Engineering Standard

SAES-J-700 22 February 2006

Control Valves

Instrumentation Standards Committee Members

Saudi Aramco DeskTop Standards

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1 Scope

This standard prescribes the minimum mandatory requirements governing the design, specification, sizing, selection and installation of control valves and regulators. This standard does not cover on/off valves.

2 Conflicts and Deviations

2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Process & Control Systems 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, Process & Control Systems 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

SAEP-302 *Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Materials System Specification

34-SAMSS-711 *Control Valves - General Services*

Saudi Aramco Engineering Standards

SAES-A-105 *Noise Control*

SAES-A-301 *Materials Resistant to Sulfide Stress Corrosion Cracking*

SAES-B-006 *Fireproofing for Plants*

SAES-B-061 *Protective Shields for High Health Hazard Piping and Equipment*

SAES-B-068	*Electrical Area Classification*
SAES-J-002	*Technically Acceptable Instruments*
SAES-J-003	*Basic Design Criteria*
SAES-J-005	*Instrumentation Drawings and Forms*
SAES-J-901	*Instrument Air Supply Systems*
SAES-J-902	*Electrical Systems for Instrumentation*
SAES-J-904	*FOUNDATION Fieldbus (FF) Systems*
SAES-L-108	*Selection of Valves*
SAES-L-132	*Materials Selection for Piping Systems*

Saudi Aramco Standard Drawings

AC-036404	*Flame Impingement Shield for Flangeless Valves*
AD-036634	*Details of Large Size Welding Neck Flanges and Blind Flanges Class 150 RF*
AD-036673	*Details of Large Size Welding Neck Flanges and Blind Flanges Class 600 RF*
AD-036698	*Details of Large Size Welding Neck Flanges and Blind Flanges Class 400 RF*
AD-036991	*Details of Large Size Welding Neck Flanges and Blind Flanges Class 300 RF*

Saudi Aramco Forms and Data Sheets

2787-ENG	*ISS - Pressure Regulator Specification*
2787-M-ENG	
8020-711-ENG	*ISS - Globe/Angle Control Valves*
8020-712-ENG	*ISS - Ball Control Valves*
8020-713-ENG	*ISS - Butterfly/ Rotary Plug Control Valves*
NMR-7925	*Non-Material Requirements for Valves - All Types*

3.2 Industry Codes and Standards

American Petroleum Institute

API STD 6D	*Pipeline Valves*
API STD 609	*Butterfly Valves: Double Flanged, Lug- and Wafer-Type*

American Society of Mechanical Engineers

ASME B1.20.1	*Pipe Threads, General Purpose (Inch)*
ASME B16.5	*Flanges and Flanged Fittings*
ASME B16.10	*Face-to-Face and End-to-End Dimensions of Valves*
ASME B16.20	*Metallic Gaskets for Pipe Flanges Ring-Joint, Spiral Wound and Jacketed*
ASME B46.1	*Surface Texture, Surface Roughness, and Process Piping*
ASME VIII D1	*Rules for Construction of Pressure Vessels*

American Society for Testing and Materials

ASTM A105	*Standard Specification for Forgings, Carbon Steel, for Piping Components*
ASTM A216	*Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service*
ASTM A350	*Forgings, Carbon and Low-Alloy Steel Requiring Notch Toughness Testing for Piping Components*
ASTM A351	*Steel Castings, Austenitic, for High-Temperature Service*
ASTM A352	*Steel Castings, Ferritic and Martensitic for Pressure Containing Parts, Suitable for Low-Temperature Service*

Fluid Control Institute

ANSI/FCI 70-2	*Control Valve Seat Leakage*

The International Society for Measurement and Control

ANSI/ISA 51.1	*Process Instrumentation Terminology*
ANSI/ISA 75.01	*Flow Equations for Sizing Control Valves*
ANSI/ISA 75.03	*Face-to-Face Dimensions for Integral Flanged Globe-Style Control Valve Bodies (ANSI Classes 125, 150, 250, 300 and 600)*
ANSI/ISA 75.04	*Face-to-Face Dimensions for Flangeless Control Valves (ANSI Classes 150, 300 and 600)*

ANSI/ISA 75.05.01	*Control Valve Terminology*
ANSI/ISA 75.08	*Installed Face-to-Face Dimensions for Flanged Clamp or Pinch Valves*
ANSI/ISA 75.11	*Inherent Flow Characteristic and Rangeability of Control Valves*
ANSI/ISA 75.16	*Face-to-Face Dimensions for Flanged Globe-Style Control Valve Bodies (ANSI Classes 900, 1500 and 2500)*
ANSI/ISA 75.19	*Hydrostatic Testing of Control Valves*
ANSI/ISA 75.22	*Face-to-Centerline Dimensions for Flanged Globe-Style Angle Control Valve Bodies (ANSI Classes 150, 300 and 600)*
ANSI/ISA RP75.23	*Considerations for Evaluating Control Valve Cavitation*
ANSI/ISA TR75.25.02	*Control Valve Response Measurement from Step Inputs*

National Fire Protection Association

NFPA 70	*National Electrical Code*

3.3 Terminology

The terminology and nomenclature used in ISA 75.05.01, "Control Valve Terminology", and other ISA 75 series standards apply to this standard.

4 Design

Selection of control valve design shall be based on application, process operating conditions, installation requirements and economic considerations. The following control valve designs may be considered: globe valves, angle valves, ball valves, butterfly valves, axial flow valves and rotary plug valves.

Control valves shall not be used as emergency shutdown (ESD) valves (ZVs), nor as emergency isolation valves (EIVs). Control valves may be used in process interlock systems.

4.1 General

4.1.1 Minimum Rating

a) The flange rating for carbon steel valve bodies smaller than 16-inch nominal size shall be minimum Class 300. Flange rating for carbon steel valve bodies 16" nominal size and larger shall be minimum Class 150.

Flange rating for valve bodies other than carbon steel shall be minimum Class 150.

b) The body rating shall never be lower than the flange rating.

c) Flangeless carbon steel valve bodies smaller than 16-inch nominal size shall be rated minimum Class 300 and be installed between piping flanges rated minimum Class 300.

4.1.2 End Connections

a) Control valve sizes 24" and smaller shall be integrally flanged. Flanged connections shall comply with ASME B16.5. Dimensions of flanges larger than 24" size shall comply with one of the following Standard Drawings:

AD-036634 *Details of Large Size Welding Neck Flanges and Blind Flanges Class 150 RF*

AD-036991 *Details of Large Size Welding Neck Flanges and Blind Flanges Class 300 RF*

AD-036698 *Details of Large Size Welding Neck Flanges and Blind Flanges Class 400 RF*

AE-036673 *Details of Large Size Welding Neck Flanges and Blind Flanges Class 600 RF*

Raised-face (RF) flanges shall be used for lines rated up to and including Class 600 and up to a design temperature of 480°C. Ring-joint (RJ) flanges shall be used for lines rated Class 900 and above, and for design temperature conditions exceeding 480°C. Ring grooves shall comply with ASME B16.20.

Separable flanges, flanges with tag welds, or flanges with partial penetration welding are not acceptable.

b) Flangeless control valves may only be applied when a flanged body is not available for the selected type of control valve.

Flangeless control valves shall not be used in:

- hydrogen services
- systems rated above Class 600
- services with design temperatures above 480°C.

