Engineering Standard

SAES-J-605 31 May 2005

Surge Relief Protection Systems

Saudi Aramco DeskTop Standards

Table of Contents

1 Scope

This standard prescribes the minimum mandatory requirement for sizing, selection and installation of liquid surge relief valves and surge relief systems. Unsteady state transient analysis is not covered in this standard and it is assumed that a complete pressure profile of the system requiring protection shall be performed by others and approved by the Manager, Process & Control Systems Department, Dhahran. Also, the scope does not cover compressor anti-surge protection.

2 Conflicts and Deviations

2.1 Any conflicts between this Standard and other applicable Saudi Aramco Engineering Standards (SAES's), Materials System Specifications (SAMSS's) Standard Drawings (SASDs), 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 latest edition or revision of the following standards, specifications, codes, forms, and drawings shall to the extent specified herein, form a part of this standard.

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

SAES-A-301	*Materials Resistant to Sulfide Stress Corrosion Cracking*
SAES-B-068	*Electrical Area Classification*
SAES-J-003	*Basic Design Criteria*
SAES-J-600	*Pressure Relief Devices*
SAES-J-700	*Control Valves*
SAES-L-132	*Material Selection for Piping Systems*

Saudi Aramco Forms and Data Sheets

8020-605-ENG	*ISS Surge Relief Valves*

3.2 Industry Codes and Standards

American National Standards Institute

ANSI S1.13	*Method for the Measurement of Sound Pressure Levels*
ANSI/FCI 70-2	*Control Valve Seat Leakage*

American Society of Mechanical Engineers

ASME B31.3	*Chemical Plant and Petroleum Refinery Piping*
ASME B31.4	*Liquid Transportation Pipelines*
ASME SEC VIII D1	*Pressure Vessels, Division 1*

The International Society for Measurement and Control

ISA S75.01	*Flow Equations for Sizing Control Valves*
ISA S75.23	*Considerations for Evaluating Control Valve Cavitation*

American Petroleum Institute

API SPEC 6D	*Specification for Pipeline Valves*

American Society for Testing and Materials

ASTM A216	*Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service*

National Association of Corrosion Engineers

4 Definitions

The following terms will be used frequently in this standard and related hydraulic studies. Design contractors shall be required to adhere to this terminology in all documentation related to surge relief valves and systems.

Accuracy: The maximum positive and negative deviation observed in testing a device under specified conditions and by a specified procedure.

Design Pressure: The maximum allowable design pressure is the highest pressure, at the maximum temperature expected during most severe plant operating conditions. This pressure is always equal to or less than the MAOP.

Effective Valve Closure Time: The period over which an Emergency Shutdown Valve reduces the flow from 90% of its steady state to zero. In relation to Total Valve Closure Time, this is typically the last 15% for butterfly valves, 25% for ball valves and 30% for plug valves.

Flow Factor: A dimensionless number similar to the liquid flow coefficient (Cv) used in control valve calculations. Flow factor vs. over pressure charts are normally used by the surge relief vendors to present capacity data for a surge relief valve.

Hysteresis: The maximum measured separation between upscale and down scale indications of the measured variable, during a full range transverse, i.e., dead band.

MAOP: The maximum allowable operating pressure is the maximum gauge pressure permissible in the piping system for a designated temperature. The MAOP is sometimes referred to as the MAWP (maximum allowable working pressure) and is the basis for the set pressure of the surge relief valve(s).

MATP: The maximum allowable transient pressure is the maximum gauge pressure permissible in the piping system for a very short duration. The MATP is not to exceed 110% of the rated MAOP. The MATP is sometime referred to as the MASP, the maximum allowable surge pressure.

Over Pressure: The pressure increase over the set pressure of the surge relief device, expressed in pressure units or as a percent of set pressure. This is also referred to as percent rise over set pressure.

Set Pressure: The gauge pressure at which the surge relief valve starts to open. In a modulating surge relief valve design, this is the pressure at which the valve begins to modulate. If the valve is of the on/off design, at this pressure plus the tolerance specified in the specifications, the surge valve will move to the full open position.

