



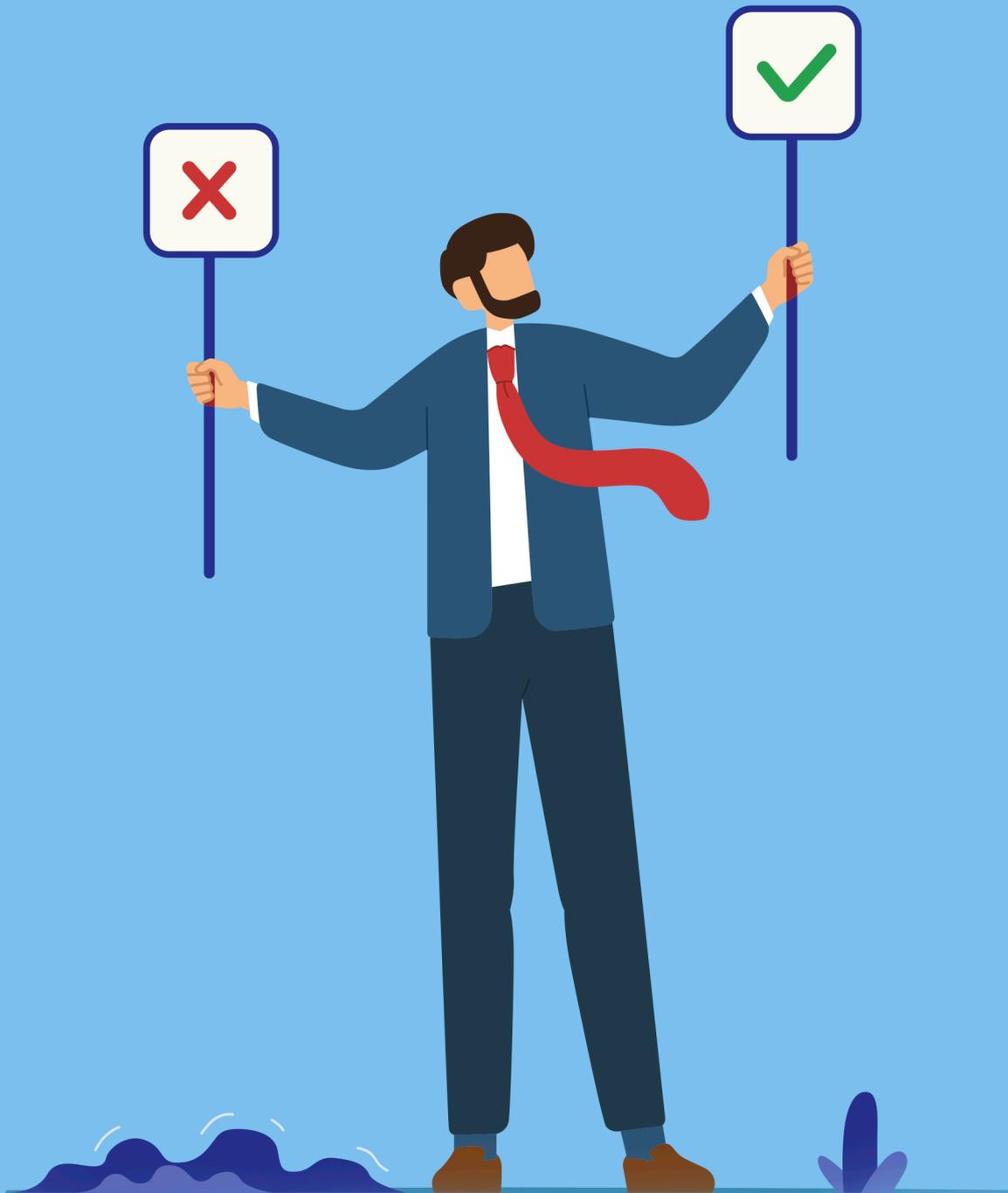
Severe service control and pressure relief valves in LNG plants

Siva Veerasakthi, Rebecca O'Donnell, Chris Jewell, and Jason Knudson, Baker Hughes, explore the various roles severe service control valves and pressure relief valves play in LNG plants and highlights the importance of choosing appropriate valves for each application.

LNG plants are being developed at a record pace across the globe, with intense focus on project execution and timely delivery to market. The importance of time-to-market is paramount for LNG developers and operators as it directly impacts competitiveness and profitability.

Once LNG trains become operational, uninterrupted plant performance becomes critically important. Key equipment is expected to run reliably for extended periods before scheduled turnarounds. This makes the selection of the right components, such as severe service control valves and critical relief valves, essential for maintaining safe and efficient operations.