For design temperatures above 205°C, bolting material for flangeless control valves shall have the same nominal coefficient of thermal expansion as the body and adjacent flanges. Flangeless control valves shall have centering means (e.g., lugs, holes, or equal) to ensure proper alignment of valve and gasket. Waver-type control valves shall not be used.

Refer to paragraph 9.3 for flame impingement shield requirements for flangeless control valves.

c) Threaded control valves shall not be used.

4.1.3 Face-to-Face Dimensions

Face-to-face dimensions of control valves shall conform to:

ANSI/ISA 75.03	*Face-to-Face Dimensions for Flanged Globe-Style Control Valve Bodies (ANSI Classes 125, 150, 250, 300 and 600)*
ANSI/ISA 75.04	*Face-to-Face Dimensions for Flangeless Control Valves (ANSI Classes 150, 300 and 600)*
ANSI/ISA 75.08	*Installed Face-to-Face Dimensions for Flanged Clamp or Pinch Valves*
ANSI/ISA 75.16	*Face-to-Face Dimensions for Flanged Globe-Style Control Valve Bodies (ANSI Classes 900, 1500 and 2500)*
ANSI/ISA 75.22	*Face-to-Centerline Dimensions for Flanged Globe-Style Angle Control Valve Bodies (ANSI Classes 150, 300 and 600)*
API STD 6D	*Pipeline Valves*
API STD 609	*Butterfly Valves: Double Flanged, Lug- and Wafer-Type*

Face-to-face dimensions of flanged ball valves shall be in accordance with ANSI/ISA 75.04. Face-to-face dimensions of axial flow valves shall be in accordance with API STD 6D. Flanged control valves not covered by any of the above references, shall comply with ASME B16.10.

4.1.4 Gasket Contact Surface Finish

The gasket contact surface of raised-face flanged valves, and flangeless control valves, up to and including Class 600 ratings shall be smooth machine-finished between 3.2 to 6.4 micrometers Ra conform to ASME B46.1. For hydrogen service, the gasket contact surface finish shall not exceed 3.2 micrometers Ra.

4.1.5 Materials

Control valve body materials shall meet, or exceed, the requirements of SAES-L-008, "Selection of Valves", for the subject piping class. Specific corrosive and erosive fluid applications, including flashing services, steam, potable water, raw water, process water and sea water services commonly require more resistant body materials than the minimum requirements of SAES-L-008. Bronze, aluminum, plastic, cast iron and ductile iron bodies are not acceptable.

Downstream temperature conditions shall be calculated and specified on the Instrument Specification Sheet (ISS) for all control valve gas pressure letdown services where the downstream temperature conditions may be reduced to below 0°C due to the Joule-Thompson effect. Body and trim materials shall meet the lowest temperature requirements.

SAES-A-301, "Materials Resistant to Sulfide Stress Corrosion Cracking" shall be applied for all materials in sour fluid services.

Trim materials shall be selected to withstand corrosion, erosion and wear. Trim material combinations shall not be susceptible to galling. AISI 300- and 400- series stainless steel shall be used as a minimum. Carbon steel or plated carbon steel trim materials are not acceptable.

Hard faced trims, or solid Stellite or Colmonoy type trims shall be used in erosive type services, including steam and water applications with pressure drop conditions exceeding 350 kPa (51 psi), other applications with pressure drop conditions exceeding 4000 kPa (508 psi) and as per manufacturer's recommendation. Harder materials, including tungsten carbide, shall be used where appropriate to ensure acceptable service life.

Monel, nickel, titanium and Hastelloy trim materials shall be used in corrosive type services to ensure acceptable service life.

Valve actuator springs shall be minimum of carbon steel with factory applied corrosion resistant coating. Alloy springs shall be considered for near shore and offshore locations.

4.1.6 Gaskets

Body gaskets shall be fully retained 316 SST, or other appropriate alloy, spiral wound, with PTFE or graphite compound fillers.

PTFE flat gaskets may only be applied where conditions permit. Gasket insert reinforcements shall be made from 316 SST or other appropriate alloy as required.

Asbestos materials shall not be used.

4.1.7 Bonnet

A standard plain bonnet shall be specified for temperatures of 0 to 230°C. Above 230°C and below 0°C, cooling fins, an extended bonnet and/or special packing shall be specified. Manufacturer's recommendation shall be evaluated and followed when feasible.

4.1.8 Packing

Packing systems shall not require lubrication. PTFE type packing, or glass filled TFE, shall be used for services up to 205°C. Above 205°C, graphite compound type packing materials or manufacturer's recommended packing shall be used. For sour gas and toxic gas services application of low leakage loaded packing systems designed to reduce fugitive emissions shall be considered at larger gas plants and refineries.

Lubricators shall not be used.

Asbestos materials shall not be used.

4.1.9 Seat Leakage

Seat leakage classification shall be in accordance with FCI 70-2. The leakage class shall be determined by the service and valve-type used.

Tight-Shut-Off (TSO) control valves shall be identified on the Process & Instrument Diagrams (P&ID's) as "TSO". TSO control valves shall be class IV or better.

Leakage class V, or better, shall be applied for compressor anti-surge and spill-back services and for gas to flare pressure letdown services in order to maximize energy conservation.

Soft-seated shut-off trim designs shall not be applied in services with design temperature conditions over 230°C nor in flashing liquid or other erosive type services.

4.1.10 Drain Provision

A threaded drain plug shall be provided for non-self-draining type control valve bodies (i.e., bodies which can trap liquid) applied in liquid sour services and liquid toxic services. Requirement for drain plug shall be specified on the ISS.

4.1.11 Hydrostatic Testing

The basis for shell hydrostatic testing control valves shall conform to:

ANSI/ISA 75.19 *Hydrostatic Testing of Control Valves*

4.2 Globe Valves

Globe valves shall be single-ported for use in shut-off services and gas compressor recycle services. Angle-type globe valves shall be single-ported.

Three-way control valve bodies shall not be used. A three-way valve requirement shall be accomplished by two two-way control valves.

Globe and angle type globe control valves shall be selected from manufacturers listed in SAES-J-002, "Technically Acceptable Instruments", Sections 711 and 714.

4.3 Ball Valves

The seat ring and seat joint area of the ball, or segmented ball, shall be designed for continuous throttling control of the process service. Stem seals shall be resistant to vibration.

Ball and segmented ball type control valves shall be selected from manufacturers listed in SAES-J-002, "Technically Acceptable Instruments", Section 712.

4.4 Butterfly and Rotary Plug Valves

Conventional flat disc/vane type butterfly valves shall be sized for a maximum travel of 60° opening. Travel in excess of 60° opening may only be applied when the butterfly disc/vane is specifically designed for stable control services up to 90° opening under low dynamic torques. Butterfly valve trims enabling stable control beyond 60° opening include a fishtail disc/vane, angular offset disc/vane, cambered disc/vane and fluted disc/vane designs.

The actuator end of valve stem shall be splined or keyed. Shear pins are not acceptable. The shear safety factor shall be minimum 150% at the specified shut-off pressure drop condition. The valve stem bearing shall be designed to prevent the stem guide bushing from rotating in the valve body. Bearing material shall be selected to prevent galling of the bearing or valve stem.

Clearance requirements for the disk shall be sufficient to eliminate any interference with heavy wall piping.

Butterfly and rotary plug type control valves shall be selected from manufacturers listed in SAES-J-002, "Technically Acceptable Instruments", Section 713.

