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National Aeronautics and Space Administration

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

COMPLIANCE IS MANDATORY

John C. Stennis Space Center STANDARD FOR CARBON STEEL PIPING SYSTEMS A, CC, D, J, J1, K1, K2, L, M, M1, N, Q, S, SS, V, and W

Approved in DDMS by:

C. Brennan Sanders	8-28-19
NASA SSC Center Operations	Date
Facilities Engineering	
Test Complex Support	
Concurrence in DDMS by:	
Gina Ladner	<u>8-23-19</u>
NASA SSC Center Operations Directorate	Date
Facility Services	
Bartt J. Hebert	8-23-19
NASA SSC Engineering & Test Directorate	Date
Son K. Le	8-26-19
NASA SSC Safety & Mission Assurance	Date
Issued by	
ISSUED CEF	<u>8-28-19</u>
Central Engineering Files	Date

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SUBJECT: Standard for Carbon Steel Piping Systems

Change/ Revision	Change Date	Originator/ Phone	Description
Basic	10.21.11	D. Dike/ ext. 2803	Initial release. Supersedes SSC standards SSC-47- 011, 47-013, 47-022, 47-023, 47-026, 47-027, 47- 031, 47-036, 47-040, and SSTD-8070-0068-PIPE; and piping systems J1, K1, K2, M1, S and SS from specifications 110GK-GMK2 and 110GT-GM03. <i>SSC CEF Archive Note:</i> This standard also supersedes COE Contracts 1544; 1550 Piping Spec. V; 1573; 1580; 2090 Piping Spec. N, Q and CC; 2488; 2588; 2876 Piping Spec J and D; 2889 Piping Spec. B and C; and 2899 Piping Spec. L, A, B, W, and M.
A	10.05.12	D. Dike/ Ext. 2803	Replaced SSTD-8070-0089-FLUIDS with RPTSTD- 8070-0001 and cite cleanliness levels of the latter standard. In Section 5.2, added referencing to applicable parts of Section 7.0 for Piping Systems CC, J1, L, Q, N, and M to cover allowances and requirements for NPT threaded pipe and fittings. Correct typ-O in piping material entry for Piping System W, was "ASTM A1067 Gr. B." Deleted reference to Piping System L in Section 7.0a. Added Section 7.0e: For Piping System L, NPT threaded end connections may be used for ½" through 1½" Sch. 40 pipe. For air and nitrogen service, NPT threaded end connections may be used for ½" through 3" Sch. 40 pipe. Pipe fittings per ASME B16.11 with NPT threaded ends made of ASTM A105 or A181 carbon steel may also be used with threaded pipe. Pipe fittings per ASME B16.3 and made of ASTM A47 or A197 malleable iron may also be used with the threaded pipe. Added new Sections 7.0g and 7.0h to cover requirements for use of PTFE tape with threaded pipe and fittings and field repairs and recoating of galvanized pipe and fittings. Added definition of appurtenances in Section 10.0. Inserted new Section 10.0a, formerly was under Section 10.0b. to have the requirement cover on-site coating application processes for all piping systems under this standard. Inserted new Section 10.0c.3. to cover painting of threaded surfaces.

Document History Log

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В	12.19.17	L. de Quay	5-year review.
		Ext. 1956	Administrative changes throughout document.
			Revised cover sheet to reflect approval by CO PMD,
			and concurrence by OMD, E&TD and SMA.
			Updated references and acronyms.
			Document updated in its entirety, including revision
			and some additional subsections in Section 5.1;
			addition of 5.2, Applied Corrosion Allowance; and
			updates to 5.3, Requirements by Piping System, to
			make this standard consistent with other SSC standards
			that cover piping systems; closure of some 'loopholes'
			in welding requirements; address of pressure rating
			discrepancies for 'K2' piping system; and reference
			5.1-f for Pressure & Leak Testing Requirements.
			11.3-e: After "ASME B31.1", added "unless specified
			otherwise by the governing WPS or SSC Standard
			cited in Section 5.1, Subsection c."
			Added 15.0, Definitions.
C	11.18.18	L. de Quay	5.3: Removed "Low Pressure Service," "Medium
		Ext. 1956	Pressure Service," "High Pressure Service," and
			"Very High Pressure Service" rows throughout
			table.
D	08.21.2019	L. de Quay	5.1.f-1: "ASME PCC-2, Part 5, Section 6.2"
		Ext. 1956	changed to "ASME PCC-2, Part 5, Article 501, Sub-
			article 501-6.2."
			5.1.f-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) and (l) of this sub-article."

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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 carbon steel pipe systems at SSC, except as noted in 2.0b.

2.0 APPLICABILITY

- a. This SSTD shall be used for specifying pipe and pipe fitting materials to be incorporated into carbon steel piping systems at SSC.
- b. This SSTD does not apply to Piping System AG, High Pressure Industrial Water Piping; see SSTD-8070-0067-PIPE
- c. Authority for modifications to existing piping systems, solely for the purpose of meeting criteria in this standard, is not implied.
- d. Piping system drawings are drawn in schematic form and are identified by system and class. Pipe spool/section marking and labeling on drawings and spool/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 B16.3, Malleable Iron Threaded Fittings

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

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

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

ASME B16.20, Metallic Gaskets for Pipe Flanges-Ring-Joint, Spiral-Would, 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 B16.37, *Hydrostatic Testing Of Control Valves*

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

ASME B16.47, Large Diameter Steel Flanges

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- 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)
- 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 Code (B&PV), Sections VIII and IX
- 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 A105, Standard Specification for Carbon Steel Forgings for Piping Applications
- ASTM A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A181, Standard Specification for Carbon Steel Forgings For General-Purpose Piping
- 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 A234, Standard Specification for Piping Fitting of Wrought Carbon Steel and Alloy Steel for Moderate to High Temperature Service
- ASTM A266, Standard Specification for Carbon Steel Forgings for Pressure Vessel Components
- ASTM A290, Standard Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears
- ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- 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
- ASTM A350, Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
- ASTM A385, Standard Practice For Providing High-Quality Zinc Coatings (Hot-Dip)
- ASTM A420, Standard Specification for Piping Fitting of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
- ASTM A487, Standard Specification for Steel Castings Suitable for Pressure Service

