Solution Guide for Partial Stroke Valve Testing (PSVT)

PHOENIX CONTACT
INSPIRING INNOVATIONS

Solution Guide: Wireless and Wired HART®-Based Partial Stroke Valve Testing (PSVT) for Emergency Shutdown (ESD) and Critical Operation Valves in the Hydrocarbon Process Industries

This document outlines the use of **Phoenix Contact Partial Stroke Valve Testing (PSVT)** System Solutions.

The Phoenix Contact PSVT System Solution can be implemented using the WirelessHART® technology for the remote operation and monitoring of valves in the hydrocarbon-based process industries, both onshore and offshore. The system can operate in a stand-alone mode — for a specific valve in a specific location — or can be connected to a supervisory DCS/SCADA or individual PLC system.

Within a conventional non-Hart 4-20 ma legacy system, it is possible to continue to use the existing wiring and install a smart positioner with a wireless adaptor on the valve. The wireless adaptor will then communicate the valve diagnostic information wirelessly to a strategically located wireless gateway. The gateway has the capability to support multiple smart devices. This type of setup can also be implemented where operations wants to keep the control system segregated from the asset management/maintenance system.

Partial stroke testing is interpreted as: *Having the capability of using a HART-enabled device to initiate a partial stroke test on a valve (e.g., physically initiate a valve movement remotely) without affecting usability or control of the valve, and to provide documentation of the parameters that verifies the test sequence and the criteria for performing the test.*

Additionally, a HART-enabled device will have the capability of electronically recording the shutdown parameters when the valve closes in an emergency and will store, document and transmit valve performance data for later analysis.

Standards and Best Practice Guidelines for PSVT

Partial stroke testing is an accepted petroleum industry standard technique and is quantified in detail by regulatory bodies such as:

IEC61508 – Functional safety of electrical/electronic/programmable electronic safety-related systems

IEC61511 – Functional safety/safety instrumented systems for the process industry sector

ANSI/ISA-84.00.01 – Functional safety/safety instrumented systems for the process industry sector: American Petroleum Institute (API) and Recommended Practices (RP)

- API RP 75
- API RPI 520
- API-RP 754

CFR-1910.119 – Process safety management of highly hazardous chemicals (requires documentation on test results and events)

P.O. Box 4100, Harrisburg, PA 17111-0100 | Phone: 717-944-1300 | Fax: 717-944-1625 | Technical Service: 800-322-3225
E-mail: info@phoenixcon.com | Website: www.phoenixcontact.com

