PARTIAL STROKE TEST FOR EMERGENCY SHUTDOWN VALVE (MASONEILAN): ANALYSIS OF DESIGN AND VERIFICATION USING AFT FATHOM SOFTWARE.

By

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CERTIFICATION OF APPROVAL

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Approved:

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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

December 2010

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Muhamad Imran Bin Aziz @ Awang

ABSTRACT

Reliability study for partial stroke test (PST) of emergency shutdown valves system (ESD) is a collaboration project between Universiti Teknologi PETRONAS (UTP) and PETRONAS Group Technology Solution (PGTS).This report will present the process of testing of the controller for Partial Stroke Test (PST) system provided by vendors and to perform Full Stroke Test (FST) using Programmable logic Controller (PLC). More specifically the test is to seek verification that FST could override PST. This project is divided into two phase, without and with medium phase .Most of the first phase testing had been done by previous seniors and for this semester, improvement will be done by doing PST on real medium (process element) and also performing destructive testing for the ESD valve. In this report, the author discusses on the project progress for Partial Stroke Test (PST) and Full Stroke Test (FST) together with test rig design and simulation for 2010 Phase. The author also includes result and analysis from AFT Fathom software simulation to verify the design before test rig construction started.

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LIST OF ABBREVIATIONS

XTS	Extended Time Simulation
AFT	Applied Flow Technology
PST	Partial Stroke Test
FST	Full Stroke Test
ESD	Emergency Shutdown
TA	Turn Around
SIL	Safety Integration Level
DCS	Distribution Control System
PFD	Probability of fail demand
PT	Pressure Transmitter
FT	Flow Transmitter

CHAPTER 1
INTRODUCTION

1.1 Background of study.

Emergency shutdown system (ESD) is a response system that will act in plant in order to protect people, instrument and environment whenever unnecessary action happened on the field that will cause danger to people or caused production profit suffered a bad influence such as power trip or system became unstable. Most of ESD system involving safety valve action to have either sudden close or sudden open response when emergency situation happen. Emergency situation could occur in the form of gas leak, tank overpressure, power trip and many more. Application of ESD system is very broad all around the world among the oil and gas industry specifically and also in generation plant generally.

This project will specifically use SIL 3 emergency shutdown system. Safety Integrity Level (SIL) is defined as a relative level of risk-reduction provided by a safety function, or to specify a target level of risk reduction. In simple terms, SIL is a measurement of performance required for a Safety Instrumented Function (SIF). Four SILs are defined, with SIL4 being the most dependable and SIL1 being the least. A SIL is determined based on a number of quantitative factors in combination with qualitative factors such as development process and safety life cycle management. The requirements for a given SIL are not consistent among all of the functional safety standards.

1.2 Problem Statement

Turn-arounds (TA) - The planned, periodic inspection and overhaul of the units of a refinery or processing plant - are being planned further apart, ranging from 3 to 5 years. The Full Stroke Test (FST) and functional test for ESD could only been done during Turn around where there is no process flow and no product. The inability to conduct FST within the required period, causing safety issues to arise due to ESD valves being stuck in position due to the very long period in one fixed position. A number of failures in PST around the world have given rise to concerns on the reliability of PST. The facility is meant for comparison and verification of the technology used for PST of ESD valves. The work includes test rig simulation and the development of the controller to execute the FST and PST sequences, data mining and analysis.

Part of the simulation is to observe and analyze the effect of PST to process medium, whether it effecting the production. During PST, partial stroking could affect flow and pressure of process medium hence could affect the entire production. As partial stroke only involving small percentage opening adjustment, the effect to production assume to be less significant hence the purpose of simulation and PST on test rig is to prove this assumption.

1.3 Objective and Scope of Study

The main objective of this project is to continue and improving of the previous project. For this 2nd Phase, destructive testing will possibly be conducted. PETRONAS is going to upgrade the testing facility with real medium flowing through the valves during testing to permit more realistic testing be conducted. The results will be utilized by PETRONAS in developing the PETRONAS Technical Standard, as well as verifying the capability of the valves' and its software reliability as claimed by the vendor. The main focus of the 2nd phase is to design and testing a system for PST and FST with real medium flowing through the valve.

As PST test rig is under construction, for Jul 2010 semester the project will be focusing on extensive simulation result analysis for test rig model. A piping base software AFT Fathom will be used to simulate and observe the fluid behaviour as PST performed.

