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Space Administration

**John C. Stennis Space Center**  
Stennis Space Center, MS  
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**SSTD-8070-0047-PIPE**

**Rev. E-1  
JULY 2022**

**Compliance Is Mandatory**  
**John C. Stennis Space Center**  
**STANDARD FOR STAINLESS STEEL PIPING**  
**SYSTEMS AA, ACK1, ACK4, ACK6, B,**  
**BCK1, BCK3, BCK4, BCK6, BCK10, C, EE, G, H,**  
**JJ, K3, L1, L2, NCK1, NCK2, NCK3,**  
**NCK10, NCK11, NCK12, P, R, T, and Z**

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## Document History Log

Change/ Revision	Change Date	Originator/ Phone	Description
Basic	02.02.16	D. Dike/ ext. 2803	Initial release. Supersedes SSC standards SSC-47-015, 47-016, 47-017, 47-021, 47-029, 47-030, 47-032, 47-038, SSTD-8070-0060-PIPE, SSTD-8070-0061-PIPE, SSTD-8070-0127-PIPE, SSTD-8070-0128-PIPE and piping systems specifications ACK1, ACK4, ACK6, BCK1, BCK3, BCK4, BCK6, BCK10, K3, L1, L2, NCK1, NCK2, NCK3, NCK10 AND NCK11. <b><i>SSC CEF Archive Note: This standard also supersedes COE Contracts 1544, 1550, 1580, 2090, 2588, 2876, 2889, 2899, and 2090; and Piping Spec. AA, B, C, D, DD, E, EE, P, R, and T.</i></b>
Basic-1	06.03.16	R. Wolfram Ext. 1164	Administrative change. Deleted irrelevant information related to carbon steel piping systems S and SS.
A	08.22.16	L. de Quay Ext. 8-1956	Administrative changes. Updated Acronyms. Included BA on Service and Maximum Design Pressure row entries for Z system. Added gaseous methane (GM) and liquid methane (LM) to Service row entries for piping systems ACK4, BCK1, BCK4, BCK10, NCK1, NCK2, NCK3, NCK10, NCK11, and NCK12. Added GM to Service row entries for piping systems ACK1 and BCK3. Added gaseous methane (GM), liquid methane (LM), and gaseous oxygen (GO) to Service row entries for piping system AA; and defined temperature range parameters for piping system AA.
B	10.31.18	L. de Quay Ext. 8-1956	Minor formatting update. 5.2, Requirements by Piping System, Piping System "G": Replaced references to Appendix J with Appendix I; and added (See Sections 9.2 and 9.8.) to piping and fitting material requirements. 5.2: Removed "Low Pressure Service" and "Medium Pressure Service" rows throughout table. 15.0: Added Definitions.

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C	08.21.2019	L. de Quay Ext. 8-1956	5.1.e-1: "ASME PCC-2, Part 5, Section 6.2" changed to "ASME PCC-2, Part 5, Article 501, Sub-article 501-6.2." 5.1.e-2: "ASME PCC-2, Part 5, Section 6.2" changed to "ASME PCC-2, Part 5, Article 501, Sub-article 501-6.2." Also, "subsection 6.2 ( <i>h</i> )" changed to "Sections ( <i>i</i> ) and ( <i>l</i> ) of this sub-article."
D	09.01.2021	L. de Quay Ext. 8-1956	Section 5.2 Table: Removed "Water" and added "IW" in "Service" (service fluid or media) row for Piping Designators ACK1, ACK4, BCK3, NCK1, NCK2, NCK3, NCK10, NCK11, and NCK12. Section 14.0: Updated acronyms to include "IW" for "Industrial Water".
E	05.23.22	L. de Quay Ext. 8-1956	Updated Acronyms and minor administrative modifications. Section 5.2 Table: <ul style="list-style-type: none"> <li>• Added "VAC" in "Service" row; "VAC, -423°F to 100°F" in "Temperature Range" row; "Section 9.5" in "End Fitting Details" row; and "or LSI" and "Section 9.4.) For vacuum service, see Section 9.6)" in "Gaskets/Seals/Clamps" row for Piping Designator Z.</li> <li>• Added "or LSI" and "Section 9.4" to "Gaskets/Seals/Clamps" row for Piping Designators NCK3, NCK11, NCK1, H, C, NCK2, AA, and NCK10.</li> <li>• Added "or LSI" and "style" to Piping Designator JJ.</li> <li>• Added ", CGI, or LSI" and "Sections 9.3 and 9.7" to Piping Designator EE.</li> </ul> Section 9.2: Added "all pipe and fittings used for" after "For" in the first line. Deleted "BCK4," from first line. Added "all" before "flanges" in second line. Revised the last sentence at end of the section to read: "For piping system designator BCK4, the above requirements apply to all pipe and fittings of nominal sizes larger than 4-inches." Section 9.3: Revised to read "For ASME B16.5 and API 605 Class 150 and 300 flange connections, (Continued on next page.)

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E <i>(Continued from previous page.)</i>	05.23.22	L. de Quay	<p>Flexitallic Style LSI gaskets or approved equals are preferred, generally for cases where applicable gasket loading is substantially less than the maximum allowed and may not be sufficient to assure zero (0) observable in-service leakage. LSI style gaskets shall not be used in Class 400 and higher pressure class flange connections.”</p> <p>Previous Section 9.3 renumbered as Section 9.4.</p> <p>Sections 9.5-9.7: Added in their entirety.</p> <p>Section numbers 9.4-9.17 renumbered to 9.8-9.21 throughout document.</p> <p>Section 9.9: Revised “Type 304L S/S” to read “Type 304L and 316L S/S”; revised “Type 304 S/S” to read “Type 304 or 316 S/S”; and revised “dual-rated 304/304L S/S” to “dual-rated 304/304L or dual-rated 316/316L S/S”.</p> <p>Section 9.12: Revised to read, “For all pipe and fittings used for piping system designators ACK4, B, BCK1, BCK10, G, NCK12, and T and for all flanges used for piping system designators C, H, and JJ, all ASTM A182, ASTM A312, ASTM A351, ASTM A403, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowable stresses of 20 ksi for ASTM A182, ASTM A312, ASTM A351, ASTM A403, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi. For piping system designator BCK4, the above requirements apply to all pipe and fittings of nominal sizes larger than 4-inches.”</p>
E-1	07.01.22	L. de Quay Ext. 8-1956	Section 5.2, C spec: “6.0” reference corrected to read “7.0” in “Pipe Sizes and Schedules” and “Fitting Details.”

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## 1.0 PURPOSE

This John C. Stennis Space Center (SSC) standard (SSTD) specifies materials and procedures for the fabrication, assembly, erection, maintenance, repair, cleaning, and testing of stainless steel (S/S) pipe systems at SSC with the exception of low pressure vacuum jacketed piping covered by SSTD-8070-0069-PIPE. For vacuum jacketed piping not covered by SSTD-8070-0069-PIPE, this standard may be used or referenced for requirements that govern inner piping (pipelines inside the vacuum annulus and outer vacuum piping).

## 2.0 APPLICABILITY

- a. This SSTD shall be used for specifying pipe and pipe fitting materials to be incorporated into S/S piping systems at SSC.
- b. Authority for modifications to existing piping systems, solely for the purpose of meeting criteria in this standard, is not implied.
- c. Piping system drawings are drawn in schematic form and are identified by system and class. Pipe spool/section marking and labeling, on drawings and spools/sections, shall be in accordance with SSTD-8070-0112-IDCODES.

## 3.0 REFERENCES

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

29 CFR 1915.1001, *Occupational Safety and Health Standards for Shipyard Employment, Toxic and Hazardous Substances, Asbestos*

29 CFR 1926.1101, *Safety and Health Regulations for Construction, Toxic and Hazardous Substances, Asbestos*

ANSI/API Spec 5L, *Specification for Line Pipe*

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

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

ASME B16.21, *Nonmetallic Flat Gaskets for Pipe Flanges*

ASME B16.25, *Buttwelding Ends*

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

ASME B16.3, *Malleable Iron Threaded Fittings*

ASME B16.37, *Hydrostatic Testing Of Control Valves*

ASME B16.39, *Malleable Iron Threaded Pipe Unions*

ASME B16.47, *Large Diameter Steel Flanges*

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

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

ASME B18.2.1, *Square, Hex, Heavy Hex, and Askew Head Bolts And Hex, Heavy Hex, Hex Flange, Lobed Head, And Lag Screws (Inch Series)*

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ASME B18.2.2, *Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, And Coupling Nuts (Inch Series)*  
 ASME B31.1, *Power Piping*  
 ASME B31.3, *Process Piping*  
 ASME B36.10, *Welded and Seamless Wrought Steel Pipe*  
 ASME B36.19, *Stainless Steel Pipe*  
 ASME Boiler and Pressure Vessel Code (B&PV), Section II, *Materials*  
 ASME Boiler and Pressure Vessel Code (B&PV), Section VIII, *Pressure Vessels*  
 ASME Boiler and Pressure Vessel Code (B&PV), Section IX, *Welding, Brazing, and Fusing Qualifications*  
 ASME PCC-1, *Guidelines For Pressure Boundary Bolted Flange Joint Assembly*  
 ASME PCC-2, *Repair of Pressure Equipment and Piping*  
 ASTM A47, *Standard Specification for Ferritic Malleable Iron Castings*  
 ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*  
 ASTM A123, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*  
 ASTM A182, *Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service*  
 ASTM A193, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications*  
 ASTM A194, *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*  
 ASTM A197, *Standard Specification for Cupola Malleable Iron*  
 ASTM A266, *Standard Specification for Carbon Steel Forgings for Pressure Vessel Components*  
 ASTM A276, *Standard Specification for Stainless Steel Bars and Shapes*  
 ASTM A290, *Standard Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears*  
 ASTM A312, *Standard Specification for Seamless Welding and Heavily Cold Worked Austenitic Stainless Steel Pipes*  
 ASTM A320, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*  
 ASTM A333, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness*  
 ASTM A350, *Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components*  
 ASTM A351, *Standard Specification for Castings, Austenitic, for Pressure-Containing Parts*  
 ASTM A358, *Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe For High-Temperature Service and General Applications*  
 ASTM A385, *Standard Practice For Providing High-Quality Zinc Coatings (Hot-Dip)*  
 ASTM A403, *Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings*



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ASTM A420, *Standard Specification for Piping Fitting of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service*  
 ASTM A480, *Standard Specification for General Requirements for Flat-Rolled Stainless Steel and Heat-Resisting Steel Plate, Sheet and Strip*  
 ASTM A487, *Standard Specification for Steel Castings Suitable for Pressure Service*  
 ASTM A780, *Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings*  
 ASTM B766, *Standard Specification for Electrodeposited Coatings Of Cadmium*  
 ASTM F104, *Standard Classification System for Nonmetallic Gasket Materials*  
 ASTM SB165, *Standard Specification for Nickel-Copper Alloy (UNO NO4400) Seamless Pipe and Tube*  
 ASTM SB564, *Standard Specification for Nickel Alloy Forgings*  
 AWWA C651, *Standard for Disinfecting Water Mains*  
 AWWA M28, *Rehabilitation of Water Mains*  
 CSINCS, *United States National CAD Standard*  
 MIL-G-21032, *Spiral Wound Gasket Fasteners*  
 MSFC-STD-3535, *Standard for Propellant and Pressurants Used for Test and Test Support Activities at SSC and MSFC*  
 MSS SP-6-2012, *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings*  
 NACE MR0175/ISO 15156, *Petroleum and natural gas industries - Materials for use in H2S-containing environments in oil and gas production (Parts 1 and 2)*  
 NFPA 54, *National Fuel Gas Code*  
 RPTSTD-8070-0001, *Surface Cleanliness Standard of Fluid Systems for Rocket Engine Test Facilities of the NASA Rocket Propulsion Test Program*  
 SAE-AS28775, *(R) Packing, Preformed – MS28775 O-Ring*  
 SAE-AS5202, *Port or Fitting End, Internal Straight Thread*  
 SPR 1440.1, *SSC Records Management Program Requirements*  
 SPR 1740.1, *SSC Pressure Vessel and Pressurized System Procedural Requirements*  
 SPR 8715.1, *SSC Safety and Health Program Requirements*  
 SSC DWG 11000-GM14, *Specification for Procurement of Spiral Wound Gaskets*  
 SSC DWG 54000-GM00, *Specification for Procurement of Glass Filled Teflon Gasket Material*  
 SSC DWG 54000-GM30, *Specification for Materials LOX/GOX Service*  
 SSTD-8070-0002-CONFIG, *SSC Facility Drafting Manual*  
 SSTD-8070-0005-CONFIG, *SSC Preparation, Review, Approval, and Release of SSC Standards*  
 SSTD-8070-0007-CONFIG, *Standard for Variance and Alternate Standard Requests*  
 SSTD-8070-0013-WELD, *Classes of Welding Inspection*  
 SSTD-8070-0017-WELD, *Gas Tungsten ARC welding of Austenitic Stainless Steel Pipe/Plate*  
 SSTD-8070-0037-WELD, *ASME Procedure for Welding Nitronic 40 Stainless Steel Alloy*  
 SSTD-8070-0038-WELD, *ASME Procedure for Welding Nitronic 40 Stainless Steel Alloy to 300 Series Austenitic Stainless Steel*

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SSTD-8070-0041-WELD, *ASME Weld Procedure for Joining Stainless Steel by Gas Tungsten Arc Welding (GTAW) Wire*

SSTD-8070-0069-PIPE, *Low Pressure Vacuum Jacketed Pipe*

SSTD-8070-0095-PRESSUR, *SSC Pressurization Standard in Support of the Recertification of Pressure Vessels and Pressure Systems*

SSTD-8070-0112-IDCODES, *SSC Line Designator Numbers*

SSTD-8070-0126-PIPE, *Tubing Systems for Facility Systems, Special Test Equipment, and Aerospace Hardware*

#### 4.0 RESPONSIBILITIES

- a. Users of this SSTD shall comply with its requirements, ensure use of the correct version of this SSTD and the documents it references, and inform the appropriate organization of needed changes in accordance with SSTD-8070-0005-CONFIG.
- b. Responsibilities for the use and control of this SSTD and for the review and approval of revisions or cancellation of this SSTD shall be as specified in SSTD-8070-0005-CONFIG and the applicable documents referenced therein.

#### 5.0 REQUIREMENTS

##### 5.1 General

- a. Existing piping systems designed and constructed prior to the issue date of this standard do not need to be modified solely to be brought into compliance with this standard. Existing piping systems, piping system sections, and pipe spools that are modified or repaired after the issue date of this standard shall conform to this standard at the specific locations where the modifications and repairs are made and where new pipe and pipe fittings are installed into or joined to lines and components of existing systems.
- b. For each piping system designator, welding shall be in accordance with the SSC standard specified for the respective piping system designator in Section 5.2. Consumable inserts and/or backing rings are not permitted. Assembly of flanged joints shall conform to recommended practices of ASME PCC-1.
- c. For each pipe system designator, weld inspections of circumferential weldments shall be performed in accordance with SSTD-8070-0013-WELD inspection class specified for the respective designator in Section 5.2. All longitudinal welds on pipe and fittings shall be inspected in accordance with SSTD-8070-0013-WELD, Class I. All welds not accessible to radiographic inspection shall be 100% dye-

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penetrant inspected at the root and core pass. All weld inspection and acceptance criteria shall be in accordance with "Normal Service Conditions" per ASME B31.3 unless otherwise specified.

- d. For each piping system, the designated system pressure shall be less than or equal to the maximum design pressure stated in Section 5.2.
- e. Unless indicated otherwise in Section 5.2, all piping systems or sections and spools thereof shall be tested in accordance with ASME B31.1 requirements for pressure tests or ASME B31.3 requirements for leak tests, whichever applies. Pneumatic tests may be used instead of hydrostatic test with permission of the project designer and National Aeronautics and Space Administration (NASA) representative. The following requirements apply and shall be satisfied for all pneumatic pressure tests:
  1. All safety precautions stated in ASME PCC-2, Part 5, Article 501, Sub-article 501-6.2 have been reviewed with supporting documentation and implemented to the maximum extent practicable and where they do not conflict with allowances and requirements of this standard.
  2. All safety precautions mandated by ASME PCC-2, Part 5, Article 501, Sub-article 501-6.2, with the exception of Sections (i) and (l) of this sub-article, have been implemented and documented, and;
  3. The NASA/SSC Safety organization has approved this type of test.
- f. A system leak test to assure leaktightness of all mechanical joints and other areas susceptible to leakage (which may include welded joints) shall be performed for each and every piping system or section thereof after assembly. The test pressure shall be no less than the designated system pressure and no more than 105% of this pressure unless stated otherwise in Section 5.2. The test pressure shall be held for no less than 10 minutes or until all mechanically sealed joints and other areas of interest are inspected, whichever is the longer amount of time. The test media shall be gaseous air or nitrogen with a dewpoint of -40°F or lower, unless indicated otherwise in Section 5.2. If the tested pipe system has been precision cleaned in accordance with RPTSTD-8070-0001 prior to leak tests, the test gas purity or the purity of each gas constituent of a test gas mixture (prior to mixing) shall conform to requirements of MSFC-STD-3535.
- g. When the designated system pressure is less than the maximum design pressure, each pipe system section, pipe spool, or fitting shall be permanently and conspicuously marked with the designated system pressure, the hydrostatic or pneumatic test pressure, and the date of the pressure test.

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- h. When the designated system pressure is less than the maximum design pressure, pipe system drawing(s) shall indicate the designated system pressure of these pipe system sections, pipe spools, pipes or fittings.
- i. For all pressure and leak tests, no permanent deformation of the tested piping system, system section(s), or spool(s) is allowed except as permitted by ASME B31.1 or B31.3, whichever applies.
- j. For all pressure and leak tests performed with liquid test media, no visible leakage is permitted.
- k. For all pressure and leak tests performed with gaseous test media, Leak-Tek ® or an equal soap solution shall be applied to all mechanically sealed and welded joints, unless stated otherwise in Section 5.2, and no visible leakage is permitted. Visible leakage is indicated by blowing, frothing, or bubble formation at locations where the soap solution is applied.
- l. For all pressure and leak tests where permanent deformation (not permitted by ASME B31.1 or ASME B31.3, whichever applies) or leakage occurs as stated in h., i, j., and k. above, the piping system, system section(s), or spool(s) shall be depressurized to zero (0) pounds per square inch gage (psig) and then repaired as needed to correct the observed deformations, prevent further deformations, and stop the observed leaks. The pressure and leakage tests shall be repeated for the repaired piping system, system section(s), or spool(s).
- m. Where RPTSTD-8070-0001 is indicated for “cleaning” in section 5.2, the cleanliness level requirements stated in this standard for specific system types and fluid service media or cleanliness level breaks on drawings specify cleaning and cleanliness level verification requirements for all service media wetted surfaces and internal volumes of piping systems. The applicable cleanliness or RPTSTD-8070-0001 cleanliness level shall be acquired and maintained prior to and during activation and operational service of the piping system and sections or spools thereof.
- n. Code compliance shall be per ASME B31.1 or ASME B31.3, whichever applies. Pipe schedule wall thickness and wall thickness tolerances and the piping outside diameter (OD) and OD tolerance corresponding to nominal pipe sizes in Section 5.2 shall be as stated in ASME B36.10 and ASME B36.19.