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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 AWWA C651, Disinfecting Water Mains AWWA M28, Rehabilitation of Water Mains MSFC-STD-3535, Standard for Propellants and Pressurants Used for Test and Test Support Activities at SSC and MSFC MSS SP-6-2007, 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 H2Scontaining environments in oil and gas production 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-34-008, SSC Weld Procedure for Carbon Steel Pipe SSC 45-001, SSC Pressurization Standard in Support of the Recertification of Pressure Vessels and Pressure Systems SSC DWG 54000-GM00, Specification for Procurement of Glass Filled Teflon Gasket Material SSTD-8070-0005-CONFIG, SSC Preparation, Review, Approval, and Release of SSC Standards SSTD-8070-0007-CONFIG, SSC Variance and Alternate Standard Requests SSTD-8070-0013-WELD, Classes of Welding Inspection SSTD-8070-0015-WELD, SSC Gas Tungsten Arc Weld (GTAW) Procedure for Carbon Steel (P-1, Group No. 1 or 2) SSTD-8070-0039-WELD, SSC ASME GTAW & SMAW Weld Procedure for Carbon Steel Pipe -Maximum 2-Inch Material Thickness SSTD-8070-0040-WELD, SSC ASME Weld Procedure for Carbon Steel Pipe (GTAW and SMAW) SSTD-8070-0047-PIPE, SSC Standard for Stainless Steel Piuping 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. SSTD-8070-0063-PIPE, SSC Pipe Systems 3-1/2% Nickel for High Pressure Gas Service "Y" SSTD-8070-0067-PIPE, High Pressure Industrial Water Piping "AG" SSTD-8070-0112-IDCODES, SSC Test Complex Line Designator Numbers SSTD-8070-0126-PIPE, Tubing Systems for Facility Systems, Special Test Equipment, and Aerospace Hardware

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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. Piping System J shall not be used for new construction. For Piping System J, requirements of this standard govern repairs to or replacements of existing systems, system sections, and pipe spools.
- c. Welding shall be per SSTD-8070-0015-WELD, SSTD-8070-0039-WELD, or SSTD-8070-0040-WELD, whichever is applicable for the base metal wall thickness and base metal ASME B&PV Section IX P-numbers and group numbers at each weld joint. Where any of the specified base metals, pipe, and fittings have a P-number and group number per ASME B&PVC Section IX that differs from those covered by the SSC welding standards listed above, weld joints are only permitted where a weld procedure has been developed, qualified, and approved in accordance with ASME B&PVC Section IX. Welded joints are not permitted for pipe and fittings made of materials not listed with a P-number and group number in ASME B&PVC; integral spools and fittings with mechanical connections are required for these cases. Consumable inserts and/or backing rings are not permitted.
- d. Assembly of flanged joints shall conform to recommended practices of ASME PCC-1.

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- e. For each piping system, the designated system pressure shall be less than or equal to the maximum design pressure stated in Section 5.3.
- f. Unless indicated otherwise in Section 5.3, 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 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, Subarticle 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 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.
- g. 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 5.3. 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 5.3. 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.
- h. 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.
- i. 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.

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- j. 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.
- k. For all pressure and leak tests performed with liquid test media, no visible leakage is permitted.
- 1. 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 5.3, and no visible leakage is permitted. Visible leakage is indicated by blowing, frothing, or bubble formation at locations where the soap solution is applied.
- m. 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 i., j., k. and l. above, the piping system, system section, or spool(s) shall be depressurized to zero (0) 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, or spool(s).
- n. Unless stated or noted otherwise by RPTSTD-8070-0001 cleanliness level or cleanliness level breaks on drawings, cleaning requirements for all service media wetted surfaces and internal volumes are as indicated in Section 5.3. The applicable cleanliness or RPTSTD-8070-0001 cleanliness level shall be acquired and maintained prior to and when piping system is activated for operational service.
- o. Code compliance shall be per ASME B31.1 or ASME B31.3, whichever applies.
- Pipe schedule wall thicknesses and wall thick ness tolerances, and the piping outside diameter (OD) and OD tolerances corresponding to nominal pipe sizes in Section 5.3 shall be as stated in ASME B36.10 and ASME B36.19, except where noted otherwise in Section 5.3.
- q. Galvanized iron and steel piping and pipe fittings shall not be painted. Pipe and pipe fittings not made of iron or carbon steel shall not be painted except where stated otherwise in Section 10.0.

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5.2 Applied Corrosion Allowance

- a. For all piping systems in this SSTD, the applied corrosion allowance on external walls of piping and fittings is zero, 0.0 mils (0.000 inches), since all carbon steel piping systems are required to have applied coatings on external surfaces that protect the piping/fitting material from moisture and other weather conditions that cause or promote corrosion.
- b. For piping systems Q, K1, SS, S, and K2, which all allow for water or steam service media, the applied corrosion allowances for internal walls of piping and fittings are as shown in Table 1 below:

Piping System	Inner Wall Applied Corrosion Allowance (mils)
Q	90
K1	90
SS	60
S	60
K2	60 if 14" NPS or smaller, 44 if 16" NPS

Table 1: Corrosion Allowances for Internal Walls of Piping and Fittings

- c. For K2 piping systems, see Notes A, B, and C in the "K2" piping system of Section 5.3 for alternative corrosion allowance options to those listed in Table 1 for 12" and larger pipe sizes. These notes provide conditions/stipulations for applying these alternate corrosion allowances.
- d. For all piping systems other than Q, K1, SS, S, and K2, the applied corrosion allowance for internal walls of piping and fittings is 0.0 mils (0.000 inches).