The scope of studies will be:

a. Hysis software manual and simulation
b. AFT fathom software manual and simulation.
c. Detail proposed design inspection and verification.
d. Study Valve datasheet for simulation purposes

The objectives will be:

a. To check vessel capacity
b. To check pressure drop cause by PST valve action
c. To check test rig capability handling destructive test.
d. To do a transient simulation using specific time range and water level
e. To get relationship between valve opening and pressure drop

CHAPTER 2
LITERATURE REVIEW

2.1 Emergency Shutdown System (ESD)

Emergency shutdown systems are designed to detect any abnormal condition and ensure a rapid return to a safe condition by shutdown of a part, or whole, of an operational plant, as may be necessary. In an emergency situation the system shall eliminate potential ignition sources and reduce the consequences in the event of a leakage. The system shall include manual activation form strategic points and automatic activation from the fire and gas and critical process shutdowns.

An emergency shutdown system is a standalone system, totally independent, but report to, of any control system. A modern plant has its control systems split into Fire & Gas, ESD and DCS. There can however, be a sharing of information from the Fire & Gas and ESD to the DCS system. Any failure of the ESD system resulting in a failure to be able to safely monitor the plant must result in an immediate shutdown.

2.1.1 Emergency Shutdown Valve

Emergency shutdown valves or sometimes called as safety valves are crucial in maintaining process in a safe condition. It does used to protect processes personnel and the environment against process disruption. These valves are the final line of defence and are critical to minimizing the chance of potential disaster during process upset. It is an actuated valve placed in pipeline used for isolation of process unit from an upstream and downstream inventory upon activation of the process unit alarm and shutdown system. In this project two valves might be used as shut down valve which are Ball and Butterfly valve.

2.1.2 Ball valve

Ball valve is a valve that opens by turning a handle attached to a ball inside the valve. The ball has a hole or port, through the middle so that when the port is in line with both ends of the valve, flow will occur. Otherwise when the valve is closed the hole is perpendicular to the end of the valve, flow will blocked (*refer figure 1*). These valves allow for shut-off or purposes of control.

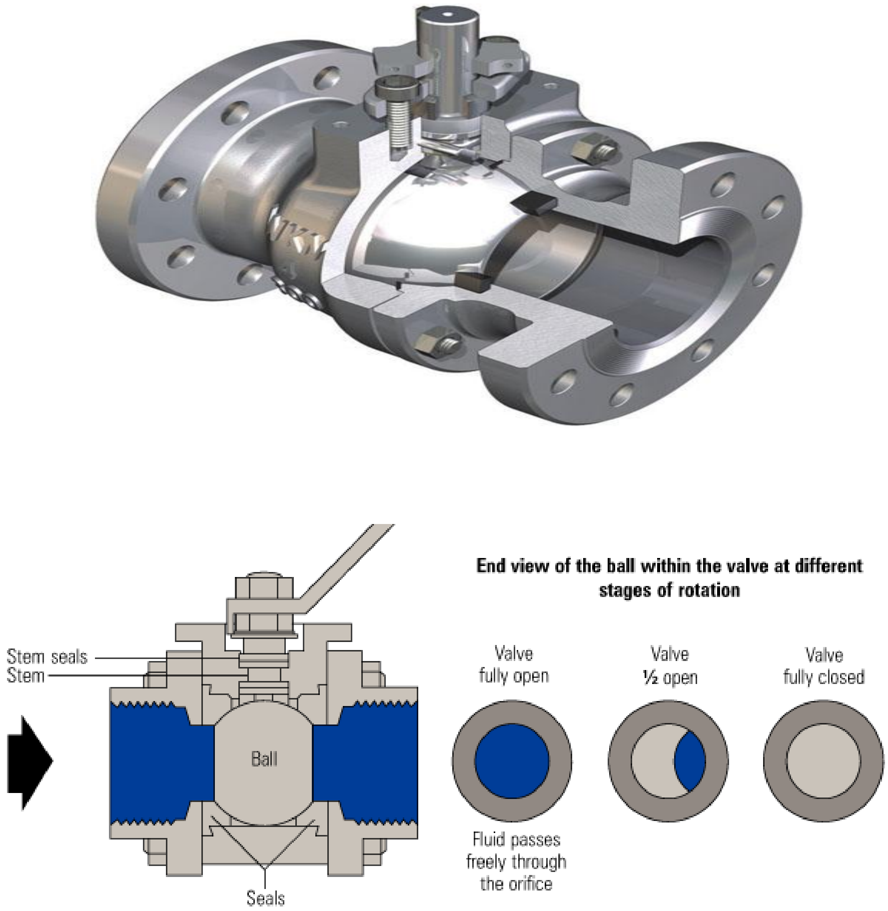


Figure 1 : Ball valves

2.1.3 Butterfly valve

A butterfly valve is also a quarter-turn valves. The valves are a metal disc mounted on a rod. When the valve is closed, the disc is turned so that it completely blocks off the passageway. When the valve is fully open, the disc is rotated a quarter turn so that it allows an almost unrestricted passage of the process fluid. Compared with ball valves, butterfly valves do not have pockets to trap fluids when the valve in the closed position. They can control various substances of air, liquid or solid currents and are situated on a spindle that allows for flow in a single direction.