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## 5.2 Requirements by Piping System

Piping System	Z	NCK3
Service	BA, CA, GH, GN, GO, HA, LH, LN, LO, VAC	GH, GM, GN, GO, HE, H202, HA, IPA, IW, JP-4, JP-5, JP-7, JP-8, LH, LO, LM, LN, RP-1
Max. Design Pressure (psig)	BA, LH/GH, LN/GN, LO/GO: 20 CA: 150 HA: 230	150
Temperature Range (°F)	LO/GO, -297°F to 100°F LN/GN, -320°F to 100°F LH/GH, -423°F to 100°F BA/CA/HA, 20°F to 150°F VAC, -423°F to 100°F	-423°F to 100°F
Piping Material	1/4" thru 1": See Sections 6.0 and 9.1. 1" thru 12": ASTM A312 TP304L, electric fusion welded or seamless; beveled ends. 14" thru 24" and 30" and 36": ASTM A358 TP 304L Class 5, electric fusion welded, beveled ends. Radiographic inspection for all longitudinal welds shall conform to applicable pipe material specification ASTM A312 RT or ASTM A358 CI 5.	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 12": ASTM A312 TP304L, electric fusion welded or seamless, beveled ends. 14" thru 20" and 24" thru 30": ASTM A358 TP 304L Class 5, electric fusion welded or seamless, corrosion resistant S/S, beveled ends. 32" thru 42": ASTM A358 TP304L Class 5, standard weight (0.375) electric fusion welded, corrosion resistant S/S, beveled ends.
Pipe Sizes and Schedules	1/4" thru 1": See Sections 6.0 and 9.1. 1" thru 12" and 14" thru 24": Sch. 10S. (See Section 9.1.) (Sch. 5S pipe and fittings may be used in lieu of Sch. 10S when deemed acceptable by engineering design. PSK, P&ID, and other piping drawings shall specifically note locations of Sch. 5S pipe, fittings, and spools.) 30" and 36": Standard weight (.375" wall)	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 30": Sch. 5S. 32" thru 42": Standard weight (.375" wall)
Fitting Material	1/4" thru 1": See Section 6.0 and Section 9.1. 1" and larger: ASTM A403 Gr. WP304L or WP316L or ASTM A182 Gr. F304L or F316L	
Fitting Details	1/4" thru 1": See Sections 6.0 and 9.1. 1" thru 12" and 14" thru 24": See Sections 6.0 and 9.1. ASME B16.9, wrought or forged, Sch. 10S buttweld ends. 30" and 36": ASME B16.28, wrought. Match pipe bore and wall thickness at weld ends.	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 42": Wrought corrosion resistant S/S Sch. 55 or 10S, buttweld ends, match pipe wall thickness. ASME B16.9, ASME B16.28. (See Sections 6.0 and 9.1.)

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Piping System (Continued)	Z	NCK3
<b>End Fitting Material</b>	1/4" thru 1 1/2": See Sections 6.0 and 9.1.  1" thru 12": ASTM A403 Gr. WP304L or ASTM A182 Gr. F304L or F316L.	
<b>End Fitting Details</b>	1/4" thru 1": See Sections 6.0 and 9.1.  1" thru 12" and 14" thru 24": ASME B16.5 150# WNRF flanges serrated finish on face, bore and wall thickness to match pipe. RTJ flanges may be used as needed to connect to existing piping systems. RTJ flanges, when used, shall conform to ASME B16.5, except that 32 RMS finish on flange sealing surfaces and 23° ± 0.2° groove angle is required. Serrations shall be concentric for hydrogen service. (See Sections 9.1 and 9.5.)  30" and 36": ASME B16.47 150# WNRF flanges serrated finish on face, bore and wall thickness to match pipe. Serrations shall be concentric for hydrogen service.	1/4" thru 1 1/2": See Sections 6.0 and 9.1.  1/2" thru 3": ASME B16.5 300# WNRF flanges.  4" thru 24": ASME B16.5 150# WNRF flanges.  26" thru 42": API 605 WNRF Flanges 150# Class.  For all flange sizes, 90° V-Groove Serrations in flange face, all sizes. Serrations shall be concentric for hydrogen service. Bore to match pipe I.D.
<b>Bolting</b>	Studs: Full-thread (strain hardened) ASTM A320 Gr. B8. (See Section 8.0.)  Nuts: Heavy Hex ASTM A194 Gr. 8.	Studs: Full-thread (strain hardened) ASTM A320 Gr. B8, corrosion resistant Type 304 S/S. (See Section 8.0.)  Nuts: Heavy Hex ASTM A194 Gr. 8, corrosion resistant Type 304 S/S.
<b>Gaskets/Seals/Clamps</b>	ASME B16.20 spiral wound Type 304L or 316L S/S. Flexitallic style CGI or LSI, Class 150 gaskets with virgin PTF filler per SSC DWG 11000-GM14. (See Sections 9.3 and 9.4.) For vacuum service, see Section 9.6.	ASME B16.20 spiral wound 304L or 316L S/S, virgin PTFE filled Flexitallic style CGI or LSI gaskets per SSC DWG 1100-GM14 (See Sections 9.3 and 9.4.); Class 300 for 1" thru 3" size and Class 150 for 4" thru 42" size.
<b>Welding</b>	SSTD-8070-0017-WELD	
<b>Weld Inspection</b> (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class IIA	
<b>Special Pressure and Leak Testing Requirements</b>	See Section 5.1.	See Section 5.1. Test gas to be nitrogen-helium mixture with 5% minimum helium by mole fraction.
<b>Cleaning</b> (See Section 5.1.m)	RPTSTD-8070-0001	

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Piping System	NCK11	ACK6
Service	GH, GM, GN, GO, H202, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1	GH
Max. Design Pressure (psig)	150	175
Temperature Range (°F)	-423°F to 100°F	-20°F to 1400°F
Piping Material	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 16": ASTM A312 TP304L, electric fusion welded or seamless, corrosion resistant S/S, beveled ends.	1/4" thru 1": See Section 6.0. 12", 16", 24": ASTM A312 Gr. 316H, electric fusion welded, corrosion resistant S/S, beveled ends.
Pipe Sizes and Schedules	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 16": Sch. 10S (See Section 9.1.)	1/4" thru 1": See Section 6.0. 12" and 16": Sch. 80. 24": Sch. 100.
Fitting Material	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 16": ASTM A403 Gr. WP304L or ASTM A182 Gr. F304L	1/4" thru 1": See Section 6.0. 12", 16", 24": ASTM A403 WP316H or ASTM A182 Gr. F316H
Fitting Details	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 16": Wrought corrosion resistant S/S Sch. 10S, match pipe bore and wall thickness at weld ends, butt weld ends. ASME B16.9, ASME B16.28. (See Sections 6.0 and 9.1.)	1/4" thru 1": See Section 6.0. 12" and 16": Sch. 80, ASME B16.9 or B16.28 24": Sch. 100, ASME B16.9 or B16.28
End Fitting Material	1/4" thru 1 1/2": See Sections 6.0 and 9.1. ASTM A182 Gr. F304L or F316L	1/4" thru 1": See Section 6.0. 12", 16", 24": ASTM A182 F316H
End Fitting Details	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 16": ASME B16.5 150# Class WNRF flanges, forged corrosion resistant S/S, butt weld ends, 125-250 AARH or RMS face finish, bore to match pipe schedule, with 90° "V" groove ring serrations in flange face. Serrations shall be concentric for hydrogen service. (See Sections 6.0 and 9.1.)	See Appendix A and Section 6.0.
Bolting	Studs: Full-thread (strain hardened) ASTM A320 Gr. B8, Class 2. (See Section 8.0.) Nuts: Heavy Hex ASTM A194 Gr. 8, corrosion resistant Type 304 S/S	Studs: Full-thread ASTM A320 Gr. B8M Class 1 ASTM A193 Gr. B8M Class 1, Type 304 S/S. Nuts: Heavy Hex ASTM A194 Gr. 8MA, Type 304 S/S.

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Piping System (Continued)	NCK11	ACK6
<b>Gaskets/Seals/ Clamps</b>	ASME B16.20 spiral wound 304L or 316L S/S virgin PTFE filled Flexitallic style CGI or LSI gaskets per SSC DWG 1100-GM14 (See Sections 9.3 and 9.4.); Class 150 for all sizes.	Everlube 1120-8® (Molybdenum Disulfide) coated Inconel 625 seal rings. For cleaning and pressure testing, other than leak tests, use PTFE coated 17-4PH S/S seal rings.
<b>Welding</b>	SSTD-8070-0017-WELD	SSTD-8070-0017-WELD or SSTD-8070-0041 WELD
<b>Weld Inspection (circumferential welds only unless noted otherwise)</b>	SSTD-8070-0013-WELD, Class IIA	SSTD-8070-0013-WELD, Class I
<b>Special Pressure and Leak Testing Requirements</b>	Section 5.1.	Hydrostatic pressure test at 1,700 psig. Pneumostatic pressure tests are not permitted. Pneumostatic leak test at 1,140 psig only after successful completion of hydrostatic pressure tests. For leak tests, test gas shall be helium or nitrogen-helium mixture with mole fraction of helium $\geq 25\%$ .
<b>Cleaning (See Section 5.1.m)</b>	RPTSTD-8070-0001	



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Piping System	NCK1	H
Service	GH, GM, GN, GO, H2O2, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1	GN, GO, LN, LO
Max. Design Pressure (psig)	230	275
Temperature Range (°F)	-423°F to 100°F	-320°F to 100°F
Piping Material	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings) and 9.1.  1" thru 12": ASTM A312 TP304L, electric fusion welded or seamless, corrosion resistant S/S, beveled ends.  14" thru 30" and 32" thru 42": ASTM A358 TP304L Class 5, electric fusion welded, corrosion resistant S/S, beveled ends.	ASTM A312 TP304L, electric fusion welded or seamless, corrosion resistant S/S, beveled ends.
Pipe Sizes and Schedules	1/4" thru 1 1/2": See Sections 6.0 and 9.1. 1" thru 30": Sch. 10S. (See Section 9.1.) 32" thru 42": Standard weight (0.375" wall). See Section 9.1.	1/2" thru 12": Sch. 10S (See Section 6.0.)
Fitting Material	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings) and 9.1. ASTM A403 WP304L or WP316L	ASTM A403 WP304L or ASTM A182 Gr.F304L or F316L
Fitting Details	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings) and 9.1. 1" thru 30": Sch. 10S, ASME B16.9 or B16.28. (See Sections 6.0 and 9.1.) 32" thru 42": Standard weight (0.375" wall), ASME B16.9 or B16.28.	ASME B16.9, Sch. 10S
End Fitting Material	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings) and 9.1.  ASTM A182 Gr. F304L or F316L	ASTM A182 Gr. F304L or 316L (See Sections 9.2 and 9.12.)
End Fitting Details	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings) and 9.1. 1" thru 3": ASME B16.5 300# (See Sections 6.0 and 9.1.) 4" thru 24": ASME B16.5 150#. 26" thru 42": API 605 150#.  For all flange sizes, WNRF flanges, forged corrosion resistant S/S, butt weld ends, bore to match I.D. for pipe schedule, 90° "V" groove ring serrations in flange face. Concentric serrations are required for hydrogen service.	ASME B16.5 Class 150 or 300 WNRF flanges, forged corrosion resistant S/S, butt weld ends, bore for pipe schedule, 90° V-groove ring serrations in flange face. (See Sections 6.0, 7.0, and 9.18.)

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Piping System (Continued)	NCK1	H
<b>Bolting</b>	<p>Studs: Full-thread ASTM A320 Gr. B8 (See Section 8.0.) Type 304 S/S.</p> <p>Nuts: Heavy Hex ASTM A194 Gr.8, Type 304 S/S.</p>	<p>Studs: Full-thread ASTM A320 Gr. B8 (See Section 8.0.), corrosion resistant, Type 304 S/S.</p> <p>Nuts: Heavy Hex ASTM A194 Gr. 8, corrosion resistant, Type 304 S/S</p>
<b>Gaskets/Seals/ Clamps</b>	<p>ASME B16.20 304L or 316L, Flexitallic style CGI or LSI, spiral wound Type 304 or 304L S/S with pure virgin PTFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge rings.</p> <p>Gaskets to compress to 1/8" thickness. (See Sections 9.3 and 9.4.)</p> <p>1" thru 3": Class 300.</p> <p>4" thru 42": Class 150.</p>	<p>ASME B16.20 304L or 316L, Class 150 or 300, Flexitallic Style CGI or LSI spiral wound S/S with pure virgin PTFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge rings. (Gaskets to compress to 1/8" thickness.) (See Sections 9.3 and 9.4.)</p>
<b>Welding</b>	SSTD SSTD-8070-0017-WELD or SSTD-8070-0041WELD	SSTD-8070-0017-WELD
<b>Weld Inspection (circumferential welds only unless noted otherwise)</b>	SSTD-8070-0013-WELD, Class IIA	SSTD-8070-0013-WELD, Class IIA
<b>Special Pressure and Leak Testing Requirements</b>	See Section 5.1.	See Section 5.1. Test gas shall be nitrogen.
<b>Cleaning (See Section 5.1.m)</b>	RPTSTD-8070-0001	

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Piping System	JJ	C
Service	RP-1	GH, GN, GO, LH, LN, LO
Max. Design Pressure (psig)	275	
Temperature Range (°F)	-20°F to 100°F	-423°F to 100°F
Piping Material	ASTM A312 TP304 or ASTM A358 TP304L S/S butt weld	S/S, weld beveled ends or straight cut. 1" thru 12": ASTM A312 TP304L or TP304/304L. 14" thru 20": ASTM A358 TP304L or TP304/304L
Pipe Sizes and Schedules	1/2" thru 20": Sch. 10S (See Section 6.0.)	1 1/4" thru 20": Sch. 10S (See Section 7.0.)
Fitting Material	ASTM A403 WP304	ASTM A480 ASTM A403 Gr.WP304L or WP304/304L
Fitting Details	1/2" thru 20": ASME B16.9 (butt weld ends), Sch. 10S (See Section 6.0.)	1/2" thru 20": ASME B16.9 (butt weld ends), Sch. 10S (See Section 7.0.)
End Fitting Material	ASTM A182 Gr.F304L or F316L (See Sections 9.2 and 9.12.)	ASTM A182 Gr.F304 or F316L (See Sections 9.2 and 9.12.)
End Fitting Details	1/2" thru 20": ASME B16.5, 150#, RF, weld neck, bore for Sch. 10S pipe. (See Section 7.0.)	ASME B16.5, 300# WNRF or WNRTJ flanges bore to match Sch. 10S. Bore to match Sch. 20S or 40S with counterbore to match Sch. 10S at butt weld end of flange is permitted; counterbore shall conform to ASME B16.9 requirements (See Section 7.0.)  For WNRF flanges, 90° V-Groove serrations in flange face unless drawings state otherwise; for hydrogen service, serrations shall be concentric.  For WNRTJ flanges, Ring Joint: Groove dimensions per ASME B16.20 except that 32 RMS or smoother finish is required on sealing surfaces.
Bolting	Studs: ASTM A193 Gr.B8 or ASTM A320 Gr. B8 TP304L S/S  Nuts: ASTM A194 Gr.8F TP304 S/S (Gr. 8F TP303S/S permitted for existing lines constructed before issue date of this standard.)	Studs: Full-thread ASTM A320 Gr. B8 (Gr. 8F TP 303S/S permitted for existing lines constructed before issue date of this standard.), TP304 (See Section 8.0)  Nuts: Heavy Hex ASTM A194 Gr.8 S/S, TP304

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Piping System (Continued)	JJ	C
<b>Gaskets/Seals/ Clamps</b>	Flexitallic Style CGI or LSI Class 150 spiral wound Type 304 or 304L S/S with PTFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge rings. (MIL-G-21032 TP2 150# ring, spiral wound, TP304 S/S with asbestos filler, 0.175" thickness, Flexitallic style CG or equal in existing systems is permitted provided gasket removal, handling, inspection, and reinstallation conforms to all applicable 29 CFR 1915.1001 and 1926.1101 requirements.)	For WNRF flanges: SSC DWG 54000-GM00 Class 300, Flexitallic Style CGI or LSI spiral wound Type 304 or 304L S/S and pure virgin PTFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge rings. Gaskets to compress to 1/8" thickness. (See Sections 9.3 and 9.4.)  For WNRTJ flanges: Octagonal ring Type 304 S/S gasket per ASME B16.20 except that groove angle shall be 23° ±0.2 and 32° RMS or smoother finish required on sealing surfaces. Max Brinnell Hardness is HB140.
<b>Welding</b>	SSTD-8070-0017-WELD	
<b>Weld Inspection (circumferential welds only unless noted otherwise)</b>	SSTD-8070-0013-WELD, Class II	SSTD-8070-0013-WELD, Class I
<b>Special Pressure and Leak Testing Requirements</b>	See Section 5.1.	
<b>Cleaning (See Section 5.1.m)</b>	RPTSTD-8070-0001	

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Piping System	NCK2	AA
Service	GH, GM, GN, GO, H202, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1	GN, GM, GO, LM, LN, LO
Max. Design Pressure (psig)	350	400
Temperature Range (°F)	-423°F to 100°F	GM & LM, -302°F TO 100°F GN & LN, -320°F to 100°F GO & LO, -297°F to 100°F
Piping Material	1" thru 16": ASTM A312 TP304L, electric fusion welded or seamless, corrosion resistant S/S, beveled ends.	½" thru 12": ASTM A312 Gr. TP304L S/S 14": ASTM A358 Gr. TP 304L S/S
Pipe Sizes and Schedules	1/4" thru 1 1/2": (See Sections 6.0 and 9.1.) 1" thru 8": Sch. 10S. 10" thru 16": Sch. 40S.	1/2" thru 12": Sch. 10S. 14": 0.250" minimum wall.
Fitting Material	ASTM A403 WP304L or WP316L Wrought, corrosion resistant S/S	
Fitting Details	1/4" thru 1 1/2": (See Sections 6.0 and 9.1.)  1½" thru 8": Sch. 10S, ASME B16.9 (butt weld ends)  10" thru 16": Sch. 40S, ASME B16.9 (butt weld ends)	ASME B16.9 (butt weld ends)  1/2" thru 12": Sch. 10S.  14": 0.250 minimum wall.
End Fitting Material	ASTM A182 Gr. F304L or F316L	ASTM A182 Gr. F304L or F316L
End Fitting Details	1/4" thru 1 1/2": See Sections 6.0 and 9.1.  1" thru 16": ASME B16.5, WNRF flanges 300# with bore to match pipe ID, 90° V-Groove serrations in flange face; if hydrogen service, serrations shall be concentric.	1/2" thru 12": ASME B16.5 300# WNRF flanges, 90° V-Groove serrations on face, bore to match ID of connected pipe or fitting. (See Sections 6.0 and 7.0.)
Bolting	Studs: Full-thread ASTM A320, Gr. B8 (See Section 8.0.), Type 304.  Nuts: Heavy Hex ASTM A194 Gr.8, Type 304.	Studs: Full-thread (strain hardened) ASTM A320 Gr. B8 (See Section 8.0.)  Nuts: Heavy Hex ASTM A194 Gr. 8
Gaskets/Seals/Clamps	ASME B16.21 304L/316L Flexitallic Style CGI or LSI Class 300 spiral wound with S/S and virgin TFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge ring. (Gasket compresses to 1/8" thickness.) (See Sections 9.3 and 9.4.)	304L or 316L S/S, Class 300 to match flanges, Flexitallic style CGI or LSI spiral wound Type 304 or 304L S/S with pure virgin PTFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge rings. (Gaskets shall compress to 1/8" thickness). (See Sections 9.3 and 9.4.)

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Piping System (Continued)	NCK2	AA
<b>Welding</b>	SSTD-8070-0017-WELD	
<b>Weld Inspection</b> (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class IIA	SSTD-8070-0013-WELD, Class I
<b>Special Pressure and Leak Testing Requirements</b>	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq 5\%$ .	See Section 5.1.
<b>Cleaning</b> (See Section 5.1.m)	RPTSTD-8070-0001	RPTSTD-8070-0001  Cleanliness Level 1000A (formerly Level 1) is the default if clean level is not indicated on drawings.