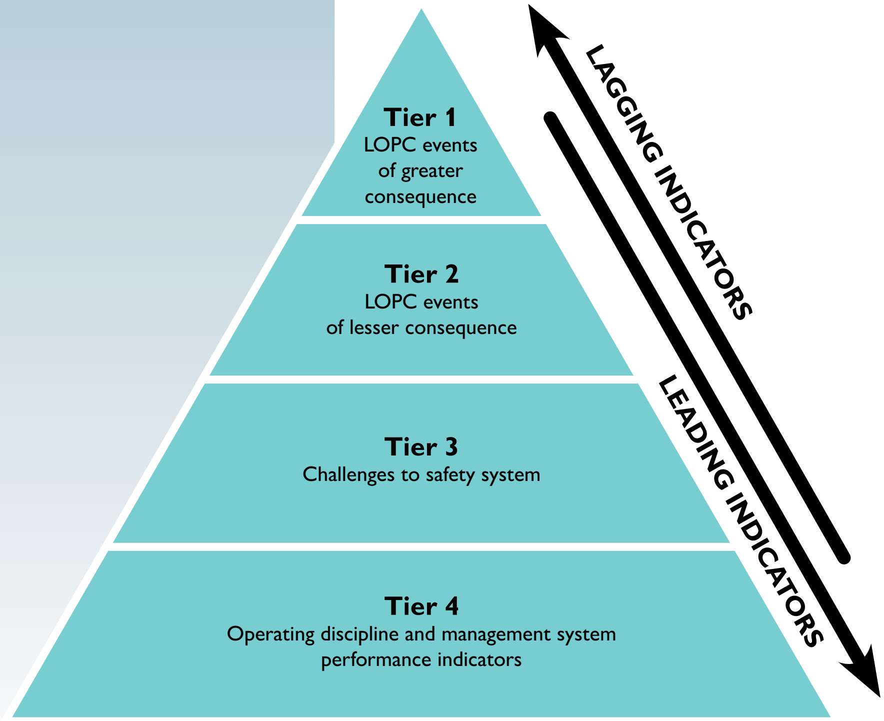


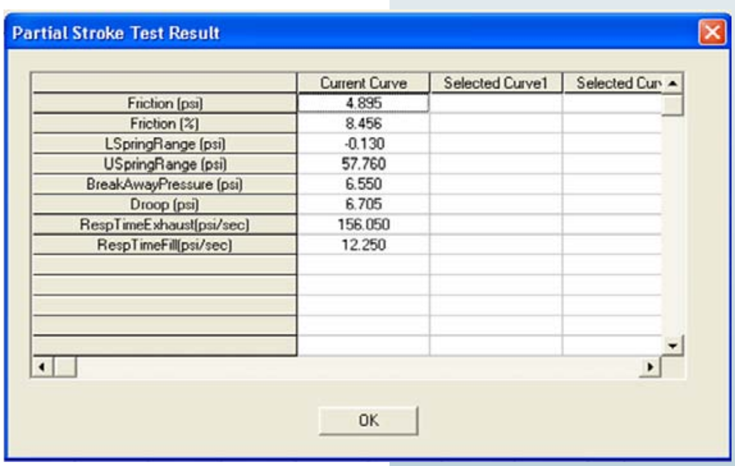
Figure 1: Process Safety Indicator Pyramid for the Refining and Petrochemical Industries

Source: API-RP-754 – Process Safety Performance Indicators for the Refining and Petrochemical Industries

Application Overview

The reliable operation of critical valves is vital to the oil and gas, petrochemical and refining industry. It has become even more important to monitor critical valves more closely than others due to specific industry regulations and industry best practices.

Before the advent of HART and smart fieldbus positioners, feedback measurements of valve and stem position were rare, because a separate position transmitter had to be installed and wired. The user generally wasn't aware that differences in valve, actuator and pneumatic positioner design were the source of cycling in the process. These new smart electro-pneumatic positioners provide a complete new information link between the control system and the valve.


Partial Stroke Test Result

	Current Curve	Selected Curve1	Selected Cur
Friction (psi)	4.895		
Friction (%)	8.456		
LSpringRange (psi)	-0.130		
USpringRange (psi)	57.760		
BreakAwayPressure (psi)	6.550		
Droop (psi)	6.705		
RespTimeExhaust(psi/sec)	156.050		
RespTimeFill(psi/sec)	12.250		

OK

Figure 2: A screenshot of a typical smart positioner display referencing key parameters

Today's smart positioners consist of stand-alone configurable devices with built-in sensors and diagnostic circuitry. They calculate specific parameters and device attributes, such as conducting the partial stroke tests and transmitting the results. This puts ESD valves or any other critical valve health information at the fingertips of plant personnel, simplifying installation and maintenance.

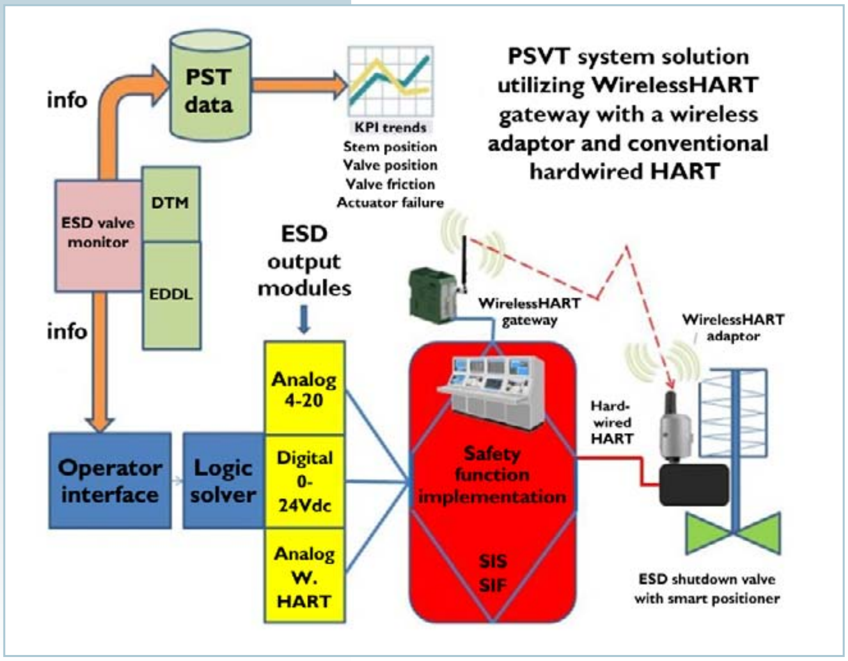


Figure 3: This diagram illustrates how a PSVT solution can be implemented and integrated with various types of shutdown signals. Highlighted are various methods of monitoring the ESD valve's condition using HART® technology.

