



**Improving Safety and Production
through New Testing Methods for
Shutdown Valves**

Crane Valve Services, Inc.

December 12, 2007
Doc.No. 1901(rev. b)

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). Crane Valve Services' ValveWatch® valve seal leakage detection system enables offshore 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 is 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 leaks 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 Norsk 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 and CRANE Valve Services collaborated on the development of an automatic online condition monitoring system for SDVs. The ValveWatch™ system is the result of that collaborative effort. ValveWatch systems are currently installed in Norway, Malaysia and the Gulf of Mexico on over 60 valves.

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.

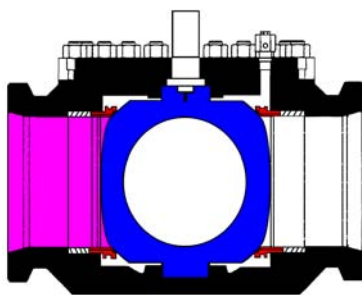


FIGURE 1

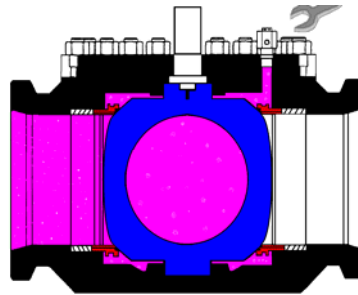


FIGURE 2

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.

Closed Flow Alternatives to Manual Testing: Another test method used to evaluate SDV seat leakage is to close the valve and listen for indications of leakage past the seats with acoustic or 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.

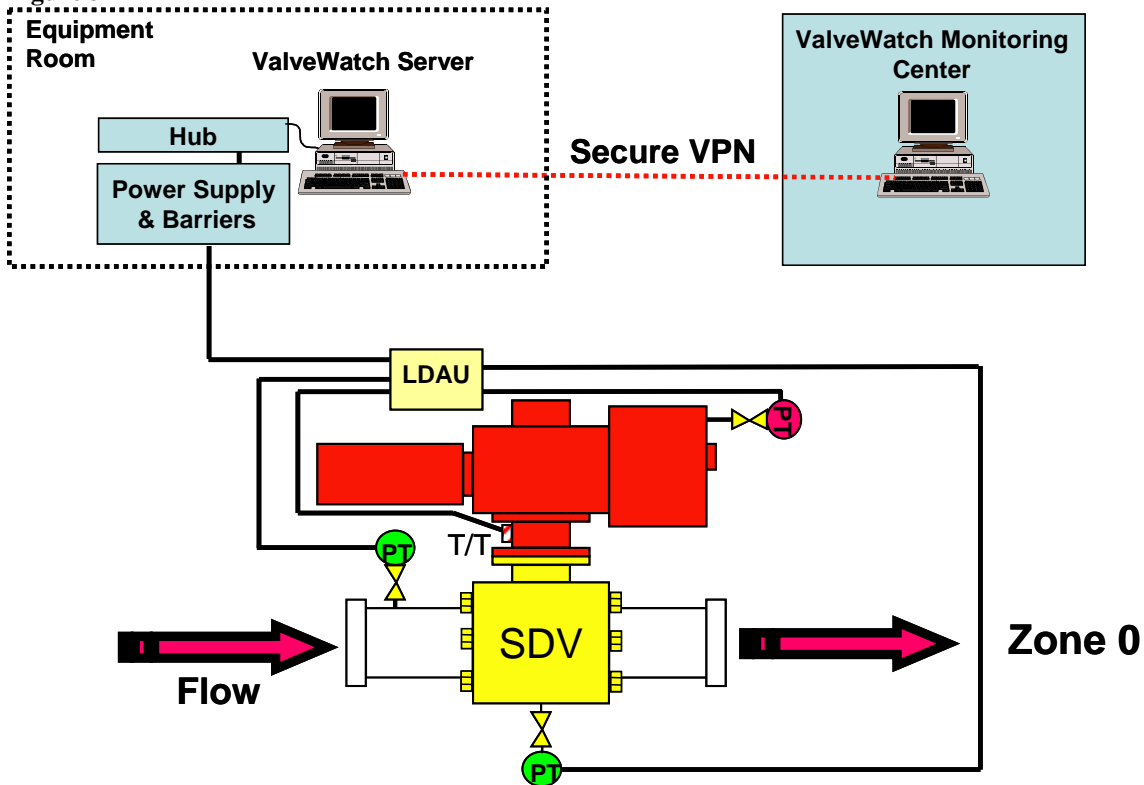
Both of the methods discussed above require the valve to be closed for testing. When SDVs are closed for testing, production stops.