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Piping System	EE	NCK10
Service	RP-1	GH, GM, GN, GO, H202, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1
Max. Design Pressure (psig)	440	600 (Can uprate to 720 psig per Sections 9.8 and 9.9.)
Temperature Range (°F)	-20°F to 100°F	-423°F to 100°F
Piping Material	ASTM A312 TP304L seamless or welded S/S	ASTM A312 TP304L electric fusion welded or seamless, corrosion resistant S/S, beveled ends. (See Section 9.10.)  14" and smaller nominal sizes: (See Sections 6.0 and 9.10)  16" nominal size: (See Sections 9.9 and 9.10.)
Pipe Sizes and Schedules	1/2" thru 8": Sch. 10S.	1/4" thru 1 1/2": See Sections 6.0, 9.1 and 9.11.  1" thru 6": Sch.10S  8" to 16": Sch. 40S (See Section 9.9.)
Fitting Material	ASTM A403 WP304L or WP316L	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings) and 9.7.  1" thru 16": ASTM A403 WP304L or WP316L or ASTM A182 Gr. F304L or F316L. (See Sections 9.9 and 9.10.)
Fitting Details	1/2" thru 8": ANSI B16.9 (buttweld) Sch. 10S	1/4" thru 1 1/2": Forged S/S 37° flared tube fittings with SAE (AN/MS) straight thread patterned connections. (See Sections 6.0, 9.1, and 9.11.)  1" thru 6": Sch. 10S, wrought or forged corrosion resistant S/S, buttweld ends. (See Sections 6.0 and 9.1.)  8" thru 16": Sch. 40S, wrought or forged corrosion resistant S/S, buttweld ends. (See Section 9.9.)
End Fitting Material	ASTM A182 Gr. F304L or F316L	1/4" thru 1 1/2": See Sections 6.0 (Tubing and Tube Fittings), 9.1, and 9.11.  1" thru 16": ASTM A182 F304L or F316L ASME B16.5 (See Section 9.8)

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Piping System (Continued)	EE	NCK10
<b>End Fitting Details</b>	1/2" thru 8": ASME B16.5, WNRF flanges 300# with bore to match pipe ID, 90° V-Groove serrations in flange face; if hydrogen service, serrations shall be concentric. (See Sections 6.0 and 7.0.)	1/4" thru 1 1/2": (See Sections 6.0, 9.1, and 9.11.)  1" thru 16": ASME B16.5 300# WNRF flanges forged corrosion resistant S/S buttweld ends bore for pipe schedule with 90° V-Groove ring serrations in flange face, bore to match ID of connected pipe or fitting. Serrations in flange face shall be concentric for hydrogen service. (See Sections 6.0, 9.8, and 9.9.)
<b>Bolting</b>	Studs: Full-thread ASTM A320, Gr. B8 (See Section 8.0.), Type 304.  Nuts: Heavy Hex ASTM A194 Gr.8, Type 304.	Studs: Full-thread (strain hardened) ASTM A320 Gr. B8 (See Section 8.0.)  Nuts: Heavy Hex ASTM A194 Gr. 8.
<b>Gaskets/Seals/ Clamps</b>	ASME B16.21 304L/316L Flexitallic style CG, CGI, or LSI Class 300 spiral wound with S/S and virgin TFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge ring. (Gasket compresses to 1/8" thickness.) (See Sections 9.3 and 9.7.)	304L or 316L S/S, Class 300 to match flanges, Flexitallic style CGI or LSI spiral wound Type 304 or 304L S/S with pure virgin PTFE filler 0.175" thick with 0.125" thick S/S inner and outer gauge rings. (Gaskets shall compress to 1/8" thickness). (See Sections 9.3 and 9.4.)
<b>Welding</b>	SSTD-8070-0017-WELD	
<b>Weld Inspection (circumferential welds only unless noted otherwise)</b>	SSTD-8070-0013-WELD, Class IIA	SSTD-8070-0013-WELD, Class I
<b>Special Pressure and Leak Testing Requirements</b>	See Section 5.1.	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction ≥5%.
<b>Cleaning (See Section 5.1.m)</b>	RPTSTD-8070-0001	



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Piping System	P	NCK12
Service	GH, GN, HE	GH, GM, GN, GO, H202, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1
Max. Design Pressure (psig)	810	1200
Temperature Range (°F)	-50°F to 150°F	-423°F to 100°F
Piping Material	ASTM A312 Gr. TP304L S/S seamless or welded, beveled ends.	ASTM 312 Gr. TP 304/304L or TP316/316L dual-rated (See Sections 9.2, 9.12, and 9.21.)
Pipe Sizes and Schedules	1/2" thru 3": Sch. 10S.	¼" thru 1 ½": See Section 6.0, 9.1, and 9.11. 1" thru 2 1/2": Sch. 10S. 3" thru 10", Sch. 40S. 12" thru 14": Sch. 80S.
Fitting Material	ASTM A403 Gr. WP304L	ASTM A182 Gr. F304/304L or F316/F316L dual-rated. (See Sections 9.2, 9.12, and 9.21.)
Fitting Details	½" thru 3": ASME/ANSI B16.9 (butt weld ends), Sch. 10S.	ASME B16.9 or B16.28 (butt weld ends). ¼" thru 1 ½": See Section 6.0, 9.1, and 9.11. 1" thru 2 ½": Sch. 10S. 3" thru 10", Sch. 40S. 12" thru 14": Sch. 80S.
End Fitting Material	ASTM A182 Gr. F304L or F316L	ASTM A182 Gr. F304L or F316L or ASTM A403 Gr. WP304L or WP316L (See Sections 9.2, 9.11, 9.12, and 9.17.)
End Fitting Details	1/2" thru 3": ASME/ANSI B16.5 600# WNRF flanges, 90° V-Groove serrations on face, bore for Sch. 10S pipe. Serrations shall be concentric for hydrogen service. (See Section 7.0.)	¼" thru 1 ½": See Section 6.0, 9.1, and 9.11. 1" thru 14": ASME B16.5 600# WNRF flanges, 90° V-Groove serrations on face, bore to match I.D. of butt welded pipe or fitting; serrations shall be concentric for hydrogen service. (See Sections 6.0, 9.1, and 9.11.)
Bolting	Studs: ASTM A193 Gr.B8 or ASTM A320 Gr.B8 (ASME/ANSI Type 304 S/S)  Nuts: ASTM A194 Gr. 8 (ASME/ANSI Type 304 S/S) (ASTM A194 Gr. 8F, Type 303 is permitted before issue of this standard.)	Studs: Full-thread ASTM A320 Gr. B8 Class 2 (See Section 8.0.), Type 304 SS  Nuts: Heavy Hex, ASTM A194 Gr. 8 Type 304 S/S
Gaskets/Seals/Clamps	Must meet requirements of SSC Drawing 54000-GM00.	Flexitallic Style CGI Spiral Wound Type 304 or 304L S/S with virgin PTFE filler with inner and outer retention rings; 0.175" thick, compresses to 0.125" thick, conforms to SSC DWG 54000-GM14. (See Section 9.3.

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Piping System (Continued)	P	NCK12
<b>Welding</b>	SSTD-8070-0017-WELD	
<b>Weld Inspection</b> (circumferential welds only unless noted otherwise)	<p>SSTD 8070-0013-WELD</p> <p>The following weld inspection classes apply:</p> <ul style="list-style-type: none"> <li>·GH Lines, MOP <math>\leq</math> 125 psig: Class I for field welds; Class II, but change 25% to 50%, for shop welds.</li> <li>·GH Lines, MOP <math>\geq</math> 125 psig: Class I</li> <li>·HE and GN Lines, MOP <math>\leq</math> 125 psig: Class IIA</li> <li>·HE and GN Lines, 125 psig &lt; MOP <math>\leq</math> 1500 psig: Class II</li> <li>·HE and GN Lines MOP &gt; 1000 psig: Class I</li> </ul>	SSTD-8070-0013-WELD, Class I
<b>Special Pressure and Leak Testing Requirements</b>	See Section 5.1.	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq$ 5%.
<b>Cleaning</b> (See Section 5.1.m)	RPTSTD-8070-0001, Level VC (formerly Level 2) for GH Service, unless indicated otherwise on drawings. Level 1000A (formerly Level 1), for GN and HE Service, unless indicated otherwise on drawings.	RPTSTD-8070-0001

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Piping System	L1	AN
Service	GH, HE, HA, GN	GN, GO, HD, LN, LO, RP-1
Max. Design Pressure (psig)	1500	1800
Temperature Range (°F)	-20°F to 100°F	Nitrogen and Oxygen, -320°F to 100°F; RP-1 and HD, -20°F to 100°F
Piping Material	1/4" thru 1": See Section 6.0 (Tubing and Tube Fittings). 1" thru 4": ASTM 312 TP304L or TP316L S/S seamless, beveled butt weld ends.	ASTM A312 Gr. TP 304L or TP316L S/S
Pipe Sizes and Schedules	1/4" thru 1": See Section 6.0. 1" thru 4": Sch. 40S.	1" thru 1½": Sch. 10S (See Section 7.0.) 2" thru 4": Sch. 40S
Fitting Material	1/4" thru 1": See Section 6.0 (Tubing and Tube Fittings). 1" thru 4": ASTM A403 Gr. WP304L or WP316L	ASTM A403 Gr. WP304L or WP316L
Fitting Details	1/4" thru 1": See Section 6.0 (Tubing and Tube Fittings). 1" thru 4": Sch. 40S, ASME B16.9 and B16.28 (butt weld ends)	ANSI B16.9 butt weld ends. 1" thru 1½", Sch. 10S. (See Section 7.0.) 2" thru 4": Sch. 40S
End Fitting Material	See Appendix B and Section 6.0.	ASTM A182 Gr. F304L Gr. F304L or F316L
End Fitting Details	1/4" thru 1": See Section 6.0 (Tubing and Tube Fittings). See Appendix B and Section 6.0.	ANSI B16.5 WNRF flanges bore to match I.D. of butt welded pipe or fitting. 900# Class flanges for 1800 psig ≥ MOP > 1200 psig 600# Class flanges for 1200 psig ≥ MOP > 800 psig 400# Class flanges for 800 psig ≥ MOP > 600 psig 300# Class flanges for 600 psig ≥ MOP > 230 psig 150# Class flanges for 230 psig ≥ MOP (See Section 7.0)
Bolting	See Appendix B.	Studs: Full-thread ASTM A320 Gr. B8 Type 304 S/S (See Section 8.0.) Nuts: Hex ASTM A194 Gr. 8 (AISI Type 304 S/S) (ASTM A194 Gr. 8F, Type 303 S/S allowed prior to issue date of this standard.)
Gaskets/Seals/ Clamps	See Appendix B.	Must meet requirements of procurement specification 54000-GM00.
Welding	SSTD-8070-0017-WELD	
Weld Inspection (circumferential welds only unless noted otherwise)	SSTD 8070-0013-WELD Class IIA	SSTD 8070-0013-WELD, Class I (for nitrogen and oxygen service, Class II for RP-1 and hydraulic fluid service.)
Special Pressure and Leak Testing Requirements	See Section 5.1. Test gas shall be helium for lines in GH or HE service.	See Section 5.1.
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	

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Piping System	L2	K3
Service	GH, GN, HA, HE	HD
Max. Design Pressure (psig)	2500	3000
Temperature Range (°F)	-20°F to 100°F	-20°F to 200°F
Piping Material	ASTM A312 TP304L or TP316L S/S seamless, beveled butt weld ends.	¼" thru 1": See Section 6.0. 1" thru 4": ASTM A312 TP304L, S/S seamless, beveled butt weld ends.
Pipe Sizes and Schedules	¼" thru 1": See Section 6.0 1" thru 1 ¼": Sch. 40S. 1 ½" thru 3": Sch. 80S. 4": Sch. 120 or 160.	¼" thru 1": See Section 6.0 1" thru 4": Sch. 160.
Fitting Material	¼" thru 1": See Section 6.0. 1" thru 4": ASTM A403 Gr. WP304L or WP316L	¼" thru 1": See Section 6.0. 1" thru 4": ASTM A182, TP304L or TP316L
Fitting Details	¼" thru 1": See Section 6.0. 1" thru 1 ¼": Sch. 40S, ANSI B16.9 or B16.28, (butt weld ends) 1 ½" thru 3": Sch. 80S, ANSI B16.9 or B16.28, (butt weld ends) 4": Sch. 120 or 160, ANSI B16.9 or B16.28, (butt weld ends)	¼" thru 1": See Section 6.0. 1" thru 4": ANSI B16.9 and B16.28. (butt weld ends); Sch. 160
End Fitting Material	See Appendix C and Section 6.0.	See Appendix D and Section 6.0.
End Fitting Details	See Appendix C and Section 6.0.	See Appendix D and Section 6.0..
Bolting	See Appendix C.	See Appendix D.
Gaskets/Seals/Clamps	See Appendix C.	See Appendix D.
Welding	SSTD-8070-0017-WELD	SSTD-8070-0017-WELD or SSTD-8070-0041-WELD
Weld Inspection (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD Class IIA	SSTD-8070-0013-WELD, Class IIA for shop welds. Class I for field welds
Special Pressure and Leak Testing Requirements	See Section 5.1. Test gas shall be helium or nitrogen-helium gas mixture with helium mole fraction ≥10% for lines in GH and HE service.	See Section 5.1. Pneumostatic and leak tests are not required if hydrostatic pressure tests have been performed.
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	RPTSTD-8070-0001 Clean Level 100 (formerly Level 4)

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Piping System	BCK3	B
Service	GH, GM, GN, GO, H2O2, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, RP-1	GH, GN, HA, HE
Max. Design Pressure (psig)	3300	3700
Temperature Range (°F)	-100°F to 100°F	-320°F to 150°F
Piping Material	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings). 1" thru 12": ASTM A312, TP304L or TP316L seamless corrosion resistant S/S, beveled ends. (See Section 9.21.)	ASTM A312 TP304L or TP316L S/S seamless, beveled ends (See Sections 9.2 and 9.12.)
Pipe Sizes and Schedules	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings). 1" thru 12": Sch. 160.	½" and ¾": Sch. 40S (See Section 7.0). 1" and 1½": Sch. 80S (See Section 7.0). 2" thru 6": Sch. 160
Fitting Material	ASTM A403 WP304L or WP316L or ASTM A182 Gr. F304L or F316L (See Section 9.21.)	ASTM A403 WP 304L or WP316 (See Sections 9.2 and 9.12.)
Fitting Details	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings). 1" thru 12": Sch. 160, ASME B16.9 or B16.28 (butt weld ends)	½" and ¾": Sch. 40S (See Section 7.0). 1" and 1½": Sch. 80S, ASME B16.9 (butt weld ends) (See Section 7.0). 2" thru 6": Sch. 160, ASME B16.9 (butt weld ends)
End Fitting Material	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings). 1" thru 12": ASTM A182, Gr. F304L or F316L (See Sections 6.0 and 9.21.)	ASTM A182 Gr. F304L or F316L (See Appendix F and Section 7.0.)
End Fitting Details	See Appendix E and Section 6.0.	See Appendix F and Section 7.0.
Bolting	See Appendix E.	See Appendix F.
Gaskets/Seals/Clamps	See Appendix E and Section 9.4.	See Appendix F.
Welding	SSTD-8070-0017-WELD or SSTD-8070-0041-WELD	SSTD-8070-0017-WELD
Weld Inspection (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class I	SSTD-8070-0013-WELD, Class I
Special Pressure and Leak Testing Requirements	See Section 5.1. Test gas shall be a nitrogen-helium mixture with helium mole fraction ≥5%.	See Section 5.1.
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	

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Piping System	T	BCK4
Service	GH, GN, HA, HE	GH, GM, GN, GO, H202, HA, HE, IPA, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1
Max. Design Pressure (psig)	4200 for 1" and smaller nominal size 4100 for nominal size larger than 1"	4840 for 6" and smaller nominal size 4550 for nominal size larger than 6"
Temperature Range (°F)	-320°F to 150°F	-423°F to 100°F
Piping Material	ASTM A312 TP304L or TP316L S/S seamless, beveled ends (See Sections 9.2 and 9.12.)	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings).  1" thru 12": ASTM A312 TP304L or TP316L seamless, buttweld ends. (See Sections 9.13 and 9.21. Sections 9.2 and 9.12 apply for Nom. Pipe Size greater than 4".)
Pipe Sizes and Schedules	1/2": Sch. 40S.  3/4" and 1": Sch. 80S.  1½" thru 4": Sch. 160	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings).  1" thru 6": Sch. XX.  8" thru 12": See Appendix H.
Fitting Material	ASTM A403 WP 304L or WP316L (See Sections 9.2 and 9.12.)	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings).  1" thru 12": ASTM A403 WP304L or WP316L or ASTM A182 or Gr. F304L or F316L. (See Sections 9.13 and 9.21. Sections 9.2 and 9.12 apply for Nom. Pipe Size greater than 4".)
Fitting Details	ASTM/ANSI B16.9 (buttweld ends) 1/2": Sch. 40S. 3/4" and 1": Sch. 80S. 1 1/2" thru 4": Sch. 160	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings). ASME B16.9 or B16.28  1" thru 4": Sch. XX, buttweld ends.  6" thru 12": Wall to match "minimum extruded" Walls stated for pipe, buttweld ends.
End Fitting Material	ASTM A182 Gr. F304L or F316L (See Appendix G and Section 7.0.)	See Appendix H and Sections 6.0 and 9.21.
End Fitting Details	See Appendix G and Section 7.0.	See Appendix H and Section 6.0.
Bolting	See Appendix G.	See Appendix H.
Gaskets/Clamps	See Appendix G.	See Appendix H and Section 9.4.
Welding	SSTD-8070-0017-WELD or SSTD-8070-0041-WELD	
Weld Inspection (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class I	

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Special Pressure and Leak Testing Requirements	See Section 5.1.	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq 5\%$ .
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	

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Piping System	G	BCK1
Service	GH, GN, HA, HE	GH, GM, GN, GOX, H202, HA, HE, IPA, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LOX, RP-1
Max. Design Pressure (psig)	6300	6500
Temperature Range (°F)	-320°F to 150°F	-423°F to 100°F
Piping Material	ASTM A312 TP304L (See Sections 9.2 and 9.12.)	¼" thru ¾": See Section 6.0. 1" thru 12": ASTM A312 TP304L or TP316L or ASTM A182 Gr. F304L or F316L seamless, butt weld ends. (See Sections 9.2, 9.12, 9.14, and 9.21.)
Pipe Sizes and Schedules	1/4": Sch. 80S. 1/2" and 3/4": Sch. 160. 1" thru 3": Sch. XXS. (See Section 7.0.)	¼" thru ¾": See Section 6.0. 1" thru 3": Sch. XXS. 4" thru 12": See Appendix J.
Fitting Material	ASTM A403 WP304L (See Sections 9.2 and 9.12.)	¼" thru ¾": See Section 6.0. 1" thru 3": ASTM A403 WP304L or WP316L or ASTM A182 Gr. F304L or F316L. (See Sections 9.2, 9.12, 9.14, and 9.21.) 4" thru 12": ASTM A182 Gr. F304L or F316L. (See Sections 9.2, 9.12, 9.14, and 9.21.)
Fitting Details	ASME B16.9, 1/4": Sch. 80S. 1/2" and 3/4": Sch. 160. 1" thru 3": Sch. XXS (butt weld ends). (See Section 7.0.)	¼" thru ¾": See Section 6.0. 1" thru 3": Sch. XX, ASME B16.9 or B16.28, butt weld ends. 4" to 12": Wall to match "minimum extruded" pipe wall, ASME B16.9 or B16.28, butt weld ends.
End Fitting Material	ASTM A182 F304L or F316L (See Appendix I and Section 7.0.)	See Appendix J and Sections 6.0 and 9.21.
End Fitting Details	See Appendix I and Section 7.0.	See Appendix J and Section 6.0.
Bolting	See Appendix I.	See Appendix J.
Gaskets/Seals/Clamps	See Appendix I.	See Appendix J and Section 9.4.
Welding	SSTD-8070-0017-WELD	SSTD-8070-0017-WELD or SSTD-8070-0041-WELD
Weld Inspection (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class I	
Special Pressure and Leak Testing Requirements	See Section 5.1.	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq 5\%$ .
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	



