



Engineering Standard

SAES-L-108

21 December 2005

Selection of Valves

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Saudi Aramco DeskTop Standards

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1 Scope

- 1.1 This Standard covers limitations on the selection of all valves normally classified under Saudi Aramco Materials System (SAMS) Class 04. This will normally include ball, butterfly, check, choke, diaphragm, gate, globe, needle, and plug valves used for on-off, for manual control service or for prevention of reverse flow, as appropriate.
- 1.2 Specifically excluded from the scope are:
- a) Control, safety-relief, relief, surge relief, solenoid, pilot and other valves classified under SAMS Class 34.
 - b) Applications involving flues and chimneys, air conditioning and ventilation ducts.
 - c) Drilling and wellhead valves classified under SAMS Class 45.
- 1.3 Where applicable, this Standard supplements the requirements of ASME B31, Code for Pressure Piping.

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 below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

[SAEP-302](#)

*Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

Saudi Aramco Engineering Standards

<u>SAES-A-301</u>	<i>Materials Resistant to Sulfide Stress Corrosion Cracking</i>
<u>SAES-L-102</u>	<i>Regulated Vendor List for Valves</i>
<u>SAES-L-110</u>	<i>Limitations on Pipe Joints and Components</i>
<u>SAES-L-133</u>	<i>Corrosion Protection Requirements for Pipelines/Piping</i>
<u>SAES-L-136</u>	<i>Pipe Selection and Restriction</i>

Saudi Aramco Materials System Specifications

<u>04-SAMSS-001</u>	<i>Gate Valves</i>
<u>04-SAMSS-002</u>	<i>Globe Valves</i>
<u>04-SAMSS-003</u>	<i>Additional Requirements for Low Temperature Valves</i>
<u>04-SAMSS-005</u>	<i>Swing Check Valves</i>
<u>04-SAMSS-035</u>	<i>General Requirements for Valves</i>
<u>04-SAMSS-041</u>	<i>Expanding Plug Valve</i>
<u>04-SAMSS-042</u>	<i>4-Way Diverter Valves</i>
<u>04-SAMSS-048</u>	<i>Valve Inspection and Testing Requirements</i>
<u>04-SAMSS-049</u>	<i>Inspection & Testing Requirements for API SPEC 6A 10,000 psi Valves</i>
<u>04-SAMSS-050</u>	<i>Thru-conduit Gate Valves</i>
<u>04-SAMSS-051</u>	<i>API SPED 6D Ball Valves</i>
<u>04-SAMSS-052</u>	<i>API SPEC 6A Ball Valves</i>

Saudi Aramco Form and Data Sheet

<i>6233-1-ENG</i>	<i>Valve Data Sheet</i>
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3.2 Industry Codes and Standards

American National Standards Institute/Fluid Controls Institute

<i>ANSI/FCI 70.2</i>	<i>Control Valve Seat Leakage</i>
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American Petroleum Institute

<i>API SPEC 6A</i>	<i>Specification for Wellhead and Christmas Tree Equipment</i>
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<i>API SPEC 6D</i>	<i>Specification for Pipeline Valves</i>
<i>API SPEC 6FA</i>	<i>Specification for Fire Test for Valves</i>
<i>API STD 598</i>	<i>Valve Inspection and Testing</i>
<i>API STD 602</i>	<i>Compact Steel Gate Valves - Flanged, Threaded, Welding, and Extended-Body Ends</i>
<i>API STD 607</i>	<i>Fire Test for Soft Seated Quarter-Turn Valves</i>
<i>API STD 609</i>	<i>Butterfly Valves, Lug-Type and Wafer-Type</i>

American Society of Mechanical Engineers

<i>ASME B16.5</i>	<i>Steel Pipe Flanges and Flanged Fittings</i>
<i>ASME B16.34</i>	<i>Valves - Flanged, Threaded, and Welding End</i>
<i>ASME B31</i>	<i>Code for Pressure Piping</i>

British Standards Institution

<i>BS 6755</i>	<i>Testing of Valves</i>
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Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

<i>MSS SP-45</i>	<i>Bypass and Drain Connection Standard</i>
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National Association of Corrosion Engineers

4 General

- 4.1 Valves shall be purchased from approved manufacturers listed in [SAES-L-102](#). Approval of purchase from manufacturers not listed in this document shall be strictly governed by the provisions provided therein.
 - 4.2 The selection of valves shall normally be limited to the materials, types and sizes that are listed in SAMS Class 04 unless no suitable valve is listed.
 - 4.3 Whenever applicable, the relevant Saudi Aramco Material System Specifications (SAMSS's) listed in Section 3 of this Standard shall be included in all requisitions.
 - 4.4 At times it is necessary to purchase a valve that is generally similar to that covered by an SAMSS but differing from it in some specific design, construction, materials or performance characteristics. In such cases, the SAMSS shall be included in the purchase requisition in addition to the required modifications provided that these modifications are in accordance with all other Mandatory Saudi Aramco Engineering Requirements.
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- 4.5 All valve requisitions, except those for API SPEC 6A 10000 psi valves 2-1/16 inch and larger, shall reference [04-SAMSS-035](#), General Requirements for Valves, and [04-SAMSS-048](#), Valve Inspection & Testing Requirements.
- 4.6 Form 6233-1-ENG, Valve Data Sheet, shall be filled out and attached to every non-SAMS class 04 valve purchase requisition.
- 4.7 Field Tests
 - 4.7.1 Testing location shall be specified by proponent.
 - 4.7.2 If requested by the proponent, all new valves designated for isolation service (as specified by the Proponent) shall be subjected to a high pressure hydrostatic seat test prior to installation in the line.
 - 4.7.3 A low pressure pneumatic seat test at 35 kPa (5 psig) shall be substituted for the high pressure hydrostatic seat test for flare system valves.
 - 4.7.4 Buttweld and socketweld end valves in nominal pipe size (NPS) 2 inches and smaller are exempt from the above field testing requirements.
 - 4.7.5 Test procedures, pressures, durations, and leakage acceptance criteria shall be equal to those that the valves were originally purchased to. All resilient (soft) seated isolation valves shall have zero leakage.
- 4.8 The use of ANSI FCI 70.2 to specify seat leakage criteria is not permitted without the specific approval of the Chairman of the Valves Standards Committee.
- 4.9 Trim material includes the stem, the body and closure seating surfaces, bushings, pins, springs, guides, and any other small parts in contact with the service fluid.