SRV: An abbreviation for surge relief valve.

Surge Pressure: The rapid change in pressure as a result of change in pipeline flow rates. In engineering terms, the conversion of kinetic energy (velocity) into potential energy (pressure).

Total Shut-Down Time: The time from manual or automatic initiation of the ESD to final closure of the ship, terminal or plant isolation valves.

Total Valve Closure Time: The total time for a valve to move from the fully open position to the fully closed position.

Wave Speed: The velocity of sound in the fluid flowing in a pipeline. This is the speed at which surge pressures are transmitted along a pipeline. Typical propagation velocities are 1,524 m/sec for water and 914 m/sec for crude oil lines.

5 Causes of Surge Pressure

Transient pressure waves are generated in a pipeline system whenever there is a sudden change in flow. The waves have both positive crests and negative troughs. The high pressure crest is commonly referred to as "surge pressure". Generally, a rapid change in flow is caused by:

- Pump start/stop
- Closure of automatic Emergency Shutdown Valves
- Rapid change in opening of flow or pressure control valves

With any of these events, both high and low surge pressure waves are generated. In the case of inadvertent pump stop, the pump discharge pressure will drop rapidly due to decrease in pump head and the suction pressure will rise due to a reduction in fluid velocity.

The prime concern is to protect the pipeline from over pressure. A surge suppression system is normally installed to relieve the high pressure peaks that exceed the pipeline MAOP. This standard defines any over pressure duration less than two minutes as "Peak Shaving". Consecutive surges of two minutes or less duration shall still be considered as "Peak Shaving".

In the case of an ESD valve closure or a control valve failure to the closed position, the surge valves may operate for an "Extended Period". This will depend on the proximity to pumps and the interaction of related instrumentation systems such as pump high discharge pressure trip, which may or may not be activated. This standard defines any flow duration in excess of two minutes and up to four hours as an extended period. Furthermore, this standard defines such an application as "Flow Diversion". An example is surge relief valves at pressure reducing stations. Surge duration in excess of four hours is unlikely, therefore, need not be considered.

For the purpose of selection and sizing of surge relief valves, surge studies shall be conducted to establish the duration and magnitude of the pressure rise. The transient analysis shall classify the surges into the two types described above.

6 Determination of Relieving Rates

As per ASME B31.4, paragraph 402.2.4, surge studies shall be conducted and surge relief systems shall be provided whenever the total pressure in the pipeline exceeds 10% above the MAOP, during abnormal operation. The surge analysis shall be based on single contingency failure modes. Dual contingencies are unlikely and shall not be used as the basis for computation of relieving rates.

The surge analysis conducted shall serve as the basis for determining the maximum relieving rates and the maximum relieving amounts. The transient analysis shall be presented as a plot of pressure vs. time and flow rate vs. time, for the contingency under study. The peak pressure and the peak relief rates shall be selected as the basis for sizing the surge relief system.

7 Selection of Surge Relief Valves

Surge relief valves are different from conventional relief valves in the sense that the valves have fast response time, high capacities and high set-point accuracy. The valves provide a choice of proportional, quick-open and on-off characteristics, with non-slam shut provisions. Direct spring loaded relief valves such as conventional relief valves are not acceptable for surge applications.

The surge relief valves shall be totally self contained and require no external electric, pneumatic or hydraulic power source. Gas loaded systems are considered to be self-contained and require no external power source. Distinction must be made between gas loaded and pneumatic systems. A pneumatic system, consumes air/gas on a continuous basis or during the operation of the valve. A gas loaded valve is considered to consume zero power, if no loss of gas is required during the opening and closing of the valve. As the valve opens, gas is compressed into an external or an internal plenum with no venting to atmosphere.

The valves shall be of the fail-safe design, i.e., fail to the open position during flowing conditions. The fail-safe design shall be accomplished by a flow-to-open or spring-to-open type configuration. The designer shall specify the type, size and other relevant process data on ISS, 8020-605-ENG.