Figure 2 : Butterfly valve

2.2 Partial Stroke Test (PST)

ESD valve partial stroke testing (PST) is a method whereby a portion of the valve assembly is tested at a more frequent interval than the full test rate. The main advantage of partial stroke testing is that it will provide a measure of confidence that a valve is not stuck in one position. This has both a preventive and corrective aspect. The valve movement can dislodge any dirt build-up to help prevent sticking. If the valve is already stuck, the test will detect it and corrective measures can be taken.

2.3 MASONEILAN SVI® II ESD

For this project, PST Masoneilan device will be used. The SVI® II ESD can be implemented using a 4-20mA signal, 0-24Vdc or a combination of both. The single 4-20mA solution is most desirable as it is SIL3 capable while at 4mA, allowing the device to execute the safety function while active. Substantial benefits are realized in capturing shutdown events, allowing continuous HART communications during a trip and facilitating local panel annunciation using the built-in discrete outputs.

In terms of PST execution, the following are available: local LCD display, remote HART access, remote use of 4-20mA analog signal, and finally, built-in scheduler functionality. The SVI II ESD automatically captures the PST in its non-volatile memory and stores the analysis. Two signatures can be stored, allowing the Valvue ESD Lookout software to automatically and regularly synchronize its database with field data. This software can be standalone or integrated.

Figure 3 :PST device

2.4 Probability to Fail on Demand (PFD)

By not having PST, The probability to fail on demand (PFD) can be calculated using the dangerous failure rate (λD) and the testing interval (TI). The mathematical relationship, assuming that systematic failures are minimized through design practice, is as follows:

$$PFD = \lambda D * TI/2$$

The equation shows that the relationship between PFD and TI is linear. Longer test intervals yield larger PFDs. For the purposes of illustration, a dangerous failure rate of 3.03E-06 failures per hour will be used. The valve failure rate varies with type, size, and operating environment (e.g., process chemicals, deposition, polymerization, etc.). The reader should determine the appropriate failure rate for the specific application.

The PFD, based on the 3.03E-06 per hour failure rate, is shown in table 1 for various testing frequencies. As expected, the valve performance at a 5-year testing interval is not the same as the valve performance at a 2-year testing interval. Reliability data for operating equipment provided justification to extend the turnaround period, in many cases by a factor of three or more. However, the impact of longer testing intervals on standby devices, such as block valves, was not evaluated. Longer turnaround intervals result in improved financial performance. The side effect is increased risk of an incident due to lower performance of safety critical devices.

Table 1 :PFD base on year

Testing Interval	PFD_{avg}
1 year	1.33E-02
2 years	2.65E-02
3 years	3.98E-02
4 years	5.31E-02
5 years	6.64E-02
6 years	7.96E-02

2.5 Valve Failure Effect

The following table shows an overview of valve failures detected by Partial Stroke Testing and Full Stroke Testing:

Table 2 : Valve failure mode

Valve Failure Modes		
Mode	**Effect**	**Test**
Valve Body	Leak	Pressure test at turnaround
Valve plug/seat	Fail to close	Pressure test / FST
Stem packing seized	Valve stuck	PST
Air line blocked	Fail to close	PST or FST
Valve stem buildup	Valve stuck	PST or FST
Air line to actuator crimped	Sluggish response	PST or FST
Debris retained in seat	Fail to close	FST / Pressure test

By having PST the possibility of ESD system failure could be minimize but in the same time it could interrupt actual process plant and could affect production rate. Below are some of the pro and cons of having PST.

2.5.1 Advantages of PST

- Provides predictive maintenance data.
- May allow extension of the full stroke test (FST).
- May reduce the need for valve bypasses.
- Valve is always available to respond to a process demand during the test period (when properly designed).

2.5.2 Disadvantages of PST

- Tests only a portion of the valve failures (30% to 70%)
- Not applicable to tight shut-off valves.
- May increase spurious trip rate.
- Incorporates additional equipment with its own testing requirements (Safe and dangerous failures).
- If PST always strokes 10%, buildup forms at 10% of stroke.

2.6 AFT Fathom 7.0

AFT Fathom 7.0 provides comprehensive, incompressible pipe flow analysis and system modeling capabilities combined with ease-of-use. Addressing open and closed loop systems, AFT Fathom includes a built-in library of fluids and fittings, variable model configurations, pump and control valve modeling and much more.