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Requirements by Piping System 5.3

Piping System	CC	Ml	J1		
Service	VAC		NG		
Max. Design Pressure (psig)	20		150		
Temperature Range (°F)					
Piping Material	ASTM A10	6 Gr. B	ASTM A53 Gr. A or B, Type S or E		
Piping Schedules	¹ / ₂ " thru 12": Sch. 40 (See Section 7.0 f.)	1-1/4" thru 8": Sch. 40	1" thru 3": Sch. 40, threaded ends		
End Fitting Material	1/8" thru 1-1/2": ASTM A105; 2" thru 12": ASTM A181	ASTM A181	ASTM A197, Galvanized Malleable Iron		
End Fitting Details	 1/8" thru 1-1/2": Unions per ASME B16.11 w/ Socket-Weld ends and fully confined PTFE seal rings (See Section 7.0 f.); 2" thru 12": ASME B16.5 WNRF 150# Class Flange w/90° V-Groove Serrations in Face, WN FF Flanges with 16 RMS finish on face may be used to match commercial components or existing equipment, bore to match pipe I.D. (See Section 7.0 f.) 	1-1/4" thru 8": ASME B16.5 WN FF 150# Class Flange, bore to match pipe I.D.	1" thru 3": ASME B16.39 Class 150 (See Section 7.0 c.)		
Fitting Material	1/8" thru 1-1/2": ASTM A105 or A181; 2" thru 12": ASTM A105 or A234 Gr. WPB (See Section 7.0 f.)	ASTM A234 Gr. WPB	ASTM A197, Galvanized Malleable Iron		
Fitting Details	 1/8" thru 1-1/2": ASME B16.11 w/ Socket-Weld ends (See Section 7.0 f.); 2" thru 12": ASME B16.9 Sch. 40, buttweld ends (See Section 7.0 f.) 	1-1/4" thru 8": ASME B16.9 Sch. 40, buttweld ends	1" thru 3": ASME B16.3 & B16.39 Class 150 (See Section 7.0 c.)		
Bolting	Studs: ASTM A193 Gr. B7, full thread; Nuts: ASTM A194 Gr. 2H Hex	Studs/Bolts: ASME B18.2.1, Hex, full thread studs, ASTM A193 Gr. B7: Nuts: ASME B18.2.2 Hex, ASTM A194 Gr. 2H Hex; Waterproof lubrication on all connections	N/A		
Gaskets	High Vacuum Gaskets with Buna-N Seals, Vacuum Research Co. Series G-1 or Equal	ASME B16.21, Buna-N	See Section 7.0		
Weld Inspection	SSTD-8070-0013-WELD Class III	SSTD-8070-0013-WELD Class IIA	N/A		
Pressure & Leak Testing Requirements	See 5.1-f.	See 5.1-f. and Section 9.0	See 5.1-f and leak test with GN at 188 psig test pressure IAW NFPA 54 Part 4.		
Cleaning	Comme	Commercial Clean (See Section 5.1.n)			

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Piping System	K1	L		Q	
Service	CW, IW, PW (above ground)	CA, GH, GN, HA, HE	CA, HA	HW	Ethylene Glycol
Max. Design Pressure (psig)	150		200	200 125	
Temperature Range (°F)	-20 to 150		-20 to 100	32 to 350	-20 to 350
Piping Material	ASTM A53 Gr. A or B, Type S or E	ASTM A106 Gr. B	Gr. B ASTM A106 Gr. B or A53 G		53 Gr. A
Piping Schedules	3/4" thru 3": Sch. 40 NPT threaded ends; 4" thru 16": Standard Weight buttweld ends	¹ / ₂ " thru 12": Sch. 40 (See Section 7.0 e.)	½" thru 24": Sch. 40 (See Section 7.0 b.)		40 b.)
End Fitting Material	34" thru 3": ASTM A197; 4" thru 16": ASTM A105	ASTM A105 or A181 (See Section 7.0 e.)	½" thru 1-1/2": ASTM A47 or A197 for Unions w/ thread ends or ASTM A105 G 2 for Unions w/ socket weld ends; 2" thru 24": ASTM A181		
End Fitting Details	 ³⁄₄" thru 3": ASME B16.3 Class 150 Galvanized Malleable Iron; 4" thru 16": ASME B16.5 WNRF 150# Class Flange w/ 90° V-Groove Serrations in Face, bore to match pipe I.D. 	ASME B16.5 WNRF 150# Class Flange w/90° V-Groove Serrations in Face, bore to match pipe I.D. <i>NOTE:</i> For GH service, concentric serrations are required. (See Section 7.0 e.)	 ¹/₂" thru 1½": Unions per ASME B16.1 or ASME B16.11 w/ socket weld ends (See Section 7.0 b.); 2" thru 24": ASME B16.5 WNRF 150: Class Flange w/ 90° V-Groove Serration in Face, bore to match pipe I.D. (See Section 7.0 b.) 		ASME B16.3 et weld ends b.); WNRF 150# we Serrations pipe I.D. b.)
Fitting	³ / ₄ " thru 3": ASTM A197;	ASTM A234 Gr. WPB	½" thru 1-1/2": ASTM A181;		1 A181;
Fitting Details	4 thru 16 : ASTM A234 3/4" thru 3": ASME B16.3 Class 150 Galvanized Malleable Iron; 4" thru 16": ASME B16.9 & B16.28 Sch. 40	(See Section 7.0 e.) ASME B16.9 Sch. 40, buttweld ends (See Section 7.0 e.)	2' thru 24 : ASTM A234 Gf. WPB %" thru 1%": ASME B16.11 w/ socket-weld ends (See Section 7.0 b.); 2" thru 24": ASME B16.9 Sch. 40, buttweld ends (See Section 7.0 b.)		B16.11 nds b.); 9 Sch. 40, ion 7.0 b.)
Bolting	Studs/Bolts: ASME B18.2.1 Heavy Hex Heads on bolts, full thread; Nuts: ASME B18.2.2 Heavy Hex, ASTM A194 Gr. 1 or 2; Waterproof lubrication on bolts and studs	Studs/Bolts: ASME B18.2.1 Hex Heads on bolts, full thread stud Nuts: ASME B18.2.2 Hex, ASTM A194 Gr. 1 or 2; Waterproof lubrication on bolts and studs			hread studs; or 2;
Gaskets	ASME B16.21, Neoprene, Buna-N, or equal	Conform to SSC DWG 54000- GM00 ASME B16.21, 1/16 Compressed (non-friable per ASTM F104 (M Classification F112600 Gasket removal, har inspection, installatio conform to all applicabl 1915.1001 and 29 CFR requirements		(16" thick ble) Asbestos (Material 500E56M6) handling, ation shall able 29 CFR 'R 1926.1101 tts.	
Weld Inspection	SSTD-8070-0013-WELD Class IIA	SSTD-8070-0013-WELD Class I for GH Service, Class II for AIR, GN, and HE Service		ELD Class III	
Pressure & Leak Testing Requirements		See 5.1-f.			
Cleaning (See Section 5.1.n)	Commercial Clean for Deluge and Chilled Water; For Potable Water clean IAW AWWA M28, disinfect IAW AWWA C651, fill w/ solution containing >= 50 ppm Chlorine, let stand 24 hours, then flush w/ clean water until Chlorine content is < 0.2 ppm; Contractor is responsible for disposal of contaminated water	RPTSTD-8070-0001 Cle Level VC for GH Servic Clean Level 1000A for GN HE Service, Clean Lev Specified by Design Eng for CA and HA Service	ean (ee, I and el gr. e	Commercial (Clean

