



Engineering Standard

SAES-L-109

5 February 2006

Selection of Flanges, Stud Bolts and Gaskets

Piping Standards Committee Members

Sannaa, Muhsen Shobbar, Chairman

Nasri, Nadhir Ibrahim, Vice Chairman

Balhareth, Nasser Mohammad

Khashab, Jaafar M.

Sharif, Talal Mahmoud

Mullen, Marshall Anson

Bannai, Nabeel Saad

Qahtani, Khalid Daifallah

Rumaih, Abdullah Mohammad

Kim, Steve Un

Fadley, Gary Lowell

Otaibi, Bander Abdulaziz

Ramadan, Mousa Sadiq

Teraiki, Abdullah Mohammad

Phan, Howard Cong

Lewis, Trevor

Mahmoud, Khalid Ahmed

Saudi Aramco DeskTop Standards

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1 Scope

This standard supplements ASME B31.3, ASME B31.4 and ASME B31.8 codes and defines mandatory requirements governing the selection of metallic pipe flanges (hereinafter called "flanges"), gaskets, and bolting for transportation and in-plant piping in the temperature range from minus 50 to 425°C.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

<i>SAEP-302</i>	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
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Saudi Aramco Engineering Standards

<i>SAES-A-301</i>	<i>Materials Resistant to Sulfide Stress Corrosion Cracking</i>
<i>SAES-L-110</i>	<i>Limitations on Pipe Joints and Components</i>
<i>SAES-L-136</i>	<i>Pipe Selection and Restrictions</i>

Saudi Aramco Materials System Specification

<i>02-SAMSS-011</i>	<i>Forged Steel Weld Neck Flanges for Low and Intermediate Temperatures</i>
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Saudi Aramco Standard Drawings

<i>AD-036991</i>	<i>Welding Neck and Blind Flanges, 26"-60" NPS, Class 300 RF</i>
<i>AC-036484</i>	<i>Welding Neck and Blind Flanges, 26"-48" NPS, Class 300 RJ</i>
<i>AC-036437</i>	<i>Welding Neck and Blind Flanges, 54"-60" NPS, Class 300 RJ</i>
<i>AD-036698</i>	<i>Welding Neck and Blind Flanges, 34"-48" NPS, Class 400 RF</i>
<i>AD-036673</i>	<i>Welding Neck and Blind Flanges, 26"-48" NPS, Class 600 RF</i>
<i>AC-036442</i>	<i>Welding Neck and Blind Flanges, 26"-48" NPS, Class 600 RJ</i>
<i>AC-036486</i>	<i>Lap Joint Flanges, 26"-48" NPS, Class 300 RJ</i>
<i>AE-036438</i>	<i>Lap Joint Flanges, 54"-60" NPS, Class 300 RJ</i>
<i>AC-036443</i>	<i>Lap Joint Flanges, 26"-48" NPS, Class 600 RJ</i>
<i>AA-036792</i>	<i>Swivel Ring Flanges, 8"-48" NPS, Class 300-1500 RJ</i>
<i>AD-036696</i>	<i>API Blind Flanges, 54"-60" NPS, Class 75 RF</i>
<i>AD-036631</i>	<i>Spectacle Pl. Bld/Spacer, Class 125 FF</i>
<i>AD-036633</i>	<i>Spectacle Pl. Bld/Spacer, Class 150 RF</i>
<i>AD-036634</i>	<i>Spectacle Plates, Blind Spacers, Class 6000 Oct. RJ</i>
<i>AD-036731</i>	<i>Spectacle Pl. Bld/Spacer for Class 250 and 300 RF</i>
<i>AD-036636</i>	<i>Spectacle Pl. Bld/Spacer for Class 600 RF</i>
<i>AD-036734</i>	<i>Spectacle Pl. Bld/Spacer for Class 600 RJ</i>
<i>AD-036735</i>	<i>Spectacle Pl. Bld/Spacer for Class 900 RJ</i>
<i>AD-036736</i>	<i>Spectacle Pl. Bld/Spacer for Class 1500 RJ</i>
<i>AD-036630</i>	<i>Installation of Jack Screws for Flanged Joints</i>