More than just pipe flow analysis, AFT Fathom lets user build piping system in software. Vary pipe sizes, pump curves, valve settings, fluid properties, operating lineup and virtually anything that user can do with the real system could be done within AFT Fathom, accurately simulating the individual system components and their interaction. Whether designing new systems, modifying existing ones or analyzing system operations, The ability to analyze alternates and the insight provided by an AFT Fathom model significantly improves the quality of systems engineering that can be achieve, leading to less costly, more efficient and more reliable piping systems.

2.6.1 AFT Fathom Applications and Features.

System Operation

A system's operating envelope can be fully explored by quickly and easily varying system parameters and configuration. Overall system configuration can be change including number of pumps in operation; pump speed, control valve settings, valve positions, fluid properties, and virtually any modeling parameter. An AFT Fathom model provides a realistic and accurate representation of the system's characteristics allowing testing under a wide variety of conditions long before committing to hardware.

Coupled Thermal Analysis

Calculating internal heat transfer coefficients in conjunction with user specified insulation, AFT Fathom determines piping heat transfer and the effect of varying fluid properties from the resulting temperature change simultaneously with the flow analysis. In conjunction with AFT Fathom's heat exchanger modeling capabilities, cooling or heating system model becomes a comprehensive fluid and thermal analysis.

Pipe Sizing

AFT Fathom's extensive capabilities for friction modeling include pulp & paper and non-Newtonian fluids. The software also provides the comprehensive output details of the contribution of individual line losses to the overall system. Visual Report's color-coding by selected criteria clearly illustrates individual lines in the context of the entire system.

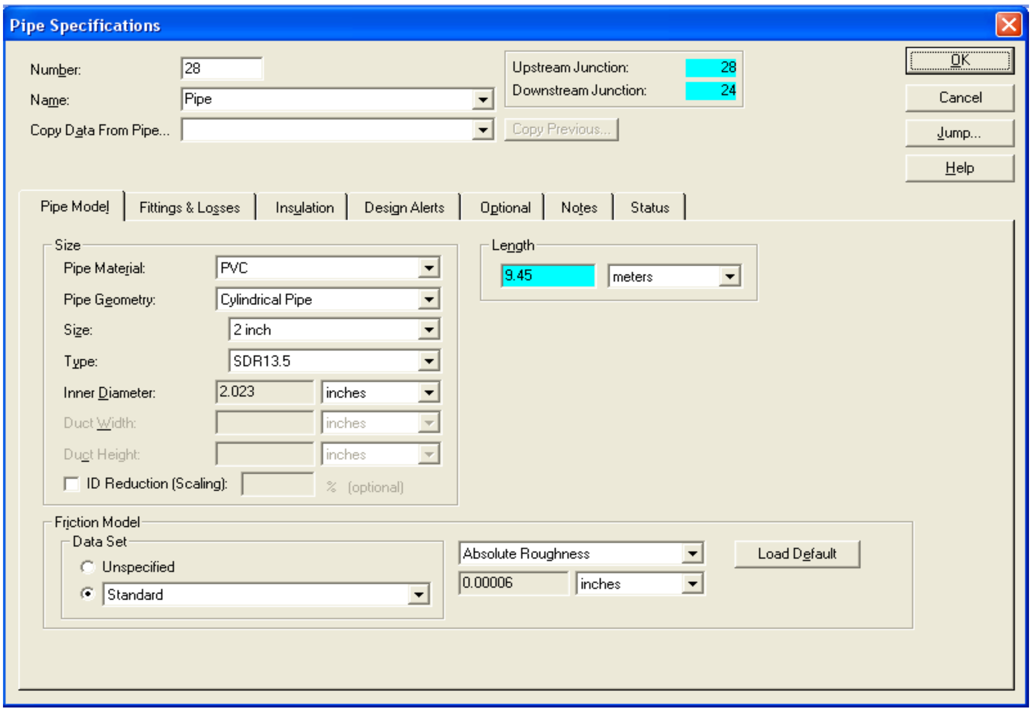


Figure 4 :Pipe specification

Pump Selection

Pump's parameter could be adjusted according to system. Pump modeling capability includes parallel and series pump operations, flow vs. head, varying pump speeds and viscosity corrections. Able to import external databases, AFT Fathom allows the system engineer to quickly evaluate a large range of potential pump selections.