7.1 Sliding Plug Axial Valves

The axial surge relief valve is a general purpose, cost effective solution for most surge applications.

Gas loaded axial valves are acceptable for "Peak Shaving" applications which can tolerate a dynamic response time of 250 milliseconds or less. These valves are also acceptable for "Flow Diversion" in low to medium pressure drop service, if the calculations indicate that no cavitation is present or the vendor can provide an adequate anti-cavitation trim. Refer to section 8.3 for anti-cavitation requirements.

The axial valve may also be pilot operated. Pilot operated valves generally have a slower response time and are better suited for clean, single phase products.

The transient analysis must demonstrate that a response time longer than two seconds is acceptable.

7.2 Y-Body Surge Valves

The Y-Body surge relief valve is similar in performance to the axial valves. The flow capacity is lower than a comparably sized axial valve, however, the valve recovery coefficient is slightly higher than the axial's. The Y-body is available in both gas loaded and pilot operated configurations. These valves shall be used in identical applications as mentioned in paragraph 7.1.

7.3 Globe Style Surge Valves

The globe style surge relief valve is a conventional control valve with a pilot operator. Because the pressure is not direct acting, and the actuator is external to the plug, the valve has a slower response time. Typically the response time will be one second or more. The strength of the globe valve lies in its ability to handle high pressure drops. This type of valve can be provided with an anti-cavitation trim with flow capacity larger than the axial type valve of the same size.

The globe surge valves shall not be used for "Peak Shaving" applications. Their applications shall be limited to the "Flow Diversion" when superior anti-cavitation performance, high capacity and slower operating times are desired. These types of valves can be fitted with modulating or snap-acting pilots.

7.4 Expandable Tube Valves

Gas loaded expandable tube valves have the fastest response time, typically, less than 250 milliseconds. For comparable body size, the flow capacity of an expandable tube valve is less than 20% of the axial flow valves. The failure mode may be to the closed position, which is not acceptable.

The simple design and the fast operating speed makes this valve ideal for applications such as tanker loading systems on jetties. However, due to their failure mode and the low capacity, applications must be justified. This type of valve shall be used only in "Peak Shaving" applications when none of the valves discussed above can meet the application needs. Prior approval by the General Supervisor, Process Instrumentation Division, Process & Control Systems Department, Dhahran, is required to employ this valve design.

7.5 Rate-of-Rise Surge Relief Valves

The rate-of rise surge valves are conventional SRV's with differential pilots, which can detect the rate of change in pressure in the pipeline and then modulate the surge valve opening proportional to this rate, thus controlling the surge rate in the pipeline. This type of system is used primarily in liquid systems with very high bulk modulus or incompressible fluids, i.e., sea water and refined products.

Such systems are equipped with an MAOP override regulator which permits the rate-of-rise modulation of the surge valves to continue, until the MAOP is reached. At MAOP, the surge valve opening is proportional to the static pressure in the pipeline. Upon restoration of the pipeline pressure below the MAOP, control is re-established by the rate-of-rise pilot.

The rate-of-rise system, due to its complexity, shall be used only when simulation studies justify the need for such a system. If a gas loaded pilot system is used, the system shall be fully compensated for change in gas density due to pipeline pressure excursions and ambient temperature.

The surge relief skid shall be equipped with an independent, self-contained test system to field check the differential pilot. The field test system shall generate a calibrated surge or dynamic rise in pressure for test purposes. The operation of the surge valve shall be verifiable at specified rate-of-rise set-point on the differential pilot.

7.6 Material Selection

Material selection shall be in accordance with API SPEC 6D, with the restrictions and exceptions noted below. For materials requirement for services not listed below, contact Process Instrumentation Division, Process & Control Systems Department, Dhahran.

7.6.1 Sweet Crude and Refined Products

Valve bodies for service temperature ranging from -28°C to +115°C shall be ASTM A216 WCC. Plug material shall be Electroless Nickel Plated ASTM A216 WCC. Seat trim material shall be AISI-316 SS. Wetted springs, if any, shall be of Chrome Vanadium or better. All dynamic valve plug seals shall be manufactured from Viton-GF. If anti-cavitation or cavitation resistant trim is required, the designer shall identify the proposed trim material on the specification sheets.

