

Improvement of Functional Safety by using Partial Stroke Valve solution

APS Forum 2010

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Remote automated safety valve testing

On-line diagnostics are used to detect failures and annunciate the failure for repair or automatic shut down

On-line diagnostic testing

- Partial Valve Stroking Test
- Run at a frequency at least ten times faster than the manual proof test frequency

Manual proof testing

- Reveals failures undetected by on-line diagnostic testing
- Generally performed during shut down



Remote automatic functional testing

When implemented, on-line diagnostics can significantly improve the reliability of the safety instrumented function (SIF)

On-line diagnostic testing

- Partial Valve Stroking Test
- Run at a frequency at least ten times faster than the manual proof test frequency

Manual proof testing

- Reveals failures undetected by on-line diagnostic testing

Generally speaking, when more often proof testing of equipment is implemented, a higher SIL can be achieved

Remote automated safety valve testing

ability to detect as much as possible dangerous failure of the remote automated safety valve

+ capability to document the results

+ ease of use and automation

= Performance of the testing method



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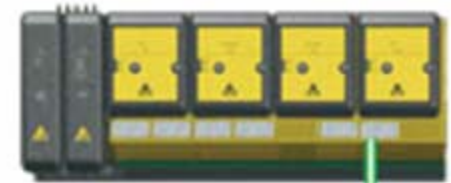
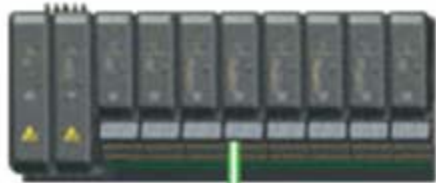
= Performance of the testing method



Remote automated safety valve testing with smart valve positioner

BPCS Control

SIS Safety



Remote automated safety valve testing with smart valve positioner

BPCS Control

- Control performance
- Robustness
- Communication capabilities
- Diagnostics capabilities

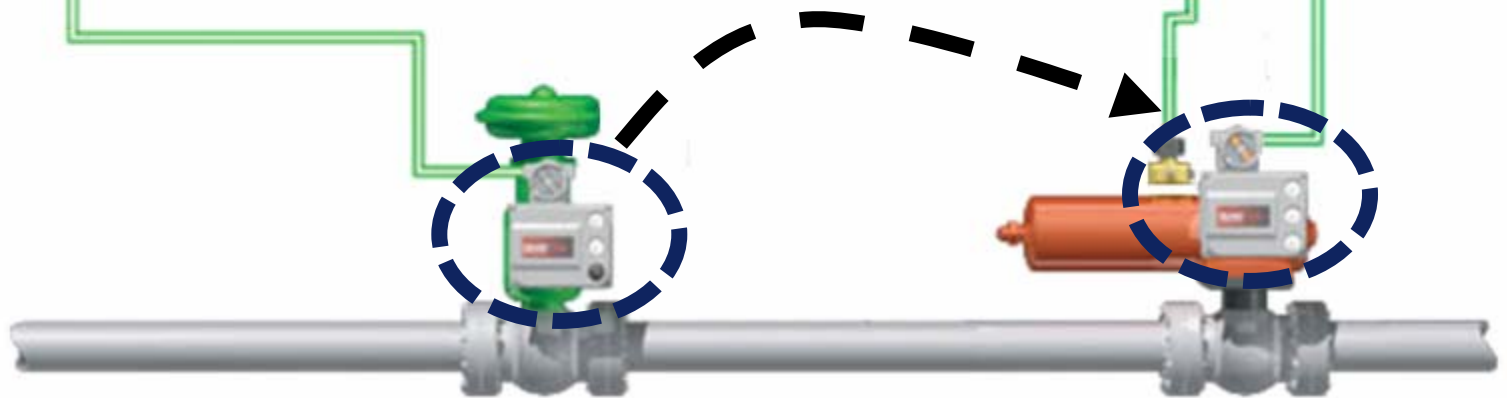
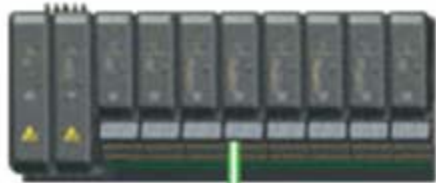
SIS Safety



Remote automated safety valve testing with smart valve positioner

BPCS Control

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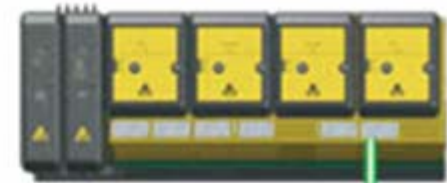


Remote automated safety valve testing with smart valve positioner

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2 wires

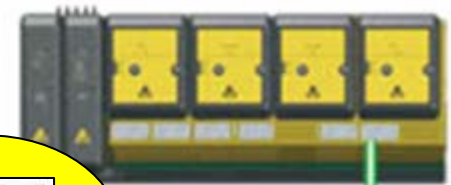


Remote automated safety valve testing with smart valve positioner

BPCS Control



SIS Safety



SIL3 certified capable

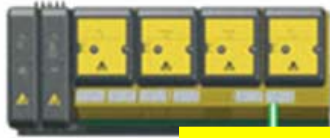
2 wires

4-20mA
0-24 VDC

travel



Proof Test & Full Valve Stroke Test (FVST)



- Full Valve Stroke Test (FVST)

Benefits:
Annual

ValveLink Custom Report
November 22, 2007
11:31:34

XV1011
DVC6000 SIS

Master Spec Sheet (XV1011)

Valve	Trim	Actuator
Manufacturer: Fisher Controls	Seat Type: Metal	Manufacturer: Fisher Controls
Type: 6510	Leakage Class: IV	Type: 1025
Size: 4 in	Port Diameter: 4.0 in	Size: 6100
Case: 300		Effective Area: 12704.64 mm ²
Rated Travel: 90.0 deg		Act: Opens
Actual Travel: 90.0 deg		Spring Set: Rad and Pin
Shaft Diameter: 0.75 in		Nominal Supply Pressure: 6.0 bar
Rating Type: TFE / Single		Spring Rate: 20.0
Crack Pressure: 10.0 bar		Stem Arm: 21.25 mm

Instrument Configuration (XV1011)