5 General Design Limitations

- 5.1 Bonnet/Cover
 - 5.1.1 Pressure seal bonnet valves shall be used only in steam or other clean non-corrosive services. They are permitted in other services only if the body has been inlaid in the bonnet sealing area with an 18-8 material or higher alloy suitable for the service.
 - 5.1.2 Bonnets retained by split rings and sealed by means of an O-ring or a seal-welded membrane shall only be used after approval by the
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Chairman of the Valves Standards Committee.

- 5.1.3 The use of welded bonnet valves in hydrocarbon services shall be limited to NPS 4 inch and smaller provided it is approved by the Manager of the responsible operating department.
- 5.1.4 Screwed bonnet and screwed body valves shall not be used in any hydrocarbon or hazardous material services unless the bonnets and body end connections are tack welded to the body or provided with locking pin.
- 5.1.5 Straight-thru union body check valves shall be used only in portions of piping systems where pipe unions are permissible.
- 5.1.6 Union bonnet valves shall not be used in any hydrocarbon or hazardous material services.

5.2 End Connections

- 5.2.1 The requirements of [SAES-L-110](#) are applicable to all valves.
- 5.2.2 Integral flanged valve bodies with tapped bolt holes shall not be used except with specific approval of the Proponent and the Chairman of the Valves Standards Committee. These requirements do not apply to lug type valves.
- 5.2.3 If requested by the proponent, critical valves, welding end valves, and others that cannot be removed from the line without serious difficulty (e.g. in restrained pipelines), NPS 8 inch and larger, shall be of a type that is repairable in the line (top-entry) provided it is specifically approved by the Chairman of the Valves Standards Committee.

5.3 Ratings

- 5.3.1 Valves utilizing soft seats do not necessarily follow ASME B16.5 or other industry standard pressure/temperature relationships at temperatures above 38°C. The specific Vendor's literature shall be consulted when the pressure-temperature ratings for higher temperatures have not been specified by the relevant SAMSS or the Purchase Order.
- 5.3.2 In hydrocarbon services, the minimum body rating of threaded and socketweld end NPS 2 inch and smaller valves shall be equivalent to API STD 602 Class 800.

5.4 Sizes

Valves shall be subject to the same size limitations specified for pipe in [SAES-L-136](#).

5.5 Stem Packing

Isolation valves NPS 3 inch and larger in hydrocarbon services shall not be provided with pure polymer/elastomer stem packing or stem seals unless the valves have been qualified as fire-safe, except as permitted by an approved SAMSS.

5.6 Actuators

5.6.1 The need for power actuation of all valves NPS 12 inch and larger in all pressure classes shall be reviewed with the responsible operating organization.

5.6.2 Chainwheel operation shall not be provided for emergency isolation valves or valves having a threaded body connection.

5.7 Installation

5.7.1 Gate valves with back-seats shall not be installed with their stems below the horizontal except in the following cases: (a) clean services, (b) when they function as isolation valves in pressure relief and flare system piping, and (c) when in utility or other similar non-critical services (firewater is considered to be critical service).

Note: *Critical / non-critical valves shall be specified by proponent and specifically approved by the Chairman of the Valves Standards Committee.*

5.7.2 Seal welding

5.7.2.1 All threaded connections on valve bodies and associated piping shall be seal welded.

Exceptions:

Exceptions are those connections that are frequently disassembled (such as vent and drain plugs) and those that are adjacent to elements that contain small moving parts (such as injection fittings and body relief valves).

5.7.2.2 Seal welding shall follow the general requirements of [SAES-L-110](#).

5.8 Coating

The body of steel gate valve shall not be internally coated unless the wedge is rubber-lined.

6 Specific Valve Type Limitations

6.1 Ball Valves

Lever operated ball valves shall be equipped with a handwheel or self-locking handle to prevent accidental operation.

6.2 Butterfly Valves

6.2.1 Concentric butterfly valves, such as the API STD 609 Category A type (typically with internal rubber linings), are permitted only in non-hydrocarbon applications.