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Piping System	R	BCK10
Service	GH, GN, GO, HA, HE, LN, LO	GH, GM, GN, GO, LM, LN, LO, H2O2, HA, HE, IPA, IW, JP-4, JP-5, JP-7, JP-8, RP-1
Max. Design Pressure (psig)	6600	6600
Temperature Range (°F)	-320°F to 150°F	-320°F to 100°F
Piping Material	ASTM A312 TP304L seamless, buttweld ends. (See Sections 9.15 and 9.16.)	ASTM A312 TP304L or TP316L seamless corrosion resistant S/S, beveled ends. (See Sections 9.2, 9.12, 9.14, and 9.21.)
Pipe Sizes and Schedules	1": Sch. 160. 1½" to 2": Sch. XXS.	¼" thru ¾": Section 6.0. 1/2" thru 1": Sch. 160. 1½" thru 4": Sch. XXS. (See Section 9.17.)
Fitting Material	ASTM A403 WP304L (See Sections 9.15 and 9.16.)	ASTM A403 WP304L or WP316L or ASTM A182 Gr. F304L or F316L. (See Sections 9.2, 9.12, 9.14, and 9.21.)
Fitting Details	1": Sch. 160, ASME B16.9. 1½" thru 2": Sch. XXS, ASME B16.9.	¼" thru ¾": See Section 6.0. 1/2" thru 1": Sch. 160, ASME B16.9 or B16.28, buttweld ends. (See Sections 9.17 and 9.21.) 1½" thru 4": Sch. XXS, ASME B16.9 or B16.28, buttweld ends. (See Sections 9.17 and 9.21.)
End Fitting Material	Same as fitting material.	See Appendix K and Sections 6.0 and 9.21.
End Fitting Details	Hubs and flanges are not permitted except where necessary to connect to other equipment.	See Appendix K and Section 6.0.
Bolting	(Same as required for connected equipment.)	See Appendix K.
Gaskets/Seals/Clamps	(See seal ring or gasket requirements of connected equipment.)	See Appendix K and Section 9.4.
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Weld Inspection (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class I	
Special Pressure and Leak Testing Requirements	See Section 5.1.	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq 5\%$ .
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	

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Piping System	ACK4	ACK1
Service	GH, GM, GN, GO, H2O2, HA, HE, IW, JP-4, JP-5, JP-7, JP-8, LH, LM, LN, LO, RP-1	GH, GM, GN, HA, HE, IW, RP-1
Max. Design Pressure (psig)	8500	15000
Temperature Range (°F)	-423°F to 100°F	-100°F to 100°F
Piping Material	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings).  1" thru 14": ASTM A312 TP304L or TP316L or ASTM A182 F304L or F316L seamless beveled ends. (See Sections 9.2, 9.12, 9.14, and 9.21.)	¼" thru ¾": See Section 6.0 (Tubing and Tube Fittings).  1" thru 12": ASTM A312 Gr. TPXM-11 seamless, beveled ends. (See Section 9.20.)
Pipe Sizes and Schedules	1/4" thru 1": See Sections 6.0 and 9.19. 1" to 1½": Sch. XX, seamless, beveled ends. 2" thru 14": See Appendix L.	1/4" thru 1": See Sections 6.0 and 9.19. 1" thru 12": See Appendix M.
Fitting Material	1" to 1½": ASTM A403 WP304L or WP316L ASTM A182 Gr. F304L or F316L. 2" thru 14": ASTM A182 TP304L or TP316L. (See Sections 9.2, 9.12, 9.14, and 9.21.)	¼" thru 1": See Sections 6.0 and 9.19. 1" thru 12": ASTM A182 Gr. FXM-11. (See Section 9.20.)
Fitting Details	1/4" thru 1": See Sections 6.0 and 9.19. 1" to 1½": ASME B16.9 or B16.28 Sch. XX, buttweld ends. 2" thru 14": ASME B16.9 or B16.28, wall to match "minimum extruded" wall of pipe, buttweld ends.	¼" thru 1": See Sections 6.0 and 9.19.  1" to 12": ANSI B16.9 or B16.28, wall to match "minimum extruded" pipe walls, forged, buttweld ends.
End Fitting Material	1/4" thru 1": See Section 6.0 (Tubing and Tube Fittings). 1" to 14": See Appendix L and Sections 6.0 and 9.17.	¼" thru 1": See Section 6.0 (Tubing and Tube Fittings). 1" thru 12": ASTM A182 Gr. FXM-11. See Appendix M.
End Fitting Details	¼" thru 1": See Sections 6.0 (Tubing and Tube Fittings) and 9.19. 1" thru 14": See Appendix L.	1/4" thru 1": See Sections 6.0 (Tubing and Tube Fittings) and 9.19. 1" thru 12": See Appendix M.
Bolting	See Appendix L.	See Appendix M.

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Piping System (Continued)	ACK4	ACK1
Gaskets/Seals/ Clamps	See Appendix L and Section 9.4.	See Appendix M.
Welding	SSTD-8070-0017-WELD or STD-8070-0041-WELD	SSTD-8070-0037-WELD. For pipe and fittings welded to 300 series S/S or P-8 Group 1 Materials, use SSTD-8070-0038-WELD and downrate pressure to that of adjoining pipe or fitting having lower rating.
Weld Inspection (circumferential welds only unless noted otherwise)	SSTD-8070-0013-WELD, Class I	
Special Pressure and Leak Testing Requirements	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq 5\%$ .	See Section 5.1. Test gas shall be nitrogen-helium mixture with helium mole fraction $\geq 5\%$ .
Cleaning (See Section 5.1.m)	RPTSTD-8070-0001	

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## 6.0 TUBING AND TUBE FITTINGS

- a. For Piping Systems Z, NCK3, NCK11, NCK1, H, NCK2, NCK10, NCK12, L1, L2, K3, BCK3, BCK4, BCK1, BCK10, seamless S/S tubing with 37° flared ends and SAE (AN/MS) straight threaded, 37° flared tube fittings per SSTD-8070-0126-PIPE shall be used for line sizes indicated below:

<u>Piping System</u>	<u>37° Flared Tubing and Tube Fitting Sizes</u>
Z	¼" thru 1", but pipe is required where indicated on design drawings
NCK1, NCK2, NCK3, NCK10, NCK11, NCK12	¼" thru 1½" if not vacuum jacketed
NCK1, NCK2, NCK3, NCK10, NCK11, NCK12	¼" thru 1" if not vacuum jacketed and if 1½" and larger line sizes are vacuum jacketed
NCK1, NCK2, NCK3, NCK10, NCK11, NCK12	(Tubing not allowed if line is to be vacuum jacketed or where design drawings indicate piping instead of tubing)
H	Tubing is not allowed. Only interfaces with tubing systems are allowed and there are no tubing size restrictions at these interfaces.
L1, L2	¼" thru 1", but piping is required for 1" nominal size lines where indicated on design drawings.
K3	¼" thru 1"
BCK3, BCK4, BCK1	¼" thru ¾"
BCK10	¼" thru ¾", but pipe is required for ½" and ¾" nominal sizes where indicated on design drawings.

- b. For NCK3, NCK11, NCK1, NCK2, NCK10, NCK12, BCK3, BCK4, BCK1 and BCK10 piping systems, all tubing, tube fitting and threaded connection seal contact surfaces shall have 16 RMS or smoother surface finish.
- c. For all cases where the tubing, tube fittings and threaded connections to these items in a piping system do not conform to leakage test acceptance requirements specified in

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Sections 5.1 and 5.2, seal contact surfaces at locations where leakage is observed during tests shall be evaluated.

1. If tightening of threaded joints does not result in conformance with leak test acceptance criteria, seal contact surfaces at these joints shall be polished or honed to have 16 RMS or smoother finish.
  2. If tightening of threaded joints does not result in conformance with leak test acceptance criteria and seal contact surfaces at these joints have been polished or honed to have 16 RMS or smoother finish, these joints shall be retested.
  3. The processes to disassemble leaking joints, polish or hone sealing surfaces and reassemble these joints shall also include procedural steps to maintain system cleanliness levels or re-clean systems which conform to requirements of RPTSTD-8070-0001.
- d. For piping system ACK6, tubing and tube fittings shall be used for ¼” thru 1” nominal size lines. The tubing and tube fittings shall be Autoclave AE Medium Pressure Slimline®, Butech M/P®, or equal coned-and-threaded type conforming to requirements of SSTD-8070-0126-PIPE, except the material shall be as follows:
1. Fittings, Inconel 625 (UNS NO6625) Gr. 2, SAE-AMS-5666 or ASTM B564
  2. Tubing, Inconel 625 (UNS NO6625) Gr. 2, SAE-AMS-5581 or ASTM B444.
- Buttwelded adapter and boss fittings and blind flanges with female coned-and-threaded tube connections are required to transition from pipe to tubing. The materials of buttwelded adapter and boss fittings and blind flanges shall match piping or pipe fitting material specifications.
- e. For ACK4 and ACK1 piping systems, the use of threaded connections shall be limited to threaded boss connections, tubing, tube fittings, and connections to fluid components in tubing systems. The nominal line size range for tubing and tube fittings shall be ¼” through ¾”, except where design drawings specify tubing for lines of 1” nominal size. The following requirements apply to tubing, tube fittings, tubing systems, and interfaces between piping and tubing systems:
1. Coned-and-threaded Autoclave AE Medium Pressure Slimline®, Butech M/P®, or equal tubing and tube fittings rated to 20,000 psig shall be used for all tubing systems.
  2. Buttweld adapter and boss fittings and blind hubs with female coned-and-threaded tube connections are required to transition from piping systems to tubing.
  3. Blind hub, welded adapter and boss fitting materials shall match piping or pipe fitting material specification.
  4. S/S tubing systems shall be in compliance with SSTD-8070-0126-PIPE.

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- f. The use of threaded connections for piping systems Z, NCK3, NCK11, NCK1, H, NCK2, NCK10, NCK12, L1, L2, K3, BCK3, BCK4, BCK1, and BCK10 shall be limited to threaded boss connections, tube fittings, and connections to components in tubing systems. Pipe-to-tube transitions for these piping systems shall be blind flanges, blind hubs, or forged and welded (Thread-O-Let type) bosses with SAE AS5202 thread connections. Blind flanges and hubs shall be Type 304, 304L, 316, or 316L S/S. Bosses shall be made of S/S material conforming to that of pipe or pipe fitting. The minimum wall thicknesses at the thread pattern and drilled port shall conform to ASME B31.3 requirements.
- g. Welded adapter and boss fitting materials and blind flange materials shall match the piping or pipe fitting material specification.
- h. For all tubing sizes, the minimum wall thickness shall conform to SSTD-8070-0126-PIPE for the design pressure of the connected piping system or shall be no less than 0.035", whichever yields the greater wall thickness.
- i. For piping system K3, PTFE coated 300 series S/S K-Seals shall be used for SAE AS5202 threaded connections.

## **7.0 THREADED PIPE**

- a. Teflon Tape
  1. The use of PTFE tape shall be used for all NPT threaded connections.
  2. PTFE tape shall be used and applied in accordance with SSTD-8070-0126-PIPE.
  3. For vacuum piping systems, when tape is used, a minimum of three (3) layers shall be used except for the first two (2) turns of the thread prior to assembly.
  4. Where fittings and pipe made of dissimilar metals are connected, the Teflon tape shall be applied such that the dissimilar metals are not in contact where moisture is present.
- b. For piping systems JJ, C, AA, EE, P, AN, B, G, and T the use of threaded pipe and pipe fitting connections shall be limited to ½" thru 1" nominal size, Sch. 40 or Sch. 40S, pipe and fittings for instrumentation, pressure, flow, temperature purge, vent, bleed, bypass, and safety valve connections. ½" thru 1" unions shall be ASTM A182 Gr. F304L, Sch. 40 or Sch. 40S, with fully confined PTFE seals and butt weld ends. Thread-O-Lets shall be ASTM A182 Gr. 304L per ASME B16.11.

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- c. For piping systems P, AN, B, G, and T the following unions also may be used for end drain, vent, and instrument shut-off (isolation) valves:
1. Nut:            ½” CPV #50N-3 or equal  
                     ¾” CPV #50N-4 or equal  
                     Material:        Type 304 or 304L S/S (Type 303 S/S allowed prior to issue date of this standard.)
  2. Tailpiece: ½” CPV #58R-3 or equal  
                     ¾” CPV #58R-4 or equal  
                     Material:        304 or 304L S/S
- d. For piping systems P, B, G, and T O-Rings used with threaded CPV pipe and pipe fittings shall be Buna-N.
- e. For piping system AN, O-ring seals used with threaded CPV type pipe and fittings will be ½” CPV #2-013V747-7 (Stock No. 5330-00-LN0-6490L) or ¾” CPV #2-018V747-7 (Stock No. 5330-00-LN0-6491L)

## **8.0 FLANGE AND CLAMP BOLTING**

- a. For piping systems with minimum service temperatures of -325°F and higher and for cases where the service media solidifies at pressure of 14.7 psig and temperatures below -325°F, ASTM A320 Gr. B8 studs and bolts may be substituted with ASTM A193 Gr. B8 studs and bolts.
- b. If the minimum service temperature is below -325°F and if the service media does not solidify (remains in liquid or gas phase) at pressure of 14.7 psig and temperatures below -325°F, the following provisions and stipulations apply:
1. ASTM A193 Gr. B8 Class 1 studs and bolts may be substituted for ASTM A320 Gr. B8 studs and bolts if ultimate tensile stress and minimum yield stress per ASME B31.3 enable flange gasket seal loading between flanges to meet pipe system leakage requirements of this standard.
  2. ASTM A193 Gr. B8 Class 2 studs and bolts may be substituted for ASTM A320 Gr. B8 studs and bolts if Supplementary Requirement S2, Charpy Impact Tests, is invoked for the former specification.
- c. Whenever ASTM A320 Gr. B8 Class 2 or ASTM A193 Gr. B8 Class 2 studs and bolts are used, they shall be conspicuously marked on both ends with “SH”, “Cl. 2”, or a similar marking to make clear that the studs and bolts are “Class 2”, strain hardened.

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- d. Whenever ASTM A320 Gr. B8 Class 1 or ASTM A193 Gr. B8 Class 1 studs and bolts are used, the following provisions apply:
1. Pipe system design and supporting pipe system stress analysis shall confirm that external loads on effected flange joints will not result in yielding of studs and bolts that join the flanges while also maintaining required gasket seal loading under all operating conditions.
  2. Contractor installing pipe systems and joining flanges shall assure proper alignment between mating flanges prior to them being connected. Angular offset between flange faces shall not exceed one degree after take-out of lateral offset, and lateral offset shall not exceed 1/8" prior to joining each pair of mating flanges.
  3. Contractor installing pipe systems and joining flanges shall follow recommended torquing sequences given in ASME PCC-1 while also assuring yield stresses of studs and bolts are not exceeded.

## 9.0 SPECIAL REQUIREMENTS

- 9.1 For piping system designators NCK1, NCK2, NCK3, NCK10, NCK11, NCK12 and Z, when these lines are vacuum jacketed as specified under piping system designators ACK1, ACK3, ACK10 or another applicable vacuum jacketed pipe system specification, tubing and tube fittings shall not be used for the inner lines and the minimum allowed line size for piping is 1-inch nominal. Unless specified otherwise on design drawings, all lines with piping system designators NCK1, NCK2, NCK3, NCK10, NCK11, and NCK12 that are not vacuum jacketed and that are 1.5-inch nominal size or smaller shall be 37 degree flared tubing and tube fittings with SAE (or the equivalent AN/MS) straight thread patterned connections fabricated in accordance with NASA/SSC SSTD-8070-0126-PIPE. Unless specified otherwise on design drawings, all lines with piping system designator Z that are not vacuum jacketed and that are 1-inch nominal size or smaller shall be 37 degree flared tubing and tube fittings with SAE (or the equivalent AN/MS) straight thread patterned connections fabricated in accordance with NASA/SSC SSTD-8070-0126-PIPE.
- 9.2 For all pipe and fittings used for piping system designators ACK4, B, BCK1, BCK10, G, NCK12, and T, and for all flanges used for piping system designators C, H, and JJ, all ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi. For piping system designator BCK4, the above requirements apply to all pipe and fittings of nominal sizes larger than 4 inches.



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- 9.3** For ASME B16.5 and API 605 Class 150 and 300 flange connections, Flexitallic Style LSI gaskets or approved equals are preferred, generally for cases where applicable gasket loading is substantially less than the maximum allowed and may not be sufficient to assure zero (0) observable in-service leakage. LSI style gaskets shall not be used in Class 400 and higher pressure class flange connections.
- 9.4** For piping system designators AA, ACK4, C, BCK1, BCK3, BCK4, BCK10, H, NCK1, NCK2, NCK3, NCK10, NCK11, NCK12 and Z, the TFE used in gaskets shall be batch/lot traceable from the TFE manufacturer in accordance with NASA/SSC Drawing 54000-GM30. This applies to piping in H202 (Hydrogen Peroxide), LOX and GOX service only.
- 9.5** For vacuum service, flanges connected to vacuum pumps, valves, and other components with ASME B16.5 flat-face flanges or end connection bolt sizes, bolt patterns, and seal contact faces that match these type flanges shall be ASME B16.5 WNFF type with 16 RMS finish on the flange face. Specific locations of all flat face flanges shall be indicated on all pipe system drawings.
- 9.6** For vacuum service, Buna-N gaskets conforming to ASME B16.21 or high vacuum gaskets with Buna-N seals shall be used for high vacuum service in cases where observable leakage or where PTFE extrusion into the piping system with the use of Flexitallic PTFE-filled spiral-wound gaskets has occurred or is likely to occur.
- 9.7** Flexitallic Style CG gaskets are permitted in existing systems provided that there are no observed indications of PTFE material extrusion into piping systems, generally caused by rapid decreases in internal piping system pressures. If, when, and where this extrusion condition is observed, the Style CG gaskets shall be replaced with Style CGI or LSI gaskets.
- 9.8** For piping system designator NCK10, uprating individual pipe spools to 720 psig is permitted for 14" and smaller nominal pipe sizes, if and only if all ASTM A182 Grade F304L or F316L S/S flanges used for pressure containing parts are certified and rated to allowed stresses of 20 ksi for ASTM A182 Grade F304 or F316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L or dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi. Furthermore, each pipe spool uprated to 720 psig shall be hydrostatically proof tested at 1080 psig in accordance with test requirements specified herein, and the respective spool shall be permanently marked with hydrostatic test pressure and the date of the test.
- 9.9** For piping system designator NCK10, uprating 16" pipe, pipe fittings, and pipe spools to 720 psig requires that either: 1) Wall thickness tolerance is +12.5%/-9.6%; or 2) All

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ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L and 316L S/S material used for pressure containing parts are certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 or 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L or dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi. All requirements stated in Section 9.8 above also apply.