3.2 Industry Codes and Standards

American Petroleum Institute

<i>API SPEC 6A</i>	<i>Specification for Wellhead and Christmas Tree Equipment</i>
<i>API STD 610</i>	<i>Centrifugal Pumps for Petroleum, Heavy Duty Chemical, and Gas Industry</i>

American Society of Mechanical Engineers

<i>ASME B16.1</i>	<i>Cast Iron Pipe Flanges and Flanged Fittings</i>
<i>ASME B16.5</i>	<i>Pipe Flanges and Flanged Fittings</i>
<i>ASME B16.20</i>	<i>Ring Joint Gaskets and Grooves for Steel Pipe Flanges</i>
<i>ASME B16.21</i>	<i>Nonmetallic Flat Gaskets for Pipe Flanges</i>
<i>ASME B16.25</i>	<i>Buttwelding Ends</i>
<i>ASME B16.47</i>	<i>Large Diameter Flanges</i>
<i>ASME B31.3</i>	<i>Process Piping</i>
<i>ASME B31.4</i>	<i>Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols</i>
<i>ASME B31.8</i>	<i>Gas Transmission and Distribution Piping Systems</i>
<i>ASME B46.1</i>	<i>Surface Texture</i>
<i>ASME SEC VIII D1</i>	<i>Boiler and Pressure Vessel Code</i>

American Society for Testing and Materials

<i>ASTM A126</i>	<i>Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings</i>
<i>ASTM A193</i>	<i>Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service</i>
<i>ASTM A194</i>	<i>Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service</i>
<i>ASTM A307</i>	<i>Standard Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength</i>

<i>ASTM A320</i>	<i>Standard Specification for Alloy Steel Bolting Materials for Low-Temperature Service for Pressure and High-Temperature Parts</i>
<i>ASTM A563</i>	<i>Standard Specification for Carbon and Alloy Steel Nuts</i>
<i>ASTM A694</i>	<i>Standard Specification for Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service</i>
<i>ASTM D1418</i>	<i>Standard Practice for Rubber and Rubber Latexes - Nomenclature</i>

Manufacturers Standardization Society

<i>MSS SP-6</i>	<i>Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings</i>
<i>MSS SP-44</i>	<i>Steel Pipe Line Flanges</i>

4 General

- 4.1 Flanges are subject to the same limitations of size and material grades as required for pipe in SAES-L-136. Weld end flanges shall be compatible with the joining methods described in SAES-L-110, and with adjoining pipe and piping components.
 - 4.2 Unless otherwise permitted by the Chairman of the Piping Standards Committee in Consulting Services Department (CSD), the selection of flanges & accessories shall be limited to materials, sizes, ratings & types shown in the Saudi Aramco Materials System (SAMS).
 - 4.3 The suitability of flanges for service under significant bending and other external piping loads shall be confirmed by calculations when the design temperature exceeds 204°C and for all temperatures when the nominal size exceeds 24-inch.
 - 4.4 Use of components which requires special analysis or proof testing (e.g., ASME B31.3, paragraph 304.7.2) shall be subject to review and approval by the Chairman of the Piping Standards Committee in CSD.
 - 4.5 Shielding shall be installed over flanged joints where leakage might spray hazardous chemicals, such as acid or caustic.
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5 Flange Material Specifications

5.1 Threaded Flanges

Gray cast iron flanges shall be used only in Category D Fluid service per ASME B31.3. Dimensions shall be in accordance with ASME B16.1, material in accordance with ASTM A126 Class B.

5.2 Weld Neck Flanges

5.2.1 Requirements for materials in low and intermediate temperature services are covered in 02-SAMSS-011; for other applications, contact the Materials Engineering Unit of ME&CCD in CSD. Do not use old (SAMS) stock A105 and A694 weld neck flanges below 0°C.

5.2.2 Refer to Table A of this specification to select line class 150 to 1500 flange materials for general services (Normal Fluid Service and Category D Fluid Service per ASME B31.3) from minus 50 to 425°C.

5.2.3 Refer to Table A for API SPEC 6A Type 6B, 3000 psi rated, weld neck line pipe flanges, for use from minus 50°C to 345°C.

