# Triple Offset Valves Can Replace Ball, Gate and Butterfly Valves

They are proving effective across a wide range of offshore applications.

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Owners and operators of offshore platforms, floating production storage and offloading units (FPSOs) and floating liquefied natural gas (FLNG) facilities face important challenges due to valve size, weight limitations and high levels of corrosion in the marine environment. Boosted by the constant need for higher production capacities, offshore applications require more robust and compact products. Emerson's Vanessa triple offset valves (TOVs) have proven effective in addressing these issues due to innovative product designs and material selection with a history of successes in this industry dating back more than 20 years. Three brief case studies that validate the effectiveness of Vanessa TOVs for offshore applications are included in this article.

Emerson's Vanessa Series 30,000 triple offset valves address the need for higher production capacities and more robust, compact designs for offshore applications. *(Images courtesy of Emerson Automation Solutions)*

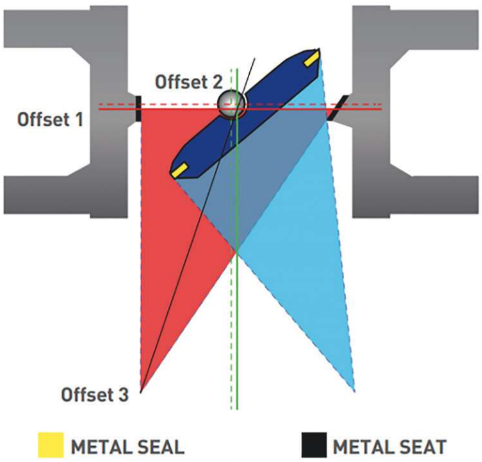
## Why triple offset valves for offshore?

Significant technological developments have been made in the butterfly valve segment over the past 40 years--the reduction or complete elimination of rubbing during rotation is part of the evolution of this type of valve. These relatively new designs (double offset, also known as high performance, and triple offset) ensure longer life cycles, require lower maintenance and provide an improved leakage performance compared to concentric types.

Nonetheless, the differences in terms of capability and functionality between double offset valves and triple offset valves are still somewhat confused. The Vanessa valve was the first to provide a triple offset valve capable of performing zero leakage by using a non-rubbing design across the entire 90° rotation (differently from double offset valves), delivering a single, instantaneous contact between sealing elements only when a closed position is achieved. (Zero leakage means no visible leakage when tested at high pressure with water and low pressure with air according to existing international standards.)

Vanessa TOVs are able to handle bidirectional flow and tightness in both sealing directions up to ASME class 1,500 pressure due to the combination of such non-rubbing rotation with torque seating (a key difference with position seated concentric butterfly valves) achieved with three "offsets":

1. The shaft is placed behind the plane of the sealing surface;
2. The shaft is placed to one side of the pipe/valve centerline; and
3. The seat and seal cone centerlines are inclined in respect to the pipe/valve centerline.



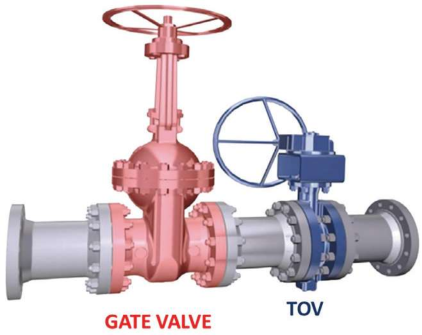

Vanessa TOVs are capable of achieving zero leakage by using a non-rubbing design across the 90° rotation capable of delivering a single, instantaneous contact between sealing elements only when a closed position is achieved.

On these premises, the seal ring (and not the disc itself, as is in the case of other butterfly valve designs) is the critical component as it represents the key flexible element necessary to perform sealing against a seat that is integral to the body and overlaid with Stellite grade 21. A dynamic spiral wound gasket ensures an adequate expansion and contraction of the seal ring during opening and closing.

## Isolation applications

For centuries, linear (multi-turn) movement valves such as gate valves have been used in process isolation based on a simple design principle (i.e., a stem pushing a wedge into a seat to achieve shutoff.)

Although this design is quite safe, over the past decades there has been a surge in the use of soft-seated quarter-turn valves. Ball valves in particular have gained popularity in view of their tighter shut-off capabilities because of the use of soft sealing materials, their functional versatility and a more compact design (which is a feature common to all other quarter-turn valves). Recently, end users have come to face tighter Health, Safety and Environment




Vanessa TOVs can be adopted for both positive and double positive isolation setups in place of a gate valve for their zero-leakage capabilities and reduced footprint.

(HSE) regulation. As a result, revisions to the design concept behind the idea of "positively" sectioning a line (i.e., with no admissible leakage downstream) are continuously made. This function ensures that equipment can be safely removed and maintenance/inspection requirements can be addressed without shutting down the entire facility. Based on their inherent characteristics and zero-leakage shutoff capability, Vanessa TOVs have been adopted for both positive and double positive isolation set-ups in lieu of both gate and ball valves, providing significant benefits in terms of operability, performance and overall cost of ownership.

## On-off applications

An on-off process functionality implies initiating/blocking the flow of a medium to manage the startup, operation and shutdown of a plant. From a process functional perspective, such actions are carried out to shutdown pieces of equipment, blow off/blow down media and redistribute flow to different lines (also known as switching).

Usually handled by ball valves, these functions are subject to several challenges, mainly correlated to the degree of severity of the service and the consequent need for valve maintenance which generates important down time costs. Ball valves are typically pressure seated valves with a cavity that requires a relief system--which is non-standard and varies from manufacturer to manufacturer. Such cavity relief requires installation on the appropriate side, depending on pressure differential, to be effective.