07 May 2004 14:34:34 Initial Set Up 30 % Partial Stroke

General	Travel Control	Deviation & Other Alarms
HART Tag: XV1011	Travel CutOff (%): 30	Travel Dev Alert Enable: Yes
Message Descriptor: XV1011	Travel CutOff (Hz): 30	Travel Dev Alert Pt (%): 5
Date: 03/25/04	Pressure: 6.0 bar	Pressure Dev Alert Enable: Yes
Value Serial Number: 02214505	Has Supply Pressure: Yes	Pressure Dev Alert Pt (%): 0.07 bar
Instrument Serial Number: 02214505	Tuning: 20	Pressure Dev Time (sec): 20.06
Rating Address: 0	Tuning Set: 20	Drive Signal Alert Enable: Yes
Initial Setup: 0	Proportional: 9	Supply Pressure Alert Point: 6.0 bar
Control Mode: Digital	Velocity: 4.5	Travel Alerts
Restart Core Mode: Digital	HAL: 28	High Enable: No
Zero Power Condition: Value Closed	Enable Integral Control: No	Hi Lo Enable: No
Travel CutOff (%): 30	Integral Gain (mg/min): 0.4	Lo Point (%): -25
Value Size: Rotary Switch	Integral Gain Set (%): 0.33	Hi Point (%): 25
Actuator Style: Piston - Col w/ Spring	Travel Malfunction Alerts	Lo Lo Point (%): -25
Spring: Code Count Alarm Enable: No	Code Count Alarm Enable: No	Hi Hi Point (%): 25
Relay Type: Relay A	Code Count Deadband (%): 2	Deadband (%): 2
Feedback Connection: Rotary-A1/25-Roller	Code Count Alarm Point: 420467135	Alert Record and Commands
Travel Sensor Position: Codeless	Code Count: 5122	Instrument Code: 07/06/2004
Aux Terminal Mode: Alarm on Coast	Travel Alarm Enable: No	Value Alerts Enable: Yes
Contacts: TV Alarm Deadband (%): 2	TV Alarm Alarm Pt (%): 420467135	Failure Alerts Enable: Yes
	Travel Actuator (%): 12451	High Alerts Enable: Yes
	SD: 20	Low Alerts Enable: Yes
	Partial Stroke Travel: 30	Run Command: 2
	Partial Stroke Speed: 1 %/s	Cmd #2 (Tranding): A-B
	Partial Stroke Rise Time: 2 sec	Pressure
	Min Partial Stroke Diff Press: 2.00 bar	
	Pressure Hold Enable: Yes	
	Upper Coasting Press: 6.0 bar	

ValveLink Custom Report
November 22, 2007
11:31:34

Total Scan (XV1011)

07 May 2004 14:37:21

Inputs

Inlet Start: -5.0 %
Inlet End: 100.0 %
Scan Time: 20.0 sec
Collection Interval: 100.0 msec

Analyzed Data

Avg. Dynamic Error: 1.07 %
Min. Dynamic Error: 1.23 %
Max. Dynamic Error: 3.06 %
Dyn. Uncertainty (Std.): 0.23 %
Zero Ranged Travel: 3.64 mm
Full Ranged Travel: 19.85 mm
Average Torque: 22.0 Nm
Minimum Torque: 20.0 Nm
Maximum Torque: 24.0 Nm
Spring Rate: 116.7 N/mm
Stem Set: 2.20 - 2.50 mm

Tuning Set

Tuning Set: User Adjusted
Gain: 9.00
Proportional: 6.00
Velocity: 4.50
HAL: 28.00
Integral Control: Disabled
Integral Gain: 0.4

Signature Analyzer Settings

Analysis: Min-Stroke/Max-Stroke
Stroke Slip (Count, Dev): 2, 20.0 %
Upper Travel Range: 74.0 - 95.0 %
Lower Travel Range: 74.0 - 95.0 %
100% Torque Allow: 20.0 Nm
Upper Torque Range: 20.0 - 100.0 %
Lower Torque Range: 20.0 - 100.0 %

Notes

Valve

Manufacturer: Fisher Controls
Type: 6510
Size: 4 in
Case: 300
Rated Travel: 90.0 deg
Actual Travel: 90.0 deg
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Rating Type: TFE / Single
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Trim

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Page 1 of 4

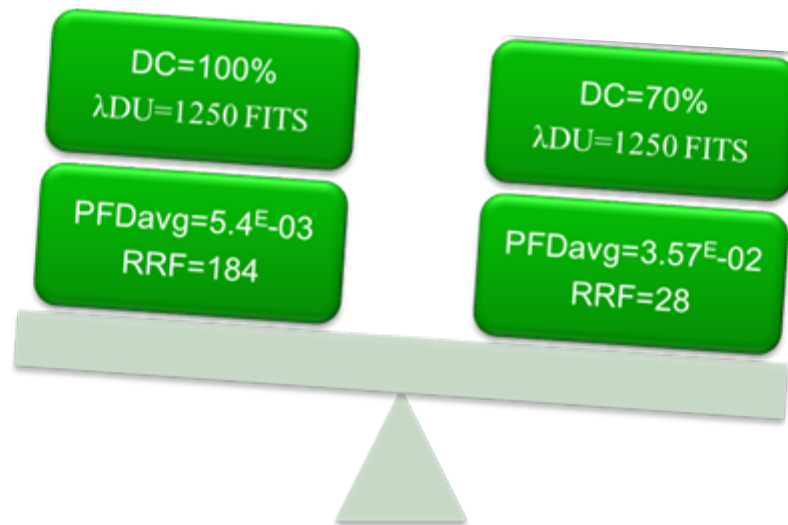
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Proof Test – Full Stroke Test (FST)

- It is important that proof test coverage is just not assume 100% because this will lead to designs without enough safety integrity

Overestimating risk by a factor of 6.5 times!