4.5 Axial Flow Valves

Axial flow control valve trim design shall be pressure balanced.

Axial flow control valves shall be selected from manufacturers listed in SAES-J-002, "Technically Acceptable Instruments", Section 721.

4.6 Trim Design

To prevent damage on cage type trims, the flow-to-open configuration (or flowing from the inner diameter to the outer diameter of the cage, or flow under the plug configuration) shall not be used for fluids containing sand, pipe scaling, or other particulate matter. Anti-cavitation type trims and low noise type trims used in fluid services with entrained particulate matter shall be of multi-stage solid cage type design (i.e. multi-plate, labyrinth or disk stack type trims shall not be used in fluid services containing dirt, debris or other particulate matter).

4.7 Regulators

Self-acting regulating valves may be used only for services where setpoint adjustments are not required, where limited rangeability is acceptable and where control performance within ± 20% is acceptable. Self-acting regulating valves shall not be used in applications where any failure, or plugging, of the sensing element or actuating system can result in unsafe operating conditions. Regulators shall not be used in sour gas, toxic gas, cavitating, flashing, high noise and erosive services.

Actuator systems for self-acting regulating valves shall be capable of withstanding 150% of the maximum upstream design pressure. Pilot-operated regulators may only be used in clean fluid applications. All sensing element and actuator system materials shall be fully compatible for the process fluid application. The correct gain and operating range shall be provided for self-acting regulating valves through proper selection of the diaphragm, spring or pilot system.

5 Specification

5.1 Instrument Specification Sheets

Individual control valve calculation and specification requirements shall be covered on one of the following Instrument Specification Sheets:

8020-711-ENG	*ISS - Globe Control Valves*
8020-712-ENG	*ISS - Ball Control Valves*
8020-713-ENG	*ISS - Butterfly/Rotary Plug Control Valves*

Other types of control valves shall also be specified on one of these ISSs (e.g., angle and axial flow type valves on 8020-711-ENG, non-symmetrical and/or segmented ball type valves on 8020-712-ENG, eccentric and/or cammed disk type valves on 8020-713-ENG, etc.).

Pressure regulators shall be specified on 2787-ENG, Pressure Regulator Specification.

The specification and process data for the ISSs shall be maintained in both hard copy and soft copy (electronic) format conforming to SAES-J-005, "Instrumentation Drawings, Forms and Drafting Procedure".

5.2 Process Data Specification

5.2.1 Process Data Operating Window

For each control valve, the process data for the following three flow conditions shall be specified as a minimum:

- Normal Flow Rate

This flow condition is generally referred to as the design flow or material balance flow.

- Maximum Flow Rate

This flow condition shall normally be consistent with the plant or equipment operational maximum flow condition.

For emergency vent and emergency de-pressurizing applications and equipment protection or bypass applications (e.g., compressor anti-surge, compressor spill-back, pump minimum flow, heat exchanger bypass, etc.), the operationally realistic maximum flow condition need to be determined on an individual basis.

The maximum flow condition is generally the governing case for required maximum Cv capacity.

- Minimum Flow Rate

This flow condition shall be consistent with the plant turndown requirement or equipment turndown capability. The minimum flow condition generally subjects the control valve to the highest differential pressure condition. The minimum flow condition is generally the governing case for the required trim performance.

The minimum and normal flow conditions shall also be specified for control valve services identified with "normally no flow" (NNF) on the Process Flow Diagrams (PFDs). The required flow conditions during non-normal plant operating conditions (e.g., start-up, venting, de-pressurizing, regeneration, etc.) shall then be specified.

Other flow conditions, which are not covered within the range of the specified minimum, normal and maximum flow conditions, shall be separately specified on additional ISS sheets (sheet 2,3, etc.).

5.2.2 Process Data for Flashing and Two-Phase Flow

For flashing services the downstream vapor phase shall be specified on the ISS in percentage (%) weight together with the average MW.

For two-phase flow services the upstream and downstream vapor phase shall be specified on the ISS in percentage (%) weight together with the average MW.

5.3 Segregation Requirement

Control valves for non-general service applications, as defined in paragraph 5.5, shall be specified and requisitioned separately from control valves in general service applications.

5.4 General Service Applications

34-SAMSS-711, "Control Valves - General Services", with associated ISSs, shall be used as a minimum basis for the specification and requisitioning of control valves in general service applications. The contractor shall issue a technical specification supplement for any technical requirement not covered by 34-SAMSS-711.

General service control valves shall be selected from manufacturers listed in SAES-J-002, "Technically Acceptable Instruments", Sections 711, 712, and 713.

5.5 Non-General Service Applications

For grass root facilities, control valves for non-general service applications, as defined in the following paragraphs, shall be specified and requisitioned separately from control valves covered by 34-SAMSS-711.

A complete technical specification, being more detailed than 34-SAMSS-711, together with associated ISSs, shall be issued for control valves in non-general service conditions. The specification shall incorporate clearly defined technical requirements for meeting the more severe service applications. The specification shall cover all technical requirements to facilitate accurate, conscious and objective technical evaluation of the bids.

Commentary Note:

> *For existing plants control valve purchases, the specification 34-SAMSS-711 can be used and any applicable technical requirement not covered in 34-SAMSS-711 shall be included in the RFQ and PO." It is not mandatory to generate a separate technical specification for such purchases.*

Non-general service control valves shall only be selected from manufacturers listed in SAES-J-002, Section 714. Most control valves for non-general service applications can be selected from standard high-performance products from these manufacturers. However, for certain non-general service applications it may be necessary to have the manufacturers standard valve trim designs modified. For some extremely severe service conditions, it may be necessary to have custom-made control valve trims to ensure trouble-free operation.

Control valves in non-general services include the applications in paragraphs 5.5.1 - 5.5.5.

5.5.1 All Fluids

- fluid temperature above 205°C
- fluid temperature below -29°C
- actuator systems other than pneumatic
- rating exceeding Class 600
- body materials other than carbon steel and stainless steel
- flare venting applications above 200 psig
- well head flow line applications

- upstream gas plant and GOSP feed applications
- compressor anti-surge control valves
- compressor spill back control valves
- pump minimum flow (recycle) control valves
- erosive fluid applications
- de-superheater (steam conditioning) applications
- all applications considered severe service by the proponent
- temperature cycling applications

5.5.2 Dry Gas and Wet Steam

- control valve body outlet velocities greater than 0.25 Mach
- all services with a pressure ratio greater than 10 (P1/P2 > 10, pressures expressed in absolute pressure units)

5.5.3 Wet Vapor and Saturated Steam

- control valve body outlet velocities in greater than 0.2 Mach
- all services with a pressure ratio greater than 5 (P1/P2 > 5; pressures expressed in absolute pressure units)

5.5.4 Gas or Vapor with Entrained Particulates

- control valve body outlet velocities greater than 0.15 Mach
- all services with a pressure ratio in greater than 3 (P1/P2 > 3; pressures expressed in absolute pressure units)

5.5.5 Liquids

- flashing services with downstream vapor content exceeding 5% weight
- cavitating services, where more than one stage let-down trim is required to meet the noise limits without application of path-treatment
- two-phase flow services with downstream vapor content exceeding 5% weight
- water injection services
- boiler feed water services
- condensate drain services

- entrained solid or particulate services
- all services for which the system application cavitation index Ksa is larger than 90% of the actual valve cavitation index Kc at the actual valve opening for any specified flow condition (Ksa0.9 Kc)
- all services for which the system application cavitation index Ksa exceeds 0.85 for any specified flow condition (Ksa 0.85)

  Ksa, the system application cavitation index, is defined as

  Ksa = $\frac{(P1-P2)}{(P1-Pv)}$, where pressures are expressed in absolute units

5.6 Control Valve Acceptance

Prior to placing the order, the Contractor shall submit a technical proposal for each control valve for acceptance to Saudi Aramco. The technical proposal shall include a completed ISS, vendor capacity and noise calculation, complete technical specification of the proposed control valve covering all material selections and trim performance data.