- 9.10** For piping system designator NCK10, cast pipe and fittings may be used provided that all requirements of ASME B31.3 are satisfied and provided that the material conforms and is certified to ASTM A351 Type CPF8 (for fittings) and ASTM A451 Type CPF8 (for pipe) except that carbon content shall not exceed 3.5% and the material shall have a casting quality factor of 1.00 in accordance with ASME B31.3 as established by machining and non-destructive examination. Furthermore, all materials must have the following guaranteed mechanical properties: Ultimate Tensile Strength, 70 ksi minimum; Yield Strength, 25 ksi minimum; Elongation in 2-inches, 35% minimum, both longitudinal and transverse.
- 9.11** For piping system designators NCK10 and NCK12, unless specified otherwise on design drawings, all lines that are 1.5-inch nominal size or smaller shall be 37° flared tubing and tube fittings with SAE (or the equivalent AN/MS) straight thread pattern connection fabricated to connections fabricated in accordance with SSTD-8070-0126-PIPE.
- 9.12** For all pipe and fittings used for piping system designators ACK4, B, BCK1, BCK10, G, NCK12, and T and for all flanges used for piping system designators C, H, and JJ, all ASTM A182, ASTM A312, ASTM A351, ASTM A403, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowable stresses of 20 ksi for ASTM A182, ASTM A312, ASTM A351, ASTM A403, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi. For piping system designator BCK4, the above requirements apply to all pipe and fittings of nominal sizes larger than 4 inches.
- 9.13** For piping system designator BCK4, centrifugally cast pipe and fittings may be used for Type 304/304L “dual-rated” material provided all requirements of ANSI B31.3 are met and the material is certified to conform to ASTM A351 Type CPF8 (for fittings) and ASTM A451 Type CPF8 (for pipe) except that carbon content shall be 0.035% maximum for all material supplied and all castings shall have a casting quality factor of 1.00 in accordance with paragraph 302.3.3 of ANSI B31.3 as established by additional machining and nondestructive examination. Furthermore, all material must have the

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following mechanical properties: Tensile Strength, 75 ksi minimum; Yield Strength, 30 ksi minimum; and elongation in 2", 35% minimum, both longitudinal and transverse.

- 9.14** For piping system designators ACK4, BCK1 and BCK10, centrifugally cast pipe and fittings may be used for Type 304/304L "dual-rated" material provided all requirements of ANSI B31.3-1990 are met and the material is certified to conform to ASTM Spec. A351 Type CPF8 (for fittings) and ASTM A451 Type CPF8 (for pipe) except that carbon content shall be 0.035% maximum for all material supplied and all castings shall have a casting quality factor of 1.00 in accordance with paragraph 302.3.3 of ANSI B31.3 as established by additional machining and nondestructive examination. Furthermore, all material must have the following guaranteed mechanical properties: Tensile Strength, 75 ksi minimum; Yield Strength, 30 ksi minimum; and elongation in 2", 35% minimum, both longitudinal and transverse.
- 9.15** For piping system designator R, for the 1" and 2" pipe sizes, one or both of the following is required if Type 304L S/S is used:
- a. Material shall be dual-rated Type 304/304L S/S with minimum ultimate tensile stress of 60,000 psi, minimum yield stress of 40,000 psi, and alloy composition conforming to requirements of both 304 and 304L S/S, and,
  - b. Wall thickness tolerance shall be -0%, +12.5% instead of the standard  $\pm 12.5\%$ .
- 9.16** For piping system designator R, ASTM A312 Type 304 S/S may be used for pipe not in hydrogen service. ASTM A403 WP304 S/S may be used for fittings not in hydrogen service.
- 9.17** For piping system designators BCK10, for the 4-inch Schedule XXS pipe, fittings, weld-o-lets, and hub butt weld ends, the wall thickness tolerance shall be -2.3% to +12.5%.
- 9.18** For piping system designator H, when practical, class 150 flanges of the specified material shall be used for new construction. Class 300 flanges can be used to connect to existing components, but specific locations of class 300 flanges shall be indicated on all pipe system drawings. Also, all ASME B16.5 Class 150 flanges shall be made from ASTM A182 Gr. F304/F304L dual-rated S/S material. These flanges shall be certified and rated to allowed stresses of 20 ksi for ASTM A182 Gr. F304 S/S. Material certification shall conform to applicable ASTM specification for dual-rated 3/4/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi. Also, flat-faced flanges are allowed, as required, to mate to specific components that cannot be readily configured with raised face flanges. Some components include, but are not limited to, pump interfaces. Specific locations of flat-faced flanges shall be indicated on all pipe system drawings.

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- 9.19** For piping system designators ACK1 and ACK4, the use of 1” tubing and tube fittings shall be limited to lines specifically designated or indicated as 1” tubing on design drawings. Otherwise, piping and pipe fittings shall be used for 1” lines.
- 9.20** For piping system designator ACK1, centrifugally cast pipe and fittings may be used for Type XM-11 material provided all requirements of ANSI B31.3-1990 are met and the material is certified to conform to ASTM Spec. A312 for seamless Type XM-11 (Nitronic 40) material except para. 5.2.3 of ASTM Spec. A312 shall read “5.3.2 At the manufacturer’s option, pipe may either hot finish or cold finished or centrifugally cast. If centrifugally cast, the pipe shall have a casting quality factor of 1.00 in accordance with paragraph 302.3.3 of ANSI B31.3 as established by additional machining and nondestructive examination.
- 9.21** Monel 400 or K500 (UNS Nos. N04400 and N05500) weld overlay is required if and where indicated on drawings. This material overlay is generally required on the internal S/S wall surfaces of pipe fittings in selected liquid, gaseous, and supercritical oxygen lines or in lines where these fluids may potentially be flowing. These selected lines may include:
- Pump discharge back pressure control lines for liquid oxygen turbopump assemblies;
  - High pressure LOX run tank vent lines;
  - High pressure LOX lines downstream of turbine flow meters or temperature probes;
  - Other locations deemed to be prone to ignition hazards due to high velocity particle impacts.

Weld overlay shall be machined to 125 RMS or smoother surface finish, and shall be no less than 1/16<sup>th</sup> thick after machining, except where transitioning to surfaces without the overlay.

Weld overlay shall not be applied within 1” of root pass on fitting or pipe butt weld end preparation.

## **10.0 PAINTING**

All S/S surfaces shall be left unpainted and free of any surface coatings.

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## 11.0 PROCUREMENT SPECIFICATION REQUIREMENTS

### 11.1 General

- a. Piping materials shall be purchased new, and shall be standard products of reputable manufacturers.
- b. All piping materials shall comply with the attached pipe specifications.

### 11.2 Material Identification

- a. All material shall be marked with the information required by the applicable specifications of the American Society for Testing and Materials (ASTM).
- b. Marking shall be done by any permanent method that will not result in harmful contamination or sharp discontinuities.
- c. Markings shall not infringe upon the minimum wall thickness.
- d. Should the identifying marks be obliterated, or the material be divided into two or more parts, the marks shall be properly transferred by the manufacturer to each piece of material during fabrication. Such transfer of markings shall be made prior to the cutting or the manufacturer may transfer markings immediately after cutting provided the control of these transfers is described in the manufacturer's Quality Control Manual.
- e. NASA does not need to witness the transfer of the marks, but the contractor shall demonstrate that procedures are in place such that markings are transferred correctly.
- f. For material thinner than standard weight, the contractor shall propose a method for permanently marking components and parts to be reviewed and approved by NASA.
- g. All material shall be fully compatible with ambient environment and service media.
- h. Materials shall not embrittle, crack nor alter in chemical properties when in contact with service media.

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### 11.3 Fabrication

- a. Piping assemblies not rated for steam service shall be fabricated in conformance with ASME B31.3, the requirements of the applicable piping specification(s) contained in Section 3.0, and as indicated on the contract drawings.
- b. Piping assemblies rated for steam service shall be fabricated in conformance with ASME B31.1, the requirements of the applicable piping specification(s) contained in Section 3.0, and as indicated on the contract drawings.
- c. Unless specified otherwise and with the exception of weld root pass penetrations/beads, all internal surfaces, surfaces wetted by service media, and weld end preparations of fabricated pipe, pipe fittings, and pipe spools in all piping systems shall have a bright annealed finish as specified by ASTM A480 or smoother.
- d. Preparation for shop and field welds shall be by mechanical means where practical.
- e. Ends preparation for butt welding shall be in accordance with ASME B16.25; alignment shall be in accordance with ASME B31.1.
- f. All pipe fittings, including clamped hubs, flanges, and Weld-O-Lets, shall conform to the following geometric requirements:
  1. The inside diameter (I.D.) of each flow passage shall match that of the adjoining pipe or corresponding pipe size butt welded to the fitting;
  2. The I.D. tolerance of each flow passage shall be the same as that allowed for pipe of the same nominal size and conforming to specified pipe O.D., wall thickness, and tolerances;
  3. The wall thickness surrounding each fitting flow passage shall be greater than or equal to the minimum allowed wall thickness of the pipe having the same I.D. and nominal size;
  4. The O.D. and wall thickness at each butt weld end preparation shall match those of the adjoining pipe or corresponding pipe size within specified dimension and tolerances;
  5. No abrupt or discontinuous transitions in I.D., O.D., or wall thickness are permitted. These transitions shall conform to ASME B16.9
- g. Flange bolt holes shall symmetrically straddle principal longitudinal axis/axial centerlines of equipment, component bodies and piping, unless indicated otherwise.

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- h. For all piping assemblies rated above 3,000 psig, ¼ degree tolerance is the maximum allowed for flange face perpendicularity to pipe axial centerline.
- i. For piping assemblies rated at 3,000 psig and under, ½ degree tolerance is the maximum allowed for flange face perpendicularity to pipe axial centerline.
- j. Branch connections on shop fabricated piping shall include appropriate fittings, or groups of fittings (i.e., flanged connections).
- k. Branches shall extend to the first flange or to the first natural weld point as indicated on the piping drawings or as required for reasonable spool piece size.
- l. All threaded connections shall be gauge-checked or chased after welding or heat treating.
- m. Openings for inserts shall be drilled through the connection and be free from obstruction.
- n. Pipe bends may be used in heavy-walled piping systems in order to reduce fluid flow pressure drops.
  - 1. All pipe bends shall have a circular bend radius that is greater than or equal to six times the nominal pipe size.
  - 2. Eccentricity of the circular or elliptical (near circular) inside flow area cross-section shall not exceed 8% of the minimum or minor diameter.
  - 3. Minimum wall thickness specified for piping shall be maintained for all bends.
  - 4. All pipe used for bends shall be seamless.

#### 11.4 Cleaning and Finishing

All shop fabricated piping assemblies shall be cleaned after all fabrication and welding as follows:

- a. Burrs and sharp edges shall be ground smooth.
- b. All piping assemblies shall be furnished with both interior and exterior clean and free of all mill scale, grease, oil, dirt, flux, weld spatter, oxidation and other contaminants.

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- c. If water is used in cleaning piping assemblies, it shall not contain more than 100 parts per million (ppm) chlorides.
- d. Where wire brushing is used, it shall be performed only with S/S brushes. Brushes and grinding equipment shall not have been previously used on other material.
- e. Solvent cleaning shall be used to remove grease, oil, and other foreign matter.

#### 11.5 Submittals

- a. When pipe spools are provided from NASA supplied piping drawings, the shop fabricator shall maintain shop detail drawings and records on all materials, mill-test reports, fabrication, heat treatment, welding repairs, and non-destructive examination for all shop-fabricated piping specified herein.
- b. All such drawings, certifications, test data and reports shall be on file with the contractor and shall be sent to the authorized NASA representative as called out in the governing purchase order or contract document.

##### *11.5.1 Procedures*

- a. Procedures to be used in fabrication and examination of piping specified herein shall be submitted to NASA as soon as possible after receipt of the purchase order for review and shall be approved by NASA before the specific procedure is used.
- b. Procedures requiring NASA review and approval for use include the following:
  1. Welding procedure specifications and procedure qualification records for all material groups and thicknesses to be welded under this specification.
  2. List and detail of shop welding processes to be used with each class of piping.
  3. List of qualified welders and welding operators, showing their qualifications.
  4. Bending procedures.
  5. Heat treating procedures, including the proposed method of attachment and location of thermocouples.



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- 6. Non-destructive examination procedures.
- 7. All requests for substitutions, modifications, or relaxations of this specification or of the documents referenced in this specification shall be fully stated in writing for the consideration of NASA, whose decision will be final.
- c. Approval by NASA of shop fabricator's procedures, substitutions, major repairs, fabrication details, drawings, etc., shall not relieve shop fabricator of the responsibility for correctness of details, and compliance with all codes, legal requirements and this specification.

#### *11.5.2 Shop Detail Drawings*

- a. When piping spool drawings are supplied by NASA, the contractor shall make shop detail drawings for all piping he fabricates.
- b. Drawings shall show the spool number, material dimensions, fabrication details, and the applicable code and procedures.
- c. Drawings shall identify equipment, lines and spools connecting to each spool. The piping drawings must be shown as a reference.
- d. Fabricator shall provide reproducible copies of the shop detail drawings.
- e. When the contractor is fabricating piping spools from NASA supplied piping drawings, each pipe spool shall be identified by a unique number consisting of the line size, fluid designator, line number, piping class, and spool piece number.
- f. Piece numbers shall be assigned by the contractor numerically, in direction of flow, wherever possible.
- g. Each spool shall be detailed on a separate sheet bearing the following information:
  - 1. Purchase Order Number
  - 2. Isometric Drawing number
  - 3. Line Number
  - 4. Spool Number
- h. Spool numbering shall conform to SSTD-8070-0112-IDCODES.

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- i. When the contractor is fabricating piping spools from NASA supplied piping drawings, the contractor shall prepare a complete spool index relating each spool to the piping drawings from which it was prepared.
- j. The contractor shall also locate each spool on a copy of the NASA piping drawings and shall transmit same to NASA prior to commencing fabrication of the spools shown on the drawing or drawings transmitted. These markups shall be used as field erection drawings. A reproducible copy of these drawings shall be sent to NASA.
- k. Drawings shall be provided in electronic format in conformance with CSI NCS (United States National CAD Standard) and compatible and usable with Autodesk AutoCad® 2014 software unless a variance is processed and approved in accordance with SSTD-8070-0007-CONFIG. If drawings in electronic format are not provided, the fabricator shall supply two (2) Mylar® transparencies of all completed spool drawings and each revision of index sheets to NASA. Match lines on piping drawings shall not influence location of field joints.

**NOTE:** The generic material name for Mylar® is BOPET (biaxially-oriented polyethylene terephthalate) polyester film.

#### 11.6 Quality Assurance Provisions

- a. NASA reserves the right to inspect work at all times during and upon completion of fabrication and to witness any and all tests. The Government Representative shall be notified seven days in advance of the time articles and materials are ready for inspection or test.
- b. The contractor shall cooperate fully to enable NASA or the NASA representative and the Government Quality Inspector to be present at the performance of tests and other activity as specifically requested.
- c. Certified reports of test procedures and results shall be submitted to NASA.
- d. The contractor shall furnish all equipment and materials for all tests except where specifically stated otherwise.

#### 11.7 Examination and Testing

- a. All examination and testing of piping rated for steam service shall be in accordance with the latest edition and addenda of ASME B31.1.

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- b. All examination and testing of piping not rated for steam service shall be in accordance with the latest edition and addenda of ASME B31.3
- c. NASA or the NASA representative shall have access at any time to the work, whether it is in preparation or in progress, and the contractor shall provide proper facilities for such access and inspection.
- d. The NASA representative shall have the authority to stop work or hold shipment if the specification requirements, including those for documentation, have not been fulfilled.
- e. Review and approval of drawings, designs, materials or fabrications shall not relieve the contractor of his responsibility.
- f. NASA shall have the responsibility of reviewing all radiography and shall verify whether the radiography meet the applicable code requirements.
- g. Should a conflict result on the film interpretation that cannot be settled between NASA and the contractor, final interpretation shall be the responsibility of the NASA/SSC Level III NDT Specialist. The NASA/SSC Level III Specialist interpretation shall be final and binding to all parties involved.
- h. All radiography shall be performed in compliance with the applicable codes and requirements specified in the applicable piping specification.
- i. Where random radiography is required and a weld is rejected, additional welds by the same welder shall be radiographed in accordance with ASME B31.1 or B31.3, whichever applies.
- j. All hydrostatic and pneumatic pressure and leak tests shall be witnessed by an authorized NASA representative per SPR 1740.1, unless the contract specifications or work order specifically states otherwise. The contractor performing the tests shall furnish a Certificate of Inspection and Testing signed by his representative and those witnessing the tests.

#### *11.7.1 Material Surface Defects, Excluding Welds*

- a. Piping, pipe fitting, and pipe spool surface finishes shall conform to requirements of this SSTD.
- b. Non-conformance to this SSTD of piping, pipe fitting, and pipe spool surface finishes shall be cause for rejection.

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- c. Surface defects resulting in wall thickness below the specified minimum wall thickness or deeper than 0.015 inch shall be cause for rejection.
- d. Defects, as described above, may be repaired, subject to NASA approval or written repair procedures.
- e. All surface defects of 0.005 to 0.015 inch deep shall be blended to prevent stress risers.
- f. All repaired areas shall be re-examined by the same method used to locate the defect.

## 12.0 FOR OFFSITE CONTRACTORS ONLY

### 12.1 Preparation for Delivery

- a. Immediately after cleaning and inspection, all pipe shall be tightly sealed as follows:
  - 1. A metal or wood cap shall be placed over each non-flanged opening and sealed to the pipe with at least three passes of waterproof sealing tape.
  - 2. Flanges shall be sealed with wooden disks wired or bolted to the flanges. Tape shall be provided around disk and flange edges.
  - 3. Small openings such as couplings and Weld-O-Lets shall be sealed using small inserts pressed in and retained with a seal of waterproof tape.
  - 4. Nipples shall be sealed using caps retained with a seal of waterproof tape.
  - 5. Materials used to secure caps, disks or inserts to pipe shall be chloride free.
- b. Each section of fabricated pipe, pipe assembly or separate fitting shall be clearly marked, using low chloride markers, in a durable manner, with appropriate spool detail number to indicate its place in the final installed assembly. This marking shall be repeated at opposite sides and ends of each fabricated spool to facilitate identification.
- c. Fabricated pipe spools shall be adequately blocked, strapped, or otherwise held in position during shipment and be further separated by dunnage, as necessary to prevent damage.
- d. All shipments of pipe spools shall include a packing list and a complete list of all spools shipped.

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- e. A copy of the packing lists shall be mailed to NASA so that it will be received prior to the arrival of the piping.
- f. Components shipped in containers shall have a packaging list in a waterproof envelope included inside the container.
- g. All small and loose pieces shall be boxed for protection during shipment, with each box identified with a securely fastened metal tag bearing the purchase order number and item number of the components.
- h. The contractor shall be responsible for preparing each shipment of materials to arrive at the jobsite undamaged and be suitable for six months of outside storage.

## 12.2 Schedule and Expediting

- a. Delivery of material to the jobsite shall be in accordance with the delivery schedule set by NASA.
- b. Within the general requirements of the delivery schedule, the contractor shall fabricate the piping systems in the sequence requested by NASA in order to meet the erection schedule.
- c. The contractor shall send facsimile or electronic biweekly progress reports to NASA showing progress of shop details, fabrication and shipment.

## 12.3 Warranty

- a. All furnished pipe and fittings shall be guaranteed against defective materials, design and workmanship for a period of one year from the date of acceptance, but not before the equipment involved has passed all specified tests.
- b. Upon the receipt of notice from the Owner (Warranty Administration) of failure of any part of the guaranteed equipment during the guaranty period, new replacement parts shall be furnished and installed promptly by the Supplier at no additional cost to the Government.
- c. The Supplier shall acknowledge his/her responsibility under these guarantee provisions by letter, stating the shipment and materials referred to herein are guaranteed and the inclusive dates of the guaranty period.

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### 13.0 RECORDS AND FORMS

- a. Records and forms required by the procedures of this SSTD shall be maintained in accordance with SPR 1440.1.
- b. All records and forms are assumed to be the latest edition unless otherwise indicated. Documents used in this SSTD: Paint and Solvent Usage Log.
- c. Forms may be obtained from the SSC Electronic Forms repository or from the NASA SSC Forms Management Officer. Quality Records are identified in the SSC Master Records Index.