Typically, the diagnostic functionality, which is built into today's smart instruments, is conveyed via communication tools using the FDT/DTM framework standards, displaying all the device attributes and information.

The new smart positioners use the HART protocol for communication. This protocol conveys and provides easy access to all the physical and calculated attributes associated with the valve — status information and configurations, for example, as well as diagnosis parameters, such as "valve stuck" and "friction above normal."

The Phoenix Contact WirelessHART Field Adaptor and Gateway Radio and hardwired HART technology are used to implement the PSVT solution on critical valves in process plants while the process is running. The PSVT testing is executed remotely, in conjunction with the existing control system from the control room, which is tied to the PSVT system.

Figure 4: The Wired Hart system

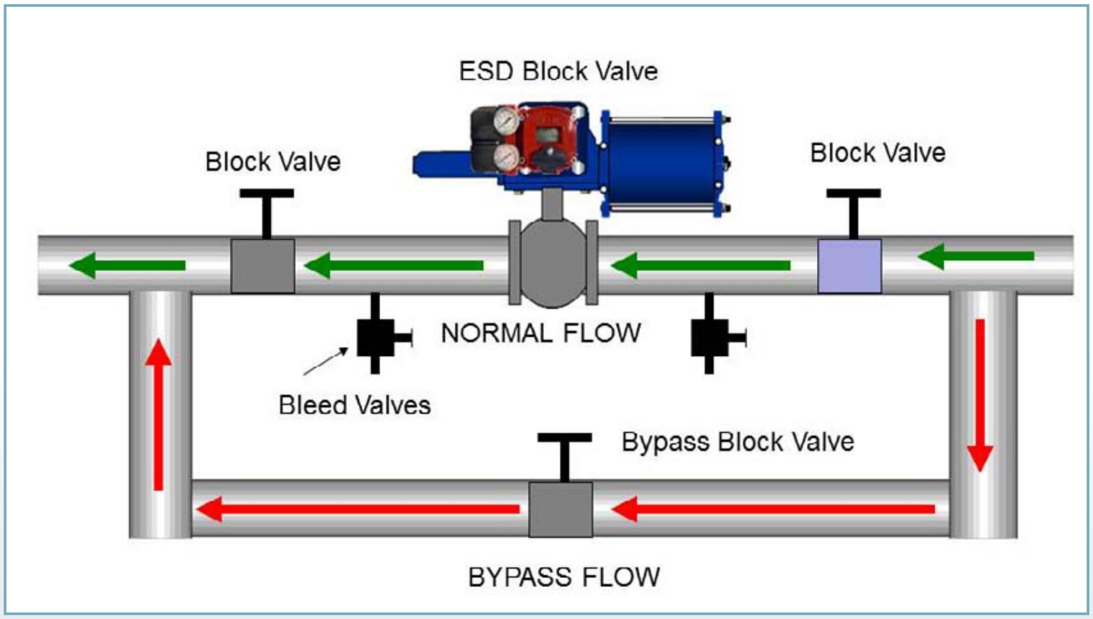
Implementing the PSVT WirelessHART solution can:

- Enable remote triggering of a partial stroke test
- Improve overall safety compliance by automatically documenting partial strike test results
- Improve overall plant safety levels
- Improve overall plant availability
- Provide remote access to the health diagnostics and status of the valve
- Enhance asset management
- Minimize the number of valves that need to be physically removed from the lines during a shutdown
- Reduce unscheduled down time due to valve failure
- Provide continuous diagnostics of electronics and mechanical assembly
- Unveil problems that may prevent a shutdown event
- Provide CFR and OSHA documentation

Why Partial Stroke Valve Testing?

Large petrochemical plant maintenance costs vary from one to three percent of replacement value per year. Reliability varies from two to 15 percent, resulting in lost capacity for computer monitoring. This is in conjunction with an asset capability solution and combined with a predictive versus reactive maintenance program, and is the most significant factor affecting reliability and maintenance.