7.6.2 Wet Sour Crude

Valve bodies for service temperature ranging from -28°C to +115°C shall be ASTM A216 WCC. Plug and seat material shall be AISI-316 SS or 17-4PH SS. Wetted springs, if any, shall be made from N06600 material. All dynamic valve plug seals shall be manufactured from Viton-GF. If anti-cavitation or cavitation resistant trim is required, the designer shall identify the proposed trim material on the specification sheets. All material selection shall comply with SAES-A-301.

7.6.3 Treated Sea Water

Valve bodies, plugs and seats for service temperature ranging from -28°C to +115°C shall be AISI-316L SS. Wetted springs, if any, shall be made from N06600 material. All dynamic valve plug seals shall be manufactured from Viton-GF. If anti-cavitation or cavitation resistant trim is required, the designer shall identify the proposed trim material on the specification sheets.

7.7 Nitrogen Control System

For gas loaded valves a control system shall be provided to facilitate set-point changes, gas bottle replacement and instrumentation for alarms. The control panel shall have a viewing window and be field mounted in proximity to the surge valves. The panel shall be suitable for the area classification, as determined by SAES-B-068 and meet basic requirements specified in SAES-J-003. The panel shall have the following minimum instrumentation:

- Dual, non-bleed Nitrogen regulators with internal pressure relief and a cross over manifold.
- Nitrogen inlet/outlet pressure gauges with 1% or better accuracy.
- Low Nitrogen supply pressure switch.
- Hi/Low Nitrogen set-point pressure switch.
- Audible alarm, with acknowledge and reset push buttons only if the control panel is located at a manned surge station.
- Relief valve protection for instrumentation down stream of the regulators.
- Dry DPDT alarm contacts to pipeline SCADA system, when applicable.

In hydrocarbon service, when secure source of sweet gas is available, the sweet gas may be used in lieu of the Nitrogen bottles, if the minimum gas pressure is 30% above the highest anticipated surge relief set-point.

The Nitrogen regulators shall be selected such that the surge relief set-point can be maintained within 2% of set, for a temperature excursion of 40 to 150°F. If temperature compensating regulators are used, Nitrogen consumption per valve shall not exceed 2.0 SCFD. The selected vendors shall provide detailed calculations to substantiate the quoted steady state Nitrogen consumption. The daily consumption restriction does not apply to systems using sweet gas from a non-bottle supply source.

In installations where a single Nitrogen system is used to provide surge set-point to multiple valves, block and bleed valves shall be provided such that each surge valve can be individually isolated for testing and maintenance.

7.8 Plenum Design and Installation

Gas loaded SRV's have an internal or an external plenum to limit the pressure rise in the set-point cavity due to the displacement of piston or jacket movement. The designer shall verify the plenum sizing calculations to insure that the pressure rise due to the valve moving to the full open position, does not exceed the set-point by 10%.

The external plenum shall be buried underground to minimize set-point drift due to thermal expansion of the gas. On offshore installations, where burial is not practical, a sunshade shall be provided. The plenum shall be fitted with a relief valve, if required, to provide protection from accidental over pressure, which may result from regulator failure. The MAOP of the plenum shall meet or exceed the MAOP of the pipeline at the point of installation. The plenum shall be constructed from carbon steel and be in compliance with ASME SEC VIII, Division 1.

7.9 Pilot Design and Installation

Two types of pilot valves are generally used in most surge relief applications. The on-off pilot is the simplest in design. In service where the surge relief valve discharges to an external tank, on-off pilots shall be used. The modulating pilot is generally more complex in design and shall be used for applications where the snap-action of the on-off pilots can lead to unstable pipeline operations. Station bypass at a pressure reducing stations is one such application. Pilot valves shall be used only in clean service, e.g., stabilized crude, refined petroleum products and processed water.