ValveWatch System

CRANE Valve Services’ ValveWatch system is a unique tool for monitoring and identifying seal leakage in critical valves. Unlike other methods of leak detection that require valves to be closed for testing, ValveWatch allows operators to monitor and identify leakage while valves are open and production is flowing. This innovative 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.

With the ValveWatch system, 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 a seal integrity problem.

Figure 3



The system also includes a strain sensor that provides an indication of stem torque or thrust levels and a static pressure sensor for monitoring actuator pressure. The strain sensor is typically used to trigger collection of data whenever the valve changes position.

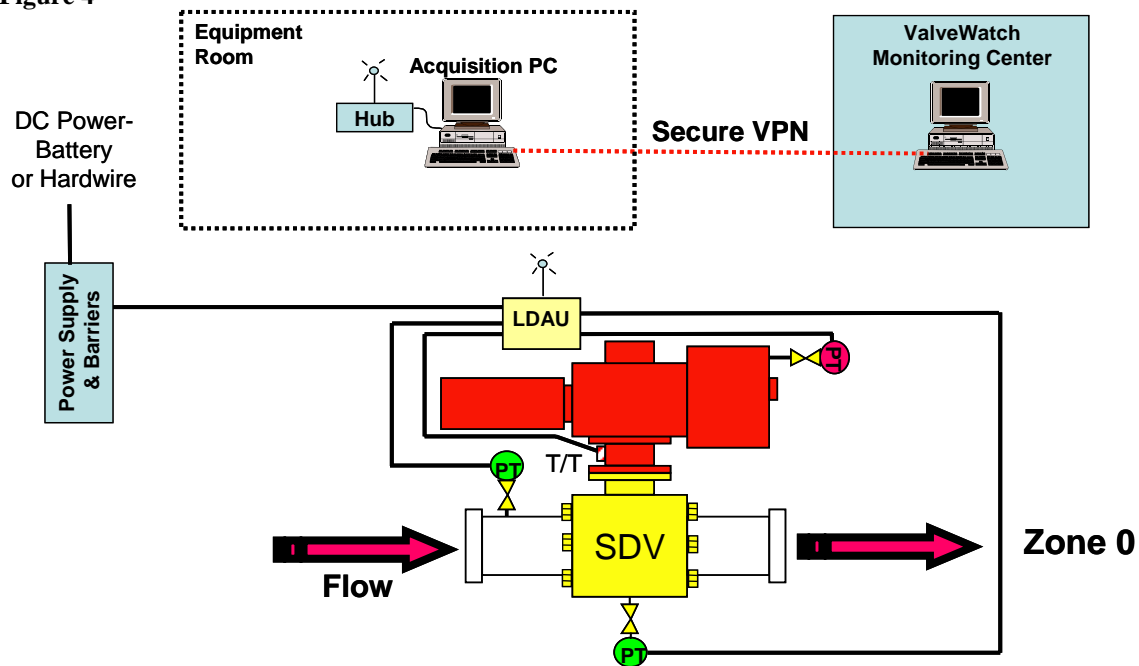
Data is collected from the sensors by the Local Data Acquisition Unit (LDAU) which consists of an IP66-rated weatherproof enclosure containing several modules installed close to the valve (within 15 meters, depending on cable routing). The standard system includes two Strain/AC modules and a Communications Module. The strain channels monitor 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 for wireless or data-over-power transmission to a Hub assembly. The LDAU assembly and the sensors are designed to be intrinsically safe and are certified according to North American and 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. The Hub assembly is typically mounted in a safe or low hazard area (Zone 2). An Ethernet cable connects the Hub to a data collection computer where the data is transmitted to the Crane monitoring center for analysis and storage.

See Figures 3 and 4 for system diagrams for ValveWatch, configured for either data-over-power or wireless communication between LDAU and Hub.

Figure 4



Remote Monitoring

All test results and data are stored in a secure Oracle database application in the Crane monitoring center. System software performs the leakage calculations using patented algorithms that run automatically whenever a test is collected. The test results are compared to pre-established limits, and alarms alert monitoring center personnel to potential degraded seal conditions.

The Crane monitoring center responds to the alarms and performs backup analysis to further evaluate an alarming valve. The monitoring center may request additional tests through the software and can change the test parameters if needed to fully characterize the leak condition. Customer personnel will be notified promptly of any alarming condition and the actions required to evaluate it. The monitoring center will provide timely recommendations for any necessary corrective action.