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Piping System	W	SS	S
Service	Acetylene, NG, RP-1	CA, GN, HA, HE	, HW, IW, Steam
Max. Design Pressure (psig)	275	450 for <= 16" NPS 400 for 18" thru 30" NPS	570
Temperature Range (°F)	-20 to 100	32 to 600	
Piping Material	ASTM A106 Gr. B	1-1/4" thru 20": ASTM A106 Gr. A, B, or C; 22" thru 24": ASTM A106 Gr. B or C; 26" thru 30": API 5L Gr. B (Rolled & Seam Welded)	1-1/4" thru 24": ASTM A106 Gr. A, B, or C
Piping Schedules	½" thru 20": Sch. 40	 1-1/4" thru 24": Standard Weight, Wall Thickness Tolerance for 20" NPS is - 7.0% to +12.5%, Wall Thickness Tolerance for 24" NPS is -9.5% to +12.5%; 26" thru 30": 0.500" Nom. Wall, 0.458" Min. Wall 	1-1/4" thru 24": Sch. 40 w/ Buttweld Ends per ASME B16.25
End Fitting Material	¹ / ₂ " thru 3": Unions: ASTM A105; 2" thru 20" Flanges: ASTM A181	ASTM A105 or A350 Gr. LF3	
End Fitting Details	 '/2" thru 3" Unions: ASME B16.11 Class 2000 Threaded Ends or Class 3000 Socket-Welded Ends, Socket Welded Ends Required if >100 psig pressure service; 2" thru 20" Flanges: ASME B16.5 WNRF 150# Class w/ 90° V-Groove Serrations in Face, bore to match pipe I.D. 	1-1/4" thru 24": ASME B16.5 WNRF 300# Class Flanges w/ 90° V-Groove Serrations in Face, bore to match pipe I.D.; 26" thru 30": ASME B16.47 WNRF 300# Class Flanges w/ 90° V-Groove Serrations in Face per ASME B16.5 Section 6.4.5.3, bore to match pipe I.D.	1-1/4" thru 24": ASME B16.5 WNRF 300# Class Flanges w/90° V-Groove Serrations in Face, bore to match pipe I.D.
Fitting Material	³ ⁄ ₄ " thru 3": ASTM A105; 2" thru 20": ASTM A234 Gr. WPB	ASTM A105 or ASTM 4	A234 Gr. WPB or WPC
Fitting Details	 1/2" thru 3" Unions: ASME B16.11 Class 2000 Threaded Ends or Class 3000 Socket-Welded Ends, Socket Welded Ends Required if >100 psig pressure service; 2" thru 20": ASME B16.9 Sch. 40 	1-1/4" thru 24": ASME B16.9 and B16.28 Sch. 40, Buttweld Ends, Wall Thickness Tolerance for 20" NPS is -7.0% to +12.5%, Wall Thickness Tolerance for 24" NPS is -9.5% to +12.5%	1-1/4" thru 24": ASME B16.9 and B16.28 Standard Weight, Buttweld Ends
Bolting	Studs/Bolts: ASME B18.2.1, Hex Head Bolts, Full Thread Studs, ASTM A193 Gr. B7; Nuts: ASME B18.2.2 Hex, ASTM A194 Gr. 1 or 2	Studs/Bolts: ASME B18.2.1, Heavy Hex Head Bolts Full Thread Studs, ASTM A193 Gr. B7; Nuts: ASME B18.2.2 Heavy Hex, ASTM A194 Gr. 1 or 2; Waterproof lubrication on all bolted connections.	

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Piping System	W	SS	S
Gaskets Weld Inspection Per	Spiral Wound Type 304 or 304L S/S w/ PTFE Filler and w/ inner and outer gage rings, Flexitallic Style CGI Class 150 or equal, Conforms to ASME B16.20 SSTD-8070-0013-WELD Class II	Spiral Wound Type 304, 304L, 316, 316L, or 321 S 0.175" thick (compresses to 1/8" thick), Class 300, Grafoil ® or Thermiculate ® 821 Filler and w/ inner outer 0.125" thick gage rings, Flexitallic Style ASP- or equal, Conforms to ASME B16.20 SSTD-8070-0013-WELD Class I	
Pressure & Leak Testing Requirements	See 5.1-f.	See 5.1-f. Hydrostatic Test Pressure: 780 psig minimum & no loss in press. during 10 minute hold to accommodate max. temperature; Pneumostatic Leak Test Pressure: 520 psig min. to accommodate max. temperature.	See 5.1-f. Hydrostatic Test Pressure: 1110 psig minimum & no loss in press. during 10 minute hold to accommodate max. temperature; Pneumostatic Leak Test Pressure: 740 psig min. to accommodate max. temperature.
Cleaning (See Section 5.1.n)		Commercial Clean	