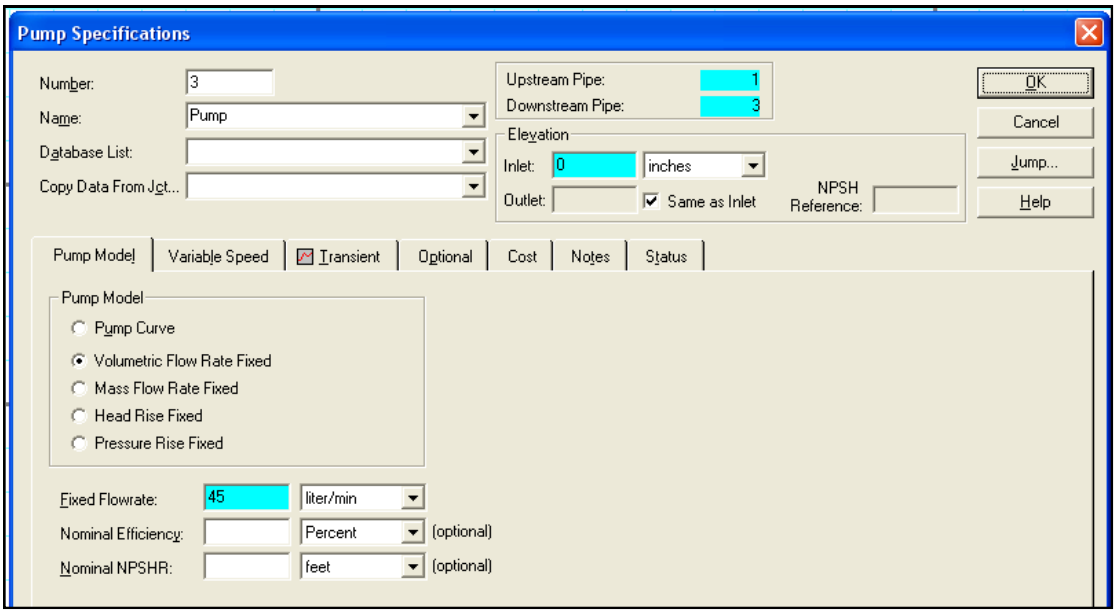


Figure 5 :Pump specification

Control Valve Selection

With comprehensive output and ease of changing component specifications, determining control valve capacity and insuring adequate pressure drop is greatly facilitated. AFT Fathom goes beyond this by simulating pressure and flow control valves so that interaction with the system can be tested in the design stage. The valve summary report displays effective Cv and K factor values for all valves in the system.

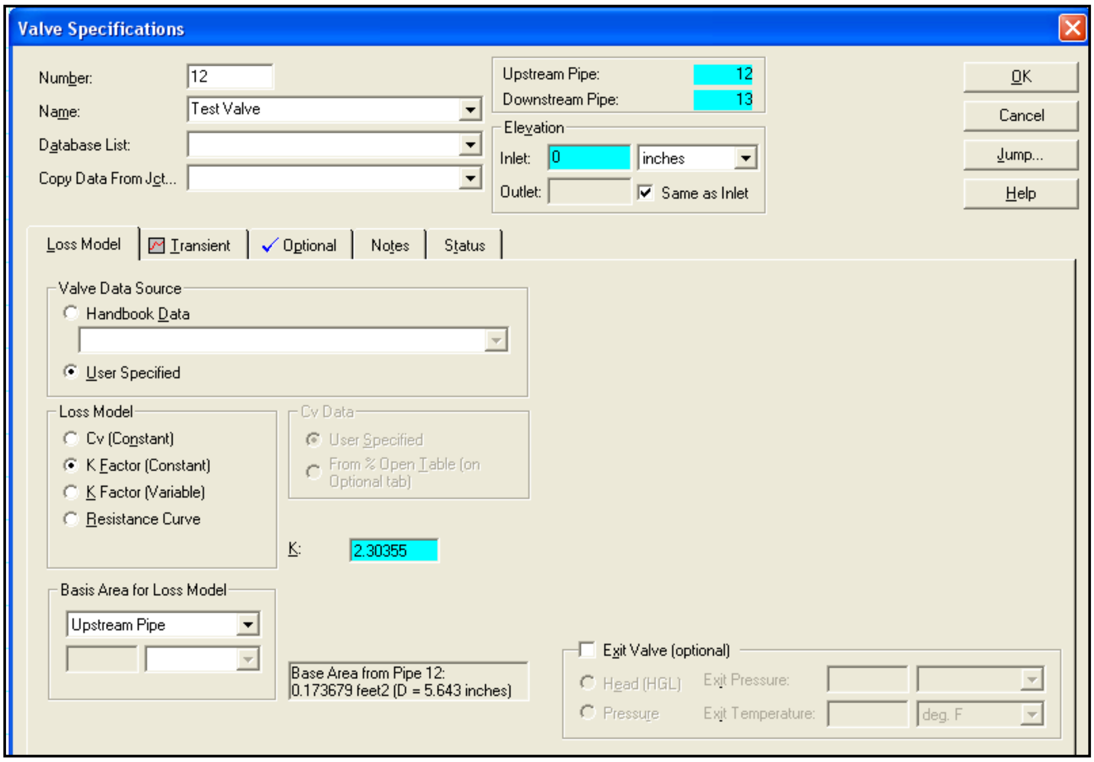


Figure 6 :Valve Specification.