The failure of a critical or emergency shutdown valve has a calculated value and negative impact on the overall bottom line of a process plant and its safety status.



The ability to detect valve problems with a simple test that does not disturb the operational state while providing sufficient diagnostics to determine maintenance or safety issues has a tremendous impact on lowering the maintenance costs and increasing the reliability and safety of a hydrocarbon processing facility.

Application/Case Studies

Critical Preventive and Predictive Maintenance of Valves in the Process Industry

Process plants operate for a number of years with scheduled and unscheduled shutdowns. These shutdowns are necessary for the maintenance and upkeep of operating units and to maintain safe and efficient operations. Scheduled shutdowns for major maintenance checks usually happen once every four to five years. Many activities take place during these shutdowns, usually lasting two to four weeks, depending on the activity schedule.

One of the primary tasks during a maintenance turnaround/shutdown is checking/verifying the functionality of the control and shutdown valves. Within a refinery or petrochemical facility, there are hundreds of valves. A huge complex will have thousands of valves. There are remotely operated control valves and manual valves. In many cases, bypass piping configurations allow the flow to be rerouted through the bypass line while the primary valve is out of service or undergoes a physical check to examine whether it is functional and operable.

Some remotely operated valves are more important than others, and their operability is critical to the safe operation of the process. These valves are classified as Emergency Shutdown (ESD) valves. ESD valves allow a plant to shut operations down in a sequenced and controlled manner. Many valves are involved in the process and, although not as vital as the critical valves, their operation is important. Therefore, they must also undergo periodic checks to ensure correct operability and functionality.

For offshore production wellhead-related valves, continuous monitoring presents a more marginal value opportunity due to the fact that they undergo six checks monthly.

Well Integrity Tests (WIT) include pressure buildup test requirements. However, offshore facilities have hundreds of critical ESD and other control valves that could be fitted with smart positioners. Critical valves in the process industries are valves defined as critical to the safe operation of the process as defined by a Hazardous Operations Analysis (HAZOP). HAZOP is carried out during the design/engineering phase of a plant or during a postconstruction study of an existing facility.

HAZOP identifies which systems and valves are categorized as critical. These will be included in the Safety Instrument System (SIS) and the Emergency Management System (ESD). During the HAZOP, all systems undergo a Failure Mode Effect and Diagnosis Analysis (FMEDA) to determine what Safety Instrumented Functions (SIF) actions need to be implemented to ensure that all plant systems function properly in an abnormal situation/emergency situation requiring immediate action. During the course of normal plant operations, it is very difficult to undertake a full stroke test on a control valve. It is also extremely difficult — in some cases, impossible — to conduct this test on an ESD valve.

For a control valve to be taken off-line, a bypass must be available with the complete double block and bleed valve configuration. This allows the process to continue uninterrupted. Because it is a manual operation, it is prone to human failure. In addition, the use of a physical mechanical blocking device to hold a valve open or closed in a static state overrides the existing shutdown system, bringing the plant into an unsafe operating condition.

In the past, a list detailed which valves were important to check during a shutdown or maintenance turnaround. As the shutdown progressed, as many valves as possible were checked. Full inspection and removal of a 10-inch or 24-inch valve is no easy task and requires manpower, equipment and sufficient time. During a shutdown, as the startup date comes closer, valves not checked are slated for inspection during the next turnaround.

Summary

When an operating facility experiences an emergency, the first thing on the operator's mind is whether the ESD or critical valves have functioned properly. Flawless performance is of utmost importance, because the shutdown process needs to take place in a safe and orderly fashion.

By initiating a Partial Stroke Testing Program (PSTP) for these valves, operators gain a level of confidence that the emergency shutdown (ESD) valves will function as designed and to proper performance specifications. An effective PSTP also improves the overall Safety Instrumented System (SIS) performance and complies with government regulations and industry standards.

USA
PHOENIX CONTACT
P.O. Box 4100
Harrisburg, PA 17111-0100
Phone: 800-888-7388
717-944-1300
Fax: 717-944-1625
E-mail: info@phoenixcon.com
Website: www.phoenixcontact.com

Fred Czubba
Senior Business Development Manager
CIS-Industry Management-Infrastructure Oil/Gas
fczubba@phoenixcon.com
717-933-1300 Ext: 3798

Troy Thacker
Industry Manager Oil & Gas
CIS-Industry Management-Infrastructure Oil/Gas
tthacker@phoenixcon.com
713-353-5934 Ext: 5943