COVER STORY



The goal of this article is to highlight the importance of severe service control valve and critical pressure relief valve product knowledge, choosing the right solution for the right application, and the value of partnering with companies that have the correct expertise. It also underscores the need for suppliers to offer local commissioning and start-up support to ensure smooth project execution and long-term reliability.

Severe service control valves

Severe service control valves play a vital role in the reliable operation of LNG plants. While there is no universally accepted industry definition for these valves, Baker Hughes™ – drawing on extensive experience with LNG operators and EPC firms – considers valves exposed to high pressure drops (greater than 750 psid), erosive or corrosive fluids, large flow variations, cryogenic temperatures (such as those caused by the Joule-Thomson [JT] effect), and suspended solids to fall under the severe service category.

Companies have seen first-hand that poor performance of these critical valves can result in serious consequences: plant trips, equipment damage, safety hazards, and costly unplanned downtime. Compounding the risk, these valves have typically long-lead items, and any trim replacement can take days or even weeks.

Given these challenges, this article emphasises the importance of early engagement with EPCs to bring special application engineers (SAEs) into the project lifecycle from the outset. Early discussions around start-up and commissioning support are equally essential. At Baker Hughes, SAEs bring deep expertise in LNG plant operations, product selection, material compatibility, and commissioning strategies, ensuring that the right solutions are in place to support long-term reliability and performance.

Below are the applications to be considered as severe service valves as minimum in an LNG plant. The valve locations are shown in Figure 1, which is a generic representation of the valve applications:

1. Feed gas control valve.
2. Lean amine pump recirculation.
3. Rich amine let down.
4. Vent to flare valve.
5. Compressor anti-surge.
6. Joule-Thomson valve.

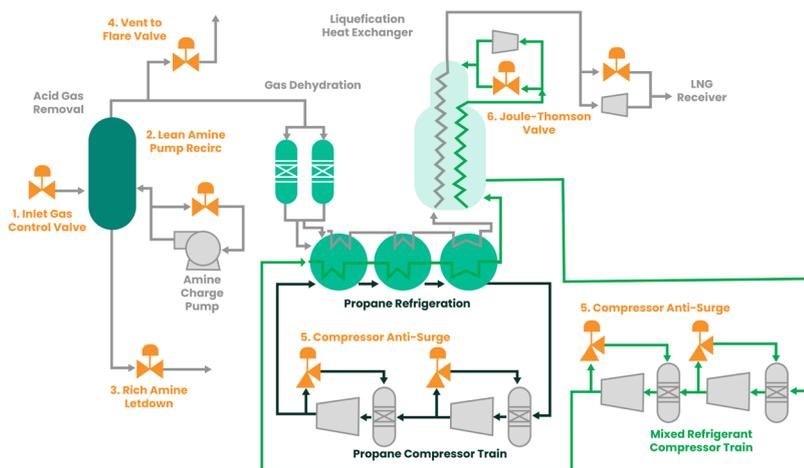


Figure 1. Generic severe service valve locations in an LNG plant.

Feed gas control valve

Feed gas to the LNG plant is critical and controls the inlet feedstock to the plant. This is the start of LNG production; the LNG plant requires steady feed gas flow and pressure to meet the nameplate capacity and performance guarantee expectations. The feed gas control valve accurately controls the flow and pressure of the feed gas entering the LNG plant.

The feed gas control valve faces high pressure drop that leads to high acoustic noise. Addressing the acoustic noise level at the source based on IEC 60534-8 is important. The path treatment of noise may not be suitable for this application as feed gas valves will have multiple operating cases and require addressing the noise for all cases. The operating cases vary from low flow to high flow. A single valve with special characterised trim may be required to address the wide operating cases. When the operating cases are too wide to handle for a single valve, a small valve in parallel with noise attenuation should be considered during start-up operation. If the feed gas has moisture, a self-flushing trim design is recommended to avoid hydrate formation or the need for heat tracing of valve and pipe. Ball or globe design is a suitable valve design for this application. For example, Becker T-Ball with Quiet Trim (T2 or T4) or Masoneilan™ 41000 Series with Lo-dB™ would be a suitable solution for the feed gas application.

