specified otherwise on drawings at specific flange joint locations, flange connections used on inner pipe spools shall be ASME B16.5 150# Class Weld Neck Raised Face or Weld Neck Ring Type Joint (RTJ) Flanges made of either:
  - 1. ASTM A182 Gr. F304/F304L or Gr. F316/316L dual rated stainless steel where material fully conforms to ASME B31.3 requirements and meets chemical composition requirements for both type 304 and 304L or both type 316 and 316L stainless steels. Furthermore, certified material test reports, showing that the ultimate tensile and yield stresses are no less than 75-ksi and 30-ksi respectively, are required for all flange materials.
  - 2. ASTM A182 Gr. F304L or F316L stainless steel. In this case, all pipe sections and spools containing flanges made of this material shall be down-rated to pressures of 230-psig or lower.
- b. The surface finish on all flange bores and weld end preparations shall be 250 RMS or smoother.
- c. Raised face flanges shall have concentric 90-degree V-groove ring serrations in the flange face in accordance with MSS SP-6.
- d. RTJ flanges shall have 16 RMS or smoother surface finish on the seal ring contact surfaces. [This required surface finish is smoother than the 63 micro-inch roughness required by ASME B16.5.]
- e. RTJ flanges shall be used only at specific locations as indicated on pipe system, section, and spool drawings.
- f. Raised face flanges shall be used where RTJ flanges are not used.

This is an uncontrolled document when printed. Verify that the document is current before use.