6.2.2 The use of high performance butterfly valves in hydrocarbon service shall be limited to a maximum rating of Class 900. Minimum requirements in hydrocarbon service are as follows:

- a) Valves shall be designed in accordance with API STD 609 Category B valves with offset-seat type construction.
- b) Valves shall be qualified fire-safe to either API SPEC 6FA, API STD 607, or BS 6755 Part 2, except in applications where other components of the system are not designed to be firesafe such as Single-Point-Mooring (SPM) systems.
- c) The body shall be of the lug-type design with tapped bolt holes, unless the (double) flanged type has been specified. Use of the wafer-type body is not permitted.
- d) Valves shall be full-rated. In systems where the normal operating pressure is 103 kPa (15 psig) or less, the valve may be specified with half-rated trim (approximately 50% of the full-rated pressure).
- e) Valves shall be bi-directional, although they may have a "preferred" direction. Valves shall be installed in the "preferred" direction indicated on the valve.

6.3 Check Valves

6.3.1 Dual and single plate wafer check and swing check valves shall not be used in reciprocating pump and compressor suction and discharge services or similar pulsating services.

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- 6.3.2 A non-slam internal-spring-assisted type check valve shall be installed at the discharge of pumps and compressors. Other check valve types shall be specifically approved by the Chairman of the Valves Standards Committee.
 - 6.3.3 If requested by the proponent, for parallel pump systems with individual pump discharge piping of NPS 20 inch and larger, a hydraulic analysis shall be conducted to verify that the selected check valves have the correct dynamic response to prevent slamming and limit pressure surge to an acceptable level. The analysis shall include consideration of the "worst case" operating mode scenario.
 - 6.3.4 For all sizes NPS 4 inch and above, a turbulence-free minimum distance of 5 pipe diameters upstream and 2 pipe diameters downstream of every check valve shall be maintained. No pipe fittings such as elbows, reducers, tees, etc., or flow restricting devices such as orifices, control valves, etc., shall be installed in these zones unless specifically approved by the Chairman of the Valves Standards Committee. Valves in intermittent service and valves in skid-mounted systems are exempt from these requirements.
 - 6.3.5 Check valves in sizes NPS 3 inch and above shall not be installed in vertical lines, unless specifically approved by the Chairman of the Valve Standards Committee. Valves in skid-mounted systems are exempt from this requirement.
 - 6.3.6 Check valves in hydrocarbon service up to Class 600 shall either have a lug-type body with tapped bolt holes or a flanged body. In higher ratings, a flanged body is mandatory. Wafer-type bodies are not permitted in any hydrocarbon service.
 - 6.3.7 Spring-assisted non-slam piston check valves (also referred to as nozzle check valves) shall be long-pattern with face-to-face dimensions in accordance with API SPEC 6D. Short-pattern valves shall not be used without the review and approval of the Chairman of the Valves Standards Committee.

6.4 Plug Valves (Hydrocarbon service only)

Flanged plug valves in hydrocarbon service shall be of the inverted lubricated pressure balanced design, except that Class 150 valves NPS 6 inch and smaller may have a standard plug with springs for balancing the plug.

7 Specific Service Limitations

7.1 Low Temperature Services

- 7.1.1 Valves in services between -45°C and -18°C shall meet the requirements of [04-SAMSS-003](#). If the service is also sour, compliance with [SAES-A-301](#) shall be specifically stated in the purchase requisition.
- 7.1.2 All valves in services below -45°C shall be full austenitic stainless steel and shall meet the requirements of [04-SAMSS-003](#), paragraph 6.3.
- 7.1.3 All valves in service below -100°C shall have an extended bonnet.
- 7.1.4 For LPG or high pressure gases which autorefrigerate, an upstream gate valve shall be installed in addition to the throttling valve in any line that discharges to the atmosphere or to a low pressure system.

7.2 Underwater Valves

Isolation valves shall be ball type per [04-SAMSS-051](#) with a minimum rating of Class 300. The flange face shall be the ring joint type.

7.3 Pressure Relief Valve Piping

Isolation valves in stand-alone pressure relief valve inlet and discharge piping shall be gate, ball, high performance butterfly (flanged) or plug valves that can be car-sealed open. A gate valve in this service shall be installed with the stem in or below the horizontal position. For clean gas service, the valves shall be soft seated with double block and bleed capability if temperature permits.

7.4 Flare Systems

- 7.4.1 Isolation valves in flare system piping shall be gate, ball, high performance butterfly or plug valves.
- 7.4.2 A gate valve in this service shall be installed with the stem in or below the horizontal position.

7.5 Emergency Isolation Valves

Emergency isolation valves (EIVs) shall be gate, ball, high performance butterfly (flanged) or plug valves. Soft seated valves shall be fire safe in accordance with API STD 607, API SPEC 6FA, or BS 6755 Part 2. Metal seated valves shall meet the same requirement if they do not have graphite seals or their standard specified leakage rate exceeds that of API STD 598.

7.6 Firewater Systems

Buried sectionalizing valves in firewater systems shall meet the requirements of SAES-B-017.

7.7 Drains and Vents

Atmospheric drain and vent valves shall be provided with a plug or blind on the discharge side.

7.8 Storage Tanks and Vessels

Flangeless valves shall not be used as the first block valve against storage tanks or vessels containing hazardous materials unless specifically approved by the Chairman of the Valves Standards Committee.

7.9 API SPEC 6A 10,000 psi services

7.9.1 Valves shall only be purchased from manufacturers approved in accordance with [SAES-L-102](#).

7.9.2 Valves shall be tested and inspected in accordance with [04-SAMSS-049](#).

7.10 Scraper Trap Valves

7.10.1 Scraper trap mainline isolation valves shall be full bore thru-conduit gate or ball valves.

7.10.2 Drain valves shall be inverted pressure balanced lubricated plug valves with Stellite hardfacing on the plug and body seating surfaces.