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Piping System	K2	Ν	М	
Service	IW	GN, HE	GH, GN, HA	
Max. Design Pressure (psig)	720	720	810	
Temperature Range (°F)	32 to 100	-20 to 150		
Piping Material	³ ⁄ ₄ " thru 8": ASTM A53	ASTM A106 Gr. B		
	or ASTM A106 10": ASTM A53 Gr. A, Type S, ASTM A53 Gr. B or C, or ASTM A106. 12"thru 16": ASTM A53 Gr. B, Type S or ASTM A106 Gr. B or C, See Notes A, B, and C below.	, , , ,		
Piping Schedules	³ ⁄ ₄ " thru 3: Sch. 40 4" thru 16": Standard Weight	½: thru 6": Sc (See Sec	h. 40 Seamless tion 7.0a)	
End Fitting Material	ASTM A105	ASTM A1	.05 or A181	
End Fitting Details	 ³/4" thru 3": ASME B16.11 Class 2000 w/ NPT Thread Ends; 4" thru 16": ASME B16.5 WNRF 300# Class Flange w/90° V-Groove Serrations in Face, bore to match pipe I.D. (May be used for 3" NPS and smaller only where needed to connect to flanged valves & components) 	ASME B16.5 WNRTJ 300# Class Flange w/ ring grooves per ASME B16.20 except 32 RMS or smoother finish on sealing surfaces, bore to match pipe I.D. (See Section 7.0a)	ASME B16.5 WNRF 600# Class Flange w/90° V-Groove Serrations in Face, bore to match pipe I.D. NOTE: For GH service, concentric serrations are required. (See Section 7.0a)	
Fitting Material	ASTM A105, A234, or A350	ASTM A234 Gr. WPB c	r WPC (See Section 7.0a)	
Fitting Details	 ³/4" thru 3": ASME B16.11 Class 2000 w/ NPT Thread Ends; 4" thru 16": ASME B16.9 and B16.28 Sch. 40, buttweld ends 	s ½" thru 6": ASME B16.9 Sch. 40, buttweld end (See Section 7.0a)		
Bolting	Studs/Bolts: ASME B18.2.1, Full Thread Studs, Heavy Hex Heads on Bolts, ASTM A307 Gr. B; Nuts: ASME B18.2.2 Heavy Hex, ASTM A194 Gr. 1 or 2; Waterproof lubrication on studs/bolts	1 Studs: ASME B18.2.1, full thread, ASTM A193 Gr. B7; Nuts: ASME B18.2.2, Hex, ASTM A194 Gr. 2H		
Gaskets	1/16" thick Neoprene, Buna-N or equal; Conforms to ASME B16.21	Octagonal Ring, type 304 S/S, per ASME B16.20 except 32 RMS or smoother finish on sealing surfaces	Conforming to SSC DWG 54000-GM00	
Weld Inspection Per SSTD-8070-0013- WELD	Class IIA	Class II	Class I for GH Service, Class II for GN and AIR service	
Pressure & Leak Testing Requirements		See 5.1-f.		

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Piping System	K2	N	М
Cleaning (See Section 5.1.n)	Commercial Clean	RPTSTD-8070-0001 Clean Level Specified by Design Engineer	RPTSTD-8070-0001 Clean Level VC for GH Service, Clean Level 1000A for GN Service, Clean Level Specified by Design Engr. for AIR Service
Special Notes:	Note A: For 12" piping, ASTM A53 Gr. A, Type S and ASTM A53 Gr. B, Type E material is allowed if wall tolerance is -11.5%/+12.5% and corrosion allowance is reduced to 0.050" or if corrosion allowance is reduced to 0.045". Note B: For 14" piping, ASTM A53 Gr. B, Type E material is allowed if wall tolerance is -10.2%/+12.5% and corrosion allowance is reduced to 0.045".		
	Note C: For 16" piping, applied corrosion allowance is 0.044". Corrosion allowance can be increased to 0.050" if wall tolerance is -11.0%/+12.5%.		