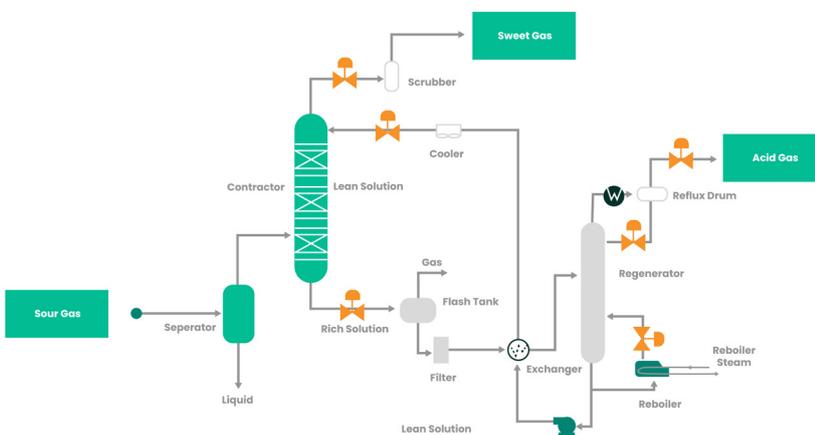


Figure 2. Generalised process flow for sweet gas and acid gas.

Lean amine pump recirculation valve

The feed gas will go through pre-treatment, acid gas removal (gas sweetening), and dehydration. The pretreatment unit helps to remove the liquids and heavy impurities.

The acid gas removal unit (gas sweetening) unit will help to remove the acid gas (for example, sulfur). The lean amine is amine before it has cleaned the feed gas. The lean amine pump is designed to pump the lean solvent to the acid gas-removed column. The minimum flow recirculation valve controls the flow to protect the centrifugal pump during start-up, shut-down, and upsets cases. The valve faces high pressure drop. Due to high pressure drop, cavitation damage can occur in the valves. The valve should be designed with anti-cavitation trim with ANSI Class V shutoff. Masoneilan 1 or 2 stage anti-cavitation trim or the 18400/78400 Series LincolnLog™ is a proven solution in this application.

Rich amine letdown valve

The rich amine letdown valve regulates the liquid level in the acid gas removal column. Rich amine, containing entrained and dissolved gases (primarily hydrogen sulfide and carbon dioxide), accumulates at the bottom of the column. Reliable and well-designed level control is critical for efficient sour gas removal.

During operation, the valve is exposed to severe vibration, gas expansion from off-gassing, and potential solids carryover. Therefore, the design must

withstand vibration, accommodate gas volume expansion, and ensure stable operation. A cage-guided, axial-flow, anti-cavitation trim combined with a reinforced stem design provides an effective solution for this service.

Special sizing methodology is required to account for off-gassing conditions. To mitigate stem twisting and related damage, the stem may be tack-welded or fitted with an additional stem pin. The Masoneilan 18400/78400 Series LincolnLog valve is a proven solution for such applications, with a long track record of reliable performance.

Flare system – pressure control valve

Proper control valve sizing must therefore account for trim noise, outlet noise, and total noise. Outlet fluid velocity should be maintained within the recommended Mach limits. Globe or angle control valves equipped with aerodynamic noise-abatement trims are preferred to address these challenges.

Acoustic-induced vibration (AIV) and flow-induced vibration (FIV) calculations should be performed to ensure there are adequate pipe supports and bracing. In many cases, the wide open flow rate of pressure valves can influence the sizing of relief valves. Accordingly, co-ordination between pressure-vacuum (PV) and pressure relief valve (PRV) sizing is essential to optimise valve C_v and ensure appropriate PRV capacity. An engineered, characterised trim is often the most effective choice for balancing PV and PRV requirements.

In addition, fixed pressure-drop noise-abatement devices, such as diffusers or stack plates, can create downstream back pressure that enables the use of relatively smaller, fit-for-purpose valve sizes. The Masoneilan 77003 Series Lo-dB valve and Lo-DB Cartridge are suitable designs in this application.

Anti-surge valve

Compressors are among the most critical equipment in an LNG plant and represent a significant portion of the capital investment. Protecting these compressors from surge conditions is essential for ensuring continuous and reliable plant operation. An optimally-designed control valve plays a key role in maintaining stable flow and preventing compressor surge.

Given the compressible fluid volumes and pressures involved, the anti-surge valve (ASV) is subject to aerodynamic noise and vibration. The valve must respond rapidly (within 1 – 2 sec.) while still delivering precise control. When out of service, it is required to provide metal-to-metal shutoff in accordance with ANSI Class V standards.

To achieve the necessary performance, the valve trim should incorporate a characterised cage, enabling both accurate control under normal conditions and the ability to accommodate large flow rates during trip scenarios. Special design considerations are required for acoustic noise prediction as well as acoustic and flow-induced vibration analysis. For continuous operation, noise levels must not exceed 85 dBA, while higher noise levels (up to 105 dBA) are permissible under intermittent conditions such as trip or hot-gas bypass.