5.3 Swivel Ring and Lapped Joint Flanges

These flange assemblies are covered by ASME B16.5, and by Saudi Aramco Standard Drawings: AA-036792 for Swivel Ring, and AE-036438, AC-036443 and AC-036486 for Lapped Joint flanges.

5.4 Blind Flanges

5.4.1 For sizes up to 24 inch NPS, select any of the following:

- From minus 20°C to 425°C, A105N
- From minus 45°C to 400°C, A350 LF2
- From minus 45°C to 425°C, A516 Gr 65

5.4.2 For sizes 26 inch NPS and larger, refer to standard drawings.

5.4.3 API SPEC 6A Table 404.2 specifies 60K material (60 ksi SMYS, 85 ksi SMTS) for all blind flanges in services up to and including 10,000 psi.

Commentary Note:

API blind flanges are forged, they are not made from plate.

5.5 Stainless Steel and Non-ferrous Flanges

Specify low carbon (F304L or F316L) A182 stainless steel weld neck flanges to match pipe of the same composition. Specify UNS C61300 tin-stabilized for aluminum-bronze weld neck flanges. For other nonferrous and stainless steel alloy flange materials, contact the Materials Engineering Unit of ME&CCD in CSD.

5.6 Match flanges with pipe of unequal strength in accordance with ASME B16.5 and ASME B31 piping codes:

- a) F36 (grade B) flanges may be used with grade X52 pipe up to 12-inch NPS;
- b) F36 flanges may be used with X42 pipe, up to 24-inch NPS;
- c) F52 flanges may be used with grade X60 pipe;
- d) F60 flanges may be used with grades X65 and X70 pipe.

6 Flange Types

6.1 Weld neck flanges with tapered hub and welding end per ASME B16.25 shall be the primary selection for flanged joints in metallic piping systems of 2-inch NPS and larger.

6.2 Threaded flanges and threaded reducing flanges are subject to limitations of threaded joints described in SAES-L-110.

6.3 Socket weld flanges and socket weld reducing flanges are subject to limitations of socket welded joints in SAES-L-110.

6.4 Slip-on flanges shall be welded at the front and back of the hub, but not on the sealing face. Slip-on flanges and reducing slip-on flanges shall not be used in:

- Severe cyclic conditions (see ASME B31.3, paragraph 300.2),
- Design temperatures above 230°C,
- ASME B16.5 Class 400 or higher rating,
- Hydrogen services,
- Flange sizes larger than 24-inch, (unless stress calculations per ASME SEC VIII D1, Appendix 2, with thermal and other external piping loads considered, indicate that the slip-on flanged joint will not be over-stressed).

6.5 Lap-joint flanges shall not be used for severe cyclic conditions. Saudi Aramco limits lap-joint flanges to special applications to avoid welding dissimilar metals, and to facilitate underwater bolt hole alignment. The lapped flange and

stub-end shall comply with ASME SEC VIII D1, Appendix-2. See Standard Drawings AE-036438, AC-036443, and AC-036486 for sizes larger than 24-inch NPS.

- 6.6 Blind flanges shall be used as end closures on flanged ends and valves unless end caps are clearly indicated by design necessity.

Blind flanges shall not be drilled for connections such as drains, flushing, etc., unless a stress calculation per ASME SEC VIII D1, Appendix 2 shows that the flanges will not be over stressed.

- 6.7 Swivel ring flanges for underwater pipe tie-in shall be in accordance with Saudi Aramco Standard Drawing AA-036792 or, if proprietary, in accordance with ASME SEC VIII D1, Appendix 2.
- 6.8 The design of ball swivel flanges, that permit angular alignment of flange faces for use in underwater pipeline tie-in shall be subject to approval by the Chairman of Piping Standards Committee in CSD.
- 6.9 Isolating flanges shall comply with the mechanical requirements of this standard. They shall be installed as required in Cathodic Protection Standards for pipelines or for Stray Current Protection on loading lines.
- 6.10 Orifice flanges shall comply with the mechanical requirements of this standard and shall be installed as required in Saudi Aramco Instrumentation Standards.