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Piping System	А	J	D	V
Service	GH, GN, HA, HE	GN, GH, HE	GN, HE	GN, GH, HE
Max. Design Pressure (psig)	3700	6300		6600
Temperature Range (°F)	-20 to 150	-50 to 150	-20 tc	150
Piping Material	ASTM A106 Gr. B	 '/2" thru 1": ASTM A333 Gr. 1; 1-1/2" thru 10": same as fitting material. (Existing 1½" thru 10" pipe may be quenched and tempered steel pipe per SSC Spec. HS-1A, min. UTS of 115 ksi, min, yield stress of 100 ksi, Spec. in SSC CEF) 	1": ASTM A333 Gr. 1; hru 10": same as fitting al. (Existing 1½" thru e may be quenched and red steel pipe per SSC S-1A, min. UTS of 115 in, yield stress of 100 Spec. in SSC (EF)½" thru 2-1/2": ASTM Gr. B or C 3" and 4": ASTM A Gr. C	
Piping Schedules	¹ / ₂ " thru 3": Sch. 160 Seamless	 ½" thru 1": Sch. 160; 1-1/2" thru 3": Sch. 80; 4" thru 10": Sch. 120; Seamless for all sizes; -0.0% to +12.5% wall thickness tolerance for 2" thru 10" NPS 	1/2" thru 1-1/2": Sch. 160; 2" thru 4": Sch. XXS	½" thru 4": Sch. XXS
End Fitting Material	Hubs: ASTM A105; Clamps: ASTM A266 Gr. 3 or A487 Gr. 1B, 2B, 4A, or 4B.	 '/2" thru 1" Hubs: ASTM A105 or A350 Gr. LF1; 1-1/2" thru 6" Hubs: ASTM A290 or ASTM A487 Grade w/ UTS of 105 ksi or higher 8" and 10" Hubs: ASTM A290 or ASTM A487 Grade w/ UTS of 112 ksi or higher. (Existing "T-1" steel hubs per Gray Tool Forging Spec. GMS-244 is also allowed for 1½" thru 10" hubs) '/2" thru 1" Clamps: ASTM A266 Gr. 3 or A487 Gr. 1B, 2B, 4B, or 4A; 1-1/2" thru 10" Clamps: AISI 4340, AISI 8630, ASTM A290 Gr. 4, 5, or 6, or ASTM A487 Gr. 4E, 6A, 6B, 9E, 10B, 14A, or CA15 	Hubs: ASTM A105; Clamps: ASTM A266 Gr. 3 or A487 Gr. 1B, 2B, 4B, or 4A	Hubs: ASTM A105; Clamps: ASTM A266 Gr. 3 or A487 Gr. 1B, 2B, 4B, or 4A
End Fitting Details	bore NPS Hub. Clamp (in.) P/N P/N ½ 1GR4 1 ¾ 1GR5 1 1 1GR7 1 1½ 1½GR14 1½ 2 2GR20 2 2½ 2½GR20 2½ 3 3GR25 3	Grayloc ® or Equal Clamped Buffw or counterbore buftweld hubs to match NPS Hub. Clamp $(in.)$ P/N P/N $\frac{1}{\sqrt{2}}$ 1GR4 1 $\frac{3}{\sqrt{4}}$ 1GR5 1 1 1GR7 1 $1\frac{1}{\sqrt{2}}$ 2GR20 2 $2\frac{1}{\sqrt{2}}$ 2GR20 2 3 3GR27 3 4 4GR34 4 6 6GR62 6 8 8GR62 X8 10 10M91 X10H	reid and Blind Hubs, pipe I.D. at weld end c NPS Hub. Clamp (in.) P/N ½ IGR4 ¾ IGR5 1 1GR7 1½ 1½GR14 2 2GR14 2½ 2½GR20 3 3GR25 4 4GR31	f hub NPS Hub. Clamp (in.) P/N P/N ½ 1GR4 1 ¾ 1GR4 1 1 1GR5 1 1 1½GR11 1½ 2 2%GR20 2½ 3 3GR25 3 4 4GR31 4

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Piping System	A	J	D	V
Fitting Material	ASTM A234 Gr. WPB or WPC	 ½" thru 1": ASTM A105, A350 Gr. LF1, or A420 Gr. WPL3, WPL8, 1-1/2" thru 6": ASTM A290 or ASTM A487 Grade w/ UTS of 105 ksi or higher 8" and 10": ASTM A290 or ASTM A487 Grade w/ UTS of 112 ksi or higher (Existing and reused fittings quenched and tempered steel per SSC Spec. HS-1A or "T-1" steel per Gray Tool Forging Spec. GMS-244 is also allowed for 1½" thru 10" fittings; Spec. in SSC CEF) 	¹ ⁴ ² " thru 3": ASTM A234 Gr. WPB or WPC; 4": ASTM A234 Gr. WPC	3/2" thru 2-1/2": ASTM A234 Gr. WPB or WPC; 3" thru 4": ASTM A234 Gr. WPC
Fitting Details	ASME B16.9 Sch. 160, buttweld ends	ASME B16.9, buttweld ends; ½" thru 1": Sch. 160; 1-1/2" thru 3": Sch. 80; 4" thru 10": Sch. 120; Seamless for all sizes; -0.0% to +12.5% wall thickness tolerance for 2" thru 10" NPS	ASME B16.9, buttweld ends, ½" thru 1-1/2" : Sch. 160, 2" thru 4" : Sch. XXS	ASME B16.9 Sch. XXS, buttweld ends
Bolting	Studs: ASTM A193 Gr. B7, full thread; Nuts: ASTM A194 Gr. 2 or 2H, spherical faced	Studs: ASTM A320 Gr. L7, full thread; Nuts: ASTM A194 Gr. 4, spherical faced	Studs: ASTM A193 Gr. B7, full thread; Nuts: ASTM A194 Gr. 2 or 2H, spherical faced	
Seal Rings	Grayloc ® Seal Ring or Equal, Carbon Steel Certified to NACE MR0175/ISO 15156, PTFE Coated except on I.D. and wetted surfaces (Ref. Gray Tool Co. Specification GCS-508 Rev. D dated Jan. 1987 for coating application), Seal Ring Size is last digits following "GR" of each corresponding hub part number shown above.			
Weld Inspection		SSTD-8070-0013-WEI	LD Class I	
Pressure & Leak Testing Requirements		See 5.1-f.	(E al har David and D	
Cleaning	RPT	STD-8070-0001 Clean Level Spec	ined by Design Engi	neer

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6.0 TUBING AND TUBE FITTINGS

- a. For Piping Systems CC, M1, J1, K1, K2, SS, and S, tubing shall be seamless stainless steel with 37° flared ends in conformance with SSTD-8070-0126-PIPE requirements. Tube fittings shall conform to SSTD-8070-0126-PIPE requirements governing tube fittings used with 37° flared tubing.
- b. Tube and Tube Fitting Details
 - 1. Allowed sizes for tube and tube fittings for Piping Systems CC, M1, S, and SS are ¼" through 1".
 - 2. Allowed sizes for tube and tube fittings for Piping Systems J1, K1, and K2 are ¼" through ¾".
 - 3. Tubing used in Piping Systems J1, K1, K2, and M1 shall have .035" or heavier wall thickness.
 - 4. For Piping Systems S and SS, the tubing wall thickness shall conform to SSTD-8070-0126-PIPE requirements with design pressure of 740 psig for Piping System S and 520 psig for piping system SS.
 - 5. Pipe-to-tube transitions for Piping Systems K1, K2, and M1 shall be blind flanges or forged type 304, 304L, 316, or 316L stainless steel welded (Thread-O-Let type) bosses with SAE AS5202 thread connections. The minimum wall thicknesses at the thread pattern and drilled port shall conform to ASME B31.3 requirements.
 - 6. For Piping System M1, PTFE coated 300 series stainless steel K-Seals shall be used for SAE AS5202 threaded connections.
 - 7. Pipe-to-tube transitions for Piping Systems S and SS shall be blind flanges or welded (Thread-O-Let type) bosses with SAE AS5202 thread connections. Bosses shall be made of carbon steel conforming to ASTM specification(s) used for pipe, fittings, and flanges, or forged type 304, 304L, 316, or 316L stainless steel. Blind flanges shall be made of carbon steel conforming to ASTM specifications covering WNRF flanges. The minimum wall thicknesses at the thread patterns and drilled ports shall conform to ASME B31.1 requirements with design pressure of 740 psig for Piping System S and 520 psig for piping system SS.