The pilot assembly shall be designed such that it shall not be susceptible to plugging from debris in the pipeline. Only high capacity pilots with large flow areas shall be used. The pilot shall have separate sensing and supply ports. Filters shall be provided for both sense and supply lines. The pilot and the filters shall be manifold mounted with a minimum of external piping. The filters shall be replaceable with the surge relief valves on-line.

The main surge valve and its pilot system shall be of the fail safe design. The vendor shall guarantee that any single failure in the pilot sensing mechanism, pilot control mechanism, springs, pilot seals and actuator seals shall not prevent the valve from opening during pipeline over pressure conditions.

The pilot sensing accuracy shall be 1% of set pressure for modulating pilots. For snap-acting pilots 2% shall be acceptable. The combined (pilot, actuator & valve) maximum hysteresis shall be no more than 2% of set-point. The modulating span shall be a minimum of 2% of the set-point.

7.10 Seat Leakage

The maximum permissible seat leakage shall be in accordance with ANSI/FCI 70-2 Class-V. This leakage class meets the requirements for most surge applications.

8 Sizing Of Surge Relief Valves

The size of the surge relief valve(s) is heavily dependent on the set pressure. Before sizing calculations can commence, the set pressure must be accurately determined. Care must be taken to select a surge set-point which is well above the normal steady state operating pressure. The location of the surge relief valve can also have an adverse impact on the surge set-point. A comprehensive surge analysis must be conducted before the surge set-point, header losses and relief station location can be finalized.

The set-point and capacity calculation guidelines presented below applies primarily to cross-country pipelines designed as per ASME B31.4. For in plant piping, such as transfer lines, designed as per ASME B31.3, there is no mandatory requirement for surge analysis or surge protection. However, pressure is not permitted to exceed 20% or 33% above the MAOP of the piping, depending on the duration of the over pressure condition. Please refer to ASME B31.3, section 302.2.4 for details. Transient analysis on transfer lines of significant length should be conducted on a case by case basis. Distinction must be made between over pressure caused by transients and over pressure caused under static conditions. The latter is covered by SAES-J-600.

8.1 Surge Relief Set-points

As discussed above, an accurate assessment of surge relief set-point in a complex pipeline can only be arrived at by surge analysis. The following limits shall apply.

8.1.1 Set-point, Peak Shaving

The selected set-point shall not exceed the MAOP of the pipeline. A 10% transient rise above the set-point, to MATP, is permitted and should be accounted for in the capacity calculations of the SRV's. This restriction applies to single and multiple SRV installations. In the case of multiple valves, if a staggered set-point strategy is used, the highest set shall not exceed the MAOP.

SRV setting below the MAOP is desirable and shall be selected whenever the surge analysis indicates its feasibility. However, to prevent activation of the surge system during normal operation, the set-point shall be at least 5% or 100 kPa (15 psig), which ever is greater, above the normal operating pressure.

8.1.2 Set-point, Flow Diversion

The set pressure plus the permissible rise over the set pressure, shall not exceed the MAOP of the pipeline. The maximum rise over the set pressure shall be limited to 10%. When modulating valves are used, the set pressure shall be calculated as the MAOP, minus the modulating range of the valve. In this case, the SRV shall be full open at MAOP. Once again transient simulation shall confirm that the set pressure is sufficiently high enough, above the normal operating pressure to prevent accidental opening of the SRV's under non-surge conditions.

8.2 Capacity Calculations

Traditionally, simulation studies and SRV vendors present the capacity data as a plot of Flow Factor vs. % Rise. The volumetric surge flow requirements, obtained from surge studies, at a given set pressure is then used to select the valve size. This method of sizing shall be used only for estimation purposes. The final sizing calculations shall be based on the conventional control valve formulas as per ISA S75.01.

Header exit/entry and branch piping losses shall be calculated at the maximum surge conditions and these values shall be incorporated in the computation of the net P across the SRV's. The computation for the valve flow coefficient, Cv, shall be based on the net P. The minimum Cv of the selected valve shall be 1.1 times the calculated maximum Cv.