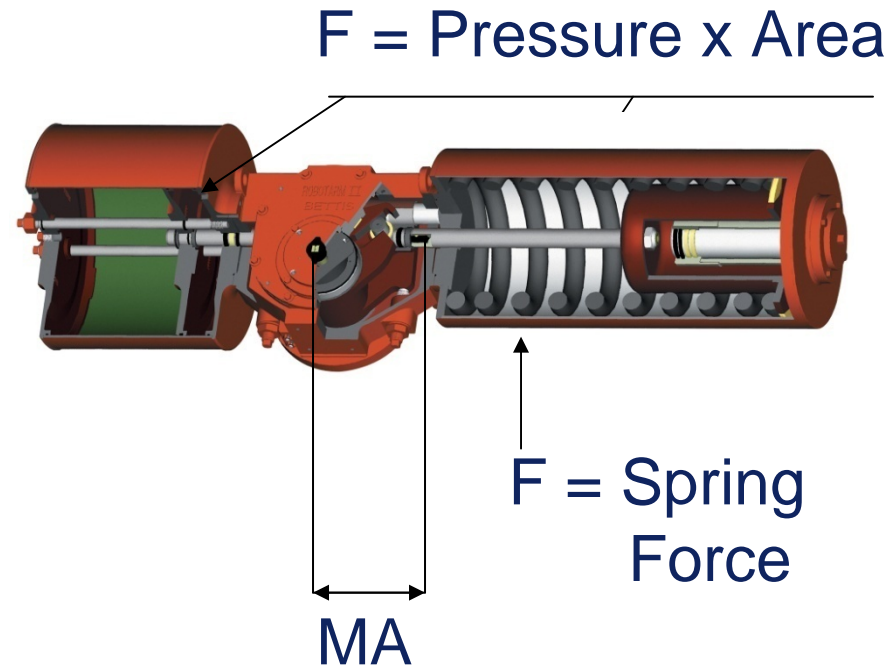
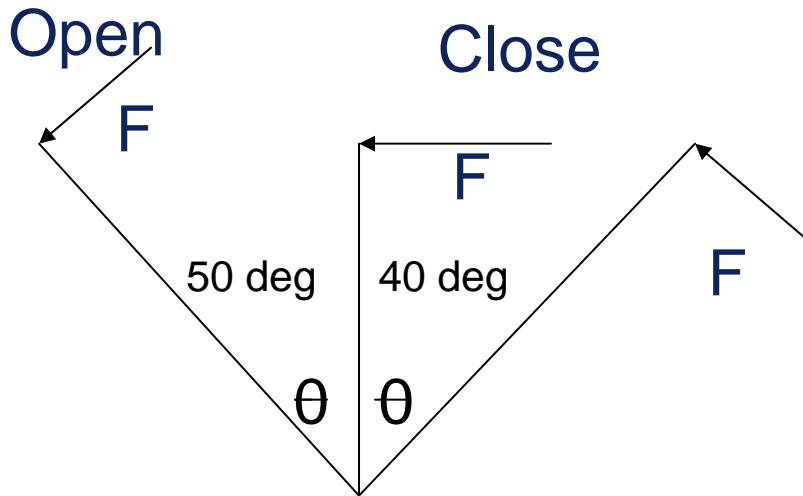
Example of a safety valve proof tested every 12 month on a 20 years mission time



Advantages of using Control Valve Diagnostics in the field of ON/OFF valve operation

- Because Digital Valve positioner includes pressure sensors along with travel sensors they can monitor and analyse forces and torque during the FVST & PVST

$$\text{Torque} = \frac{E \times MA \times F}{(\text{Cos } \theta) \times (\text{Cos } \theta)}$$



E = Efficiency

MA = Effective Moment Arm

Advantages of using Control Valve Diagnostics in the field of ON/OFF valve operation

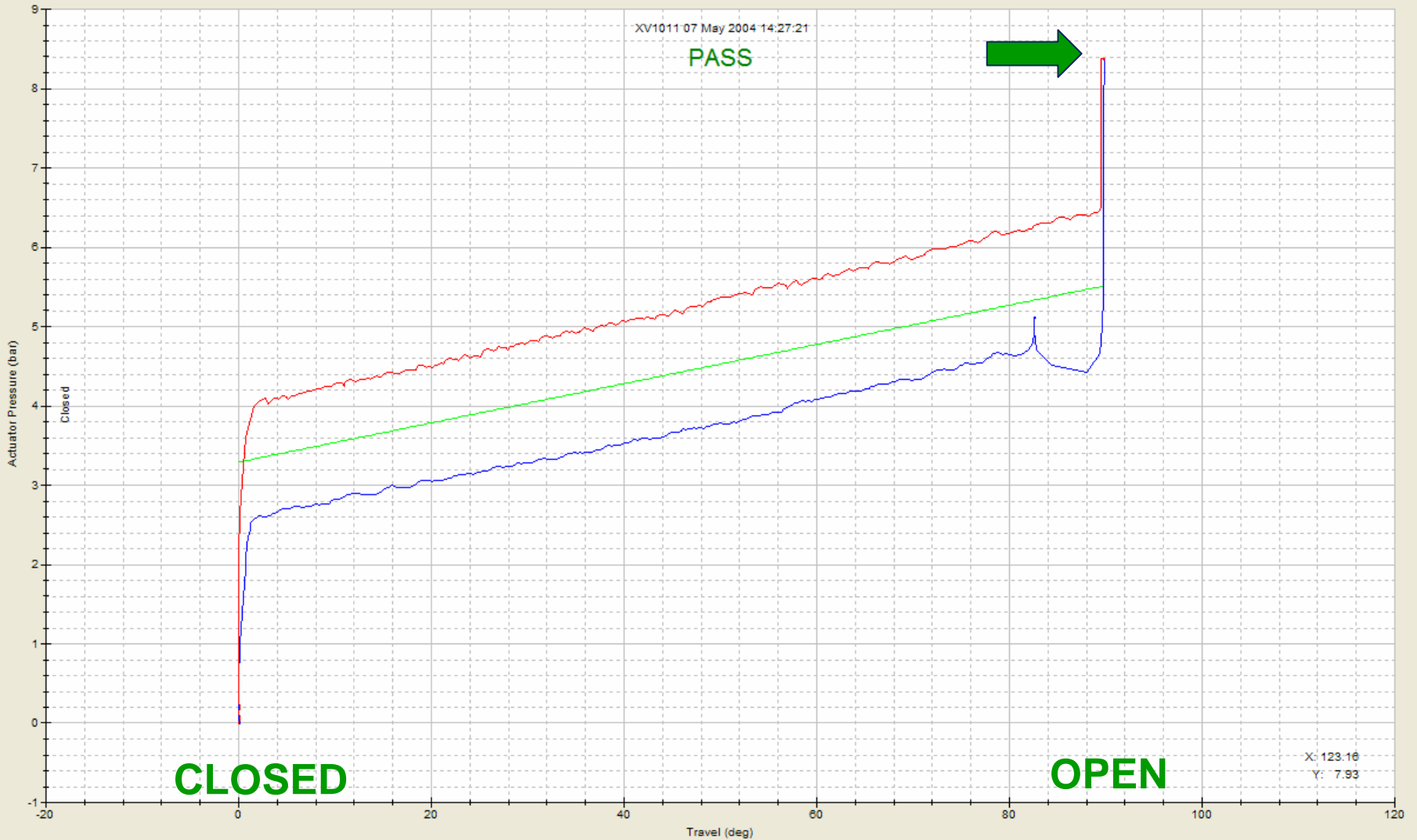
- Digital Positioners can automatically detect failures that could not have been detected by traditional mechanical methods, such as:
 - Shaft Broken
 - Torque degradation
 - Stick Slip phenomena
 - Friction degradation
 - Pneumatic path leakages