7.0 THREADED PIPE

Pipe with NPT threaded ends may be used in Piping Systems M and N for instrument connections, pressure gages, and threaded safety valves for ¹/₂" through 1" Sch. 40 pipe. Pipe fittings per ASME B16.11 with NPT threaded ends and made of ASTM A105 or A181 carbon steel shall be used with threaded pipe.

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- b. Threaded pipe may be used in Piping System Q in air systems with operating pressures less than 25 psig within temperature ranges listed in Section 5.3 of this standard. Pipe fittings with NPT threaded ends listed in Section 5.3 for these piping systems may be used with the threaded pipe.
- c. Thread sealant for Piping System J1 shall be Rectoseal #5 or equal UL listed sealant; joints shall be 100% visually inspected.
- NPT threaded end connections for Piping System W may be used for ½" through 3" Sch. 40 pipe. Pipe fittings with NPT threaded ends listed in Section 5.3 for this piping system shall be used with threaded pipe.
- e. For Piping System L, NPT threaded end connections may be used for ½" through 1½" Sch. 40 pipe. For air and nitrogen service, NPT threaded end connections may be used for ½" through 3" Sch. 40 pipe. Pipe fittings per ASME B16.11 with NPT threaded ends made of ASTM A105 or A181 carbon steel may also be used with threaded pipe. Pipe fittings per ASME B16.3 and made of ASTM A47 or A197 malleable iron may also be used with threaded pipe.
- f. NPT threaded end connections for Piping System Piping System CC may be used for 1/8" through 12" Sch. 40 pipe. Pipe fittings per ASME B16.11with NPT threaded ends and made of ASTM A105 or A181 carbon steel shall be used with threaded pipe.
- g. Teflon Tape
 - 1. The use of Teflon tape shall be in accordance with SSTD-8070-0126-PIPE.
 - 2. 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.
 - 3. Where fittings and pipe made of dissimilar metals, such as carbon steel and stainless steel, are connected, the Teflon tape shall be applied such that the dissimilar metals are not in contact where moisture is present.
- For cases where galvanized pipe is threaded (after hot-dip galvanizing) or where the galvanic coating is damaged or removed, shop or field applied coatings that conform to ASTM A780 shall be applied to the uncoated and damaged surfaces. The processes for surface preparation and coating application shall also comply with ASTM A780. Applied coatings on threaded surfaces shall be fully cured and hardened in accordance with product manufacturer recommendations prior to assembly of the threaded connections.

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8.0 VALVES

For Piping Systems A, D, M, and V that use union end shutoff valves, drain valves, and/or vent valves, the following materials may be used:

- a. Nuts made of Carbon Steel 1018 (UNS Number G10180), Cadmium plated, ½" CPV #50N-3 or equal, ¾" CPV #50N-4 or equal.
- b. Tailpiece made of Carbon Steel 1018, Cadmium plated, ½" CPV #58R-3 or equal,
 ¾" CPV #58R-4 or equal.
- c. "O" Rings made of Buna-N and conforming to SAE AS28775; Part MS28775-212 for ¹/₂" tailpiece and Part MS28775-214 for ³/₄" tailpiece.

9.0 SPECIAL TESTING REQUIREMENTS

Piping System M1 shall be tested as follows:

- a. Pressure testing shall be done with dry, oil-free, -40°F dewpoint, compressed air as the test medium.
- b. Pressure testing shall be done in two stages; preliminary and acceptance.
- c. Preliminary testing shall be done with application of air pressure of 5 psig or less internally to the system. All joints are to be swabbed with standard high film-strength soap solution. If any observed bubbles or blowing occurs at swabbed locations, the system shall be depressurized and leaking joints shall be repaired followed by a repeat of the test.
- d. Piping systems shall then be pressurized to 25-psig minimum, and the test pressure shall be maintained for no less than two (2) hours without any external supply pressure source and with no observed pressure drop. If any pressure drop occurs, all leaks should be located, the system shall then be depressurized and leaking joints shall then be repaired followed by a repeat of the test.
- e. The piping system shall then be evacuated to have an internal vacuum of 100 microns of mercury or lower, absolute. Each system valve is to be operated at least three (3) times during this test. The observed rate of pressure rise shall not exceed one micron per hour over a 24-hour period.
- f. If and when pressure rise exceeds the allowed rate stated above, one of the following methods may be used to locate the source(s) of leakage:

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- i. Suspected area(s) of leakage charged with halogenated refrigerant and vacuum pump exhaust checked with a high sensitivity electronic halogen gas detector;
- ii. Suspect area may be enclosed in a 90- to 100-percent halogen refrigerant atmosphere retained by a plastic sheet enclosure and vacuum pump exhaust is checked as stated above;
- iii. Helium mass spectrometer leak detection testing with system internally pressurized with helium.
- g. Test specified in e. above shall be repeated if and when the pressure rise exceeds the allowed rate.