7.10.3 Kicker valves and vent valves shall be inverted pressure balanced lubricated plug valves.

7.10.4 The scraper trap isolation valve and the kicker valve shall have a minimum trim metallurgy of SS F 51 regardless of service. In addition, the valve seat pockets (applicable to spring loaded seats only) shall be specified to have an Inconel 625 weld overlay. The requirements of this paragraph override the materials requirements listed in the Appendix, unless those are more stringent.

7.11 Instrumentation root isolation valves

7.11.1 Instrumentation root isolation valves shall be API STD 602 gate valves. Approval of equivalents shall be referred to the Chairman of the Valves Standards Committee.

7.11.2 Modular valve assemblies consisting of a root isolation valve together with bleed/vent and other types of valves and instruments are permitted subject to specific review and approval by the Chairman of the Valves Standards Committee on a case-by-case basis.

7.12 Steam service

Isolation valves, NPS 2 inch and larger, in Class 600 and higher rated systems shall be parallel slide gate valves equipped with a cavity pressure relief system. Other gate type shall be specifically approved by the Chairman of the Valves Standards Committee.

7.13 Blowdown Valves

Blowdown valves in gas pipelines shall be plug valves.

7.14 Bypass/equalization valves

Mainline bypass/equalization valves in gas service shall be inverted pressure balanced lubricated plug valves.

8 Materials Limitations

8.1 Valves with Bodies of cast iron, ductile iron, or low melting point alloys (such as brass or bronze) shall not be used in hydrocarbon services.

8.2 Valves with steel bodies shall be used in the following cases:

- a) The first valve on all tanks and other vessels if failure could create a personnel or fire hazard or result in a large monetary loss.
- b) In hazardous areas where it is essential that the valve not fail in a fire.

8.3 Minimum material requirements are specified in the attached Materials Appendix, except as modified above. Refer to paragraph 4.3 for cases where the required materials differ from those in the SAMSS.

8.4 When austenitic stainless steels are to be seal-welded, welded or overlaid, low carbon grades shall be specified.

Revision Summary

21 December 2005

Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.

Materials Appendix

Table I – Service and Application Requirements Valve Body and Trim Materials

Environment	Conditions		Valve Materials		Remarks
	Conc.(%)	Temp.(C)	Body	Trim	
Acid, Hydrochloric	LT 37	5 - 50	PVC B-2	PVC B-2	No ferric ions or other oxidants for B-2
Acid, Hydrofluoric non-oxidizing	1 - 70 GT 65	5 - 50 5 - 40	M400 PTFE	C-276 PTFE	No glass or glass reinforced plastics; no titanium, zirconium or tantalum
Acid, Hydrofluoric (aerated or oxidizing)	All conc.	to 50	20	20	
Acid, Nitric	1 - 70 70 - 99	5 - 50 30 max.	304L (6) 304L	304L 304L	304L is preferred to 316L for nitric acid
Acid, Phosphoric	1 - 85	5 - 50	316 G-3(X)	316L G-3(X)	Applies to chloride or fluoride free grades of phosphoric acid only
Acid, Sulfuric(8) or Sulfurous	90 -100+ 1 -103 to 60 1 - 100	to 50 to 65 to 65 100	316 20 CPVC C-276	316L 20 CPVC C-276	
ADIP (Amino-Diisopropanol)	20 - 30	5 - 150	CS	316	No copper alloys allowed
Air or Nitrogen gas	N/A	0 - 400	CS BR	410 BR	
Ammonia, Anhydrous (10)	100	0 - 50	CS	410	No copper alloys allowed
Carbon Dioxide dry wet	100 LT 100	0 - 150 5 - 90	CS 316	410 316	
Chlorine, dry (12) wet (13)	100 LT 100	0 - 70 0 - 70	CS M400 PVC C-276	M400 M400 PVC C-276	For castings, Hastelloy C-4 is preferred to C-276
Chlorine/Water	1 - 5	to 50 50 - 80 to 80	PVC CPVC C-276	PVC CPVC C-276	For castings, Hastelloy C-4 is preferred to C-276

(Refer to General and Specific Notes at the end of Table 1)

Table I (Cont'd)

Environment	Conditions		Valve Materials		Remarks
	Conc.(%)	Temp.(C)	Body	Trim	
Crude Oil or Product (15)	N/A	to 220	CS	ENP	Up to 10% water cut only (10 year projected rate) TEFZEL or PEEK soft seals and seats shall be specified if valves will be exposed to acidizing conditions
		to 280	CS	410	
			CS	316	
			CS	TC	
		280 to 340	CrMo5	410	
		340 to 500	316	316	
Diglycolamine (DGA) or Diethanolamine (DEA)	to 100	to 65	CS	410	Use 316 bodied valves where 304 or 316S.S. pipe is employed or for throttling applications
	20 - 70	5 - 190	CS	316(X)	
CS			316		
316(X)			316		
Flare Lines	N/A	to 400	CS	410	
			CS	316	
Freon	100	0 to 70	CS	410	
		-100 to 0	316	316	
Hydrocarbon Gas including Khuff Gas (15, 18)	N/A	-18 to 220 - 18 to 280	CS	ENP	ENP trim not permitted for wet or sour gas (Ref: SAES-L-133 para 3.1,3.2,3.3)
			CS	410	
			CS	316	
			CS	TC	
Hydrogen (16)	100	0 - 220	CS	ENP	
			CS	410	
			316(X)	316(X)	
		220 to 325	CrMo22	410	
			316(X)	316(X)	
325 to 400	316	316			
Hypochlorite, Sodium or Calcium	to 5	5 - 50	PVC	PVC	
			C-276	C-276	
Light Hydrocarbons (Butane, Ethane, Hexane, Methane, Pentane and Propane) and NGL	100	-18 to 220 -18 to 400	CS	ENP	ENP trim not permitted for wet or sour gas
			CS	410	
			CS	316	
		-45 to -18 LT -45	CS	TC	
			LTS	316	
			304	304	
Lube Oil	100	5 - 120	CS	410	
			304	304	
			316	316	