AFT Fathom Add-on Modules

1. XTS-eXtended Time Simulation to model dynamic system behavior
2. GSC-Goal Seek and Control to automate the determination of input parameters that will yield desired output values and simulate control functions within systems
3. CST-CoST calculations of pipes and components

The AFT mode that will be used for the project is **XTS-** e**X**tended **T**ime **S**imulation to model dynamic system behavior of PST in real time operation.

CHAPTER 3
METHODOLOGY

3.1 Procedure Identifications

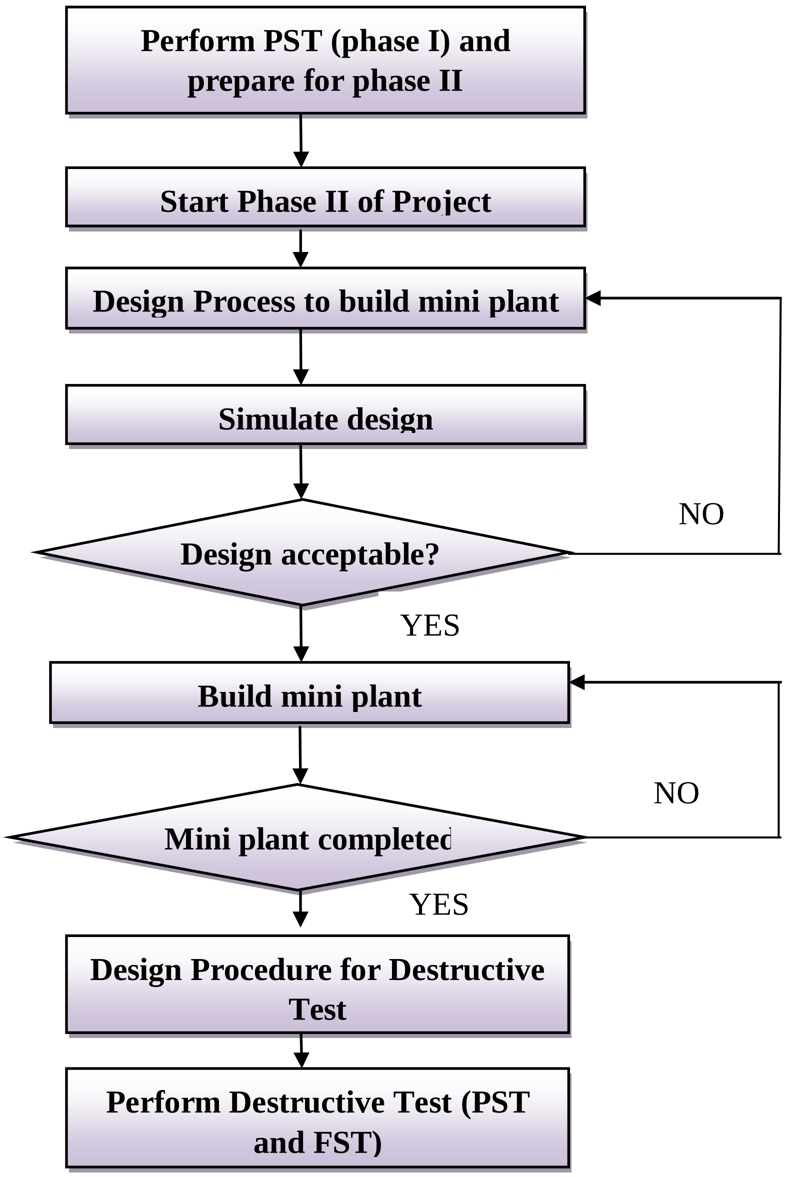


Figure 7 : Flow Chart of FYP1 and FYP2

3.2 Hardware Configuration

This project involves eight valves from four different manufacturers. These valves swill be controlled by a Programmable Logic Controller (PLC) and Personal Computer (PC). The PLC is needed to execute the Full Stroke Testing (FST) as set in the sequence requirements. Thus, it is important to develop the right hardware system between input and output devices. A complete wiring connection will ensure the communications between all devices are successful. The diagram below shows the hardware system for this project.