**Low Torque
Safety Factor**



FVST Mechanical Signature

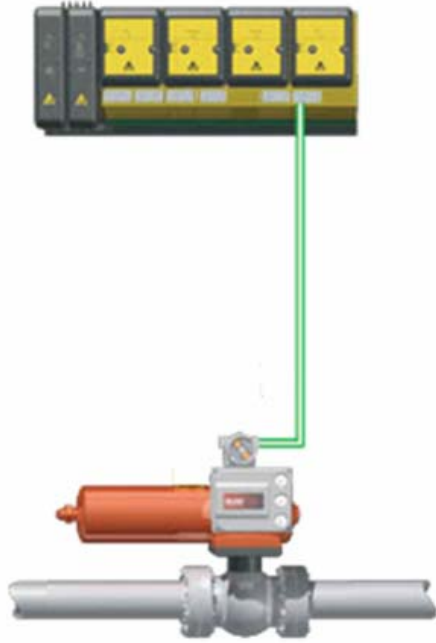


Return to Test View

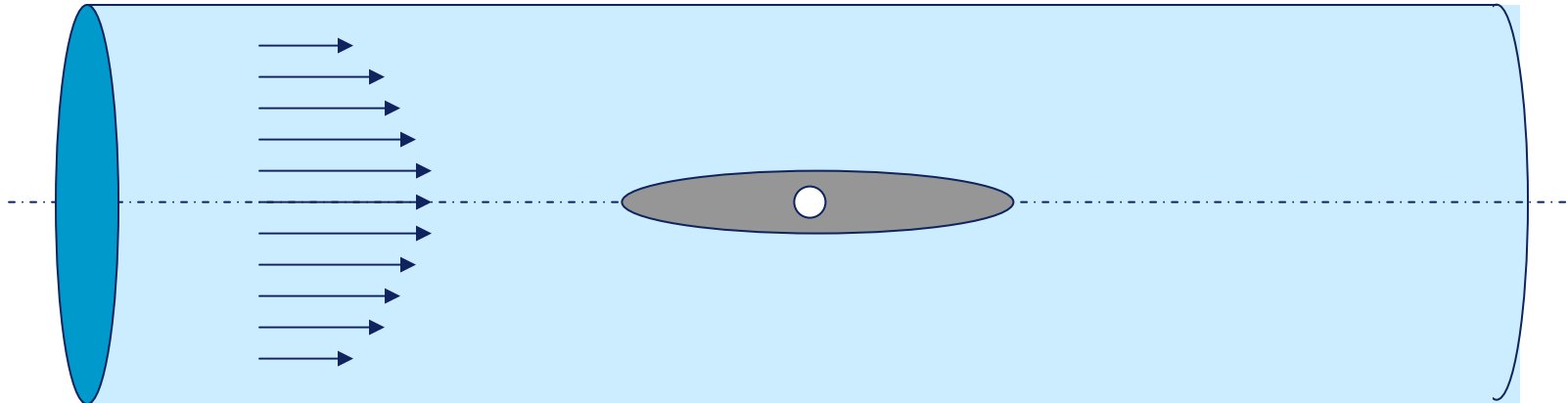
Zoom Out

Zoom Back

Partial Valve Stroke Test (PVST)

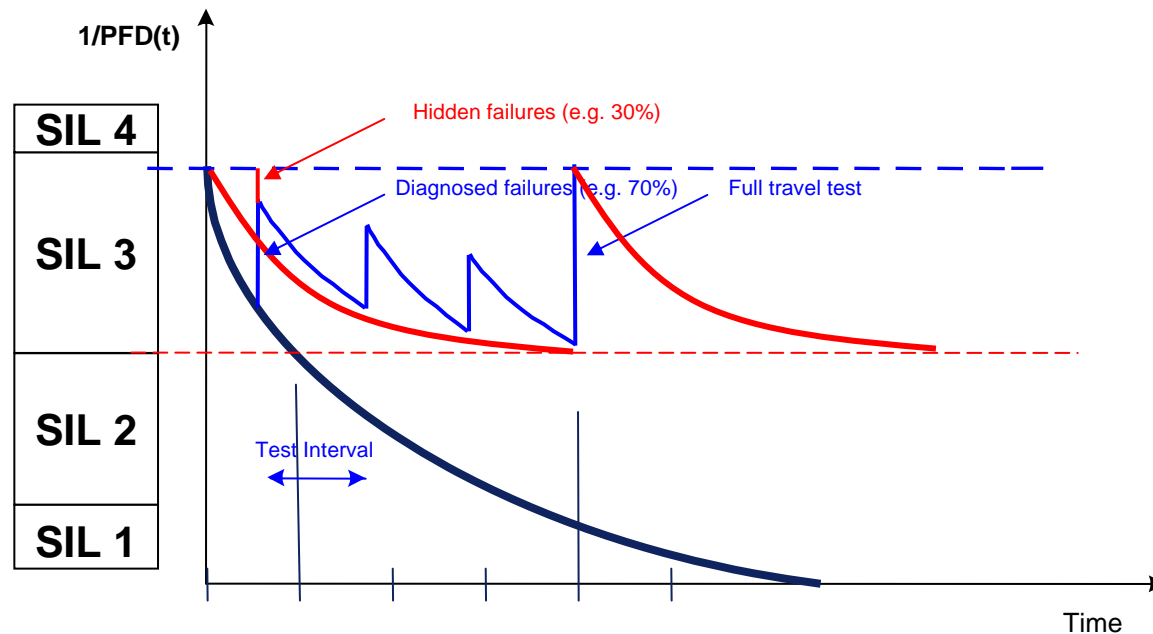


- Partial Valve Stroke Test (PVST)
 - PVST uncover dangerous failures while safety loop in operation
- ➔ Lower safety valve PFD to enable longer proof test interval