ValveWatch Monitoring Center (Web Interface)

A simple web interface (see Figure 5) allows the operator easy access to the system status from any location. Security is provided so that only authorized persons can access the site.

The web interface provides a geographical and geometric presentation of the platform location and color coded alarm indicators for both valve and system status. An explorer tree shows the individual status of valve sensors and communication equipment (on the configuration tab). At the bottom of the screen is an event log with the condition of equipment alarms and time stamp information. Access to the web site is through a secure encrypted password login.

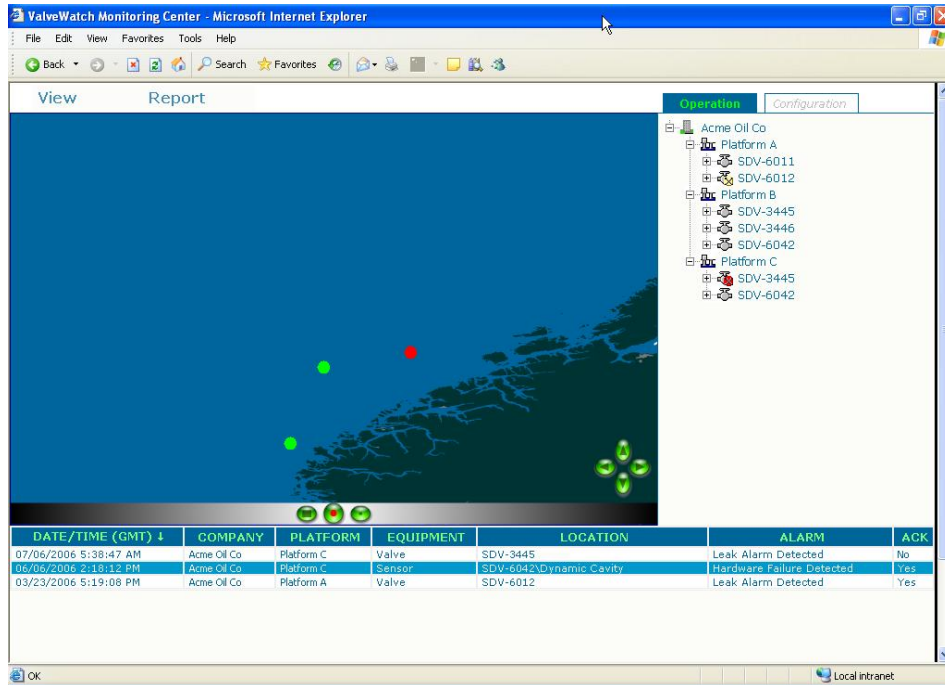


Figure 5 - ValveWatch Monitoring Center Web Interface

From this site to the customer can generate reports similar to the “ValveWatch Trend Report” shown in Figure 5.

Equipment Calibration

There is no equipment in the ValveWatch system that requires periodic calibration. Each component is addressed below.

Strain Sensor: This sensor is scaled in volts and is only used to look at relative trends in load and as a signal to trigger the data acquisition. The sensor is not calibrated to torque or thrust. A function test could be performed to verify the bridge resistance but Crane does not recommend this.

Dynamic Sensors (Cavity and Upstream or Downstream): These sensors are delivered from the manufacturer with a calibrated sensitivity. It is Crane’s experience that these sensors will operate for the life of the sensor without re-verifying the sensitivity number. The major reason driving this determination is that the sensor is used to compare frequency content from two locations (cavity and in-stream) and relative changes in amplitude between the two locations after significant amounts of data have been taken and averaged many times. Some customers actually use a generic sensitivity for all sensors and this does not affect the ValveWatch results. This sensor does not have any adjustments to calibrate so a simple function test would be more relevant if a test were to be performed.

Static Pressure Sensors (Actuator Pressure): These sensors are delivered from the manufacturer with a calibrated sensitivity. Crane sees no need for calibration. We can also use these to trigger the acquisition as the valve is positioned and we look at relative trends in this data over time. No specific action is taken upon the absolute value of these sensors. This device can be calibrated in the field using OEM equipment but Crane does not feel this is necessary.

Local Data Acquisition Unit: This device is given an initial factory calibration to optimize the gain factors but does not require recalibration in the field. The reasoning applied to the sensors is also applicable to the acquisition unit. ValveWatch does not make any determinations based on specific calibrated amplitude. All functions are based on relative changes in signals and these are based on averages of averages. This unit could be field calibrated with a Function Generator, DVM and Calibrated Strain Simulation device, however Crane does not believe this is necessary.