7 Flange Dimensional Standards

- 7.1 Dimensional standards for flanges are normally specified as one of the following: ASME B16.5, ASME B16.47, API SPEC 6A Type 6B, MSS SP-44, or Saudi Aramco Standard Drawings (SASDs). Nominal sizes and ratings, e.g., 22-inch NPS Class 900, are described in SAMS Stock Descriptions. The dimensional standards listed below apply to metallic flanges and bolt hole patterns of nonmetallic companion flanges. Saudi Aramco limits the selection of flanges as follows:

- 7.1.1 ASME B16.1, Class 125 only, 1-inch through 24-inch NPS, for integral cast iron flanges and blind flanges.
- 7.1.2 ASME B16.5, Classes 150, 300, 600, 900, 1500 up to 24-inch and class 2500 up to 12 inch NPS. Class 400 carbon steel flanges for sizes smaller than 30-inch shall not be used. For sizes larger than 24-inch, use Saudi Aramco Standard Drawings (SASD's). If the sizes and ratings are not covered by SASD's, use ASME B16.47 Series A.

Dimensionally, ASME B16.47 Series A flanges are identical to MSS SP-44 flanges.

- 7.1.3 API SPEC 6A Type 6B rating 20.7 Mpa (3000 psi), 1½-inch through 10-inch NPS.
- 7.1.4 ASME B16.47 Series B (supersedes API 605), Class 75 only.
- 7.1.5 ASME B16.47 Series A for 26-inch through 60-inch NPS in class 150 through 900.
- 7.1.6 Nonferrous and stainless steel flanges shall be in accordance with dimensional requirements of ASME B16.5.
- 7.2 The Saudi Aramco Standard Drawings listed below are mandatory dimensional standards for the size range, rating, flange type, and facing as listed in Table 1.
- 7.3 Flanges not covered by the above drawings shall be designed in accordance with ASME SEC VIII D1, Appendix 2 and, for blind flanges, in accordance with ASME SEC VIII D1 Section UG-34.

8 Flange Facings

- 8.1 Flat face flanges, finished in accordance with MSS SP-6, with full face gaskets shall be used when one or both of the mating flanges in a joint is ASME B16.1, Class 125 gray cast iron, or aluminum, or plastic, or other material that could be over-stressed by bearing against a raised face.

Table 1

NPS Range	Class	Type	Facing	Standard Drawing
26 - 60	150	WN	RF	AD-036634
26 - 60	300	WN	RF	AD-036991
26 - 48	300	WN	RJ	AC-036484
54 - 60	300	WN	RJ	AC-036437
30 - 48	400	WN	RF	AD-036698
26 - 48	600	WN	RF	AD-036673
26 - 48	600	WN	RJ	AC-036442
26 - 48	300	Lap	RJ	AC-036486
54 - 60	300	Lap	RJ	AE-036438
26 - 48	600	Lap	RJ	AC-036443
8 - 48	300-1500	SwRng	RJ	AA-036792
54 - 60	75	Blind	RF	AD-036696

(WN: weld neck; RF: raised face ; RJ: ring joint)

- 8.2 Except for underwater service, raised face flanges in ratings up to Class 600 shall be used at design temperatures from minus 50 to 425°C. Smooth machine finish 3.2 to 6.4 micrometers Ra (ASME B46.1) shall be specified for use with spiral wound gaskets. For hydrogen service, flange facing finish shall not exceed 3.2 Ra.
- 8.3 Ring joint flanges for use with ring joint gaskets per ASME B16.20 shall be used for:
- Flanges in Class 900 and higher ratings,
 - Underwater pipelines in Class 300 and higher ratings,
 - Design temperatures in excess of 480°C,
 - API SPEC 6A Type 6B flanges.
- 8.4 The assembly of raised face to ring joint companion flanges is permissible only in exceptional cases with certain gaskets when approved by the Chairman of Piping Standards Committee in CSD.
- 8.5 Tongue-and-groove facing or male-and-female facing joints shall not be used, except in special cases when it is necessary to match existing equipment.
- 8.6 Flanged connections in lined piping systems containing flammable fluids shall be properly designed and assembled to prevent leakage:
- when the softening point of the lining is less than 375°C,
 - when exposure to temperatures that are likely to damage lining material lapped over the flange faces.

This requirement also applies to firewater lines which may be exposed to fire while pressurized under no-flow conditions.