The Design Contractor shall provide the vendor with the application data necessary to confirm the valve sizing and selection. The valve selection and sizing shall be tentative until confirmed by the vendor. The vendor shall provide third party Certified Flow Test data for the proposed valve. Flow data on the proposed valve, if available from tests conducted by Saudi Aramco and validated by the Process Instrumentation Division, P&CSD, may be used in lieu of "third party" certification.

8.3 Cavitation and Flashing

ISA S75.23 shall be used to determine cavitation and/or flashing conditions. Vendor shall provide test data to verify the Valve Recovery Coefficient (FL) and Cavitation Index (Kc). This information shall be used as follows:

For Peak Shaving applications, the maximum allowable delta-P shall be calculated and used (instead of actual delta-P) for computing the maximum flow capacity. When cavitation is present with a standard off-the-shelf trim, the vendor shall demonstrate that the cavitation is within the tolerable limits of the standard trim. Otherwise, a valve with a heavy duty cavitation resistant trim shall be used.

For Flow Diversion applications, an anti-cavitation trim with a suitable Kc shall be selected to eliminate cavitation. Multi-stage trim shall be used, when required, to accomplish this task. The preferred flow direction shall be over the plug.

Commentary Note:

> *Distinction must be made between "cavitation resistant" and "anti-cavitation" trims. Cavitation resistant trims do not eliminate cavitation, instead the potential damage to the valve is minimized by selection of hardened trim materials. This can be a cost effective solution for valves which have short duty cycles and are dormant for more than 90% of the installed life cycle. The "anti-cavitation" trims on the other hand, eliminates the cavitation phenomena by dropping pressure in multiple stages or by tortuous path technology.*

8.4 Surge Valve Noise Limitations

Vendor specific software shall be used to predict installed noise levels. The vendor shall guarantee that the measured sound level shall not exceed the limits specified below. The sound pressure level (SPL) shall be measured as per ANSI S1.13.

For Peak Shaving applications, the maximum calculated noise level shall not exceed 105 dbA, at maximum flow capacity. Heavier branch piping, tapered reducers and lower exit velocities shall be specified to limit valve noise to 105 dbA.

For Flow Diversion applications, the maximum calculated noise level shall not exceed 90 dbA at maximum flow capacity. The bulk of the hydrodynamic noise is caused by cavitation. Therefore, selection of an appropriate anti-cavitation trim shall be used to accomplish this task.

8.5 Exit Velocity

The exit velocity shall be calculated at the discharge flange of the surge valve, at the maximum design flow. For all applications, the maximum allowable exit velocity shall not exceed 58 ft/sec. For high capacity valves, this will limit the usable Cv of the valves. The designer may have to increase the number of valves to meet this requirement.

8.6 Correction for Pipe Reducers

Whenever an SRV is mounted between pipe reducers, the calculated Cv for the selected valve shall be corrected for piping configuration. Vendor supplied, flow tested, correction factors for standard pipe reductions shall be used whenever this data is available. If no data is available, refer to SAES-J-700, paragraph 5.4 for the correction factors.

8.7 Liquid Viscosity Correction

The viscosity of most hydrocarbon fluids and water transported within the Saudi Aramco pipelines do not warrant correction. However, the vendor shall be consulted whenever the viscosity is larger than 100 SSU.

8.8 Back Pressure Effects

In surge applications, in most cases, the maximum flow requirement occurs when the back pressure is maximum. Therefore, the valve Cv shall be calculated at the maximum back pressure. Similarly, cavitation calculations shall include evaluation under the minimum outlet back pressure conditions. These values shall be extracted from the surge analysis, with single contingencies.

8.9 Multiple Valve Installation

Multiple valves shall be used when the design flow capacity or the exit velocity exceeds the largest available surge valve. In some cases, such as a surge valve relieving to a tank with limited capacity, multiple smaller valves are preferred, to guard against over filling the tank due to one valve failing. The designer shall calculate the number of valves required on the basis of the relief duration and the design criteria established by the project proposal. The minimum and maximum relief duration's shall be specified by the proponent's organization.