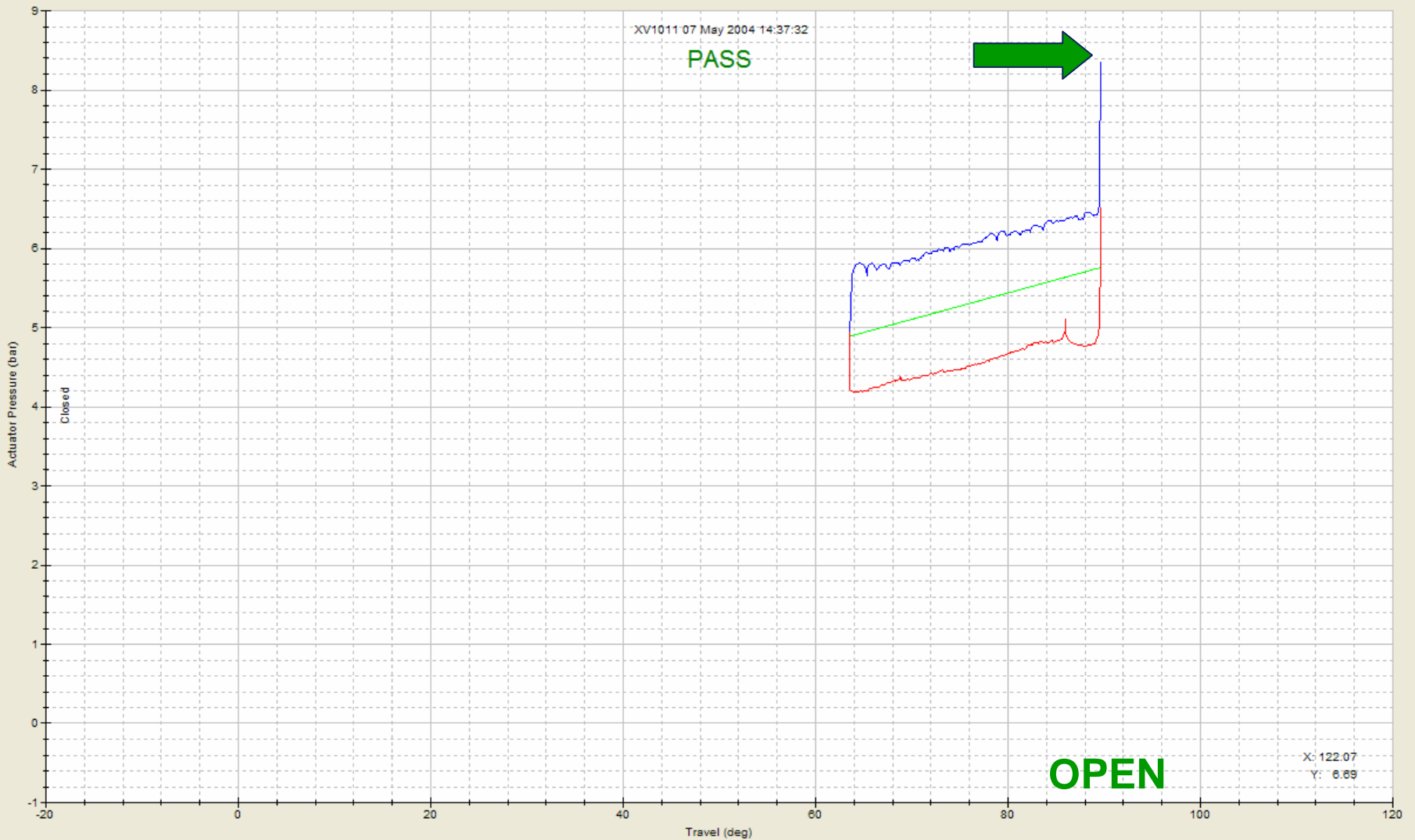


Partial Valve Stroke Test (PVST)

- SAFELY EXTENDS TIME BETWEEN SCHEDULED PLANT SHUTDOWNS
- Partial Stroking allows SIL rating to be maintained for longer continuous operating periods



PVST Mechanical Signature



Overlay of the FSVT and PVST Mechanical Signature



Mechanical Signature

AMS ValveLink Software - Partial Stroke - XY1011

Tag Network Instrument Setup Calibration Diagnostics Spec Sheet Tools Customize ValveLink Help

AMS ValveLink Software Version 3.3 Datasets: 07 Mar 2014 14:37:33 Save Test Spec Sheet

Inputs Configuration Graph Data Points Analyzed Notes Valve Trim Actuator Reference

Pressure (bar)

Travel (deg)

Signature Analyzer Boundary Editor

Analysis

- Maximum Torque
- Minimum Torque
- Shaft Integrity
- Stick-Slip

Adjust Boundaries

Travel Range [X Axis]