9 Bore of Welding Neck Flanges

- 9.1 For pipe of minimum wall thickness, the bore of welding neck flanges shall not be larger than the inside diameter (I.D.) of the attached pipe, and within ASME B16.25 tolerances. When the flange bore is less than the pipe I.D., the welding neck shall be taper-bored on the I.D. to match the pipe wall, per ASME B16.5.
- 9.2 Except as stated in paragraph 9.3, the design thickness of the flange hub at the welding end of flanges with a specified minimum yield strength (SMYS) less than that of the attached pipe (see ASME B16.5 Figure 14) shall be at least equal to the pipe wall thickness multiplied by the ratio, pipe-to-flange, of the SMYS. The SMYS ratio must be from 1.0 to 1.5 for this criterion to hold.
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- 9.3 The bore of welding neck flanges of lower SMYS may be equal to the I.D. of attached pipe of higher SMYS, if calculations per ASME SEC VIII D1, Appendix 2, based on full rated pressure or the pipe MAOP (whichever is lower), show that the flanged joint will not be over-stressed.
- 9.4 The maximum allowable bores for flanges shown on Saudi Aramco Standard Drawings and in API SPEC 6A for 42 ksi and 45 ksi SMYS respectively, have been determined based on full rated pressures. Bores on these flanges can be enlarged only with the approval of the Chairman of Piping Standards Committee in CSD.

10 Blinds

- 10.1 The piping design shall include provision for spectacle plates or blanks and spacers at flanged joints as required for pressure testing, for blinding off during repairs or inspection, for positive product segregation, or for other operating reasons. Blinds shall be located to minimize fluid loss during closing.
- 10.2 All blinds, including temporary blanks for protection during repairs or hydrotest, shall meet the requirements of ASME B31.3, paragraph 304.5.3. Slip blinds of less-than-code thickness may be used for protection during welding only if the piping on both sides of the blind is de-pressurized and vented. Saudi Aramco Standard Drawings for blinds are shown in Table 2.
- 10.3 Jackscrews in accordance with Saudi Aramco Standard Drawing AD-036630 or similar Saudi Aramco approved design shall be used to facilitate flange separation for maintenance. Joint assemblies which often require frequent separation include orifice plates, spectacle plates, spacers, screens, and drop-out spools. Piping layout shall be designed such that flanges can be separated without excessive force. Jackscrews shall be installed to be accessible from both sides of the pipe. For orifice flanges, jackscrews shall be installed at 3 and 9 o'clock positions. When flange separators are used, jackscrews are not required.

Table 2

NPS Range	Class	Facing	Standard Drawing
2 - 48	125	FF	AD-036631
2 - 48	150	RF	AD-036633
54 - 60	250, 300	RF	AD-036731
2 - 48	250, 300	RF	AD-036731
2 - 48	600	RF	AD-036636
2 - 30	600	RJ	AD-036734
2 - 24	900	RJ	AD-036735
2 - 24	1500	RJ	AD-036736