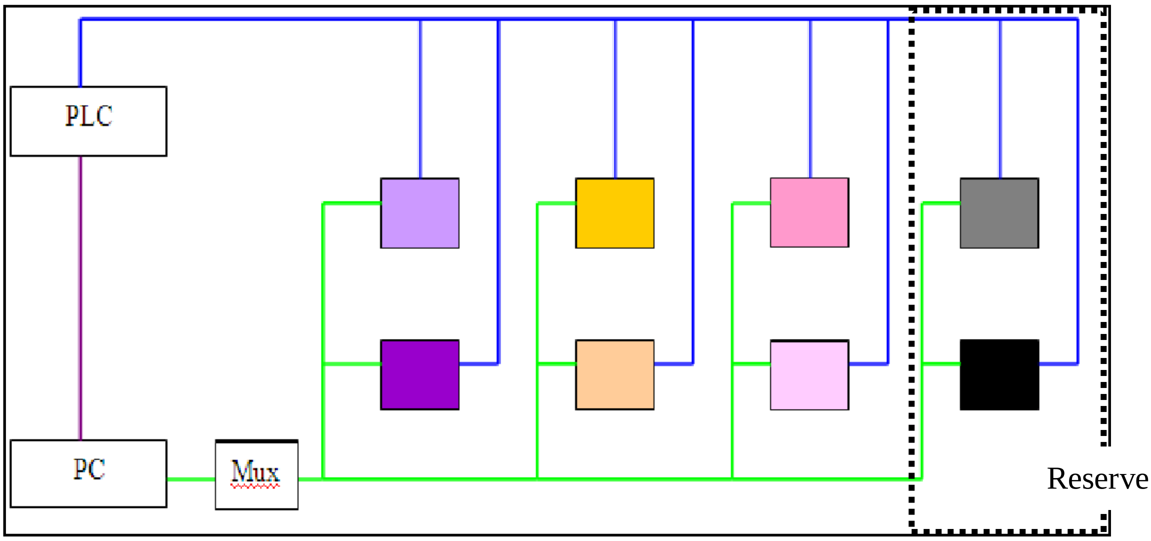


Figure 8 : Hardware connection between the valve, PLC and the PC

Table 3 :Valve manufacturer

	FISHER Ball Valve		FISHER Butterfly valve
	METSO Ball valve		METSO Butterfly valve
	MASONEILAN Ball valve		MASONEILAN Butterfly valve
	ROTORK Ball valve		ROTORK Butterfly valve

Rotork valves introduced during January 2010 semester and not included in the initial design configuration (*Refer appendix A and B*). Rotork valves will be part of 2nd phase PST test.

PST performed by following a set of procedure (*Refer appendix D*) that has been prepared during January 2010 semester (phase I).

3.3 ESD PARAMETERS

Result from PST and FST will be evaluated based on this criteria:

a. PST Travel

   The allowed valve travelling movement from it full open position condition to the partial close position and measured in percentage of travel. A typical value is 20% and the maximum allowed is 30%, and for Masoneilan valve it is from 5 % to 30% range. The greater the travel rate, more accurate the result from PST will be.

b. Minimum Pressure

   Minimum pressure is the allowed reduction in pressure level in the valve actuator in order to achieve the desired PST travel position. This value depends on the spring range and the valve/ actuator hysteresis and the data collected from software and also can be seen in graph displayed.

c. Maximum Time

   Total time measured for doing the PST testing. It is also defined as allowed amount of time in seconds before the PST test aborts.

   Maximum time = (Travel Range x 2 x PST speed) + Dwell time + 5 seconds

d. PST Speed

   PST speeds indicate how fast the valve operates and is measured in % travel per second.

e. Dwell Time

   Dwell time is the amount of time in seconds between the down ramp and the up ramp of valve stroke and is displayed after the testing is completely done.

f. Friction(Psi,Kpa,BAR)

   High limit for high alarm threshold and Low limit for low alarm threshold.

g. Breakout Limit

   The Alarm threshold set up for valve breakout force that is required to move valve from initial position to the start movement.

h. Droop Limit (PSI,kPa or BAR)

   The alarm threshold for air supply inlet droop. This alarm is set if the analyzed Air Supply Droop from the PST test is more than this value, indicating a possible clogged up air filter in the air set or lack of volume feeding the SVI II ESD.

3.4 Design and Construction

One of the requirements for PST by PETRONAS Group Technology Solution (GTS) is PST done in real medium will have only small effect on process medium or production. Test done in real medium could also ensure that PST could be performs 90 days without fail as in first phase. So new test rig with real medium flow through valve need to be designed. Bellow is the proposed design for the test rig and contractor's scope for the construction process.