For control valves in non-general service conditions, as defined in paragraph 5.5, the Contractor shall also provide the documentation requirements covered in paragraph 10.2. omplete technical proposals for non-general service control valves shall be submitted for review and approval to the General Supervisor, Process Instrumentation Division, Process and Control Systems Department of Saudi Aramco, Dhahran.

6 Engineering

6.1 Sizing

Control valve sizing shall generally be based on ISA 75.01, "Flow Equations for Sizing Control Valves". Manufacturer may deviate from the ISA formulas provided that the reason is detailed in the technical quotation (see also paragraph 6.7). Proposed deviations from ISA 75.01 shall be submitted for approval to Supervisor, Instrumentation Unit, Process Instrumentation Division, Process & Control Systems Department, Dhahran.

The manufacturer shall be provided with all data necessary to select and size the control valve and actuator assembly and to accurately evaluate the minimum trim performance requirements.

Capacity and noise level calculations for all operating conditions shall be specified on sheet 2 of the ISS. The calculation basis and results shall be shown for manual or computer calculations. The calculated Cv capacities for the minimum, normal and maximum flow conditions and the highest calculated noise level shall also be specified on sheet 1 of the ISS.

6.2 Selection

6.2.1 Minimum Body Size

The minimum control valve nominal body size shall be 1". The control valve nominal body size shall not be smaller than half of the upstream nominal line size.

Control valve bodies with reduced trims shall be considered for the following applications:

a) Pressure drop application in excess of 5170 kPa (750 psi)

b) Gas/vapor outlet velocity application in excess of 0.25 Mach

c) High pressure drop ratio of P1/P2 > 20 (absolute)

d) Choked flow service

e) Flashing service exceeding 5 % weight of liquid being vaporized

f) Erosive service

g) Services where future capacity increase is anticipated

Nominal body sizes 1¼ inch, 2½ inch, 3½ inch, 5 inch or higher odd numbers shall not be used.

6.2.2 Minimum Cv Capacity (Cv Required)

The selected control valve trim capacity (Cv selected) shall meet the following:

a) An equal percentage trim shall operate below 93% travel at maximum flow condition. If no maximum flow condition is specified on the ISS, then the trim shall operate below 85% travel at normal flow condition.

b) A linear trim and quick opening trim shall operate below 90% travel at maximum flow condition. If no maximum flow condition is specified on the ISS, then the trim shall operate below 75% travel at normal flow condition. Exception: Anti-surge control valves shall operate below 55% travel at maximum flow condition.

c) A modified parabolic trim shall operate below 90% travel at maximum flow condition. If no maximum flow condition is specified on the ISS, then the trim shall operate below 80% travel at normal flow condition.

The minimum Cv capacity required to meet above criteria is referred to as "Cv required". The actual Cv capacity is referred to as the "Cv selected".

Specific applications may require an over-sized Cv capacity (e.g., anti-surge control, venting to flare, etc.), which shall be specified on the ISSs.

A control valve affecting the load of a safety/relief valve system may be reduced in capacity only by a reduced trim (e.g., a mechanical travel stop is not acceptable).

When the capacity of a control valve affects the load of a safety/relief valve system, then the following shall be specified on the ISS: "Valve Trim Size Affects Safety/Relief Valve System Load". The bypass of this control valve shall be "car-sealed closed".

6.2.3 Minimum Rangeability

The installed rangeability of each control valve shall meet all flow conditions specified on the ISS. The specified minimum flow condition shall operate above 10% travel for all control valves, except for butterfly valves which shall operate above 20% travel. When the minimum required rangeability can not be met with one control valve, two or more parallel runs of control valves with split range control shall be provided.

Manufacturer's control valve characteristics shall conform to ISA 75.11, "Inherent Flow Characteristic and Rangeability of Control Valves".

6.2.4 Flow Characteristic

The control valve flow characteristic shall be selected to meet the above rangeability requirements and to provide stable control over the required range of operating conditions. These are initial selecting criteria for the flow characteristic:

a) linear flow characteristic

- when the ratio of differential pressure across the control valve at minimum flow over the differential pressure across the control valve at maximum flow is equal to or less than 1.5

- when the differential pressure conditions across the control valve under all specified flow conditions are more than ⅔ of the differential pressure across the control valve in the closed condition
- when two control valves are used in pairs as a 3-way valve
- for compressor recycle (spill-back) applications
- for compressor anti-surge control valves
- for pump minimum flow bypass applications
- for pressure-reducing services where the pressure drop is constant, within ±15%, over all specified flow conditions

b) equal percentage flow characteristic

- for all other modulating control applications, except for those under a), c) and d)

c) modified parabolic flow characteristic

- may only be substituted for equal percentage trim applications, provided that the smaller inherent rangeability is acceptable for the subject application

d) quick opening flow characteristic

- on/off control applications

Permissible deviations between actual and manufacturer-stated inherent flow characteristics shall not exceed the limits specified in ISA 75.11.

The installed characteristic (i.e., characteristic at actual pressure drop and flow rate conditions in the process system) shall provide stable process control for all specified operating conditions without the need to change controller tuning parameters.

6.2.5 Minimum Flow Capacity

Mechanical stops may be used for minimum flow requirements in, e.g., furnace/boiler feed system, burner fuel system, heat exchanger bypass, etc.

However, mechanical stops are not acceptable in critical safety applications such as e.g., compressor suction control. For these applications the trim of the control valve shall provide a minimum flow capacity (Cv) in the fully closed position (e.g., both the cage type trim and plug can have openings, the disc of a butterfly valve can have holes or be undercut, etc.). For compressor suction control a butterfly valve with undercut disk may be preferred, provided that it fully meets all technical requirements. As an alternatively, a piping bypass valve, with restricted flow capacity and being locked open, may be installed across the control valve.

6.3 Piping Geometry Factor, FP

For valves mounted between pipe reducers or other pipe fittings, the calculated valve capacity shall be corrected for a decrease in valve capacity conforming to ISA 75.01. The piping geometry factor FP, control valve manufacturer's correction factor, calculated FLP and/or XTP factors shall be specified on sheet 2 of the ISS.

6.4 Reynolds Number Factor, FR

For valve Reynolds numbers below 10,000, the calculated valve capacity shall be corrected for a decrease in valve capacity conforming to ISA 75.01. The Reynolds Number Factor FR shall be specified on sheet 2 of the ISS.

6.5 Critical Downstream Pressure Conditions

The downstream pressure conditions of the control valve shall be accurately calculated and specified on the ISS for each flow condition. This is critical for minimum flow conditions in cavitating, flashing and choked-flow services. To determine the worst-case service conditions, which is most severe to the control valve, considerations shall be given to the different downstream pressures that can exist under various operating conditions. Accurate back pressure data is also critical for control valves with low differential pressures at maximum flow.