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## 14.0 ACRONYMS AND ABBREVIATIONS

AARH	Arithmetic Average Roughness Height
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association
BA	Breathable Air
BOPET	biaxially-oriented polyethylene terephthalate
CA	Compressed Air
CAD	Computer-aided Design
CEF	Central Engineering Files
CGI	Computer-generated imagery
CPV	CPV Manufacturing, Inc.
CSI	Construction Specifications Institute, Inc.
°F	Degrees Fahrenheit
DWG	Drawing
FF	Flat Face (flange)
GH	Gaseous Hydrogen
GHe	Gaseous Helium
GM	Gaseous Methane
GN	Gaseous Nitrogen
GO	Gaseous Oxygen
GOX	Gaseous Oxygen
H202	Hydrogen Peroxide
HA	High (Pressure) Air
HD	Hydraulic Fluid
HE	Helium
IAW	In Accordance With
”	Inch
ID	inside diameter
IW	Industrial Water
JP	Jet Propellant
ksi	Thousand Pounds per Square Inch
LH	Liquid Hydrogen
LO	Liquid Oxygen
LOX	Liquid Oxygen
LM	Liquid Methane
LN	Liquid Nitrogen
MIL	Military

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MDP	Maximum Design Pressure
MOP	Maximum Operating Pressure
MSFC	Marshall Space Flight Center
MSS	Manufacturers Standardization Society
NACE	National Association of Corrosion Engineers
NASA	National Aeronautics and Space Administration
NCS	(United States) National CAD Standard
NFPA	National Fire Protection Agency
NPS	Nominal Pipe Size (in inches)
NPT	National Pipe Thread Taper
OD	outside diameter
psia	pounds per square inch absolute
psig	pounds per Square Inch Gage
ppm	Parts per Million
PTFE	Polytetrafluoroethylene (also see TFE)
RF	Raised Face (flange)
RP	Rocket Propellant
RTJ	Ring Type Joint (flange)
RMS	Root Mean Square (surface finish measurement)
SAE	Society of Automobile Engineers
SORD	Site-wide Operational and Repair Documentation
S/S	Stainless Steel
SSC	John C. Stennis Space Center
SSTD	John C. Stennis Space Center Standard
SPR	Stennis Procedural Requirements
TFE	(Poly)tetrafluoroethylene (also known as PTFE)
UNS	Unified Numbering System (for metal alloys)
UTS	Ultimate Tensile Stress
VAC	Vacuum (Service)
WN	Weld Neck (flange)
WNFF	Weld Neck Flat Face (flange)
WNRF	Weld Neck Raised Face (flange)
WNRTJ	Weld Neck Ring Type Joint (flange)



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## 15.0 DEFINITIONS

### Design Pressure

The maximum allowed internal pressure of a piping system at its most severe in-service operating condition with coincident temperature and external pressure (minimum or maximum), except as provided by exceptions specified in ASME B31.3. If the exceptions allowed under ASME B31.3 are invoked, written approval of the NASA/SSC Office of Safety and Mission Assurance is required before implementation. For the purposes of this standard, the coincident temperature corresponding to the most severe operating condition is the maximum temperature of the fluid contained in the system unless specified otherwise. For purposes of this standard, the coincident external pressure corresponding to the most severe operating condition is 14.7 psia (0.0 psig), unless specified otherwise. [Internal piping system pressures during leak tests per ASME B31.3 or pressure tests per ASME B31.1 will almost always be higher than the design pressure, and this is allowable because the piping system is not in operational service during the time of these tests.]

### Designated System Pressure

A pressure that is less than or equal to the design pressure and is assigned to a piping system, subsystem, system branch, system section(s), or system spool(s), based on any combination of the following:

- a. The minimum design pressure or minimum pressure rating of one or more component(s) connected to or installed in the piping system.
- b. The minimum design pressure of other piping systems, subsystems, system sections, system branches, system spools connected to the respective piping system, where these can or will be subjected to the same operating pressure as that in the respective system.
- c. Program/project needs or requirements that dictate less severe operating conditions.
- d. Additional safety requirements imposed at the discretion of the end user, operations organization.

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**(Maximum) Operating Pressure** Pressure that is defined by the “Design Pressure” in accordance with the following Table 2:

**Table 1: (Maximum) Operating Pressure**

Design Pressure	Operating Pressure
50.0 psig (64.7 psia)	-14.7 psig to 25.0 psig (0.0 psia to 10.3 psia)
Above 50.0 psig to 250.0 psig (64.7 psia to 264.7 psia)	No greater than Design Pressure (in psig units) minus 25.0 psig
250.0 psig to 1000.0 psig (264.7 psia to 1014.7 psia)	No greater than 91% of Design Pressure
1000.0 psig to 2000.0 psig (1014.7 psia to 2014.7 psia)	No greater than Design Pressure (in psig units) minus 100.0 psig
2000 psig (2014.7 psia) and higher	No greater than 95% of Design Pressure
For cases where the “Designated System Pressure” is less than the “Design Pressure,” substitute “Designated System Pressure” for “Design Pressure” in all entries above.	
<p>For special cases, “Design Pressure” may be substituted with “Set Pressure or Burst Pressure” for the pressure relief or overpressure prevention device(s) that is (are) protecting the piping system, subsystem(s), system branch(es), system section(s), system spool(s). When more than one pressure relief or overpressure prevention device is used to protect a piping system, subsystem, system branch, system section, or system spool, this “Set Pressure or Burst Pressure” is defined as that of the device having the minimum “Set Pressure or Burst Pressure.” If the minimum “Set Pressure” or “Burst Pressure” of these devices is greater than the “Design Pressure” as allowed by ASME B31.3 with owner approval, the following requirements apply:</p> <ol style="list-style-type: none"> <li>Written approval of the NASA/SSC OSMA must be acquired before implementation, and</li> <li>“Operating Pressure” shall not be greater than “Design Pressure,” except as permitted by ASME B31.3. See SPR 1740.1, Chapter 3, <i>Operational Variations in Piping Systems</i>, for guidance.</li> </ol>	

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## APPENDIX A: Piping System ACK6; End Fitting (Connector) Details

### Clamped Hub Connectors:

Nominal Pipe Size	(Former) Reflange T-Con® Hub P/N	Reflange Inner Seal Ring P/N	Secondary Seal Ring P/N	Clamp P/N
12	VPTF1208	ST11375	38000-2710	C-12M
16	VPTF1608	ST14314		C-X16
24	VPTF2410	ST21000	38000-2711	C-X24

Clamps made of ASTM A351 CF8M S/S.

### E-Con® Flange Connectors:

Nominal Pipe Size	(Former) Reflange E-Con® Flange P/N	Reflange Seal Ring P/N
12	E1208-900	S11375
16	E1608-900	S14314
24	E2410-900	S21000

Blind flanges or hubs compatible and having the same or higher pressure rating at 1400°F service temperature as butt welded to flange or hub listed above may be connected to corresponding flange or hub listed above. Blind flanges or hubs used in operational piping systems shall be made of the same material as the butt weld hubs and flanges.

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## APPENDIX B: Piping System L1; End Fitting (Connector) Details

**Hubs:** Field Transfer Lines: For E-Test Complex, Reflange R-Con® type S/S connectors or equal per Table L1-I unless indicated otherwise with part numbers and at specific locations on drawings. For all areas outside E-Test Complex, Grayloc® or equal type S/S connectors per Table L-1-II unless indicated otherwise with part numbers and at specific locations on drawings.

Hub materials shall be ASTM A182 Gr. F304, F304L, F304/304L dual-rated, F316, F316L, or F316/316L dual-rated S/S.

Clamps shall be Type 304 or 316 S/S per ASTM A182 or A403 or cast CF8M or CPF8 S/S per ASTM A351 or A451.

At locations where hubs connect to carbon steel hubs, including interface points between hydraulic pump skid and distribution piping, and at locations where carbon steel hubs are connected, including hydraulic pump skid, internal connections, dielectric (insulated) clamps shall be used.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without transition seal rings.

**Seal Rings:** Silver coated 17-4PH S/S seal rings for R-Con® and Grayloc® connectors (See part numbers on Tables L1-I and L1-II); dielectric (insulated) seal rings shall be used at all locations where S/S hubs connect to carbon steel hubs.

**Bolting:** Bolts and Studs: ASTM A320 Gr. 8, Type 304S/S, full thread

Nuts: ASTM A194 Gr. 8, Type 304 S/S, Heavy Hex

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**Table L1-I**

<b>L1 Pipe, R-Con® List 7</b>				
<b>Pipe Nominal Size (in.)</b>	<b>Buttweld Hub Part No.</b>	<b>(Former) Reflange Seal Ring P/N*</b>	<b>Graloc® Seal Ring P/N*</b>	<b>Clamp Set Part No.</b>
1	F0104	S1049	FH60003-3	C-01
1.5	F1.504	S1610	FH60023-5	C-01.5
2	F0204	S2063	RH60005-8	C-02
2.5	F2.504	S2500	RH60021-3	C-2.5
3	F0304	S3063	RH60012-11	C-03
4	F0404	S4063	RH60013-10	C-04
*Seal rings are silver coated.				

**Table L1-II**

<b>L1 Pipe, Grayloc® Hub Connector List</b>				
<b>Pipe Nominal Size (in.)</b>	<b>Hub Connector Part No.</b>	<b>Buttweld Hub Part Number</b>	<b>Seal Ring P/N*</b>	<b>Clamp Set Part No.</b>
1	1GR11	53231D	51143G	C-01
1.5	1.1/2GR14	52813D	51147	C-01.5
2	2GR20	52821D	H90174-19	C-02
2.5	2.1/2GR25	52825D	51141G	C-2.5
3	3GR27	52844D	H90210-40	C-03
4	4GR40	52851D	51148	C-04
*Seal rings are silver coated.				

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## APPENDIX C: Piping System L2; End Fitting (Connector) Details

**Hubs:** For E-Test Complex, Reflange R-Con® type S/S connectors or equal per Table L2-I unless indicated otherwise with part numbers and at specific locations on drawings. For all areas outside E-Test Complex, Grayloc® or equal type S/S connectors per Table L2-II unless indicated otherwise with part numbers and at specific locations on drawings.

Hub materials shall be ASTM A182 Gr. F304L, F304/304L dual-rated, F316, F316L, or F316/316L dual-rated S/S.

Clamps shall be Type 304 or 316 S/S per ASTM A182 or A403 or cast CF8M or CPF8 S/S per ASTM A351 or A451.

At locations where hubs connect to carbon steel hubs, including interface points between hydraulic pump skid and distribution piping, and at locations where carbon steel hubs are connected, including hydraulic pump skid internal connections, dielectric (insulated) clamps shall be used.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without transition seal rings.

**Bolting:** Bolts and Studs: ASTM A320 Gr. B8, Type 304 S/S, full thread

Nuts: ASTM A194 Gr. 8, Type 304 S/S, Heavy Hex

**Table L2-I**

L2 Pipe, R-Con® List 8				
Pipe Nominal Size (in.)	Buttweld Hub Part No.	(Former) Reflange Seal Ring P/N*	Grayloc® Seal Ring P/N*	Clamp Set Part No.
1	F0104	S1049	FH60003-3	C-01
1.5	F1.508	S1500	RH60011-6	C-01.5
2	F0208	S1939	RH60031-9	C-02
2.5	F2.508	S2375	RH60089-1	C-2.5
3	F0308	S2900	RH60038-5	C-03
4	F0412	S3688	RH60081-5	C-04
*Seal rings are silver coated.				

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**Table L2-II**

<b>L2 Pipe, Grayloc® Hub Connector List</b>				
<b>Pipe Nomimal Size (in.)</b>	<b>Hub Connector Part No.</b>	<b>Buttweld Hub Part Number</b>	<b>Seal Ring P/N*</b>	<b>Clamp Set Part No.</b>
1	1GR11	53231D	51143G	C-01
1.5	1.1/2GR14	52814D	51147	C-01.5
2	2GR20	52822D	H90174-19	C-02
2.5	2.1/2GR25	52826D	51141G	C-2.5
3	3GR27	52845D	H90210-40	C-03
4	4GR34	55888D	51145G	C-04
*Seal rings are silver coated.				

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## APPENDIX D: Piping System K3; End Fitting (Connector) Details

**Hubs:** For E-Test Complex, Reflange R-Con® type S/S connectors or equal per Table K3-I unless indicated otherwise with part numbers and at specific locations on drawings. For all areas outside E-Test Complex, Grayloc® or equal type S/S connectors per Table K3-II unless indicated otherwise with part numbers and at specific locations on drawings.

Hub materials shall be ASTM A182 Gr. F304, F304L, F304/304L dual-rated, F316, F316L, or F316/316L dual-rated S/S.

Clamps shall be Type 304 or 316 S/S per ASTM A182 or A403 or cast CF8M or CPF8 S/S per ASTM A351 or A451.

Dielectric (insulated) clamps shall be used at locations where hubs connect to carbon steel hubs, including interface points between hydraulic pump skid and distribution piping, and at locations where carbon steel hubs are connected, including hydraulic pump skid internal connections.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without transition seal rings.

**Seal Rings:** Silver coated 17-4PH S/S seal rings for R-Con® and Grayloc® connectors (See part numbers on Tables K3-I and K3-II.)

**Bolting:** Field Transfer Lines and Skid

Studs: Full thread, Type 304 S/S, ASTM A193 Gr. B8 or ASTM A320, Gr. B8

Bolts: Type 304 S/S, ASTM A193 Gr. B8 or ASTM A320 Gr. B8. For carbon steel flanged pipe connections, including interface points between hydraulic pump skid and distribution piping, internal pump skid pipe connections, non-conducting rubber grommets shall be used to prevent carbon steel to S/S contact.

Grommets: Rubber

Nuts: Heavy Hex, Type 304 S/S, ASTM A194, Gr. 8

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**Table K3-I**

<b>K3 Pipe, R-Con® List 9</b>				
<b>Pipe Nominal Size (in.)</b>	<b>Buttweld Hub Part No.</b>	<b>(Former) Reflange Seal Ring P/N*</b>	<b>Graloc® Seal Ring P/N*</b>	<b>Clamp Set Part No.</b>
1.5	F1.516	S1375	RH600025-8	C-01.5
2	F0216	S1689	RH60055-1	C-02
2.5	F2.516	S2125	RH60002-3	C-2.5
3	F0316	S2672	RH60045-2	C-03
4	F0416	S3438	RH60037-3	C-04
*Seal rings are silver coated.				

**Table K3-II**

<b>K3 Pipe, Grayloc® Hub Connector List</b>				
<b>Pipe Nominal Size (in.)</b>	<b>Hub Connector Part No.</b>	<b>Buttweld Hub Part Number</b>	<b>Seal Ring P/N*</b>	<b>Clamp Set Part No.</b>
1.5	1.1/2GR14	52815D	51147	C-01.5
2	2GR20	52823D	H90174-19	C-02
2.5	2.1/2GR20	52827D	H90174-19	C-2.5
3	3GR25	52846D	51141G	C-03
4	4GR34	52853D	51145G	C-04
*Seal rings are silver coated.				

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## APPENDIX E: Piping System BCK3; End Fitting (Connector) Details

### Connections:

1" thru 12" Clamped ASTM A182 Gr. F304L or F316L hubs with buttweld ends, used with forged ASTM A82 Gr. F304, wrought ASTM A403 WP304, or cast ASTM A351 or A451 CF8M or CPF8 clamps.

For E-Test Complex, Reflange R-Con® hub connectors as listed in Table E-I or equals shall be used unless drawings indicate connectors shown in Tables E-II or E-III.

For all other areas at NASA/SSC, outside of the E-Test Complex, Grayloc® hub connectors shown on Table E-III or equals shall be used unless drawings indicate connectors shown in Tables E-I or E-II.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be made of the same material as the buttweld hubs if they are installed as part of the operational piping system.

### Seal Rings:

1" thru 12" Silver coated 17-4PH S/S seal rings are required and PTFE coated seal rings are not permitted for operational service.

Use PTFE coated and do not use silver coated seal rings during welding processes, cleaning processes, and hydrostatic tests.

See Tables E-I, E-II, or E-III for seal ring part numbers. Table E-I is the default for all areas in the E-Complex. Table E-III is the default for all areas outside of the E-Complex.

**Bolting:** Studs: Full thread, ASTM A320 Gr. B8, corrosion resistant Type 304 S/S  
Nuts: Heavy Hex, ASTM A194 Gr. B8, corrosion resistant Type 304 S/S

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**Table E-I**

<b>BCK3 Pipe, R-Con® List 1</b>					
Pipe Nominal Size (in.)	Buttweld Hub Part No.	(Former) Reflange Seal Ring P/N*	Graloc® Seal Ring P/N*	Clamp Set	
				Material	Part No.
1	F0116-S0832	S0832	RH60004-5	304 S/S	C-01
1.5	F1.516-S1375	S1375	RH60025-8	304 S/S	C-1.5
2	F0216-S1689	S1689	FH60055-1	304 S/S	C-02
2.5	F2.516-S2125	S2125	RH60002-3	304 S/S	C-2.5
3	F0316-S2672	S2672	RH60045-2	304 S/S	C-03
4	F0416-S3438	S3438	RH60037-3	304 S/S	C-04
6	F0616-S5250	S5250	RH60077-3	304 S/S	C-06
8	F0816-S6813	S6813	RH60059-3	CF8M ^	C-X8
10	F1016-S8500	S8500	RH60041-3	CF8M ^	C-X10H
10	F1016~1004-S8500	S8500	RH60041-3	CF8M ^	C-X10H
12	F1216-S10125	S10125	RH60087-1	CF8M ^	C-X12M
*Seal rings are 17-4PH S/S coated with silver.					
^ See Note E-1.					

**Table E-II**

<b>BCK3 Pipe, T-Con® List 1</b>						
Pipe Nominal Size (in.)	Buttweld Hub Part No.*	(Former) Reflange Inner Seal Ring P/N**	Graloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set	
					Material	Part No.
1	VPTF0116-S0832	S0832	RH60004-5	38000-2688	304 S/S	C-01
1.5	VPTF1.516-S1375	S1375	RH60025-8	38000-2536	304 S/S	C-1.5
2	VPTF0216-S1689	S1689	RH60055-1	3800-2690	304 S/S	C-02
2.5	VPTF2.516-S2125	S2125	RH60002-3	38000-2692	304 S/S	C-2.5
3	VPTF0316-S2672	S2672	RH60045-2	38000-2526	304 S/S	C-03
4	VPTF0416-S3438	S3438	RH60037-3	38000-2696	304 S/S	C-04
6	VPTF0616-S5250	S5250	RH60077-3	38000-2700	304 S/S	C-06
8	VPTF0816-S6813	S6813	RH60059-3	38000-2704	CF8M ^	C-X8
10	VPTF1016-S8500	S8500	RH60041-3	38000-2532	CF8M ^	C-X10H
10	VPTF1016~1004-S8500	S8500	RH60041-3	38000-2532	CF8M ^	C-X10H
12	VPTF1216-S10125	S10125	RH60087-1	38000-2709	CF8M ^	C-X12M
*Hub part numbers reflect hubs with vent ports between inner and outer seal rings. Delete "VP" prefix for hubs without vent ports. T-Con® Hubs shall have bent ports unless noted otherwise on drawings.						
**Seal rings are 17-4PH S/S coated with silver. Older Reflange inner seal ring part numbers started with "ST" instead of "S".						
^ See Note E-1.						

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**Table E-III**

<b>BCK3 Pipe, Grayloc® Hub Connector List</b>				
<b>Pipe Nominal Size (in.)</b>	<b>Hub Connection Part Number</b>	<b>Buttweld Hub Part Number</b>	<b>Seal Ring Part Number #</b>	<b>Clamp Set Part Number</b>
1	1GR7	53233D	66271	1
1.5	1.1/2GR14	52815D	51147	1-1/2
2	2GR20	52823D	H90174-19	2
2.5	2.1/2GR20	52827D	H90174-19	2-1/2
3	3GR25	52846D	51141G	3
4	4GR34	52853D	51145G	4
6	6GR52	52876D	51136G	6
8	8GR67	TBD	H90643-43	8 ^
10	10H84	52903	H90038-34	10H ^
12	X12M102	52907	H90042-22	X12M ^
# Above seal ring part numbers reflect silver coated 17-4PH S/S seal rings				
TBD = To Be Determined by manufacturer when initial orders are placed.				
^ See Note E-1				

**Note E-1:** For clamps made of castings and used for 8” nominal pipe size Grayloc® or equal hubs, 100% radiography or alternate NASA approved non-destructive testing to attain casting quality factor of 1.0 in accordance with ASME B31.3 is required.