10.0 PAINTING

- a. For each coating application process performed on-site at NASA SSC, the contractor shall maintain a "Paint and Solvent Usage Log" to provide a permanent record of the respective process.
- b. For purposes of this standard, appurtenances stated and referenced in this section are defined as all parts and materials in contact with pipe and fittings. These include bolts, studs, and nuts used for flange and clamped connections; weld and mechanically connected restraints and supports; and other items directly contacting pipe and fittings.
- c. The following painting requirements shall be used for Piping Systems K1, K2, M1, S, and SS:
 - 1. Painting shall be performed after completion and acceptance of all welds to the maximum extent possible.
 - 2. Surface preparation prior to painting and painting application processes shall conform to manufacturer specifications and recommendations.
 - 3. Where field welds are required to enable transport of pipe spools to the job site and where use of mechanical pipe connections are not feasible, the pipe and fitting material shall be left unpainted within 6-inches of the field weld end preparations.
 - 4. Threaded and other surfaces that are coated with lubricating or anti-seizing compounds, are not galvanized, and need to be left unpainted during piping system assembly shall be left unpainted until after completion of pressure and leakage tests.
 - 5. All weather-exposed carbon steel surfaces that are not painted after completion of piping system assembly and pressure and leakage tests shall be painted or coated with waterproof lubricant.

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- d. For Piping Systems K1, K2, and M1, the following shall apply:
 - 1. Carbon steel piping, pipe fittings, pipe spools, and appurtenances that are not galvanized shall receive one (1) shop coat of inorganic zinc primer (Carbon Zinc 11 or equal).
 - 2. Final painting with Carbon Zinc 11 or equal primer at field weldments and with full application of intermediate and top coats shall be performed in the field after erection of piping systems and completion of all welds.
- e. For Piping Systems S and SS, the following shall apply:
 - 1. Carbon steel piping, pipe fittings, pipe spools, and appurtenances shall receive one (1) shop coat of Hi-Temp 1027 or equal on all exterior, weather exposed and insulation covered, surfaces.
 - 2. Final painting with Hi-Temp 1027 or equal at field weldments followed with full application of a top coat of Hi-Temp or equal on all external, weather exposed and insulation covered surfaces shall be performed in the field after erection of piping systems and completion of all welds.
 - 3. Paints or coatings other than Hi-Temp 1027 are subject to full evaluation of chemical and physical properties, environmental impacts, and worker safety, and these may be used only with written approval by NASA.

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

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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.

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 Piping Systems M1, S, and SS shall have a bright annealed finish or smoother.
- d. Preparation for shop and field welds shall be by mechanical means where practical.
- e. End preparation for butt-welding shall be in accordance with ASME B16.25; alignment shall be in accordance with ASME B31.1, unless specified otherwise by the governing WPS or SSC Standard cited in Section 5.1, Subsection c.
- f. All pipe fittings, including clamped hubs, flanges, and Weld-O-Lets, shall conform to the following geometric requirements:

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- 1. The inside diameter (I.D.) of each flow passage shall match that of the adjoining pipe or corresponding pipe size buttwelded 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 buttweld 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.
- 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.
- 1. 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.

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.

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- 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.
- c. If water is used in cleaning piping assemblies, it shall not contain more than 100 ppm chlorides.
- d. Where wire brushing is used, it shall be performed only with stainless steel 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.
- c. For Piping Systems S and SS, material certifications including physical and chemical properties, which show compliance with the referenced specifications, shall be furnished for all piping components.
- 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.

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- 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.
- 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

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- h. Spool numbering shall conform to SSTD-8070-0112-IDCODES.
- j. 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.
- k. The contractor shall 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 version of these drawings shall be sent to NASA.
- 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 (biaxiallyoriented 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 (7) 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 meets 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 and non-conformance shall be cause for rejection.
- b. Surface defects resulting in wall thickness below the specified minimum wall thickness or deeper than 0.015 inch shall be cause for rejection.

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- c. Defects as above may be repaired subject to NASA approval or written repair procedures.
- d. All surface defects of 0.005 to 0.015 inch deep shall be blended to prevent stress risers.
- e. 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 (3) 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.
- 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.

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h. The contractor shall be responsible for preparing each shipment of materials to arrive at the jobsite undamaged and be suitable for six (6) 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 (1) 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.

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

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	
BOPET	Biaxially-oriented Polyethylene Terephthalate	
CA	Compressed Air	
CEF	Central Engineering Files	
CFR	Code of Federal Regulations	
CPV	CPV Manufacturing, Inc.	
CW	Chilled Water	
°F	Degrees Fahrenheit	
DWG	Drawing	
FF	Flat Face (Flange)	
GH	Gaseous Hydrogen	
GN	Gaseous Nitrogen	
HA	High (Pressure) Air	
HE	Helium	
HW	Hot Water	
IAW	In Accordance With	
"	Inch	
IW	Industrial Water	
ksi	Thousand Pounds per Square Inch	
MSS	Manufacturers Standardization Society	
NACE	National Association of Corrosion Engineers	
NASA	National Aeronautics and Space Administration	
NFPA	National Fire Protection Agency	
NG	Natural Gas	
NPS	Nominal Pipe Size (in inches)	
NPT	National Pipe Taper	
OD	Outside Diameter	
psia	pounds per square inch (absolute)	
psig	pounds per square inch gage	
ppm	parts per million	

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PTFE	Polytetrafluoroethylene (also see TFE)
PW	Potable Water
RF	Raised Face (Flange)
RP	Rocket Propellant
RPT	Rocket Propulsion Test
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
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 press assigned section(following	ture that is less than or equal to the design pressure and is d to a piping system, subsystem, system branch, system (s), or system spool(s), based on any combination of the ng:
	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 that is defined by the "Design Pressure" in accordance with the following Table 2:

Table 2: (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.				
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: a. Written approval of the NASA/SSC OSMA must be acquired before implementation, and				
b. "Operating Pressure" shall not be greater than "Design Pressure," except as permitted by ASME				

B31.3. See SPR 1740.1, Chapter 3, Operational Variations in Piping Systems, for guidance.