6.6 Cavitation, Choked Flow and Flashing

ISA 75.01 and ISA RP75.23, together with the manufacturer's valve cavitation index data, shall be used for determining the severity of cavitation, choked flow or flashing conditions in a control valve.

If cavitation cannot be eliminated completely, (e.g., by providing more downstream pressure through relocating the valve in the piping system) then a special control valve shall be selected with a high liquid pressure recovery coefficient FL and high anti-cavitation index KC that will provide maximum lifetime for the valve and piping system. Noise and piping vibration levels shall not exceed the limits defined in paragraph 6.8.

Control valves in potentially cavitating service conditions shall be analyzed in detail to ensure that the intensity, or degree, of cavitation of the selected trim is acceptable (see also ISA RP75.23). The Ksa, the system application cavitation index defined in paragraph 5.5.5, shall be specified on sheet 2 of the ISS for all operating conditions.

Contingencies on the minimum required control valve cavitation index shall be applied to compensate for inaccuracies in process data and inaccuracies in manufacturer's control valve cavitation index data.

The location and piping installation of a control valve in flashing services shall be designed to facilitate the flashing process in order to minimize erosion in the control valve outlet area and downstream piping section.

6.7 Noise and Vibration

6.7.1 Noise Limits

The actual maximum noise level emission measured 1 m (3 ft) downstream of the valve and 1 m (3 ft) away from the valve including noise contributions from the piping system, piping elbows and reducers, is not allowed to exceed the following limits for any specified operating condition:

a) 85 dB(A) for continuous and intermittent services (e.g., intermittent services include compressor anti-surge and spill-back services)

b) 90 dB(A) for infrequent services (i.e., services where the control valves are closed for more than 4 hours during an 8-hour shift, including emergency de-pressurizing and emergency vent valves)

The maximum noise levels are specified in terms of equivalent continuous A-weighted Sound Pressure Levels (SPL) with a maximum inaccuracy of ± 5 dB(A).

The Contractor is responsible for not exceeding these upper noise limits during any specified operating condition. The contractor is responsible for the design of the complete system (piping, control valve and manifold). When these upper noise limits are exceeded during tests, the Contractor is responsible for upgrading the performance of the control valves and manifold piping system to meet these noise limits.

Manufacturers shall be required to include inaccuracies of their quoted noise levels and shall be requested to guarantee that the noise emission from the proposed control valve in the specific piping system shall not exceed above stated limits for any specified operating condition.

Contingencies need to be included in the design to ensure that the actual noise levels will be not be exceeded.

For control valves in potential noise and vibrating type service conditions, the Contractor shall provide piping layout information (e.g., piping isometric drawings) with the Request for Quotation to the bidding control valve vendors.

Overall plant noise emission limits shall conform to SAES-A-105, "Noise Control". Control valve noise levels are measured at a distance of 1m downstream of the valve and 1 m away from the valve. Any new control valve installation exceeding a predicted SPL of 85 dB(A) shall be reported in writing to the Occupational Medicine Division, Industrial Hygiene Unit in conformance with SAES-A-105.

Control valve noise shall be treated at the source through the provision of low-noise multipath trim designs. To ensure that excessive noise and piping vibration problems will not occur a contingency in trim performance shall be provided in high energy dissipating type services, severe cavitating type services and high pressure letdown services (i.e., a better trim shall be provided than what is minimum required to meet the noise limits). An oversized control valve body with high performance trim may need to be used to meet the trim performance contingency criteria.

When the noise limit can not be met by source treatment alone, application of diffusers, baffle plates and silencers may be considered, subject to approval by the Supervisor, Instrumentation Unit, Process Instrumentation Division, Process & Control Systems Department. Special attention shall be given to the limited flow rangeability of these devices (i.e., noise reduction can only be accomplished at high flow conditions, but virtually no noise reduction can be obtained at low flow conditions).

Acoustic or thermal insulation shall not be used for control valves in continuous or intermittent services.

A control valve noise and vibration test shall be conducted for each control valve with a calculated noise level in excess of 80 dB(A) (e.g., as part of a plant performance test).

6.7.2 Vibration Limits

The maximum vibration levels of the control valve, manifold and piping system shall be less than 12.5 mm/sec. Root Mean Square

(0.5 inch/sec. RMS) under all specified operating conditions.

Proper control valve selection shall ensure that the required energy can be dissipated without exceeding the maximum vibration levels in the piping system. The control valve manifold piping layout and piping support design shall facilitate maximum reduction of control valve induced vibration.

Control valve vibration can be reduced by multipath trim designs and heavy trim guiding (refer also to paragraph 6.8.1, Noise Limits).

It is recommended to conduct a control valve vibration and noise test for each control valve with any calculated noise level in excess of 85 dB(A) (e.g., as part of a plant performance test).

6.8 Outlet Velocity Limits

Body outlet velocity, defined as the fluid velocity at the discharge flange of a control valve, shall be limited to:

- 0.3 Mach for dry clean gas and superheated steam services
- 0.25 Mach for wet gas, vapor and saturated steam services
- 0.2 Mach for gas, vapor and steam services containing any particulate matter

Oversized control valve body with reduced trim may need to be used to meet these limits.

7 Actuators

7.1 General

The control valve manufacturer shall be made responsible for correctly sizing the actuators based on the technical specification(s) and the data specified on the ISS. The contractor is responsible for the Engineering and design of stable and correctly performing control systems, including determining the minimum requirements for the control valve actuating systems, technical specification(s), ISS data, etc.

Actuators shall operate on control signals defined in SAES-J-003, "Instrumentation - Basic Design Criteria". The bench set (spring range) of actuators shall be specified on the ISS's. Actuator sizing shall be based on a minimum available instrument air pressure of 415 kPag (60 psig), including worst-case requirements for maximum force/torque. Air supply system design pressure conditions are generally 930 kPag (135 psig) at 82°C, or less. Actuator systems shall be suitable for non-lubricated air. A large capacity regulator with filter shall be used to provide a constant air supply pressure under all operating conditions. A regulator is not required for pneumatic piston type actuators with design pressure conditions in excess of 930 kPag (135 psig).

The total maximum inaccuracy of the valve travel position due to any limitation (e.g., repeatability, dead band, resolution, hysteresis, non-linearity, etc.) shall be less than 1.5% for valves with a positioner and less than 2.5% for valves without a positioner.

Materials of the pneumatic tubing, valves and fittings, which are to be supplied by the control valve manufacturer, shall be a minimum of AISI 316 stainless steel. Carbon steel, copper, bronze, brass, and AISI 304 stainless steel materials shall not be used on a control valve and actuator assembly. Air tubing, fitting or connection nipple sizes shall not be less than ¼" NPT. Flexible metal hoses shall be used for air supply and control connections to valves in potentially vibrating services. Instrument air supply and distribution systems shall conform to SAES-J-901, "Instrument Air Supply Systems".

Control valve position instability and limit cycling problems are commonly related to insufficient actuating power. Actuator force/torque requirements are not constant over the full range of travel and the torque requirements must be specified for the worst case service requirements. Type and size of actuator system shall develop minimum 110% of the required seat load to meet the leakage class and the shut-off pressure drop specified on the ISS.