Torque Range

Upper: 74 To 95 % 2 To 8 %

Lower: 74 To 95 % 2 To 8 %

100% Torque Value = 556.302 N.m

Stick-Slip

Count: 2

Deviation Pct: 10 %

Zoom & Pan

Use Default Settings

OK

Cancel

Help

View Full Screen Zoom Out Zoom Back Add Overlay(s) Valve Signature

Signature Analyzer Config

Diagnostic Save Dataset Delete Dataset Extract

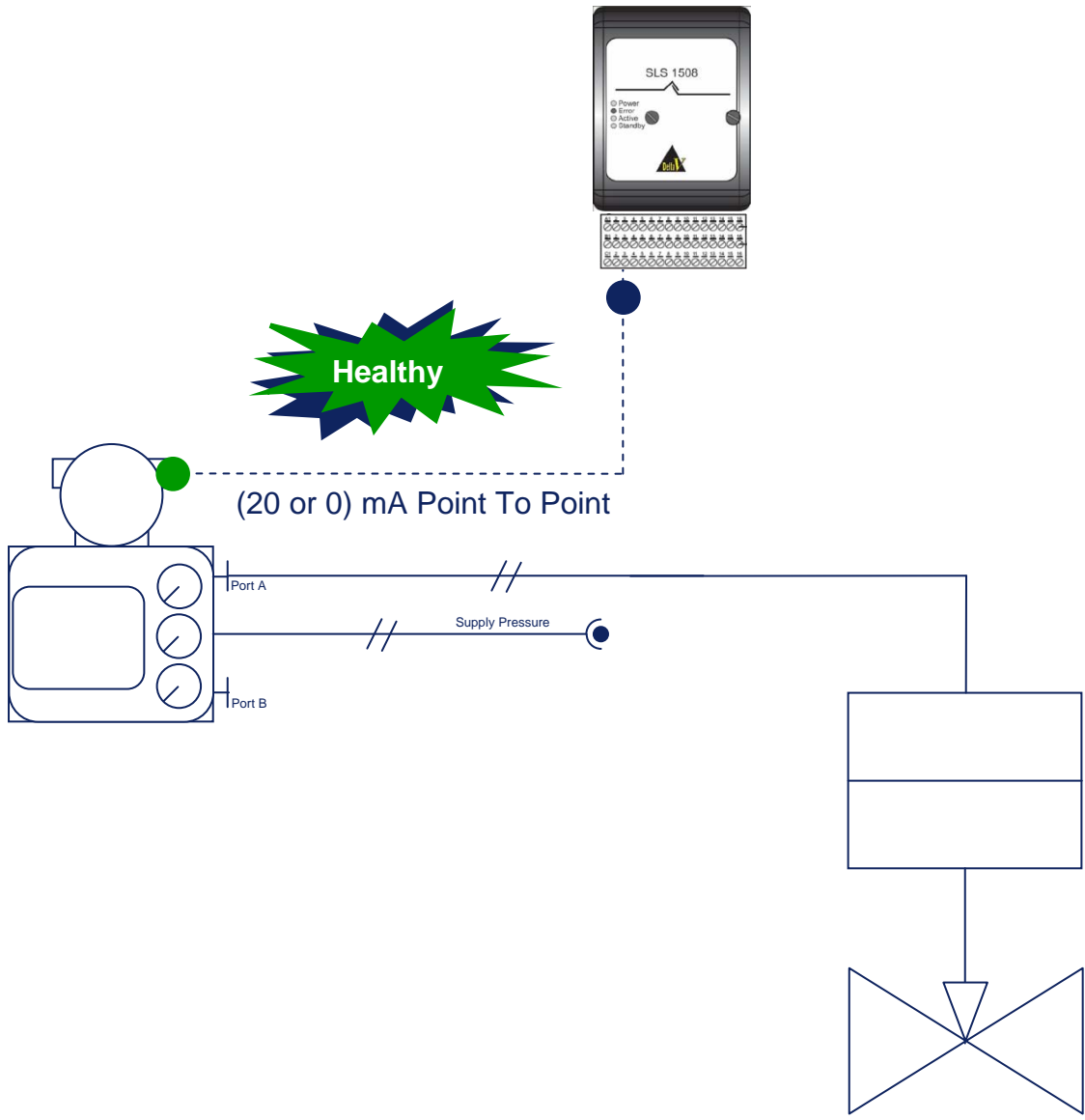
Close Tag Help

XY1011

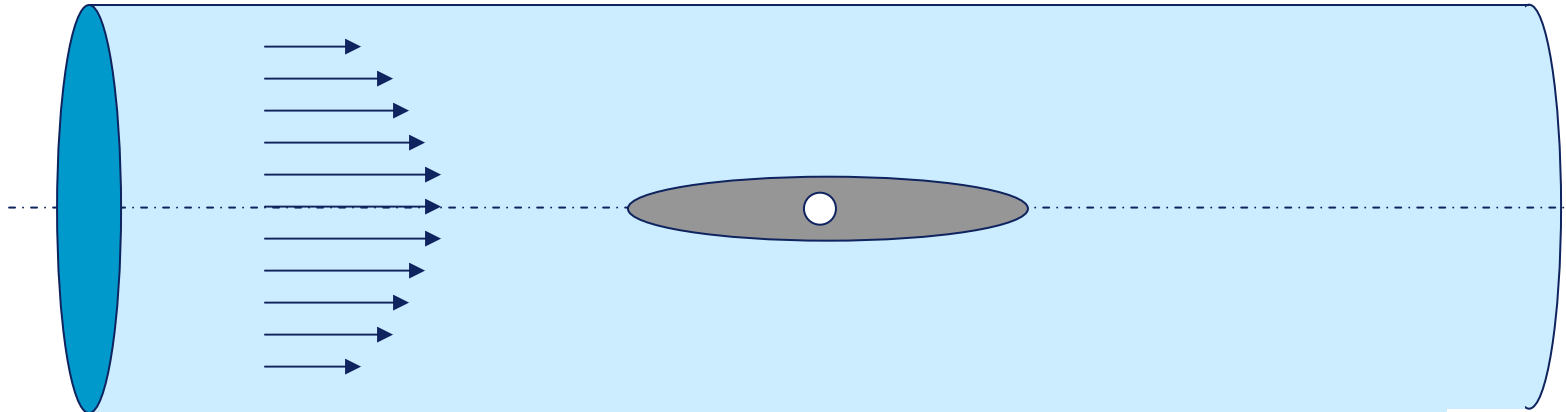
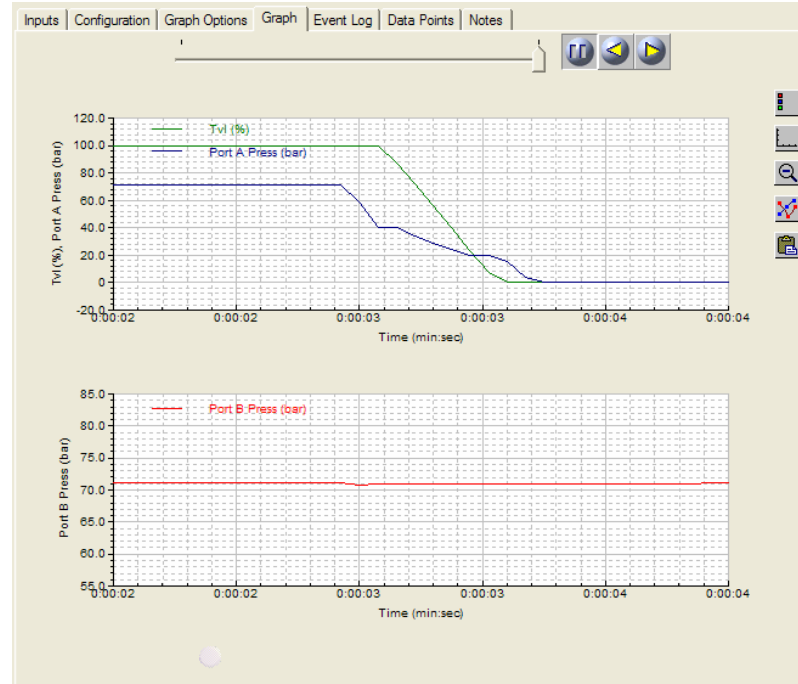
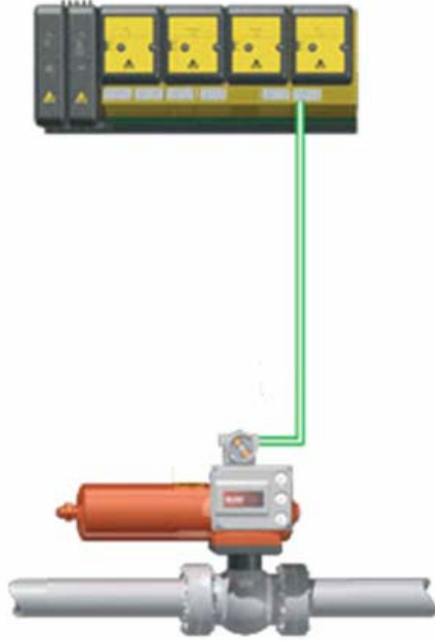
de récep... FIELDVUE Soft... DVC6000SIS... PWSmartWire... Presentation... Sans titre - Paint AMS ValveLink... 19:03