(Refer to General and Specific Notes at the end of Table 1)

Table I (Cont'd)

Environment	Conditions Conc.(%)	Valve Materials		Remarks	
		Temp.(C)	Body		Trim
Naphtha	100	0 - 150	CS CS	410 316(X)	
Sewer, Oily Water	N/A	5 - 50	DI (7)	Br(20)	
Sewer, Storm or Sanitary	N/A	5 - 50	DI (7) Br (20) PVC	Br(20) Br(20) PVC	
Sodium Hydroxide	50	5 - 50	D2 316(X)	20 316(X)	
		50 - 80	CS M400(X)	M400 M400 (2)	
	20	5 - 50	CS 304L(X)	M400 304L(X)	
	7	5 - 80	CS	316	
	7	80 - 100	CS M400	M400 M400	
Steam	100	120 - 400	CS	410	Seat rings shall be overlaid with Stellite. For Class 600 systems and higher, all seating areas shall be overlaid
		400 - 480	CRMoll	410	
Steam Condensate	100	5 - 120	CS CS	410 410	
Sulfur Dioxide (Solution)	0.5		C-276	C-276	Solution in deaerated sea- water, pH 1.5
Sulfur Molten	100	GT 107	CS	316	Keep dry. Moisture causes corrosion
Water Non-corrosive (oxygen free or (inhibited)	N/A	0 - 100	CS D1 (7) Br CS	410 Br Br 316	Includes deaerated and/or inhibited sea, raw, well water Zeolite softened, chilled, and boiler feed water. pH GT 6, oxygen LT 25 ppb
Potable (Sweet)	N/A	5 - 50	Br (20) PVC CS (26) D1 (7)	Br (20) PVC 316 Br (20)	
		50 - 72	Br (20) CPVC CS (26)	Br (20) CPVC 316	

(Refer to General and Specific Notes at the end of Table 1)

Table I (Cont'd)

Environment	Conditions		Valve Materials		Remarks
	Conc.(%)	Temp.(C)	Body	Trim	
Saline (includes all untreated sea, raw, well, and aquifer waters) (Aerated, corrosive) (14, 28, 29)	N/A	5 - 80	SSS	SSS	For sour brine, formation and disposal water, and other highly corrosive waters such as untreated sea water, Wasia water, upto NPS 4-inch. (21,23)
			SSS	Ti	
			Br (20)	Br (20)	
			CS	SSS	
			CS (24)	Br (20)	
			CS	316 (27)	
			DI	Br (20)	
			Br (20)	Br (20)	For low pressure utility service waters (raw water, well water) which are not as aggressive.
			D2	Br (20)	
			DI (7)	Br (20)	
Soft or Pure	N/A	5 - 500	PVC	PVC	Includes Zeolite softened, distilled or demineralized.
			304	304	
			316	316	

General Notes:

- (A) All valve designs shall incorporate features required to resist galling of mating surfaces by means of necessary hardness differentials, weld overlays, galling resistant material combinations, etc.
- (B) Trim material includes the stem, the body and closure seating surfaces, bushings, pins, springs, guides, or any small parts in contact with the service fluid.
- (C) The gate, disc, piston, ball, or plug that provide closure are normally made from the "trim" material in smaller valve sizes (less than about 6 inches). The closure may be made from material equivalent to the valve body except that the closure seating surfaces shall be of the material having a corrosion resistance equal to or "better" than the trim.
- (D) See Table IV(a), (b) and (c) for material designations.
- (E) LT means "Less Than", GT means "Greater Than."
- (F) (X) indicates materials for critical applications such as hazardous service, poor accessibility for maintenance, or significant loss of production in the event of failure.
- (G) Austenitic ("300 Series") stainless steel components that are to be welded or weld overlaid shall be low carbon (.03% carbon maximum) grades. Low carbon grades may be substituted for regular carbon grades, but not vice versa.

Specific Notes:

- (2) Monel K-500 may be substituted for Monel 400 where additional hardness or strength is required.
- (6) Do not expose stainless-steel trim to HCl acid-cleaning.
- (7) Gray cast iron valve bodies may be substituted for ductile iron. However, ductile iron is preferred.