Leakage problems are commonly related to insufficient seat loading. The maximum shut-off differential pressure shall always be calculated and specified on the ISS. For all metal-to-metal shut-off applications exceeding FCI 70-2 Class IV requirements, actuator load calculations shall be made and shown on sheet 2 of the ISS (more sheets may be added when required). Calculations are required to show the minimum load to be applied to the plug/seat arrangement for meeting the required shut-off specifications.

7.2 Pneumatic Diaphragm Actuators

Spring-return pneumatic diaphragm actuators are preferred and shall be used whenever feasible. Valve positioners shall be applied when required. Typical justifications for digital positioners may include, but are not limited to, the following:

a) minimize process variability

b) standardize on maintenance support management system

c) process systems with time lag

d) excessive dead band applications

e) minimum hysteresis requirements

f) split-range signal from analog controller

Exception:

This does not apply to DCS split range applications detailed in paragraph 7.6.

g) valve characterization requirement to match installed system characteristic to obatin constant unity gain

h) valve travel position indication

Each positioner application shall be verified in detail to ensure that the positioner does not impair the minimum control performance requirements (see paragraph 7.1). Positioners shall not be applied in very fast process systems. A diaphragm-actuated control valve, with a booster if so required, shall be used for very fast process systems to ensure stable control performance. The positioner requirement for each valve shall be determined and specified on the individual ISSs.

7.3 Pneumatic Piston Actuators

Air failure position shall be accomplished without the aid of process pressure conditions. Air failure position shall be testable during inspection and during plant commissioning when piping systems are de-pressurized.

When the "air failure open" (AFO) or "air failure close" (AFC) action mode of a piston-operated actuator system can not be accomplished due to insufficient spring force, then a volume tank with fail-safe trip valves shall be provided (refer to paragraph 8.5. for volume tank requirements). Air failure mode movement of the control valve shall be prompt in the event of air supply failure.

When "air failure lock" (AFL) action mode is required, also referred to as "air failure steady" (AFS), for any critical valve operation, lock-up valves and if so required, a volume tank shall be provided to lock the actuator in the last operating position upon air supply failure for a minimum period of 30 minutes.

7.4 Actuator Systems other than Pneumatic Air Operated

Control valve actuator systems other than pneumatic shall be applied on an exception basis only.

Application of actuator systems other than pneumatic requires prior written approval of the Supervisor, Instrumentation Unit, Process Instrumentation Division, Process and Control Systems Department of Saudi Aramco, Dhahran.

Requests for approval shall include justification(s) and a technical specification for the subject actuator system.

The following actuator systems may be applied on an exception basis only:

- Electro-Hydraulic Actuators

  For applications where high thrusts, fast stroking times and/or long strokes are required, electro-hydraulic actuators may be considered.

- Electric Motor-Operated Actuators

  For applications where instrument air supply cannot practically be made available, electric motor-operated actuators may be considered.

- Nitrogen-Hydraulic Actuators

  For applications where instrument air supply cannot practically be made available and the nitrogen consumption will be low, nitrogen-hydraulic actuators may be considered. Nitrogen-hydraulic actuators shall not be used at any indoor location.

- Process Gas as Actuating Medium

  For applications where instrument air supply cannot practically be made available, sweet, clean, dry process gas may be considered as the actuating medium. Sour gas shall never be used. Process gas operated actuator systems shall never be used at an indoor location or enclosed area.

  Prior written approval by the Supervisor, Instrumentation Unit, Process Instrumentation Division, Process and Control Systems Department shall be obtained for the use of process gas as actuating medium. A complete design package, including all detailed requirements, shall be provided for approval.

  Actuator materials, specifically the elastomer seals, shall be suitable for the particular process gas application. All materials in the actuator and control instrumentation shall be certified for the particular process gas services.

  The gas shall be properly conditioned through a fully redundant gas supply system each with a dedicated inlet and outlet block valve (e.g., dual regulators, dual liquid knock-out pots with drain valves, dual filtering systems, over-pressure relief valves etc.) connected to a ring header to enable on-line maintenance on one system at the time.

  The gas supply ring header piping shall be sloping, without pockets, towards the knock-out pots installed at the lowest point. The liquid knock-out system design shall be over designed such to ensure trouble-free operation even during upset conditions of the process.

Sweet gas venting shall be kept to a minimum (i.e., selecting instruments with the lowest venting rates available, minimizing the number of venting instruments, etc.). The area around a combustible gas venting instrument that discharges gas continuously or for long periods of time is classified as Class 1, Zone 0, to meet SAES-B-068. Sweet gas venting shall be elevated to direct the gas away from the immediate area around the control valve. Consideration shall be given to connecting individual instrument vents to a common vent manifold which is subsequently connected to an elevated vent stack.

All enclosures shall be metallic (i.e., non-metallic actuator systems shall not be used in sweet gas services). Grounding of the complete system shall be in accordance with NFPA 70.

7.5 Actuator Stroke Speed Requirements

Minimum stroke speed for control valve systems is functional to the valve body size (d) and process requirements (see note below for exceptions). For minimum control performance requirements, the minimum stroke speed in modulating modes of process operation shall be:

- 4 inches per second for anti-surge control applications
- 0.75 inch per second for time-critical gas/vapor control applications, including but not limited steam pressure, fuel gas pressure, etc.
- 0.15 inch per second for general control applications.

For example: The maximum stroke times for a 8" valve are:

- 2 sec's at a stroke speed of 4"/s
- 11 sec's at a stroke speed of 0.75 "/s and
- 53 sec's at a stroke speed of 0.15"/s

All applications need to be verified for the actual stroke speed requirements by the contractor. For example, the required anti-surge control valve stroke speed needs to be verified for the worst-case process upset conditions in the specific compressor system application (e.g., the quick closure of a shutdown valve may even dictate a faster stroke speed than 4 inches per second!). The required stroke time shall be specified on the ISS for each control valve.

Stroke times shall be tested on a 50% control signal step change (i.e., on a 50% step change the resulting 50% stroke need to be performed within 50% of the subject stroke time) without the aid of process pressure conditions. Stroke times shall be tested during manufacturer's inspection and during plant commissioning when piping systems are de-pressurized. Boosters may be applied to meet stroke time requirements, but stroke movements shall remain stable at 20%, 50% and 80% control signal step changes (i.e., overshoot to be less than 120% of the input step change and be dampening as defined in ANSI/ISA 51.1, "Process Instrumentation Terminology" and ANSI/ISA RP75.25.02, "Control Valve Response Measurement from Step Inputs". Two control valves in parallel may be used to meet the required stroke time.

Fast-stroke time requirements under air failure conditions shall be separately specified on the ISS (e.g., stroke times faster than the manufacturer's standard; piston-type actuators may have prolonged stroke times under air failure conditions). Typical applications requiring fast stroke times on air failure conditions include vent and flare dump valves to prevent safety/relief valves from being lifted. Quick-exhaust valves may be used, provided that they do not interfere with the normal control operation of the actuator system.

Exception:

> *Prolonged stroke times shall be applied for control valves in liquid lines, when required to prevent hydraulic surge conditions to exceed the pipeline Maximum Allowable Surge Pressure (MASP). Application of prolonged stroke times to prevent hydraulic surge conditions does not require a Waiver Request (WR) procedure. When the stroke time of a control valve affects the pipeline MASP, or the load of a surge relief valve system, then the following note shall be specified on the ISS: "Valve Stroke Time Affects Pipeline MASP or Surge Relief Valve System Load". Typical applications may include pipelines, loading lines, tankage transfer lines, etc.*

7.6 Distributed Control System Signal Standardization

Each control valve connected to a Distributed Control System (DCS), shall be operated through its own field wiring, on a standard 4 - 20 mA signal or standard digital communication signal in compliance with SAES-J-003.