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## APPENDIX F: Piping System B; End Fitting (Connector) Details

**Connections:** Grayloc® or Equal Hub Connections (See Notes F-1 and F-2)

**Table F-I**

<b>B Pipe, Grayloc® Or Equal Hub Connector List</b>				
<b>Pipe Nominal Size (in.)</b>	<b>Hub Connection Part Number (Note F-1)</b>	<b>Buttweld Hub Part Number</b>	<b>Seal Ring Part Number</b>	<b>Clamp Set Part Number</b>
½	55955D	1GR5	51231N	C-01
¾	53440D	1GR7	51232N	C-01
1	53218D	1GR11	51233N	C-01
1 ½	52814D	1-1/2GR14	51235N	C-01.5
2	52823D	2GR20	51236N	C-02
2 ½	52827D	2-1/2GR20	51236N	C-02.5
3	52846D	3GR25	51237N	C-03
4	52853D	4GR34	51240N	C-04
6	52876D	6GR52	51242N	C-06

Pressure-tapped hubs are permitted for hub sizes of 1 ½” and larger, but shall not be used unless absolutely necessary (no other options to connect instrument lines, relief devices).

Clamp materials shall be ASTM A182 Gr. F304, ASTM A182 Gr. F316, or ASTM A351-CF8M.

If service temperature is -20° or higher, dielectric (insulated) carbon steel clamps may be used. Clamp material shall be ASTM A266 Gr. 3 or ASTM A487 Gr. 1B, 2B, 4B, or 4A.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be made of the same material as buttweld hubs if installed as part of the operational piping system and if either of the following apply:
  - Minimum service temperature is below -20°F; or,
  - Necessary to attain and maintain precision clean level requirements.

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**Seal Rings:** PTFE coated 17-4PH S/S seal rings. PTFE coating to be applied per Gray Tool Co. Specification GCS-508 and ABB Vetco Gray, Inc. Document VGS 9.14.2 (no PTFE coating on seal ring I.D.)

Part numbers on Table F-I above.

**Bolting:** Studs: Full thread, ASTM A193 Gr. B8, Type 304 S/S  
If service temperature is -20°F or above and carbon steel clamps are used, ASTM A193 Gr. B7 studs shall be used.

Nuts: Heavy Hex, ASTM A194 Gr. 8, Type 304 S/S  
If service temperature is -20°F or higher and carbon steel clamps are used, ASTM A194 Gr. 2 or 2H nuts shall be used.

**Note F-1:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note F-2:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

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## APPENDIX G: Piping System T; End Fitting (Connector) Details

**Connections:** Grayloc® or Equal Hub Connections (See Notes G-1 and G-2)

**Table G-I**

Pipe Nominal Size (in.)	Hub Connection Part Number (Note G-1)	Buttweld Hub Part Number	Seal Ring Part Number	Clamp Set Part Number
½	53439D	1GR5	51231N	C-01
¾	53218D	1GR7	51232N	C-01
1	53232D	1GR11	51233N	C-01
1 ½	52815D	1-1/2GR14	51235N	C-01.5
2	52823D	2GR20	51236N	C-02
2 ½	52827D	2-1/2GR20	51236N	C-02.5
3	52846D	3GR25	51237N	C-03
4	52853D	4GR34	51240N	C-04

Pressure-tapped hubs are permitted for hub sizes of 1 ½” and larger, but shall not be used unless absolutely necessary (no other viable options to connect instrument sense lines, relief devices).

Clamp materials shall be ASTM A182 Gr. F304 or F316 or ASTM A351-CF8M.

If service temperature is -20°F or higher, dielectric (insulated) carbon steel clamps may be used. Clamp material shall be ASTM A266 Gr. 3 or ASTM A487 Gr. 1B, 2B, 4B, or 4A.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be made of the same material as buttweld hubs if installed as part of the operational piping system and if either of the following apply:
  - Minimum service temperature is below -20°F, or;
  - Necessary to attain and maintain piping system precision clean level requirements.

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**Seal Rings:** PTFE coated 17-4PH S/S seal rings. PTFE coating to be applied Gray Tool Specification GCS-508 and ABB Vetco Gray, Inc. Document VGS 9.14.2 (no PTFE coating on the seal ring I.D.) Part numbers on Table G-1 above.

**Bolting:** Studs: Full thread, ASTM A193 Gr. B8, Type 304 S/S  
If service temperature is -20°F or higher and carbon steel clamps are used, ASTM A193 Gr. B7 shall be used.

Nuts: Heavy Hex, ASTM A194 Gr. 8, Type 304 S/S  
If service temperature is -20°F or higher and carbon steel clamps are used, ASTM A194 Gr. 2 or 2H nuts shall be used.

**Note G-1:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note G-2:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.



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## APPENDIX H: Piping System BCK4; Piping and End Fitting (Connector) Details

### Pipe:

- 1" thru 6" Sch. XXS, seamless corrosion resistant S/S, beveled ends.
- 8" thru 12" Sch. 160, wall thickness and tolerances per Table H-I, below, seamless corrosion resistant S/S, beveled ends.

**Table H-1**

Nominal Pipe Size (inches)	Outside Diameter, O.D. (inches)	Pipe Wall Thickness (inches)		Manufacturing Tolerance on Wall Thickness	Schedule
		Nominal	Minimum extruded		
8	8.625	0.906	0.906	+12.5%/-0.0%	160
10	10.750	1.125	1.125	+12.5%/-0.0%	160
12	12.750	1.312	1.329	+1.3% to +12.5%	160

### Connections:

(See notes H-2 and H-3.)

- 1" thru 12" Clamped ASTM A182 Gr. F304L or F316L hubs with buttweld ends, used with forged ASTM A182 Gr. F304, wrought ASTM A403 WP304, or cast ASTM A351 or A451 CF8M or CPF8 clamps.

For E-Test Complex, R-Con® hub connectors as listed in H-II or equals shall be used unless drawings indicate connectors shown in Tables H-III or H-IV.

For all other areas at NASA/SSC, outside the E-Test Complex, Grayloc® hub connectors shown on Table H-IV or equals shall be used unless drawings indicate connectors shown in Tables H-II or H-III.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be made of the same material as buttweld hubs if installed as part of the operational piping system.

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### Seal Rings:

1" thru 12" Silver coated 17-4PH S/S seal rings are required, and PTFE coated seal rings are not permitted for operational service.

Use PTFE coated and do not use silver coated seal rings during welding processes, cleaning processes, and hydrostatic tests.

See Tables H-II, H-III, or H-IV for seal ring part numbers. Table II is the default for all areas in the E-Complex. Table IV is the default for all areas outside the E-Complex.

### Bolting:

All Sizes Studs: Full thread, ASTM A320 Gr. B8, corrosion resistant Type 304 S/S

Nuts: Heavy Hex, ASTM A194 Gr. 8, corrosion resistant Type 304 S/S

### Table H-II

BCK4 Pipe, R-Con® List 2					
Nominal Pipe Size (in.)	Buttweld Hub Part No.	(Former) Reflange Seal Ring P/N*	Grayloc® Seal Ring P/N*	Clamp Set	
				Material	Part Number
1	FO1XX-S0625	S0625	RH60027-3	304 S/S	C-01
1.5	F1.5XX-S1125	S1125	RH60009-8	304 S/S	C-1.5
2	F02XX-S1500	S1500	RH60011-6	304 S/S	C-02
2.5	F2.5XX-S1771	S1771	RH60088-1	304 S/S	C-2.5
3	F03XX-S2300	S2300	RH60006-4	304 S/S	C-03
4	F04XX-S3152	S3152	RH60034-5	304 S/S	C-04
6	F06XX-S4855	S4855	RH60066-2	304 S/S	C-06
8	F10-0816-S6813	S6813	RH60059-3	CF8M^	C-X10H
10	F12-1016-S8500	S8500	RH60041-3	CF8M^	C-X12M
12	F14-1216-S10125	S10125	RH60087-1	CF8M^	C-X14
*Seal rings are 17-4PH S/S coated with silver.					
^See Note H-1.					

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**Table H-III**

BCK4 Pipe, T-Con® List 2						
Nom. Pipe Size (in.)	Buttweld Hub Part No.*	(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set	
					Material	Part Number
1	VPTF01XX-S0625	S0625	RH60027-3	38000-2520	304 S/S	C-01
1.5	VPTF1.5XX-S1125	S1125	RH60009-8	38000-2523	304 S/S	C-1.5
2	VPTF02XX-S1500	S1500	RH60011-6	38000-2689	304 S/S	C-02
2.5	VPTF2.5XX-S1771	S1771	RH60088-1	38000-2691	304 S/S	C-2.5
3	VPTF03XX-S2300	S2300	RH60006-4	38000-2693	304 S/S	C-03
4	VPTF04XX-S3152	S3152	RH60034-5	38000-2695	304 S/S	C-04
6	VPTF06XX-S4855	S4855	RH60066-2	38000-2699	304 S/S	C-06
8	VPTF10-0816-S6813	S6813	RH60059-3	38000-2704	CF8M^	C-X10H
10	VPTF12-1016-S8500	S8500	RH60041-3	38000-2532	CF8M^	C-X12M
12	VPTF14-1216-S10125	S10125	RH60087-1	38000-2709	CF8M^	C-X14
*Hub part numbers reflect hubs with vent ports between inner and outer seal rings. Delete "VP" prefix for hubs without vent ports. T-Con® Hubs shall have vent ports unless noted otherwise on drawings.						
**Seal rings are 17-4PH S/S coated with silver. Older Reflange inner seal ring part numbers started with "ST" instead of "S".						
^See Note H-1.						

**Table H-IV**

BCK4 Pipe, Grayloc® Hub Connector List				
Nominal Pipe Size (in.)	Hub Connection Part Number	Buttweld Hub Part Number	Seal Ring Part Number #	Clamp Size
1	1GR5	53234D	66260	1
1.5	1.1/2GR14	52816D	51147	1-1/2
2	2GR14	52824D	51147	2
2.5	2.1/2GR20	52828D	H90174-19	2-1/2
3	3GR25	52847D	51141G	3
4	4GR31	52854D	H90029-44	4
6	6GR52	52877D	51136G	6
8	X8GR67	TBD	H90643-43	125600^
10	12M84	TBD	H90038-34	124202.0^
12	5P102	TBD	H90042-22	A90501-1449540^
# Above seal ring part numbers reflect silver coated 17-4PH S/S seal rings.				
TBD = To Be Determined by Manufacturer when initial orders are placed.				
^ See Note H-1.				

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**Note H-1:** For clamps made of castings for 8" and larger nominal pipe size hubs, 100% radiography or alternate NASA approved non-destructive testing to attain casting quality factor of 1.0 in accordance with ASME B31.3 is required.

**Note H-2:** For nominal pipe sizes larger than 4", all ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note H-3:** For nominal pipe sizes larger than 4", all ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

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## APPENDIX I: Piping System G; End Fitting (Connector) Details

**Connections:** Grayloc® or Equal Hub Connections (See Notes I-1 and I-2.)

**Table I-I**

Nominal Pipe Size (in.)	Buttweld Hub Part No.	Hub Connector Part No.	Seal Ring Part No.	Clamp Set Part No.
½	53439D	1GR4	51230N	C-01
¾	53442D	1GR5	51231N	C-01
1	53234D	1GR5	51231N	C-01
1 ½	52816D	1-1/2GR14	51235N	C-01.5
2	52824D	2GR14	51235N	C-02
2 ½	52828D	2-1/2GR20	51236N	C-2.5
3	52847D	3GR25	51237N	C-03

Pressure-tapped hubs are permitted for hub sizes of 1½” and larger, but shall not be used unless absolutely necessary (no other viable options for instrument sense lines, or relief devices).

Clamp materials shall be ASTM A182 Gr. F304, A182 Gr. F316 or A351-CF8M.

If service temperature is -20°F or higher, dielectric (insulated) carbon steel clamps may be used. Clamp material shall be ASTM A266 Gr. 3 or ASTM A487 Gr. 1B, 2B, 4B, or 4A.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without transition seal rings.
- Shall be made of same material as that of buttweld hubs if installed as part of the operational piping system and if either of the following apply:
  - Minimum service temperature is below -20°F; or,
  - Necessary to maintain precision clean level requirements.

**Seal Rings:** PTFE coated 17-4PH S/S seal rings. PTFE coating to be applied per Gray Tool Co. Specification GCS-508 and ABB Vetco Gray Inc. Document FBS 9.14.2 (no PTFE coating on the seal ring I.D.) Part numbers on Table I-I, above.

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**Bolting:** Studs: Full thread, ASTM A193 Gr. B8, Type 304 S/S.  
If service temperature is -20°F or higher and carbon steel clamps are used, ASTM A193 Gr. B7 studs shall be used.

Nuts: Heavy Hex, ASTM A194 Gr. 8, Type 304 S/S.  
If service temperature is -20°F or higher and carbon steel clamps are used, ASTM A194 Gr. 2 or 2H nuts shall be used.

**Note I-1:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note I-2:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

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## APPENDIX J: Piping System BCK1; Piping and End Fitting (Connector) Details

### Connections:

(See Notes J-1 and J-2.)

1" thru 12" Clamped ASTM A182 Gr. F304L or F316L hubs with buttweld ends, used with forged ASTM A182 Gr. F304, wrought ASTM A403 WP304, or cast ASTM A351 or A451 CF8M or CPF8 clamps.

See J-II, J-III, and J-IV. Table J-II applies, unless noted otherwise on drawings.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and
- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be made of same material as buttweld hubs if installed as part of the operational piping system.

### Seal Rings:

1" thru 12" Silver coated 17-4PH S/S seal rings. Do not use for welding, cleaning, or hydrostatic tests. Use for final pneumatic tests. Use Virgin Polytetrafluoroethylene (PTFE) coated 17-4PH S/S seal rings for cleaning and hydrostatic tests. (See J-II, J-III, and J-IV for seal ring part numbers. Table J-II applies, unless noted otherwise on drawings.)

### Bolting:

All Sizes Studs: Full thread, ASTM A320 Gr. B8, corrosion resistant Type 304 S/S

Nuts: Heavy Hex, ASTM A194 Gr. 8, corrosion resistant Type 304 S/S

### Pipe:

1" thru 3" Sch. XXS, seamless corrosion resistant S/S, beveled ends

4" thru 12" Wall to match "minimum extruded" wall in Table J-I, below, seamless, beveled ends

*Continued on next page.*

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**Table J-I**

ASTM A312 TP304L (Note 3)		Pipe Wall Thickness (inches)	Manufacturing Tolerance on Wall Thickness
Nominal Pipe Size (inches)	Outside Diameter O.D. (inches)	Minimum Extruded	Extruded
4	4.500	0.647 *	+12.5%/-0.0% *
6	6.625	0.953	+12.5%/-0.0%
8	8.625	1.240	+12.5%/-0.0%
10	10.750	1.546	+12.5%/-0.0%
12	12.750	1.834	+12.5%/-0.0%
*4" Schedule XXS pipe and fittings may be used if wall thickness tolerance is +12.5%, -3.6%. However, when new pipe and fittings are welded to existing pipe and fittings, butt weld end transitions may be needed and field verification of the effected butt weld ends on existing pipe and fittings shall be performed.			

**Table J-II**

BCK1 Pipe, R-Con® List 3					
Pipe Nom. Size (in.)	Butt weld Hub Part No.	(Former) Reflange Seal Ring P/N*	Grayloc® Seal Ring P/N*	Clamp Set	
				Material	Part Number
1	F01XX	S0625	RH60027-3	304 S/S	C-01
1	F1.5-01.278	S0750	RH60042-8	304 S/S	C-01.5
1.5	F1.5XX	S1125	RH60009-8	304 S/S	C-01.5
2	F02XX	S1610	RH60023-5	304 S/S	C-02
2.5	F2.5XX	S1771	RH60088-1	304 S/S	C-2.5
3	F03XX	S2300	RH60006-4	304 S/S	C-03
3	F03XX-0301	S2300	RH60006-4	304 S/S	C-03
3	F03XX-0316	S2300	RH60006-4	304 S/S	C-03
4	F05-04.643	S3250	RH60058-8	304 S/S	C-05
4	F05-04.643-0401	S3250	RH60058-8	304 S/S	C-05
6	F08-06.953	S4750	RH60093-2	CF8M	C-X8
8	F10-081.240	S6065	RH60001-6	CF8M	C-10H
10	F12-101.546	S7750	RH60082-2	CF8M	CX12M
12	FS-121.834	S9000	RH60107-1	CF8M	C-S
14	FS-142.013	S10020	RH60051-6	CF8M	C-S
*Seal rings are 17-4PH S/S coated with silver.					

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**Table J-III**

<b>BCK1 Pipe, T-Con® List 3</b>						
Pipe Nom. Size (in.)	Buttweld Hub Part No. *	(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set	
					Mat'l	Part No.
1	VPTF01XX	S0625	RH60027-3	38000-2520	304 S/S	C-01
1	VPTF01XX~0101	S0625	RH60027-3	38000-2520	304 S/S	C-01
1.5	VPTF1.5XX	S1125	RH60009-8	38000-2523	304 S/S	C-01.5
2	VPTF02XX	S1610	RH60023-5	38000-2524	304 S/S	C-02
2	VPTF2.5-02.504~02.436	S1375	RH60025-8	38000-2536	304 S/S	C-2.5
2.5	VPTF2.5XX	S1868	RH60085-2	38000-2627	304 S/S	C-2.5
3	VPTF03XX	S2300	RH60006-4	38000-2693	304 S/S	C-03
3	VPTF08-06.953~03XX	S4750	RH60093-2	38000-2539	CF8M	C-X8
4	VPTF05-04.643	S3250	RH60058-8	38000-2538	304 S/S	C-05
4	VPTF06-04.953~04.643	S2672	RH60045-2	38000-2526	304 S/S	C-06
5	VPTF06-05.796	S4750	RH60093-2	38000-2539	304 S/S	C-06
6	VPTF08-06.953	S4250	RH60057-4	38000-2629	CF8M	C-X8
6	VPTF08-06.953~061.563	S4750	RH60093-2	38000-2539	CF8M	C-X8
8	VPTF10-081.240	S6065	RH60001-6	38000-2702	CF8M	C-10H
10	VPTF08-06.953~101.546	S4750	RH60093-2	38000-2539	CF8M	C-X8
10	VPTF12-101.546	S7750	RH60082-2	38000-2531	CF8M	C-X12M
12	VPTFS-121.834	S9000	RH60107-1	38000-2707	CF8M	C-S
14	VPTFS-142.013	S10020	RH60051-6	38000-2708	CF8M	C-S
*Hub part numbers reflect hubs with vent ports between inner and outer seal rings. Delete "VP" prefix for hubs without vent ports. T-Con® hubs shall have vent ports unless noted otherwise on drawings.						
**Seal rings are 17-4PH S/S coated with silver. Old seal ring part numbers start with "ST" instead of "S".						