Your best valve expert is now telling you if the test pass ... And if it fails, he tells you why!

Managing test regime



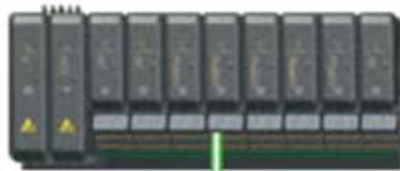
Record & time stamp valve closure signature during Safety & Spurious trip



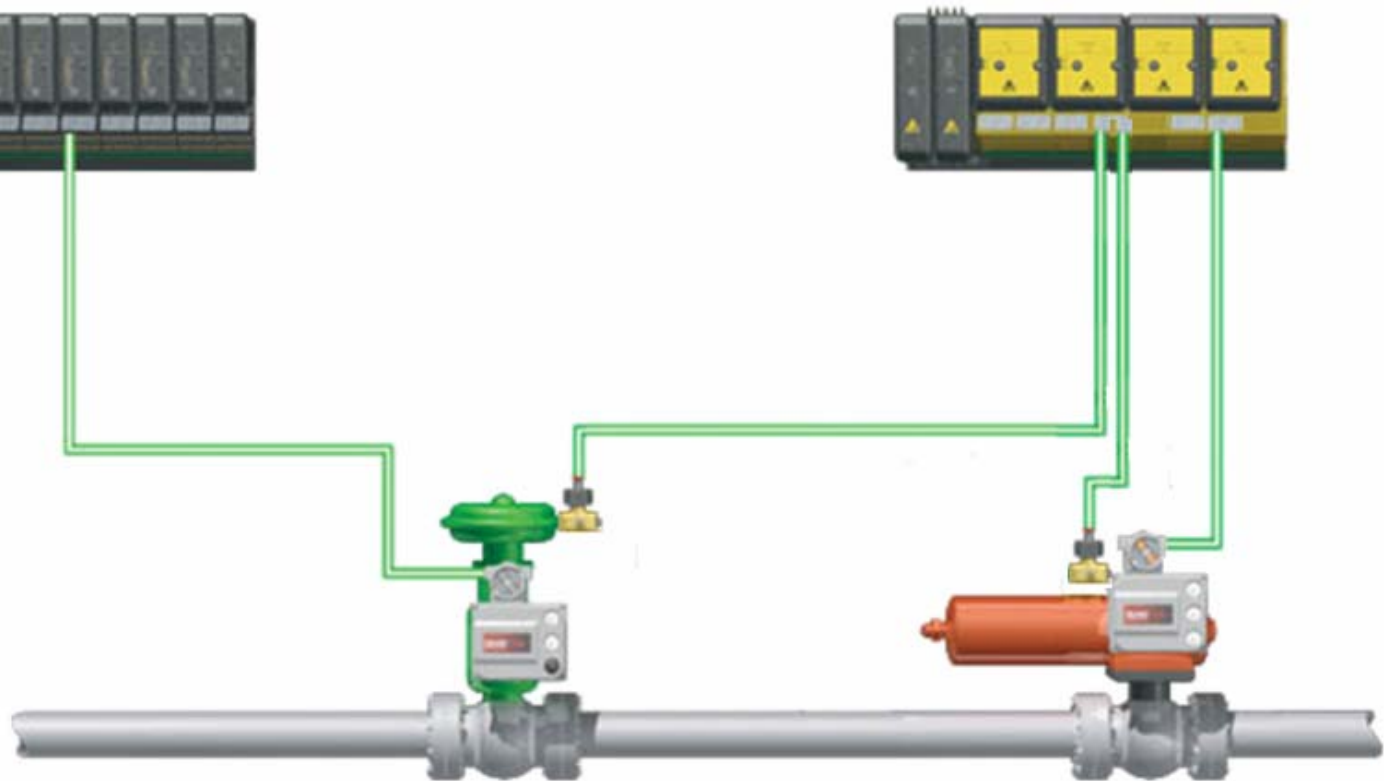
Test external SOV when in operation

- Pulse test on the external SOV of a:
 - Dual purpose control valve
 - Remote operated safety valve