Table I (Cont'd)

- (8) Sulfuric acid concentrations over 100% ("Oleum") contain free sulfur trioxide.
- (10) Inhibited against stress corrosion cracking of steel with minimum 2000 ppm water.
- (12) Dry chlorine contains less than 2000 ppm water; do not use with titanium components.
- (13) Wet chlorine contains at least 2000 ppm water.
- (14) These services are subject to additional considerations such as galvanic compatibility, velocity effects or additional water chemistry factors. For example, high velocities or low pH may dictate against the use of bronze trim or Ductile Iron (DI) bodies. Copper alloy bodied valves shall not be used with carbon steel pipe in corrosive water service without the use of insulating sets.
- (15) Materials for valves in wet sour service shall meet the requirements of [SAES-A-301](#). [SAES-A-301](#) defines sour service. See also [SAES-L-133](#).
- (16) See Nelson Charts for details concerning the influence of temperature and partial pressure of hydrogen on material selection.
- (18) Body materials for Khuff Gas valves are per API SPEC 6A. Drain valves and valves at low points where water may collect under stagnant conditions shall have 316 stainless steel "or better" bodies.
- (20) Where indicated, the zinc content of wetted copper alloy components shall be 16% or less.
- (21) Availability of bronze valves in ratings above Class 150 is limited, and have not yet been tried in Saudi Aramco.
- (22) Linings are generally used in butterfly valves, non-lubricated plug valves, and some wedge gate valves. Coatings are used on ball, check, globe and gate valves, and shall be specified in accordance with 09-SAMSS-080 and 09-SAMSS-091 as applicable.
- (23) Sour brine services may require specification of [SAES-A-301](#).
- (24) Use ductile iron body, if available, for butterfly valves in non-hydrocarbon services.
- (26) For potable water service, carbon steel body valves with SS316 trim are allowed in NPS 4-inch and above only. For critical service, use coated or lined valves.
- (27) Type 316 trim is only acceptable when there is a high degree of confidence that occasional oxygen ingress cannot occur due to startup conditions, pump or valve packing leaks, etc. All trim shall be full SS316.
- (28) Carbon steel overlaid with Inconel 625 may be substituted for super austenitic or duplex stainless steels (SSS) provided that (a) the entire exposed area is overlaid and (b) the fused material has no more than 30% dilution.
- (29) Where seawater is chlorinated, residual chlorine should be limited to 2 ppm or less for SSS alloys rated A in Table IV-B, 1 ppm for those rated B, and 0.5 ppm for those rated C. Where residual chlorine exceeds 2 ppm, the Alloy C family of alloys in Table IV-A should be considered.

Table II – Alternate Stem and Spring Materials

The stem and spring alloys listed below may be used in valves having the trim materials specified in Table I. These alloys usually may be fabricated to the required strength levels more readily than the general trim materials and their corrosion resistance is approximately equal to or better than that of the corresponding general trim.

Specified Trim	Alternate Stem Materials	Alternate Spring Materials (2)
Stainless Steels		
410	17-4, A286	17-4, X750, 600
6NM	17-4, A286	17-4, X750, 600
304	17-4, A286	17-4, X750, 600
316	N50, 718	718, MP35N, E1g
20	625	MP35N, Elg, 625, C-276
SSS	625	MP35N, Elg, 625, C-276
Low Alloy Steels		
CrMoll, CrMo22, CrMo5	17-4, 410	17-4, X750
Copper Alloys		
Br	M400, MK500, SSS, Aluminum Bronze, Nickel Aluminum Bronze, Silicon Bronze C69400	625, C-276, MP35N, Elg
Nickel Base Alloys		
M400	MK500, 718, C-276 (1)	MP35N, Elg, C-276, 625, 718
G-3	625, C-276	MP35N, Elg, C-276, 625

Notes:

- (1) A specialized application for gaseous chlorine service.
- (2) Iron base alloy springs shall not be used in sour service.

Table III – Service and Application Requirements - Plastic/Elastomeric Components

M A T E R I A L S (2)
 (See Table IV)
 (See Notes 7 and 8)
 Regarding Fluorocarbon Materials)

Environment (1)	O-Rings, Diaphragms & Resilient Seats (8)	Plastic Parts (7)
Acid, Hydrochloric	EPDM, PTR, IIR, CR	PVC, CPVC, PE, PP
Acid, Hydrofluoric	CSM, PTR	PP, PE, PVDC, CPE
Acid, Nitric to 100% to 60%	PTFE/Elastomer PF(3) Fluorocarbon Elastomer	CPE, PTFE, FEP CPVC, CPE
Acid, Phosphoric	EPDM, IIR, CR, RN, CSM	PVC, CPVC, PE, PP, CPE, PVDC
Acid, Sulfuric Oleum	PTFE/Elastomer, PF	Fluorocarbon Plastics only, except PVDF
Acid, Sulfuric 90%+ LT 60%	CSM CR, CSM, IIR, EPDM	PVDC, CPE PVDC, CPE, CPVC
Acid, Sulfurous	Fluorocarbon elastomers	
Air	Any within dry temperature and pressure limits	
Ammonia (8)	Any except amine cured FKM, TFE/P	Any except Nylon
Amines (MEA, DEA, DGA, ADIP) (8)	VMQ, EPDM, PTR, CSM (amine cured FKM, TFE/P not suitable)	FEP, PTFE
Carbon Dioxide, Dry 150°C	Any within dry temperature limits and pressure limits	
Carbon Dioxide, Wet 90°C	Any within temperature/ pressure limits	
Chlorine, Dry	Fluorocarbon Elastomers FVMQ (4)	Fluorocarbon Plastics
Chlorine, Wet	Fluorocarbon Elastomers FVMQ	PVC, CPVC
Crude Oil to 50°C to 200°C	Fluorocarbon Elastomers Fluorocarbon Elastomers	PVC, CPVC, PP, PPS Fluorocarbon Plastics
Freon 11 or 12	NBR, CSM, ECO, TFE/E (FKM not suitable)	CPVC, Nylon