All required signal manipulations (e.g., for split range, gap and dead zone control, conversion to indirect signal, scaling, biasing, etc.) shall be performed by the DCS.

7.7 FOUNDATION Fieldbus (FF) Systems

Fieldbus installations shall be in accordance with SAES-J-904, "FOUNDATION Fieldbus (FF) Systems". Each FF digital positioner and FF digital converter shall meet the minimum device requirements detailed in paragraph 7.1 of SAES-J-904.

The Contractor shall prepare an attachment to 34-SAMSS-711, "Control Valves - General Services", or specification supplement to cover the minimum device requirements for the digital positioners and converters in detail.

7.8 Control Valve Maintenance Support System

A PC based control valve maintenance support system shall be provided for grass root facilities. This system shall interface with all control valve digital positioners and converters, collect valve performance data, provide diagnostic capabilities and maintenance reporting functions. The contractor is responsible to deliver a consistent operating system being fully compatible with all control valves.

The contractor shall prepare a specification to cover the PC based control valve maintenance support system requirements in detail.

The contractor shall optimize the control valve flow characteristic for each valve to facilitate constant controller gain over the required flow range (re: paragraph 6.2.4).

8 Accessories

8.1 Positioners, Electro-Pneumatic (I/P) Transducers and Boosters

8.1.1 Digital positioners shall be applied for all new applications, on control valves that require positioners. Electro-pneumatic or pneumatic positioners may be used for upgrades or retrofits to existing installations.

8.1.2 Digital positioners and their associated software, shall be specified to include full diagnostic capability and shall be capable of generating hysteresis curves of control signal versus valve travel, actuator pressure versus stem travel, etc.

8.1.3 A positioner bypass valve shall only be provided for valves with a 3 - 15 psig pneumatic signal to spring-loaded actuators (e.g., only when the input signal range is the same as the valve positioner output range). A bypass valve shall not be installed on reversed- or reversible-type positioners.

8.1.4 Boosters may be applied to meet the actuator stroke speed requirements or to meet air volume requirements at larger actuator systems.

8.2 Handwheels

A handwheel shall be provided on valves when local manual control is required by the Proponent. Handwheel installations shall meet the following requirements:

a) Neutral position shall be clearly indicated.

b) Handwheel mechanism shall not add friction to the actuator.

c) Handwheel shall not be used as travel stops.

d) Handwheel shall be fully accessible for operation.

8.3 Limit Switches

Limit switches shall be actuated by mechanical switch or proximity sensor. Limit switch enclosures shall be hermetically sealed. Switch contact outputs shall be at minimum, Single-Pole, Double-Throw (SPDT). Contact rating shall be at minimum, 0.5 Amp inductive at 125 VDC.

8.4 Solenoid Valves

Requirements for solenoid valves shall be specified on the subject control valve ISS. High temperature class "H" coil insulation rated for continuous duty shall be used with viton elastomers (i.e., lower class coil insulations or Buna-N elastomers are not acceptable). Solenoid valves shall be selected from manufacturers listed in SAES-J-002, section 827, "Solenoid Valves".

Commentary Note:

Solenoid valves shall not be used for process service applications.

8.5 Volume Tanks

Volume tanks shall be mechanically designed to withstand a maximum pressure of 930 kPag (135 psig) at 82°C. Volume tanks shall be manufactured in accordance with ASME VIII D1 (stamped UM) requirements, or equivalent. Volume tanks shall have a minimum capacity for one complete stroke operation of the control valve at the minimum available instrument air pressure of 415 kPag (60 psig). The I/P transducer shall also be supplied from this volume tank.

8.6 Travel Stops

When travel stops are required, the adjustment must be lockable or be equipped with a jam-nut arrangement. Travel stop arrangements through the hand wheel mechanism are not acceptable.

Travel stops used in applications where the Cv capacity impacts the safety/relief valve capacity shall be made permanent. A permanent locking system or a complete weld is acceptable; however, a jam-nut arrangement or a tack welding arrangement is not acceptable.

8.7 Position Indication

8.7.1 Valve Position Indicator

Each control valve shall be provided with a valve position indicator. The indicating pointer shall be directly connected to the stem or shaft. The valve position shall be indicated on a reversible scale, with clearly graduated markings at the 50% valve opening position and the words OPEN and CLOSED at the valve travel limits.

8.7.2 Valve Position Transmitter

An electronic travel position transmitter, providing a proportional valve stem or shaft position signal, shall be specified when required for remote valve position indication. Typical applications may include anti-surge, flare vent and emergency de-pressurizing valves. The total maximum inaccuracy of the valve travel position signal due to any limitation (e.g., repeatability, dead band, resolution, hysteresis, etc.) shall be less than 3.0%.

8.8 Marking and Identification

8.8.1 Marking

The direction of flow shall be cast or steel-stamped on the valve body, or alternatively a stainless steel arrow shall be permanently fixed to the body by rivets, for all appropriate valves which have been designed or selected for a specific flow direction.

For butterfly valves, the vane position shall be indicated by an engraved marking on the shaft end.

8.8.2 Identification

Name plates shall be provided for all control valves. Name plates shall be permanently fastened to the valve (i.e., adhesive fastening is not acceptable).

9 Installation

9.1 General

Control valves shall be installed in horizontal lines.

Control valves and their actuating systems shall be mounted such that all adjustments are accessible (and all indicators/gauges are readable) from grade, permanent platform, walkway or fixed ladder. Portable platforms and portable ladders shall not be used. Sufficient clearances shall be provided for the removal of any part of the control valve or actuator assembly. Access space for lifting equipment shall be provided for valve and actuator assemblies weighing over 50 kg.

Control valve actuating systems and cabling shall not be located in close proximity to high temperature sources. Thermal shielding shall be applied from surfaces exceeding 260°C (500°F) when less clearance than 1000 mm (40 inches) is provided.

During flushing and hydrotesting the control valves shall be removed from the piping system. Control valves are hydro-tested by the manufacturer and should not be hydro-tested in the field.

Electrical installation shall conform to SAES-J-902, "Electrical Systems for Instrumentation". The electrical area classification of the control valve location shall be specified on the ISS. Electrical installation shall comply with NFPA 70, National Electrical Code (NEC).

9.2 Manifold

9.2.1 Block and bypass valves shall be provided as standard for each control valve installation. However, the block valves and bypass valve arrangement are not mandatory for control valves installed in:

- identical pieces of equipment installed in parallel (e.g., pumps, compressors, heat exchangers, etc.) with one piece of equipment used for standby, spare or redundant capacity (e.g., one duty and one standby, two duty and one standby, etc.), enabling on-line maintenance of any one control valve at any one time without affecting the required capacity
- identical process systems installed in parallel (e.g., trains, modules, units, boilers, furnaces, etc.) with one process system used for spare or redundant capacity, enabling on-line maintenance of any one control valve at any one time without affecting the required capacity
- process or equipment which is only intermittently operated in association with a continuous process (e.g., during start-up, regeneration, etc.)
- non-critical equipment which may be shut down without affecting the operation of the main process
- applications where, for safety reasons, a block and bypass valves arrangement is not desirable (e.g., to reduce leakage sources of hazardous fluids, such as hydrogen, phenol, hydrofluoric acid, etc.)