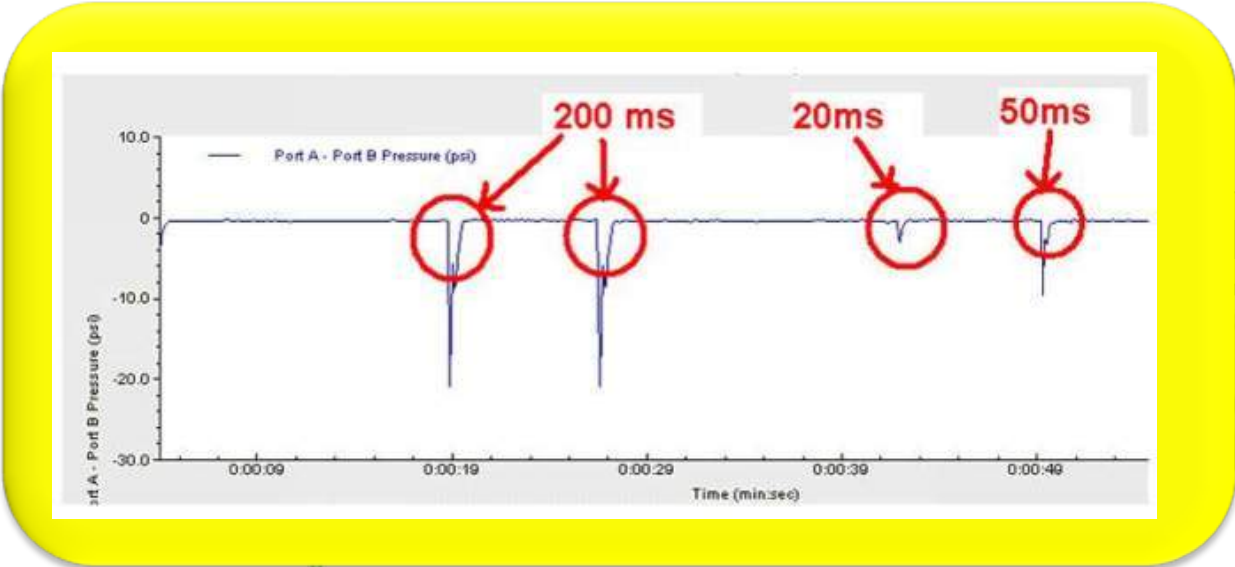
BPCS Control



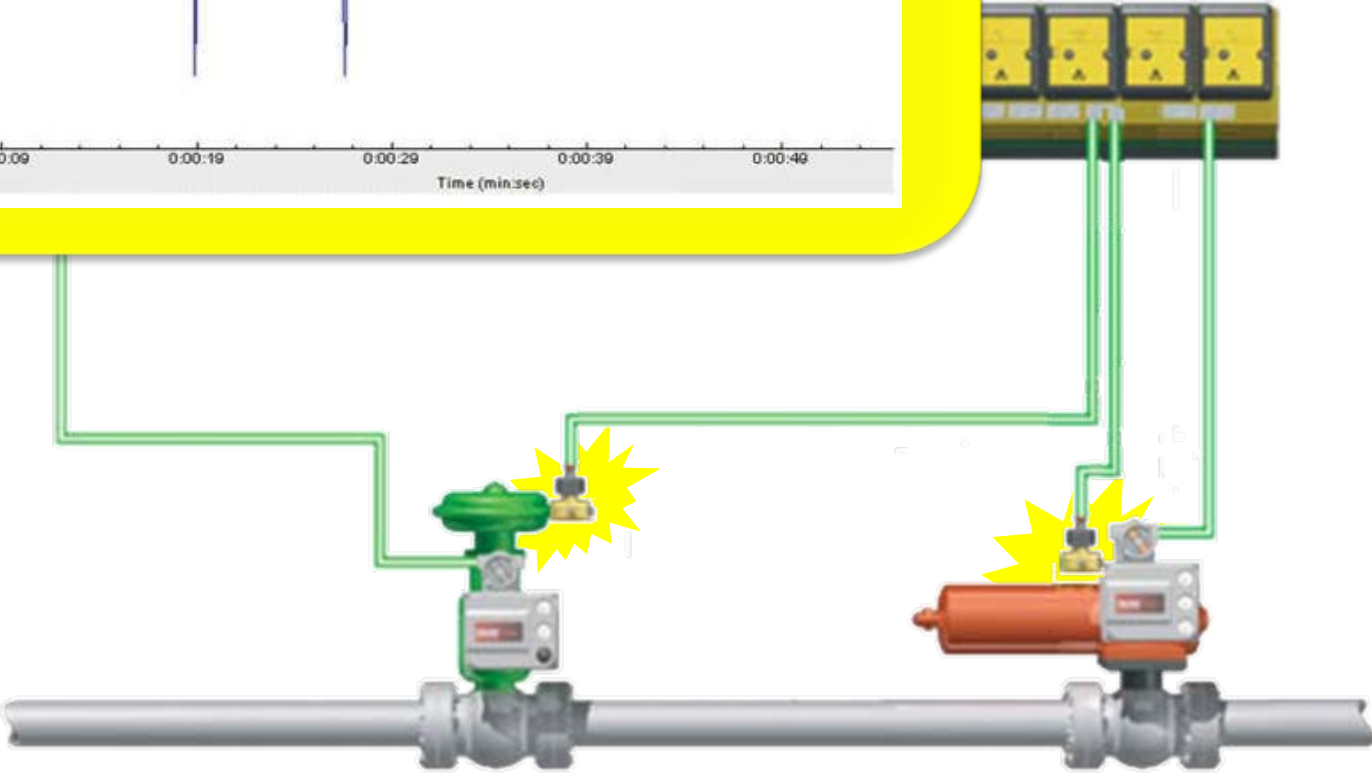
SIS Safety



Test external SOV when in operation



S Safety



Conclusion

- Techniques and procedures initially introduced into the process control industry are now capable of being utilised in remote automated safety valves.