In multiple valve installations, a mixture of different valve sizes and types are not permitted unless it can be shown by surge analysis, that the application requires a combination of valves suited for Peak Shaving and Flow Diversion. The design shall be reviewed by Instrumentation Unit of P&CSD. A written approval is also required from the Manager, Process & Control Systems Department, Dhahran.

8.10 Spare Valves

In single and multiple valve installations, an identical spare valve shall be provided to facilitate periodic testing and maintenance of the SRV's. The spare valve shall be in service during normal plant operation. However, the flow capacity of the spare valve shall not be included in station capacity calculation.

At a given time, only one surge relief valve may be taken out of service for testing and maintenance.

9 Design Requirements for Surge Relief Piping

The branch piping in surge relief piping may be exposed to cavitation, flashing, noise and high fluid velocities. One or any combination of these factors can lead to severe vibration and consequently, structural damage. The skid shall be designed for maximum stiffness and minimum changes in flow direction. The lateral transitions from the header to branch piping shall be radiused. Use of stab-end connections and any connections with sharp edges protruding into the headers are not permitted. The following guidelines shall be used in designing surge skids:

9.1 Inlet and Outlet Piping

For the Flow Diversion applications the inlet/outlet headers, branch piping, block valves and the surge relief valves shall be in the same horizontal plane. Piping runs must be kept to a minimum length by close coupling of the surge valve and inlet/outlet block valves. The branch piping shall be adequately supported to prevent vibration by bolting the block valves to the skid.

For Peak Shaving applications, especially on jetties, where space is restricted this condition may be relaxed. Prior approval, by the General Supervisor, Process Instrumentation Division, P&CSD is required.

Velocity limits in the branch piping shall be governed by SAES-L-032.

Drains on branch piping shall be provided per SAES-J-700, paragraph 9.2.5.

9.2 Block Valves

For hydrocarbon service, block valves shall be provided on both the inlet and outlet sides of the surge valves. The block valves shall be either quarter turn ball valve, slab or wedge type gate valves. If gate valves are selected, the failure of the gate, shall be in the open position. For sizes up to 12 inches, the block valves shall have manual operators. For sizes 16 inches and above, the operator shall be motorized.

Block valves with manual operators shall be car sealed or locked open. Valves with motorized operators shall be provided with position indicators in the control room and shall be interlocked to prevent inadvertent closing.

For sea water and general water service, only the inlet block valve is mandatory. Outlet block valves are required only if the discharge header is elevated or filled with liquid under pressure.

All block valves, in any service, shall be of the full port design, no restrictions in the flow path is permitted. The block valves shall be of the same or larger size than the surge valve. All block valves shall be painted orange.

9.3 Surge Detection

Surge flow detection shall be provided. This may be accomplished by either direct or indirect means. The preferred method shall be to use an external proximity limit switch to monitor valve opening. If this option is not available on the selected valve, a thermal flow switch shall be provided on the outlet branch piping. The preferred mounting position for the switch shall be 45 degrees from the horizontal axis of the branch piping.

The switch in both cases, shall have dry DPDT contacts mounted in an enclosure suitable for the environment and area classification.

Instrument power supplied to dry contacts, for detection of flow or valve position, does not violate the "no electric power condition" specified in Section 7.

10 Testing and Inspection

Factory acceptance test is not mandatory for the standard off the shelf surge relief valve which are in frequent use within Saudi Aramco facilities. Factory testing is required for complex rate-of-rise or modulating valves which are custom built to meet a particular application.

Surge valves shall be tested in-situ every twelve months. The testing procedure is quite different from safety relief valves in that flow through the valve is not mandatory during the test. The set-point at which the valve opens shall be checked by creating a static pressure upstream of the valve, with the inlet isolation valves fully closed. This pressure can be created by a manual or electric driven hydraulic pump. Each surge relief valve shall have a 3/8 inch or larger port with plug installed to facilitate the testing requirements.

For gas loaded valves, gas cylinder pressure shall be inspected on a weekly basis. For pilot operated valves filters shall be checked and replaced as necessary on a quarterly basis.

Revision Summary

31 May 2005 Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.