Table III (Cont'd)

M A T E R I A L S (2)
(See Table IV)
(See Notes 7 and 8)
Regarding Fluorocarbon Materials)

Environment (1)	O-Rings, Diaphragms & Resilient Seats (8)	Plastic Parts (7)
Gas [T LT 121°C (250°F)]	Fluorocarbon Elastomers (5)	PVC, CPVC, PPS
Gasoline (9)	FKM,PTR,FVMQ	PVDF,PVDC,CPE
Gasoline, MTBE blend	NBR (min. 40% acrylonitrile)	Fluorocarbon plastics
Hydrogen Sulfide	PTR,CSM,EPDM	PE, PP, PVC, PVDF
Hypochlorite, Ca/Na	Butyl, CSM, CR, ECO	PVC, CPVC, PCDC
Light Hydrocarbons (Butane, Ethane, Methane, Pentane, Propane)	PTR, ECO, FKM, FVMQ	Fluorocarbon Plastics, PPS
Naphtha	PTR, ECO, FVMQ	PVDC, CPE
Sewage, Oily	CR, NBR, PTR	PVC, CPVC, PVDC
Sewage, Sanitary	Any	Any
Sodium Hydroxide	Any except FKM and TFE/P at high conc.	Any except PVDC
Sodium Carbonate (all conc.)	Any	Polypropylene, RN, PVC, CPVC
Sodium Sulfite	Any	Any
Sulfur, Molten	PTFE/Elastomer, PF	Fluorocarbon Plastics
Sulfur Trioxide Solution 0.5%	Fluorocarbon Elastomers	
Sulfamic Acid (to 30%)	EPDM, IIR, CSM, RN	PP, PVC
Water, All Services	Any	Any (6)

Notes:

- (1) Temperatures are 49°C or less unless otherwise indicated.
- (2) See Table IV-A, B and C for material designations.
- (3) "/Elastomer" indicates any backup elastomer within the permissible temperature range.

Table III (Cont'd)

- (4) Do not use diaphragm valves in dry chlorine service.
- (5) Viton shall be peroxide cured Grade GF, GLC or equal where amine inhibitor is employed.
- (6) For water services, use PVC up to 50°C. Use CPVC in range between 50°C and 72°C.
- (7) The fluorocarbon plastics PTFE, FEP, ETFE, ECTFE, CTFE, and PVDF are compatible with all of the services listed in Table III, except that PVDF is not suitable for oleum service. To avoid excessive repetition, these materials are not referred to in Table III, except for the notation "fluorocarbon plastics" where the above are the only suitable materials for plastic liners.
- (8) Services not compatible with fluorocarbon elastomers are the exception. These materials are not listed under "O-Rings, Diaphragms and Resilient Seats," except for services where fluorocarbon elastomers are the only suitable materials for these components. The term "fluorocarbon elastomers" refers to PF, FKM, TFE/P, or PTFE/E in Table IV-B, but not FVMQ (Fluoro-silicone Rubber). PF (Kalrez Perfluoroelastomers), and PTFE backed elastomers (PTFE/Elastomer) are suitable for all services in Table III. FKM (Viton, or Fluorel) and TFE/P (Aflas) are not resistant to concentrated nitric acid (G.T. 60%), oleum, concentrated caustic, ammonia, many amines (except Viton "GF"), steam, Freon. Peroxide cured FKM (grades GF or GLC) may be used in amines or ammonia, but not amine cured FKM.
- (9) Nitrile Rubber (NBR) is not suitable for gasoline or sour fluids.

Table IVA – Metallic Material Designations

Alloy Designation	Description	UNS No.
17-4	17-4 PH Stainless Steel	S17400
20	Alloy 20	N08020
304	AISI 304 Stainless Steel	S30400
304L	AISI 304L Stainless Steel	S30403
316	AISI 316 Stainless Steel	S31600
316L	AISI 316L Stainless Steel	S31603
410	AISI 410 Stainless Steel	S41000
4140	AISI 4140 Steel	G41400
600	Inconel 600	N06600
625	Inconel 625	N06625
6NM	13 Cr-4Ni Stainless Steel (Grade CA6NM) (4)	J91540
718	Inconel 718	N07718
800	Inconel 800	N08800
825	Inconel 825	N08825
A286	Precipitation - Hardening Stainless Steel	S66286
B-2	Hastelloy B-2	N10665
Br	Bronze (See Note 1 and Table IV-B)	-
C-276	Hastelloy C-276	N10276
CI	Gray Cast Iron	-
CS	Carbon Steel	-
CrMoll	1-1/4 Cr 1/2 Mo Steel	J11872
CrMo22	2-1/4 Cr 1 Mo Steel	J21890
CrMo5	5 Cr-1/2 Mo Steel	J42045
D2	Ductile Ni Resist	F43000
DI	Ductile Iron	-

Table - IVA (Cont'd)

Alloy Designation	Description	UNS No.
Elg	Elgiloy	R30003
ENP	Electroless Nickel Plating	-
G-3	Hastelloy G-3	N06985
LTS	Carbon Steel for Low Temperature Applications (2)	-
M400	Monel 400	N04400
MK500	Monel K-500	N05500
MP35N	MP35N	R30035
N50	Nitronic 50	S20910
NiRe	Ni Resist Type 1	F41000
NiRe2	Ni Resist Type 2	F41002
SSS	Special Stainless Steels	(See Table IV-B)
St12	Alloy 12 (Stellite No. 12)	R30012
St6	Alloy 6 (Stellite No. 6)	R30006
TC	Tungsten Carbide	-
Ti	Titanium (Unalloyed)	-
X750	Inconel X750	N07750

Notes:

- (1) Copper alloys shall have 16% or less zinc when used in corrosive aqueous service.
- (2) Reference: [04-SAMSS-003](#).
- (3) CA6NM Stainless Steel may be substituted for Type CA15 (AISI 410) for cast valve components.