11 Gaskets

- 11.1 Gaskets shall be suitable for the intended service and compatible with the flange facing, the strength of the flange, and bolting. Not more than one gasket shall be used between mating surfaces.
- 11.2 Octagonal, pressure energized Type R, low carbon steel ring joint gaskets per API SPEC 6A shall be used with API SPEC 6A Type 6B flanges. Type BX gaskets per API SPEC 6A shall be used with Type 6BX flanges.
- 11.3 Gasket selection shall be in accordance with ASME B31.3 and the following:
- 11.3.1 Spiral wound type 316 stainless steel winding, flexible graphite filled, with carbon steel guide ring, per ASME B16.20, for raised face flanges in most services, including steam and process hydrocarbons.
- In oxidizing environments, the maximum temperature is limited to 454°C. Gaskets operating in temperatures below minus 45°C, the guide ring shall be type 304 stainless steel material. Filler materials that deteriorate at elevated temperatures, e.g., Teflon, shall not be used in hydrocarbon services.
- 11.3.2 For Class 125 and 150 flat face flanges in non-hazardous services up to a maximum temperature of 230°C, use compressed synthetic fiber with oil resistant binder, 1.6mm thick per ASME B16.21. Example: Lube oil piping per API STD 610.
- 11.3.3 For plastic flanges, use full face gaskets of elastomeric material 3 mm thick with Shore A Durometer hardness between 50 and 60. For wet chlorine service and hypochlorite services, the elastomer shall be ASTM D1418 class CSM.
- 11.3.4 Full face synthetic rubber gasket, ASTM D1418 Class CSM on flat face flanges, may be used for most acid services up to 70% concentration and to 65°C. For sulfuric acid above 70 percent concentration (including oleum), and nitric acid (all concentrations), use full face ASTM D1418 class FKM elastomer on flat face flanges. When raised face flanges are to be used, the flange finish shall be 3.2 to 6.4 micrometers Ra, and the gaskets shall be PTFE-filled spiral wound Alloy 20 stainless steel with stainless steel inner ring. Applications involving other acids must be approved by the Chairman of Piping Standards Committee in CSD.
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- 11.3.5 For ASME B16.5, ASME B16.47 Series A, or MSS SP-44 or Saudi Aramco standard flanges with ring joint facing, use soft iron, octagonal ring joint gaskets in accordance with ASME B16.20.
- 11.4 Untreated water services, such as seawater, raw water, Wasia water, etc., use spiral wound gaskets or octagonal soft iron ring joint gaskets. The use of proprietary gaskets such as PIKOTEK or approved equal must be concurred by the Operating Department. The PIKOTEK gaskets are with Teflon sealed, glass reinforced epoxy laminated to 316 stainless steel core. For low pressure services, the stainless steel laminate is not required.

By using the PIKOTEK gaskets, the pressure rating of the flanged joints may be increased subject to review and approval by the Chairman of Piping Standards Committee in Consulting Services Department.

Commentary Note:

For example, in certain piping systems with a MAOP of 3000 psi, Class 900 lb flanges in combination with Pikotek gaskets may be used in place of Class 1500 lb flanges with ring joint gaskets. Contact the Piping Standards Committee Chairman for additional details.

- 11.5 The PIKOTEK gaskets, or approved equal, with isolating sleeves and washers shall be used for isolating dissimilar metal flanged joints (i.e., electrical isolation), and insulating joints for cathodic protection. Proprietary approved equal gaskets shall be submitted to the Chairman of Piping Standards Committee in CSD for approval.
- 11.6 When spiral wound gaskets are used, the gasket contact area of the flange shall not be coated to ensure proper contact surface for sealing purpose.

12 Bolting

Bolting For flanged joints shall be selected in accordance with ASME B16.5 and ASME B16.47.

- 12.1 Materials for process and general services shall be ASTM A193 Grade B7 stud bolts with ASTM A194 Grade 2H nuts for service temperatures from minus 20 to plus 450°C.
- 12.2 Materials for low temperature services shall be as follows:
- 12.2.1 Stud bolts conforming to ASTM A320 Grade L7 with nuts to ASTM A194 Grade 4 or 7 shall be used for bolt service temperatures from minus 18 to minus 101°C.

- 12.2.2 ASTM A320 Grade L7M studs and A320 Grade 7M nuts may be used for low temperature services from minus 18 to minus 73°C.
 - 12.2.3 Under certain circumstances, with approval by the Chairman of Piping Standards Committee in CSD, ASTM A193 Grade B7 bolts with A194 Grade 2H nuts may be used at bolt service temperatures as low as minus 30°C, and A193 Grade B7 bolts with A194 Grade 7M nuts may be used at minus 45°C.
 - 12.3 Materials for upper intermediate temperature services shall be as follows:
 - 12.3.1 ASTM A193 Grade B7 or B7M studs with A194 Grade 7 or 7M nuts for services up to 450°C.
 - 12.3.2 ASTM A193 Grade B16 stud bolts with A194 Grade 7 nuts, for bolt service temperatures from 450 to 510°C. For higher temperatures, contact the Materials Engineering Unit in CSD.
 - 12.4 Materials for sour services shall be as follows:
 - 12.4.1 Standard quenched and tempered ASTM A193 Grade B7 stud bolts with 2H nuts shall be used for sour wet services when the bolting is (a) not directly exposed to hydrogen sulfide, (b) not buried or insulated, (c) not equipped with flange protectors, or not deprived of direct atmospheric exposure. ASTM A320 Grade L7 stud bolts with Grade 4 or 7 nuts can be used under the same conditions.
 - 12.4.2 Stud bolts conforming to ASTM A193 grade B7M with nuts to A194 Grade 2HM shall be used under conditions of (a) direct exposure to sour environments or when the bolting will be (b) buried or insulated, or (c) equipped with flange protectors, or otherwise deprived of direct atmospheric exposure. ASTM A320 Grade L7M bolts and Grade 7M nuts can be used under the same conditions.
 - 12.4.3 Steel machine bolts conforming to ASTM A307 Grade B may be used on flat-faced cast-iron or non-metallic flanges in non-sour environment; nuts shall conform to ASTM A563 Grade D. This bolt/nut combination may be used in sour services when the Grade D nuts are not resulfurized, and the flange materials are deemed suitable by the Materials Engineering Unit of ME&CCD in CSD. Such bolting may be zinc coated or preferably zinc-aluminum (Galvalum) coated.
 - 12.5 For fluid temperatures below minus 45°C, the selection of bolting material or the bolting design shall include consideration of differential contraction between flanges and bolts such that changes in gasket seating pressure will not result in
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leakage. Similarly, differential expansion shall be considered at operating temperatures above 300°C.