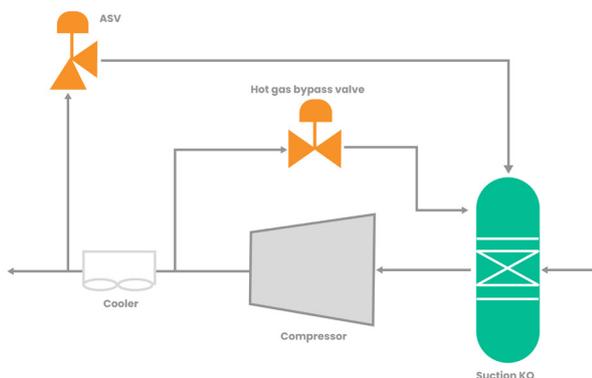


Figure 3. General anti-surge valve system.



Figure 4. Examples of 41005 Masoneilan and Nuovo Pignone anti-surge valves.

The ASV must be supplied with an engineered actuation package capable of meeting the stringent dynamic performance requirements specified by compressor original equipment manufacturers (OEMs). In cases where hot-gas bypass flow rates exceed the capacity of a single control valve, the use of an automated on-off butterfly or ball valve in parallel should be considered to optimise overall process control and valve sizing. The Masoneilan 7200S Series high-capacity valve with engineered characterised trim and actuator package is a proven solution in anti-surge applications.

Joule-Thomson valve

The main JT valve functions as a critical bypass element, diverting flow around the turboexpander when the expander is offline or unable to meet process flow requirements. Depending on the plant design, the fluid entering the valve can be in liquid, gas, two-phase, or liquid with dissolved gas. The valve is designed for cryogenic service and incorporates a characterised cage to address flashing, off-gassing, and potential cavitation effects.

During normal operation, the JT valve remains closed; therefore, reliable shutoff performance is essential. To ensure compliance with cryogenic leakage requirements under all operating conditions, dedicated cryogenic seat leakage testing must be conducted. Proper trim and seat design, along with actuator sizing and seat load verification, are required to achieve consistent and repeatable shutoff performance.

Cryogenic pressure relief valves

In LNG operations, PRVs are critical components that provide last-resort protection against overpressure events. Due to the high-risk nature of these systems, PRVs must meet stringent design and material standards. For cryogenic applications specific to LNG, BS-EN 13648 and ISO 21013 offer product testing guidance to ensure compliance and operational safety.

Unlike control valves, PRVs operate in a normally closed position, with the primary leak path at the

disc-to-nozzle interface. Due to elastomer incompatibility at low temperatures, metal-to-metal seating is standard.

Leakage-prevention technology

To address leakage concerns commonly encountered in cryogenic service applications, Baker Hughes engineered and patented the cryodisc design. This specialised solution significantly enhances seat tightness, ensuring reliable sealing both before and after a pressure relief event.

Central to the cryodisc's performance is its proprietary thermolip technology, engineered to actively adapt to fluctuating thermal loads by mitigating stress concentrations and preserving structural integrity. During extreme temperature fluctuations, the thermolip deflects downward, generating uniform contact pressure across the nozzle seat. This adaptive behaviour helps maintain a tight seal even under the demanding conditions typical of cryogenic applications, where conventional seat designs may struggle to perform consistently.

Full nozzle pilot-operated pressure relief valves

Full nozzle pilot-operated PRVs are preferred in LNG liquefaction due to their superior sealing, stability, and reliability in cryogenic service. Their metal-to-metal seating eliminates the need for elastomers, which are incompatible at cryogenic temperatures, while the full nozzle and seat isolates the main valve from direct process exposure during normal operations. These valves also tolerate operation closer to their set pressure, allowing for increased system throughput without compromising safety. This capability is especially valuable in low temperature LNG processes, where maximising flow efficiency is critical. Additionally, pilot-operated PRVs along with the metal-to-metal cryodisc can help improve re-seat integrity and reduce the risk of leakage, product loss, and fugitive emissions.

Conclusion

LNG plants are designed by EPC contractors in close alignment with licensor requirements. These facilities are expected to operate safely and reliably, with minimal downtime, to meet long-term contractual obligations. Severe-service control valves and PRVs are therefore critical to ensuring dependable LNG plant performance.

This article outlines the key factors to consider in the selection of severe service control valves and critical PRVs. Beyond these factors, the integration of digital diagnostics in valve positioners enables non-intrusive preventive maintenance, helping to avoid plant trips and equipment failures.

Furthermore, early engagement of SAEs during the project development phase allows EPCs to identify the most suitable valve for each application, while also accelerating sizing and procurement activities. [LNG](#)



Figure 5. Consolidated Type 2900TM Full Nozzle POSRV.