Vanessa TOVs are capable of overcoming all these issues with a low maintenance solution combined with reduced weight and footprint.

## Emergency shutdown applications

The IEC 61508/61511 standards set up key provisions for implementing a safety integrity system (SIS). The design purpose of an SIS is to protect personnel, equipment and the environment by mitigating the likelihood and severity of the potential risk. In a modern industrial facility, the SIS is designed to prevent or reduce hazardous events by taking the process to a safe state when predetermined conditions are violated.

SIS is commonly an emergency shutdown system (ESD), high integrity pressure protection system (HIPPS), safety interlock or safety shutdown system. SIS typically includes the design and implementation of a variety of shutdown and/or blowdown valves. Based on the probability of failure, there are four safety integrated level (SIL) classes going from SIL 0 (none, lowest risk) to SIL 4 (highest risk).

Higher reliability/plant availability is achieved by using proper safety components (design), installing such components according to manufacturer's guidelines and testing them both at initial startup, as well as at specified intervals or after any modification. This is why an inherently safer SIL 3 Vanessa TOV, coupled with appropriate automation and controls, can contribute to delivering an overall safer system.

Vanessa TOVs feature a non-symmetric design which implies that, depending on installation direction, the valve can fulfill a safety function facilitated by the flow (open to close) or pressure (close to open). This is possible in view of extremely low running torque values due to the non-rubbing rotation and the asymmetric trim design.

## Case Studies

### *Early Vanessa TOV adoption in the Norwegian North Sea*

For most offshore platforms in operation in the Norwegian North Sea, ball and gate valves had been considered by a major oil and gas company the standard for most of their flow isolation applications for decades. However, in 1994, this oil and gas customer chose to test Vanessa TOVs during a yearly routine production shutdown as a means of exploring a lighter, cheaper and potentially more reliable solution. When the end user overhauled the crude oil pump, the Vanessa valves—which were operated by an actuator--were also deployed to manage the isolation of the pumps from the main oil header under full pressure. The test was so successful that these Vanessa valves were kept in service. Since then, Vanessa TOVs have been installed in numerous offshore applications around the world.

### *Further developments in offshore Brazil*

Reducing weight while also maximizing space is a constant quest for EPCs and end users who are building platforms and FPSOs.  To address these critical needs, a major oil and gas company operating in fields off the coast of Brazil replaced all heavy top-side ball and high-performance butterfly valves with Vanessa triple offset valves on two of their FPSOs. This type of valve had been installed previously on the cargo tank piping system on the main deck and in the pump room, and proved difficult to operate and disappointing in terms of long-term performance. As an alternative, Vanessa valves were adopted in these areas instead to address both isolation and ESD functions with a single product. Several years later, these Vanessa triple offset valves were in operation. Subsequently, because of the success of the first installation, this customer also chose Vanessa valves for installation on three additional FPSOs.

### *New TOV applications in E&P*

In recent years, with the newest developments of FLNG (including floating storage regasification units or FSRUs) technology has leaped forward, and so has the TOV range of applications. While utilities (including the ones used on topsides and floating units) have been easily handled by Vanessa valves for many years, there have been new groundbreaking adoptions within processing areas. To name a few, TOVs have been specified in separators (used to separate oil from gas and other debris including sand), in vapor recovery units (where waste gas in a FLNG is recovered instead of being flared), HIPPS and as isolation valves in gas flaring systems.

Furthermore, another important process in which TOV adoption is gaining traction is the dehydration and purification of gas through molecular sieving. Used in both gas FPSO and FLNG applications, molecular sieving has historically been handled by heavy rising stem ball valves. These valves on larger sizes and pressure classes are extremely heavy and have a large footprint, generating a number of direct (material use) and indirect (installation and increased floating vessel weight) costs that engineers must account for during frontend engineering design (FEED) project phases. The tilting mechanism itself, a variant on a standard quarter-turn ball valve, is subject to wear and can degenerate over time. Although the valve sealing elements may not involve rubbing capabilities, friction is transferred to both the shaft cam (towards core pins) and the S-shaped pin slot. This valve design requires specialized maintenance, including the use of costly spare parts, significant time and effort.

Since 1999, Vanessa TOVs have been used on molecular sieve offshore operations in Malaysia. Some of the Vanessa valves replaced rising stem ball valves for a CO2 membrane system that featured a two- to four-hour open/close cycle; those valves are still in operation. Hundreds of rising stem ball valves have also been replaced in gas plants in solid bed molecular sieve applications, and there are many more cases of TOV evaluation and adoption in response to the recommendations by major molecular sieve process licensors.

## Conclusion

In offshore applications, 100% metal-constructed TOVs such as Vanessa represent a robust fire-safe valve for services (e.g., crude oil) containing debris and other solid particles. Furthermore, TOVs are valves that are not affected in terms of performance by piping loads that may distort the valve body compared to sealing plane/trim. This differs from comparable ball valves, where two seating planes will become misaligned with each other, thus increasing the friction with the ball in between and, therefore, increasing operating torque. Such benefit is even more significant in emergency-type of operations.

Non-rubbing in a triple offset valve also means lower wear of sealing components. This is how a TOV fundamentally differs from high-performance butterfly valves (typically featuring rubbing for approximately 20 percent of rotation) and it is an extremely crucial feature whenever the valve is used in process applications entailing a high number of cycles, including those found offshore. Compared to gate and ball valves, the savings in terms of weight and footprint reduction are massive. Furthermore, TOVs are easier to operate than gate valves even with a manual gear because of a low running torque and no need for extra safety factors during actuator sizing. TOVs also have the ability to open against full pressure without any need for upstream depressurization, which is another collateral cost-reducing benefit compared with ball valves that may require a bypass line instead.Q

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