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**Table J-IV**

<b>BCK1 Pipe, T-Con® List 3V (Connections to ANSI 4500# Class Valves)</b>						
Pipe Nom. Size (in.)	Buttweld Hub Part No. *	(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set	
					Mat'l	Part No.
<b>1</b>	VPTF01XXV	S0625	RH60027-3	38000-2520	304 S/S	C-01
<b>1.5</b>	VPTF1.5XXV	S1125	RH60009-8	38000-2523	304 S/S	C-01.5
<b>2</b>	VPTF02XXV	S1610	RH60023-5	38000-2524	304 S/S	C-02
2.5	VPTF2.5XXV	S1868	RH60085-2	28000-2627	304 S/S	C-2.5
3	VPTF04-03XXV	S2300	RH60006-4	38000-2693	304 S/S	C-04
3	VPTF04-03XXV~0301	S2300	RH60006-4	38000-2693	304 S/S	C-04
3	VPTF08-06.953V~03XX	S4250	RH60057-4	38000-2629	CF8M	C-X8
4	VPTF0403XXV~-04.643	S2300	RH60006-4	38000-2693	304 S/S	C-04
4	VPTF05-04.643V	S3250	RH60058-8	38000-2538	304 S/S	C-05
6	VPTF08-06.953V~03XX	S4250	RH60057-4	38000-2629	CF8M	C-X8
8	VPTF10-081.240V	S5500	RH60072-7	38000-2553	CF8M	C-X10H
* Hub part numbers reflect hubs with vent ports between inner and outer seal rings. Delete "VP" prefix for hubs without vent ports. T-Con® hubs shall have vent ports unless noted otherwise on drawings.						
**Seal rings are 17-4PH S/S coated with silver. Old seal ring part numbers started with "ST" instead of "S".						

**Note J-1:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note J-2:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

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## APPENDIX K: Piping System BCK10; End Fitting (Connector) Details

### Connections:

(See Notes K-1 and K-2.)

Buttweld ASTM A182 Gr. F304L or F316L hubs per Table K-I, below, with forged ASTM A182 Gr. F304, wrought ASTM A403 WP304, or cast ASTM A351 or A451, Type 304 or CPF8 clamps.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs below; and,
- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be made of same material as buttweld hubs if installed as part of the operational piping system.

**Table K-I**

Nom. Pipe Size (in.)	Reflange, Inc. R-Con® Buttweld Hub P/N	R-Con® Seal Ring P/N	Grayloc® Seal Ring P/N	Clamp Set P/N
½	F.5008~.516S-0546	S-0546	RH60035-6	C-01
¾	F.7516S-0625	S-0625	RH60027-3	C-01
1	F01XX~0116S-0625	S-0625	RH60027-3	C-01
1 ½	F1.5XXS-1125	S-1125	RH60009-8	C-1.5
2	F02XXS-1500	S-1500	RH60011-6	C.02
2 ½	F2.5XXS-1771	S-1771	RH60088-1	C.03
3	F03XXS-2300	S-2300	RH60006-4	C-03
4	F05-04.643~04XXS-3250	S-3250	RH60058-8	C-05

**Seal Rings:** Silver coated 17-4PH S/S seal rings per Table K-1, above. (Do not use for welding, cleaning, or hydrostatic tests.) Use for final pneumatic test. Use Virgin PTFE coated 17-4PH S/S seal rings for cleaning and hydrostatic tests.

### Bolting:

All Sizes      Studs:              Full thread, ASTM A320 Gr. B8, corrosion resistant Type 304 S/S.

                     Nuts:                Heavy Hex, ASTM A194 Gr. 8, corrosion resistant Type 304 S/S.

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**Note K-1:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note K-2:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

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## APPENDIX L: Piping System ACK4; Piping and End Fitting (Connector) Details

### Pipe:

1" and 1.5" Sch. XXS, seamless corrosion resistant S/S, beveled ends

2" thru 14" Wall to match "minimum extruded" wall in Table L-I, below, seamless corrosion resistant S/S, beveled ends

**Table L-I**

ASTM A312 TP304L (Note 3)		Pipe Wall Thickness (inches)	Manufacturing Tolerance on Wall Thickness
Nominal Pipe Size (inches)	Outside Diameter O.D. (inches)	Minimum Extruded	Extruded
2	2.375	0.433	+12.5%/-0.0%
2.5	2.875	0.524	+12.5%/-0.0%
3	3.500	0.638	+12.5%/-0.0%
4	4.500	0.821	+12.5%/-0.0%
6	6.625	1.208	+12.5%/-0.0%
8	8.625	1.573	+12.5%/-0.0%
10	10.750	1.961	+12.5%/-0.0%
12	12.750	2.325	+12.5%/-0.0%
14	14.000	2.553 (Note L-1)	+12.5%/-0.0%

### Connections:

(See Notes L-2 and L-3.)

1" thru 14" Clamped ASTM A182 Gr. F304L or F316L hubs with buttweld ends, used with forged A182 Gr. F304, wrought ASTM A403 WP304, or cast ASTM A351 or A451 CPF8 or CF8M clamps.

See Tables L-II, L-III, L-IV, and L-V. Table L-II applies except where noted on drawings.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,

*Continued on next page.*

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- Shall be compatible with buttweld hubs without the use of transition seal rings.
- Shall be same material as buttweld hubs if installed as part of operational piping system.

### Seal Rings:

1" thru 14" Silver coated 17-4PH S/S seal rings. Do not use for welding, cleaning, or hydrostatic tests. Use for final pneumatic tests. Use Virgin PTFE coated 17-4PH S/S Seal Rings for cleaning and hydrostatic tests. (Rings: See Tables L-II, L-III, L-IV, and L-V. Part numbers: Table L-II applies except where noted otherwise on drawings.)

### Bolting:

All Sizes Studs: Full thread, ASTM A320 Gr. B8, corrosion resistant Type 304 S/S

Nuts: Heavy Hex, ASTM A194 Gr. 8, corrosion resistant Type 304 S/S

**Table L-II**

ACK4 Pipe, R-Con® List 4					
Pipe Nom. Size (in.)	Buttweld Hub Part No.	(Former) Reflange Seal Rings P/N*	Grayloc® Seal Ring P/N*	Clamp Set	
				Mat'l	Part No.
1	FO1XX	S0625	RH60027-3	304 S/S	C-01
1.5	F1.5XX	S1125	RH60009-8	304 S/S	C-01.5
2	F02.433	S1610	RH60023-5	304 S/S	C-02
2.5	F2.5.524	S1868	RH60085-2	304 S/S	C-2.5
3	F04-03.638	S2300	RH60006-4	304 S/S	C-04
4	F05-04.820-S2900#	S2900#	#	304S/S	C-05
4	F05-04.820##	S3250##	RH60058-8##	304 S/S	C-05
6	F08-061.208	S4250	RH60057-4	CF8M	C-X8
8	F10-081.573	S5500	RH60072-7	CF8M	C-X10H
10	F12-101.961	S6875	RH60094-1	CF8M	C-X12M
12	F12.122.325	S8125	RH60106-1	CF8M	C-X12M
14	FS-142.554**	S8875	RH60067-2	CF8M	C-S
*Seal rings are 17-4PH S/S coated with silver.					
**See Note L-1.					
#See Note L-4.					
##See Note L-5.					

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**Table L-III**

ACK4 Pipe, T-Con® List 4						
Pipe Nom. Size (in.)	Buttweld Hub Part No.*	(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set	
					Mat'l	Part No.
1	VPTF01XX	S0625	RH60027-3	38000-2520	304 S/S	C-01
1.5	VPTF1.5XX	S1125	RH60009-8	38000-2523	304 S/S	C-01.5
1.5	VPTF02.433	S1610	RH60023-5	38000-2524	304 S/S	C-02
2	VPTF02.433~0201	S1610	RH60023-5	28000-2524	304 S/S	C-02
2.5	VPTF2.5-02.504~02.436	S1868	RH60085-2	38000-2627	304 S/S	C-2.5
3	VPTF04-03.638	S2300	RH60006-4	38000-2693	304 S/S	C-04
4	VPTF05-04.820-S2900#	S2900#	#	38000-2538	304 S/S	C-05
4	VPTF05-04.820##	S3250##	RH60058-8##	38000-2538	304 S/S	C-05
4	VPTF05-04.820-04.643	S3250	RH60058-8	38000-2538	304 S/S	C-05
6	VPTF08-061.208	S4250	RH60057-4	38000-2629	CF8M	C-X8
8	VPTF10-081.573	S5500	RH60072-7	38000-2553	CF8M	C-X10H
8	VPTF10-081.852 ^^	S5500	RH60072-7	38000-2553	CF8M	C-X10H
10	VPTF12-101.961	S6875	RH60094-1	38000-2705	CF8M	C-X12M
12	VPTF122.325	S8125	RH60106-1	38000-2706	CF8M	C-X12M
14 ^	VPTFS-142.554 ^	S8875	RH60067-2	38000-2718	CF8M	C-S
*Hub part Number reflects hub with vent port between inner and outer seal rings. For hubs without vent ports, delete the "VP" prefix from part number. T-Con® hubs shall have vent ports unless noted otherwise on drawings.						
^ See Note L-1.						
^^ This hub part number is made of ASTM B564 Monel 400 instead of ASTM A182 F304L S/S.						
#See Note L-4.						
##See Note L-5.						

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**Table L-IV**

ACK4 Pipe, T-Con® List 4V (Connections to ANSI 4500# Class Valves)						
Pipe Nom. Size (in.)	Buttweld Hub Part No.*	(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set  Mat'l Part No.	
<b>1</b>	VPTF01XXV	S0625	RH60027-3	38000-2520	304 S/S	C-01
<b>1.5</b>	VPTF1.5XXV	S1125	RH60009-8	38000-2523	304 S/S	C-1.5
<b>2</b>	VPTF02.433V	S1610	RH60023-5	38000-2524	304 S/S	C-02
<b>2.5</b>	VPTF2.5-02.504~02.436	S1868	RH60085-2	38000-2627	304 S/S	C-2.5
<b>3</b>	VPTF04-03.638V	S2300	RH60006-4	38000-2693	304 S/S	C-04
<b>4</b>	VPTF05-04.820V	S3250	RH60058-8	38000-2538	304 S/S	C-05
<b>6</b>	VPTF08-061.208V	S4250	RH60057-4	38000-2629	CF8M	C-X8
<b>8</b>	VPTF10-081.573V	S5500	RH60072-7	38000-2553	CF8M	C-X10H
<b>10</b>	VPTF12-101.962V	S6875	RH60094-1	38000-2705	CF8M	C-X12M
*Hub part number reflects hub with vent port between inner and outer seal rings. For hubs without vent ports, delete the "VP" prefix from part number.						
**Seal rings are 17-4PH S/S coated with silver. Old part numbers started with "ST" instead of "S".						

**Table L-V**

ACK4-4T (Tank Nozzle Connectors), 8500 psig rating							
Nozzle			Pipe Side Buttweld Hub or Blind Part No.*	Tank Nozzle Side Buttweld Hub Part No.	(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N
Nom Size (in.)	O.D. (in.)	Wall (in.)					
1	1.315	0.358	TB01XX	TF01XX	S0625	RH60027-3	38000-2520
6	6.500	1.409	VPTF061.208	TF06-6.51.409	S3688		38000-2527
14	14.000	2.750	VPTF12- 142.554	TF12-142.750	S8500	RH60041-3	38000-2532
14	14.000	2.750	VPTF12- 142.554~ 061.208	TF12-142.750	S8500	RH60041-3	38000-2532
*Hub part number reflects hub with vent port between inner and outer seal rings. For hubs without vent ports, delete the "VP" prefix from part number.							
**Seal rings are 17-4PH S/S coated with silver. Old part numbers started with "ST" instead of "S".							
Clamp sets are C-01, Type 304 S/S, for 1" nozzles; C-06, Type 304 S/S, for 6" nozzles; and C-X12M, CF8M S/S, for 14" nozzles.							

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**Note L-1:** Existing pipe and fittings of 14-inch nominal size may have been fabricated with 2.750-inch minimum wall thickness and with -0.0%/+12.5% tolerance. Therefore, field verification of existing 14-inch pipe and fittings shall be performed whenever these are used in construction and whenever new pipe and fittings are to be welded to these existing pipes and fittings. Inside diameter transitions from 2.750-inch to 2.553-inch and vice versa shall conform to requirements of ASME B16.9 and the following:

- 3:1 or greater ratio taper (19° or less included cone half angle) for convergent or divergent section forming the transition.
- Tapered (convergent or divergent) section shall be ½” or more from the weld root pass.
- Corners and surfaces shall be smooth, 250 RMS or smoother, and shall be free of scratches, protrusions, burrs, shavings, nicks. Rounding of corners is permitted.

**Note L-2:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 304 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 304/304L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note L-3:** All ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316L S/S material used for pressure containing parts shall be certified and rated to allowed stresses of 20 ksi for ASTM A312, ASTM A182, ASTM A403, ASTM A351, and ASTM A451 Type 316 S/S. Material certification shall conform to applicable ASTM specifications for dual-rated 316/316L S/S material and ASME B31.3 having a minimum yield stress of 30 ksi and a minimum ultimate tensile stress of 75 ksi.

**Note L-4:** Hub with S2900 seal ring is used only where depicted on drawings or where required to connect to existing hubs with this seal ring size and transition seal rings cannot be used. Hub with S2900 seal ring is used for cases where seal ring I.D. needs to closely match pipe I.D., such as for Venturi flow meters.

**Note L-5:** If new hub is being connected to existing piping systems or sections thereof, field verify existing hub for seal ring size (S2900 or S3250). If existing hub uses S2900 seal rings, use transition seal ring or use F05-04.820-S2900, TF05-04.820-S200, or VPTF05-04.820-S2900 hub.

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## APPENDIX M: Piping System ACK1; Piping and End Fitting (Connector) Details

### Pipe:

1" thru 12" Wall to match "minimum extruded" wall in Table M-I, below, seamless corrosion resistant S/S, beveled ends

**Table M-I**

		Pipe Wall Thickness (inches)	Manufacturing Tolerance on Wall Thickness
Nominal Pipe Size (inches)	Outside Diameter O.D. (inches)	Minimum Extruded	Extruded
1	1.315	0.278	+12.5%/-0.0%
1.5	1.900	0.402	+12.5%/-0.0%
2	2.375	0.502	+12.5%/-0.0%
2.5	2.875	0.608	+12.5%/-0.0%
3	3.500	0.740	+12.5%/-0.0%
4	4.500	0.951	+12.5%/-0.0%
6	6.625	1.400	+12.5%/-0.0%
8	8.625	1.823	+12.5%/-0.0%
10	10.750	2.272	+12.5%/-0.0%
12	12.750	2.694	+12.5%/-0.0%

Connections: Clamped ASTM A182 Gr. FXM-11 hubs with buttweld ends, used with forged A182 Gr. F304, wrought ASTM A403 WP304, or cast ASTM A351 or A451 CPF8 or CF8M clamps.

Blind hubs may be used, but they:

- Shall have same pressure rating as buttweld hubs; and,
- Shall be compatible with buttweld hubs without the use of transition seal rings. (See Tables M-II, M-III and M-IV. Table M-II applies except where noted otherwise on drawings.)
- Shall be same material as buttweld hubs if part of operational piping system.

Seal Rings: Silver coated 17-4PH S/S seal rings. Do not use for welding, cleaning, or hydrostatic tests. Use for final pneumatic tests. Use Virgin PTFE coated 17-4PH S/S seal rings for cleaning and hydrostatic tests. See Tables M-II, M-III, and M-IV. Table M-II applies except where noted otherwise on drawings.

Bolting: Studs: ASTM A320 Gr. B8, Full thread, corrosion resistant Type 304 S/S  
Nuts: ASTM A194 Gr. 8, Heavy Hex, corrosion resistant Type 304 S/S

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**Table M-II**

ACK1 Pipe, R-Con® List 5					
Pipe Nom. Size (in.)	Buttweld Hub Part No.	(Former) Reflange Seal Ring P/N*	\Grayloc® Seal Ring P/N*	Clamp Set	
				Mat'l	Part No.
<b>1</b>	F1.5-01.281	S0750	RH60042-8	304 S/S	C-1.5
<b>1.5</b>	F-02-1.5.405	S1125	RH60009-8	304 S/S	C-02
<b>2</b>	F2.5-02.502	S1375	RH60025-8	304 S/S	C-2.5
<b>2.5</b>	F04-2.5.608	S1610	RH60023-5	304 S/S	C-04
<b>3</b>	F05-03.740	S2063	RH60005-8	304 S/S	C-05
<b>4</b>	F06-04.953	S2672	RH60045-2	304 S/S	C-06
<b>6</b>	F08-061.400	S3875	RH60028-11	CF8M	C-X8
<b>8</b>	F12.081.823	S4855	RH60066-2	CF8M	C-X12M
<b>10</b>	FS-102.272	S6375	RH60053-2	CF8M	C-S
<b>12</b>	FS-122.694	S7250	RH60015-4	CF8M	C-S
*Seal rings are 17-4PH S/S coated with silver.					

**Table M-III**

ACK1 Pipe, T-Con® List 5						
Pipe Nom. Size (in.)	Buttweld Hub Part No.*	(Former) Reflange Inner Seal Ring P/N **	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N	Clamp Set	
					Mat'l	Part No.
<b>1</b>	VPTF1.5-01.281	S0750	RH60042-8	38000-2521	304 S/S	C-01.5
<b>1.5</b>	VPTF02-1.5.405	S1125	RH60009-8	38000-2523	304 S/S	C-02
<b>2</b>	VPTF2.5-02.502	S1375	RH60025-8	38000-2536	304 S/S	C-2.5
<b>2</b>	VPTF2.5-02.504~ 02.436	S1375	RH60025-8	38000-2536	304 S/S	C-2.5
<b>2.5</b>	VPTF04-2.5.608	S1610	RH60023-5	38000-2524	304 S/S	C-04
<b>3</b>	VPTF05-03.740	S2063	RH60005-8	38000-2537	304 S/S	C-05
<b>4</b>	VPTF06-04.953	S2672	RH60045-2	38000-2526	304 S/S	C-06
<b>4</b>	VPTF06-04.953~ 04.643	S2672	RH60045-2	38000-2526	304 S/S	C-06
<b>6</b>	VPTF08-061.400	S3875	RH60028-11	38000-2697	CF8M	C-X8
<b>8</b>	VPTF12-081.823	S4855	RH60066-2	38000-2699	CF8M	C-X12M
<b>10</b>	VPTFS-102.272	S6375	RH60053-2	38000-2703	CF8M	C-S
<b>12</b>	VPTFS-122.694	S7250	RH60015-4	38000-2530	CF8M	C-S
*Hub part number reflects hub with vent port between inner and outer seal rings. For hubs without vent ports, delete the "VP" prefix from part number.						
**Seal rings are 17-4PH S/S coated with silver. Old Reflange part numbers started with "ST" instead of "S".						

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**Table M-IV**

<b>ACK1-5T (Tank Nozzle Connectors), 9500 psig Rating for Hub End Only</b>									
Nozzle			Pipe Side Buttweld Hub or Blind		Tank Nozzle Side Buttweld Hub		(Former) Reflange Inner Seal Ring P/N**	Grayloc® Inner Seal Ring P/N**	Outer Seal Ring P/N
Nom Size (in.)	O.D. (in.)	Wall (in.)	Mat'l	Part No.	Mat'l	Part No.			
1	1.315	0.358	304L*	TB01.278	304L*	TF01XX	S0625	RH60027-3	38000-2520
4	4.500	1.000	FXM-11	VPTF04.951	304L*	VPTF041.000	S2500	RH60021-3	38000-2725
4			FXM-11		304L*	VPTF04.951~04.726	S2500	RH60021-3	28000-2725
6	6.000	1.250	FXM-11	VPTF061.400	304L*	VPTF06-6.01.250	S3580	RH60098-2	38000-2726
6	6.625	1.563	FXM-11	VPTF061.400~061.208	304L*	F0600 S3500	S3500-3580		38000-2726
**"VP" prefix reflects hub with vent port between inner and outer seal ring. Delete this prefix for hubs without vent ports.									
**Seal rings are 17-4PH S/S coated with silver. Old part numbers started with "ST" instead of "S".									
All clamps are made of Type 304 S/S. Clamp set part numbers are C-01 for 1" nozzles; C-04, for 4" nozzles; and C-06, for 6" nozzles.									