Historical Performance

ValveWatch has been in use for several years on many offshore platforms and is currently installed on platforms in the North Sea, Malaysia and the Gulf of Mexico. ValveWatch has proven to be useful in the evaluation of seal integrity that is critical to the safety function of the ESD, as well as in more general condition monitoring to facilitate general purpose asset integrity.

The following are examples of how ValveWatch technology has helped operators identify ESD-related issues that could impact the proper operation of their ESDs.

Examples

In October 2003, ValveWatch raised a leak alarm for a monitored valve on a North Sea platform. After reviewing the acquired data, the ValveWatch analyst concluded that seal integrity had degraded, and a manual leakage test was performed, confirming the leak. After flushing the seats with diesel fuel, another manual test was performed to ensure the valve was no longer leaking and the ValveWatch alarm cleared. See Figure 6.

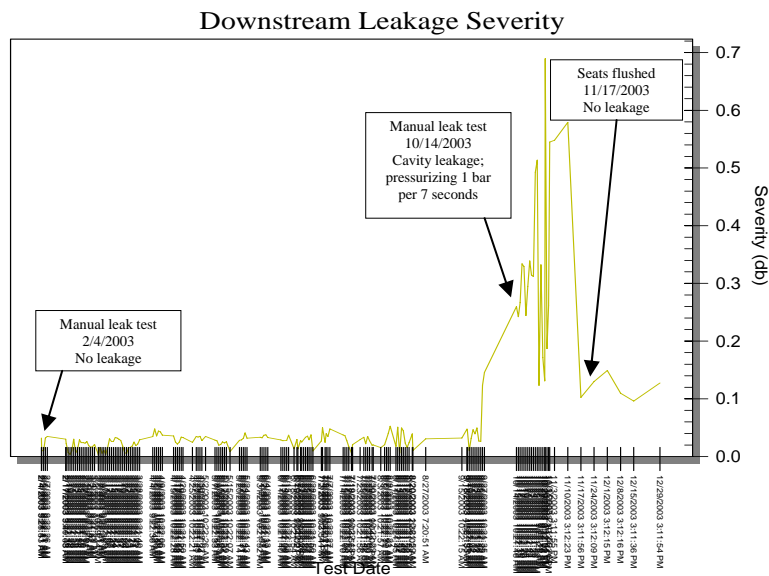


Figure 6 - ValveWatch Monitoring Center Web Interface

In January 2006, while reviewing performance trends for a valve on a platform in Malaysia, the ValveWatch analyst noted a significant rise in yoke strain over the course of several months, indicating increasing torque required to open and close the valve. The analyst notified the operator and maintenance was performed at the next opportunity. A subsequent stroke test showed that yoke strain had decreased significantly. See Figure 7

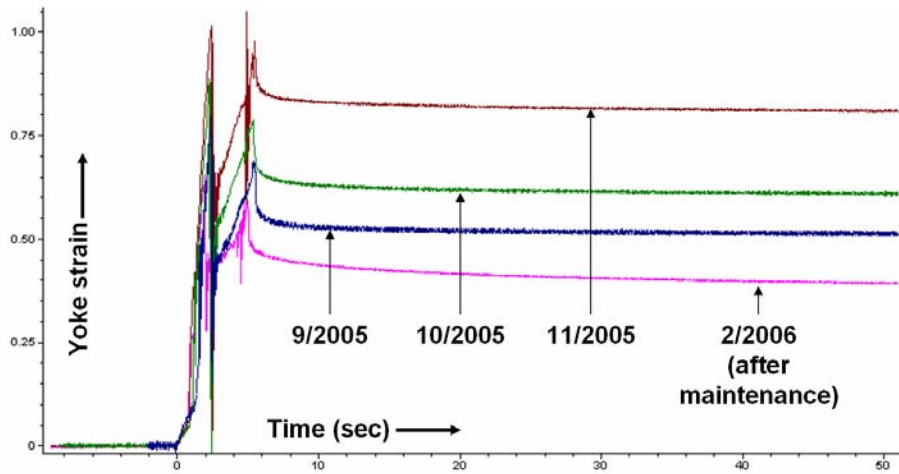


Figure 7 - Increasing stem load trend from open valve strokes

For more information, contact Brett Allen at ballen@cranevs.com or call 770-429-4732.