12.6 Washers

12.6.1 Flat washers under the nuts are required for special cases only, such as on insulating flanges and under the nuts bearing against plastic flanges.

12.6.2 Belleville washers may be required for severe cyclic service, and bolt service temperatures above 450°C. Review by the Chairman of Piping Standards Committee in CSD is required.

Revision Summary

5 February 2006

Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with no other changes.

Table 3 - Recommended Weld Neck Flange Materials for General Services ⁽¹⁾

Specification (2)	ASME B16.5 Mat'l	SAMSS Mat'l Code	Design Temperature	Nominal Size Inch				
				CL 150	CL 300	CL 600	CL 900	CL 1500
ASME Gr B/F36 - 36 KSI SMYS Normalized	Group (8)	ASME P No.		CL 150	CL 300	CL 600	CL 900	CL 1500
ASTM A105 N Standard Quality	1.1	A P1 GR1	-20 to 425°C	2 - 24	2 - 24	2 - 12	NA	NA
ASTM A105 N (STD) Limited Service (3)	1.1	*A P1 GR1	-20 to 425°C	NA	NA	14 - 24	2 - 12	2 - 12
ASTM A350 LF2 N Standard Quality	1.1	B P1 GR2	-30 to 400°C	2 - 24	2 - 24	2 - 24	2 - 12	2 - 12
ASTM A350 LF2 N LO TEMP Quality	1.1	C P1 GR2	-45 to 345°C	2 - 24	2 - 24	2 - 24	NA	NA
ASTM A266 CL2 S2 S9 N Standard Quality	1.1	D P1 GR2	-20 to 425°C	26 - 60	26 - 36	14 - 24	14 - 18	NA
ASTM A266 CL4 S2 S9 S13 N Standard Quality	1.1	E P1 GR2	-30 to 400°C	26 - 60	26 - 60	26 - 48	14 - 36	14 - 24
ASME F42 - 42 KSI SMYS Normalized				CL 150	CL 300	CL 600	CL 900	CL 1500
ASTM A707 L3 CL1 N Standard Quality	1.7	F P1 GR3	-30 to 375°C	26 - 60	26 - 60	14 - 60	NR	NR
DIN 17103 TStE355 N Standard Quality	1.7	H P1 GR3	-30 to 400°C	26 - 60	26 - 48	NR	NR	NR
ASME F52 - 52 KSI SYMS Normalized				CL 150	CL 300	CL 600	CL 900	CL 1500
ASTM A350 LF6 CL1 N (STD) LO TEMP Quality (4)	1.7	G P1 GR3	-30 to 375°C -50 to 375°C	2 - 24	2 - 24	2 - 12	NR	NR
DIN 17103 TStE355 N (STD) LO TEMP Quality (4)	1.7	H P1 GR3	-30 to 400°C -50 to 400°C	2 - 24	2 - 24	2 - 12	NR	NR
ASME F52 - 52 KSI SMYS Quenched & Tempered	Group (8)	ASME P No		CL 150	CL 300	CL 600	CL 900	CL 1500
ASTM A707 L3 CL3 QT (STD) LO TEMP Quality (4)	1.7	J P1 GR3	-30 to 375°C -45 to 375°C	NR	NR	38 - 48	NR	NR
API 52K - 52 KSI SMYS (5) Normalized				-	-	-	API 3000 psi	-
ASTM A350 LF6 CL1 N (LT) (4) API SPEC 6A Type 6B	API SPEC 6A Appendix G	G P1 GR3	-50 to 120°C	NA	NA	NA	2&1/16 -11 in. (2 - 10)	NA
DIN 17103 TStE355 N (LT) (4) API SPEC 6A Type 6B	API SPEC 6A Appendix G	H P1 GR3	-50 to 120°C	NA	NA	NA	2&1/16 -11 in. (2 - 10)	NA
ASME F60 - 60 KSI SMYS Quenched & Tempered				CL 150	CL 300	CL 600	CL 900	CL 1500
DIN 17103 TStE355 QT (STD) LO TEMP Quality (4)	1.7	*H (1) P1 GR3	-30 to 400°C -45 to 400°C	26 - 36	26 - 36	14 - 24	2 - 18	NA
ASTM A707 L3 CL3 QT (STD) LO TEMP Quality (4)	1.7	J P1 GR3	-30 to 375°C -45 to 375°C	26 - 60	26 - 48	14 - 36	2 - 24	2 - 12
ASTM A707 L5 CL3 QT (STD) LO TEMP Quality (4)	1.7	K P1 GR3	-30 to 345°C -50 to 345°C	NA	50 - 60	38 - 60	26 - 48	14 - 30