- applications where, for safety reasons, manual operation by means of the bypass valve is not desirable (e.g., anti-surge control, turbine speed control, fuel control to boilers and process heaters, etc.)
- applications, for which the proponent specifically does not require block and bypass valves to be installed

The capacity impact (i.e., friction losses) of the manifold need to be verified during detailed design of the control valve system. This is especially important for high-recovery-type control valves operating under low-pressure drop conditions.

9.2.2 Manifold Piping

The manifold piping shall be arranged to provide flexibility for removing control valves for maintenance (e.g., particularly where ring joint flanges are used).

The piping around control valves shall be self-supporting or shall be permanently supported so that when the control valve is removed, the lines will remain in place without the need for temporary supports.

Sizes of main line piping and branch piping shall be selected to conform to the fluid velocity limitations governed by SAES-L-032, "Materials Selections for Piping Systems". These fluid velocity limitations may only be exceeded for piping installed between the control valve and reducers provided that one schedule heavier piping is used for this piping than the schedule required by the piping code.

For control valves in non-general service applications, as defined in paragraph 5.5, with Cv/d^2 values in excess of 15 ($Cv/d^2 > 15$) a straight piece of piping shall be installed over a length of at least 2D upstream and 6D downstream of the control valve before any fitting (e.g., elbow, tee, or reducer). Additonally, the angle of the reducer(s) shall be smaller than 40° ($\theta < 40°$).

Control valves in flashing services shall be located as close as practically possible to the downstream vessel.

When heavier schedule piping is installed for noise reduction (see paragraph 6.8.1.) it shall be installed over a minimum length of 10 D upstream and 20 D downstream of the control valve before any fitting (e.g., elbows, tee, or reducer), where D is the nominal size of the piping.

Requirements for non-standard reducers and heavier wall piping shall be specified on the Piping & Instrument Diagrams.

9.2.3 Bypass Valve

Bypass valves shall meet the minimum requirements of SAES-L-008 applicable for the subject piping class.

The bypass valve shall be manually operable and have a correct trim and control characteristic suitable for controlling the service requirements without excessive noise or piping vibration. Additionally, the bypass valve shall have a capacity at least equal to the required Cv of the control valve, but not greater than twice the selected Cv of the control valve. When the line may be required to handle larger flows at a later date, the bypass valve capacity shall be selected to accommodate the future flow rate.

For applications where it is impractical, or unsafe to operate the process on a manual bypass valve, a control valve with an actuator system shall be installed as a bypass valve. A pneumatic valve arrangement shall then be provided to allow smooth transfer of the control signal between the main control valve and the bypass control valve. Alternatively, two smaller redundant control valves, each having 50% of the required flow capacity, may be provided. Such applications include, but are not limited too quench flow control and temperature control on an exothermic reactor, pressure control requirements above 80% of the PZV set pressure, boiler feed water control, steam drum pressure control, etc.

For applications requiring control valve body sizes in excess of 12", multiple parallel arrangements of identical smaller body size valves may be considered. A duplicate control valve shall then be provided as a common bypass valve for any one control valve (e.g., the same type of control valve with a handwheel, but without an actuator).

For critical applications (e.g., including those where control valves with special low-noise and anti-cavitation-type trims are installed) and for applications where the bypass valve must be able to remain in service for an extended period of time, a duplicate control valve shall be provided as a bypass valve (e.g., the same type of control valve with a handwheel, but without an actuator).

9.2.4 Block Valves

Block valves shall conform to SAES-L-008 for the subject piping class. Block valves shall generally be the same size as the line size and shall be full capacity type valves.

9.2.5 Drain and Vent Valves

Both sides of a control valve in a manifold shall be provided with a drain valve, unless otherwise specified by the proponent. Drain valves shall be installed on the bottom of each spool piece or reducer between the control valve and the block valves.

Control valve installations without block and bypass valves shall also be provided with a drain valve on each side of the control valve.

The size of drain valve shall be large enough to drain the enclosed liquid within 2 hours under atmospheric conditions, but be ¾" minimum.

Vent valves shall be provided where required. Size of vent valve shall be ¾" minimum.

The type of drain and vent valve shall be suitable for the selected piping class, conforming to SAES-L-008. Drain and vent valves shall be plugged or blinded per SAES-L-008.

9.3 Protective Shields and Flame Impingement Shields

Protective shields, to prevent injury to personnel, shall be installed on valves handling dangerous or flammable liquids, in accordance with SAES-B-061. Protective shields shall be of a type that can be removed while the equipment is in service.

Flame impingement shields, to protect flangeless control valves in fire-hazardous zone services as defined in SAES-B-006, shall be installed in accordance with Standard Drawing AC-036404. This requirement is applicable for all onshore, near-shore and offshore facilities.

9.4 Anti-Static Devices

Control valve designs shall be evaluated for the presence of electrically isolated metal parts when used in non-conductive fluid services.

Anti-static devices shall be provided to ensure electric continuity between all isolated parts and the valve body. These shall fulfill the following requirements:

a) Provide a discharge path with an electrical resistance of not greater than 10 ohms.

b) Be of such a design that the valve cannot be assembled, or reassembled, without the device.

10 Documentation Requirements

10.1 General Service Applications

For control valves in general service applications (as defined in paragraph 5.4), the documentation covered by Form NMR-7925 - "Non-Material Requirements for Valves - All Types" shall be provided as a minimum.

10.2 Non-General Service Applications

For control valves in non-general service applications (as defined in paragraph 5.5), the documentation covered by Form NMR-7925 together with the documentation listed in one of the following sections, shall be provided as a minimum:

For compressible fluid applications:

- Capacity data (Cv) as a function of travel; this data shall be supplemented to indicate that the required rangeability can be met conform to ISA 75.11 (see also paragraph 6.2.3).
- Noise calculations for each specified flow condition; the manufacturer shall specify the maximum total inaccuracy (e.g., tolerance expressed in ± dB(A) for each noise calculation).
- Performance data showing the acoustic efficiency factor as a function of travel; this performance data shall be specific for the selected flowing application (e.g., under or over the plug, flow tending to open or close, balanced trim, etc.).
- Body and trim exit fluid velocity calculations for each specified flow condition expressed in sonic velocity (Mach number).

For non-compressible fluid applications:

- Capacity data (Cv) as a function of travel; this data shall be supplemented to indicate that the required rangeability can be met conform to ISA 75.11 (see also paragraph 6.2.3).
- Noise calculations for each specified flow condition; the manufacturer shall specify the maximum total inaccuracy (e.g., tolerance expressed in ± dB(A) for each noise calculation).
- Cavitation index data and choked flow parameter data both as a function of travel; these data shall be specific for the selected flowing application (e.g., under or over the plug, flow tending to open or close, balanced trim, etc.).

- Size Scale Effect (SSE) correction data for the cavitation index data.
- Pressure Scale Effect (PSE) correction data for the cavitation index data.
- The manufacturer shall be requested to state in writing that the selected cavitation index meets all specified service conditions for trouble free operation.
- Body and trim exit fluid velocity calculations for each specified flow condition.
- For system applications with Ksa values exceeding 0.90 (see also paragraph 5.5.5), the manufacturer shall be requested to substantiate his quoted cavitation index data (e.g., test data of similar control valves, etc.).

Revision Summary

28 February 2006	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with no other changes.