



Improving Safety and Production for Shutdown Valves

Solberg & Andersen As

Executive Summary

Production Output, Safety Integrity Levels, and Flow Assurance are important production metrics that directly affect the performance of your assets. One of the essential activities that improves safety but reduces period production and flow assurance is required testing of critical shutdown valves (SDVs). Solberg & Andersen's ValveWatch® valve seal leakage detection and condition monitoring system enables offshore and onshore oil and gas producers to remotely monitor their emergency shutdown valves 24/7/365, minimizing the need for shut-ins and increasing production uptime. Because seal integrity can be detected with the valve in the open flow position, there is no need to shut-in on a monthly basis thus improving monthly production and reducing downtime and labor costs required for manual leak testing on the platform

The remote monitoring capability can increase safety integrity levels by monitoring, recording and flagging for valve leak and valve operational readiness 24/7. Fully automated testing and real time data acquisition facilitate compliance with regulatory test requirements. Additionally, the operator can view the valve status at any time using a web application

The test frequency for critical SDVs varies from monthly to annually depending on the country and regulatory requirements. A new online monitoring system has been deployed in the Gulf of Mexico, North Sea and Malaysia that enables continuous online testing for SDV seat leakage (passing) while the valves remain in the full open, full flow position. While avoiding valve closure for manual leakage testing, this new approach can increase the Safety Integrity Level and enhance Asset Management thereby reducing the maintenance workload and assuring continuous flow and optimizing production.

Background

Following the Piper Alpha accident, the Norwegian Petroleum Directorate (NPD) increased pressure on oil companies operating in the North Sea to verify, through periodic testing, the ability of critical SDVs to perform as required during an emergency. Statoil and Norse Hydro struggled with the impact of SDV testing requirements on production output and the increased O&M cost due to the testing process. As a consequence, Statoil, Norsk Hydro CRANE Valve Services and Solberg and Andersen as collaborated on the development of an automatic online condition monitoring system for SDVs. The ValveWatch™ system is the result of that collaborative effort. Since the first Norwegian installations Solberg & Andersen As was working with the development of applications of the system, making the condition monitoring feature the same important as the leakage detection. ValveWatch systems are currently installed in Norway, Malaysia and Brazil.

Manual Testing Methods: The most common valve type used in offshore SDV applications has sealed cavities. These include ¼-turn trunnion mounted ball valves as well as various configurations of slab-gate valves. FIGURE 1 depicts a ¼-turn trunnion mounted ball valve in the closed position. The product is isolated on the upstream side by the ball blocking the inlet orifice. The seals, or seat, between the valve body and ball prevent leakage (passing) into the ball valve cavity. The other side of the ball and another seat blocks the downstream piping. Both seats must leak before product can pass completely by the valve.

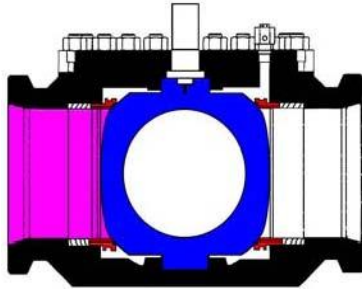


FIGURE 1

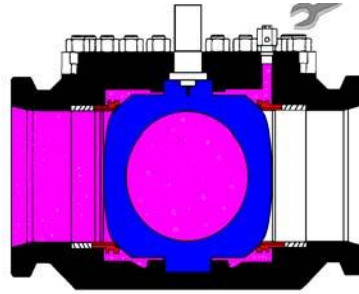


FIGURE 2

SDV test procedures often require that the main valve be closed to assess the integrity of the valve seats. When an SDV is closed, the cavity will be filled with product and pressurized as depicted in FIGURE 2. The upstream seat can be evaluated by venting the cavity, then monitoring for an increase due to seat leakage. The cavity can also be pressurized with inert gas and monitored in order to evaluate the integrity of both seats. This testing requires the production to be shut down

Valve Watch leakage detection with acoustic sensors: Another test method used to evaluate SDV seat leakage is to close the valve and listen for indications of leakage past the seats with ultrasonic sensors. This method requires the creation of differential pressure across the valve where both seats leak, thereby generating a high frequency noise as pressurized product escapes to the lower pressure area downstream of the valve. The acoustic sensors allows to test valves with no closed cavity, like butterfly valves or to be used on valves where no intrusion is allowed to the valve or the pipeline downstream of it, like export valves..

This method requires the valve to be closed for testing. The Valve Watch system uses the unplanned stops to take tests with the acoustic sensors.

The ultrasonic leakage detection system with ValveWatch is made in cooperation with ClampOn as, Norway

ValveWatch leakage detection with dynamic pressure transducers

Unlike other methods of leak detection that require valves to be closed for testing, ValveWatch with dynamic pressure transducers allows operators to monitor and identify leakage while valves are open and production is flowing. This solution offers operators the chance to minimize the labor and downtime related to testing. It also gives them the ability to trend valve seal performance and proactively plan for maintenance or repair

The ValveWatch system with dynamic pressure transducers sense the fluid oscillation in the sealed cavity of a valve and compare the frequency content and amplitude to the oscillations in either the upstream or downstream flow stream. As the signals become similar, alarms are set to warn operators of seal integrity

ValveWatch Condition monitoring

Both types of leak monitoring ValveWatch systems are equipped with a strain sensor, mounted on the actuator yoke and one or two static pressure sensors mounted on the actuator tubing .These allow:

- To calculate
 - solenoid actuation time (both ESD and PSD),
 - peak valve load, average valve load, stroke time
 - actuator pressure/time curve
 - strain/ time curve
- To measure the valve safety factor
- To record ESD/PSD/PPS signal timestamps, valve limit switch timestamps via OPC ,
- To identify opening and closing “benchmark” test with valve in good condition and compare subsequent tests to the benchmarks.

Data handling

Data is collected from the sensors by the Local Data Acquisition Unit (LDAU) Assembly which is placed in a weather proof box, installed as close as possible to the valve. The LDAU system includes two Strain/AC modules and one Communications Module. The strain channel monitors signals from the strain and static pressure sensors, and the AC channels handle the dynamic pressure sensors. The signals are conditioned and converted to digital in the sensor modules and passed to the Communications Module transmitting to a HUB Assembly in the safe area. The acoustic sensor is conditioning the signal in the sensor. The LDAU Assembly and the sensors are designed to be intrinsically safe and are certified according to European standards for installation in areas where an explosive gas mixture can be continuously present (Zone 0).

An additional communications and Ethernet module are housed in the HUB Assembly along with all the power supply, terminal strips, and intrinsically safe barriers. An Ethernet cable connects the HUB to a data collection computer where the data is transmitted via OPC to the control system and to the on shore diagnostic center. All the test results and data are stored in a secure Oracle database application.

The system software performs the leakage calculations using patented algorithms that run automatically whenever a test is performed. The test results are compared to pre-established limits, and alarms warn operators. Each valve is analyzed during initial start-up of the Valve Watch system using the “Learn-Mode” feature of Valve Watch.

Learn-Mode is used to determine the characteristics of a valve while it is new and to set thresholds for the alarms.

Security is provided so that only authorized persons can access the system map, alarm window and system tree to view platform, valve and sensor status. The software provides reports and trending plots so that operators can evaluate ongoing performance.