Table 3 - Recommended Weld Neck Flange Materials for General Services ⁽¹⁾ (cont'd)

Notes:

- 1) From 02-SAMSS-011 Table 1; except material Code *H has been added to denote quenched and tempered condition in SAMSS Code H. Select other flanges from 02-SAMSS-011 or contact CSD.
- 2) All 02-SAMSS-011 materials may be used in SAES-A-301 wet sour service. Unless otherwise specified, manufacturers may substitute materials within limits described in 02-SAMSS-011 Section 2, paragraph 5.
- 3) In sizes indicated, ASTM A105N SAMSS Code *A material is permitted ONLY in non-hydrocarbon or flare service; this limitation does not apply to material Code D.
- 4) Obtain LO TEMP quality in F52 and stonger flanges by transverse impact testing and meeting other requirements in 02-SAMSS-011.
- 5) Standard API SPEC 6A Type 6B 45K weld neck flange material is specified at 45 ksi SMYS and 70 ksi SMYS. SAMSS/API 52 K materials, Codes G and H Class 1, meet or exceed API SPEC 6A requirements in all respects. These flanges are API Materials Class EE, meaning suitable for wet sour service per SAES-A-301 and that sealing surfaces may be overlaid with stainless alloy (usually Inconel 625) if found necessary, for example, as a maintenance requirement.
- 6) API temperature rating, U, is shown in API SPEC 6A Section 300 as minus 20 to 120°C. However, because SAMSS/API 52K material is impact tested at minus 50°C, the range of temperatures where full 3000 psi rating applies is extended down to minus 50°C. SAMSS/API 52K flanges can be used up to 345°C; see API SPEC 6A, Appendix G, for pressure ratings at elevated temperatures. Standard 45K API SPEC 6A 3000 psi flanges are bore-limited to ensure minimum of schedule 80 for API sizes thru 7-1/6 inch (6 NPS), and schedule 100 for sizes 9 and 11 inch (8 and 10 NPS); SAMSS/API 52K flanges are stronger; 9 and 11 inch sizes may be over-bored to schedule 80. API SPEC 6A Product Specification Level for SAMSS/API 52K flanges is at least PSL1. API flanges use only ring type gaskets.
- 7) NA = not applicable; NR = not recommended; STD = standard quality; LT = LO TEMP quality.
- 8) ASME/ANSI ratings are only valid at temperatures shown above.
- 9) ASTM A694, residual stock material F42 thru F60, may be used as shown for DIN 17103 TStE355, SAMSS Code H and *H.