Table IVB – Special Stainless Steels and Copper Base Alloys

Alloy Designation	Generic, Popular, or Trade Name	Form	UNS No.	Spec or Grade	
SSS	Duplex Stainless (1)				
	Ferrallium	(A)	Wrought	S32550	A240
	SAF 2507	(A)	Wrought	S32750	A276, 182
	Zeron 100	(A)	Wrought	S32760	A276, 182
	Zeron 100	(A)	Cast	J93380	
	Zeron 25	(B)	Wrought		
	SAF 2205	(B)	Wrought	S31803	A182-F51
	SAF 2205	(B)	Cast	J92205	A890-4A
	CD4MCu	(C)	Cast	J93370	A743, A890
	CD4MCu	(B)	Cast		DIN 9.4462
	Escoloy	(B)	Cast	J93345	A890-2A
	Escoloy	(B)	Cast		A890-3A
	Alloy 958	(A)	Cast	J93404	A890-5A
SSS	Superaustenitic				
	A16XN	(A)	Wrought	NO8366	B675, B690
	25-6Mo	(A)	Wrought		B475, B649
	1925HMO	(A)	Wrought	NO8926	A240, A479
	254 SMO	(A)	Wrought	S31254	A182, A312
	254 SMO	(A)	Cast		A351 CKMCuN
	Nitronic 50	(B)	Wrought	S20910	A479-XM19
	904L, 2Rk65	(B)	Wrought	N08904	B625, B649
	JS-700	(B)	Wrought	N08700	B672, B599
	IN872, HV-93	(B)	Cast		A743-CN3M
BR	Copper Alloys				
	Aluminum Bronze		Cast	All	B148 (2)
	Aluminum Bronze		Wrought	C60600	B169
	Aluminum Bronze		Wrought	All	B150
	Valve Bronze		Cast	C92200	B61
	Ounce Metal		Cast	C83600	B62
	Copper-Silicon Alloy		Wrought	C65100	B98
	Copper-Silicon Alloy		Wrought	C65500	B98
	Copper Alloy		Cast	C84400	B584

Notes:

- (1) SSS alloy rankings for pitting and crevice corrosion resistance are shown in parentheses next to the name, (A) being best. SSS alloys for seawater or sour brine service must be those ranked (A).
- (2) ASTM B148 components for seawater service shall receive a temper anneal heat treatment per ASTM B601 Condition "TB".

Table IVC – Plastics and Elastomers

Material Designation	Generic or Trade Names	Polymer
PLASTICS		
PVC	PVC	Polyvinyl Chloride
CPVC	Chlorinated PVC	Chlorinated Polyvinyl Chloride
PE	Polyethylene	Polyethylene
PP	Polypropylene	Polypropylene
PVDF	Kynar	Polyvinylidene-Fluoride
FEP		Fluorinated Ethylene-Propylene
ETFE	Tefzel	Ethylene-Tetrafluoro Ethylene
ECTFE	Halar	Ethylene-Chlorotrifluoro-Ethylene
CTFE	Kel-f	Chlorotrifluoro-Ethylene
PTFE	Teflon	Poly-Tetrafluoro-Ethylene
	Nylon	Polyamide
PVDC	Saran	Polyvinylidene Chloride
CPE	Penton	Chlorinated Polyether
PPS	Ryton	Polyphenylene Sulfide
ELASTOMERS		
RN	Natural Rubber	Poly-Isoprene
CR	Neoprene or Chloroprene	Poly-Chloroprene
EPDM	Nordel, Epcar	Ethylene-Propylene
IIR	Butyl Rubber GR-1	Isobutylene Isoprene
NBR	Buna-N, Nitrile Rubber, GR-N	Butadiene-Acrylonitrile
SBR	Buna-S, GR-S	Styrene-Butadiene
CSM	Hypalon	Chlorosulfonated Polyethylene
PTR	Polysulfide Rubber	Dichlorile-Polysulfide

Table - IVC (Cont'd)

Material Designation	Generic or Trade Names	Polymer
ELASTOMERS (Cont'd)		
ECO	Epichlorohydrin Rubber	Epichlorohydrin
EU	Adiprene	Polyester/Urethane
AU	Adiprene Vulcollan	Polyester/Urethane
VMQ	Silicone Rubber	Organic Silicone
FVMQ(1)*	Fluorosilicone Rubber	Fluorinated Organic Silicone
FLUOROCARBON-ELASTOMERS		
PF		Perfluoroelastomer
FKM	Fluorel, Viton	Vinylidene Fluoride-Hexafluoropropylene
TFE/P	Aflas	Tetrafluoroethylene-Propylene
PTFE/Elastomer	PTFE with any elastomer backing	Poly-tetrafluoro-ethylene/Elastomer

Note:

* FVMQ is NOT categorized as a fluorocarbon elastomer.