3.4.1 Design

3.4.1.1 List of valve:

Table 4 :ESD valve size

Brand	Ball Valve	Butterfly Valve
Fisher	6 inch	3 inch
Masoneilon	6 inch	4 inch
Metso	6 inch	6 inch
Rotork	6 inch	6 inch

3.4.1.2 Test rig design

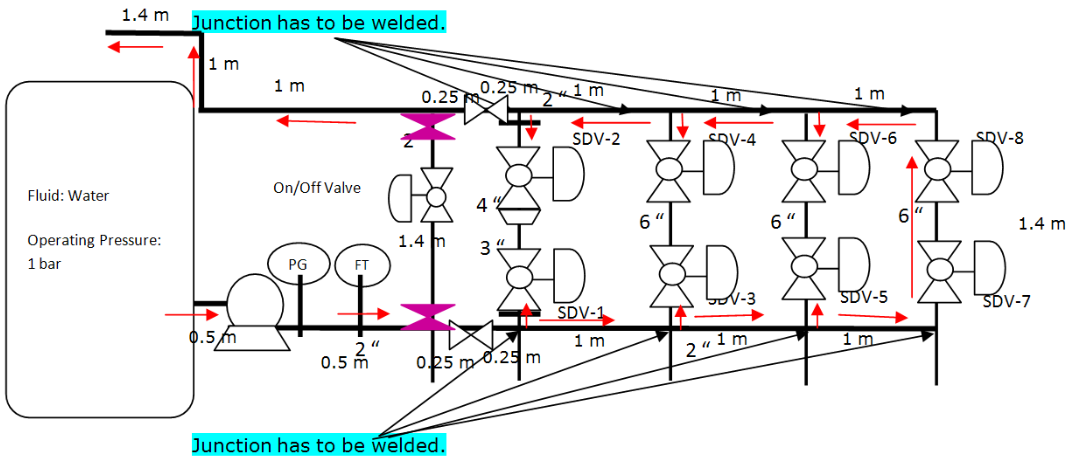


Figure 9 :

Pump rating:45l/min
Tank size:1 m in height and 0.25 m in radius(0.1963 m3)

Detail Calculation (ensure flow continuity):

Volume for 2" pipe diameter

$r = 1" = 0.0254 \text{ m}$

$\text{l} = 0.5 + 0.5 + 0.25 + 0.25 + 3 + 3 + 0.25 + 0.25 + 1 + 2.4 = 11.4 \text{ m}$

$\text{A} = \pi\text{r}^2 = \pi(0.0254)^2 = 0.00203\text{m}^2$

$\text{V} = \text{Al} = 0.00203\text{x}11.4 = 0.023142 \text{ m}^3$

Volume for 6" pipe diameter

$r = 3" = 0.0762m$

$l = (0.35m\ x\ 6) + 1.4 + = 3.5m$

$A = \pi r^2 = \pi(0.0762)^2 = 0.01824m^2$

$V = Al = 0.01824x3.75 = 0.06384m^3$

$V_{total} = V_{2"} + V_{6"} = 0.023142 + 0.06384 = 0.086982m^3$

The output discharge of the available pump is $45\, {}^{l}/_{min} = 0.045\, {}^{m^3}/_{min}$

$\therefore Volumetric\ flow\ rate, \dot{V}$

$\dot{V} = \frac{V}{t}$

$t = \frac{V}{\dot{V}} = \frac{0.086982}{0.045} = 1.933min = 115.98s \approx 120s$

$t_{testing} = 80s$

#Total time required = $t + t_{testing} = 120 + 80 = 200s = 3.333min$

$$\therefore minimum\ volume\ tank\ required = V_{piping} = 0.045\, m^3/min \times 3.333min$$
$$= 0.14985m^3$$

<u>Check back the volume of the tank with the specified *r* and *h*</u>

$V_{tank} = \pi r^2 h = \pi \times 0.25^2 \times 1 = 0.1963m^3$

Thus the size of the tank is valid because

$V_{tank} > V_{piping}$

$0.1963m^3 > 0.14985m^3$

3.5 Software Simulation

Two main simulation softwares relevant to this project for simulate piping flow design:

i. Hysis
ii. AFT Fathom

The simulation process will be focusing on using AFT Fathom rather than Hysis software as Hysis focused more on chemical reaction.As we use water as main flow material and not involve any other chemical process, AFT Fathom piping software is sufficient enough. Simulation using Hysis also tedious and complex as data on process material such as temperature, pressure, flow and thermodynamic properties need to be fill before entering simulation environment.AFT Fathom also more simpler with user friendly graphical user interface (GUI).

AFT fathom can perform either steady state or transient state time base simulation. For this project steady state simulation will be used to get test rig status during either 100% , 80% or 70% opening. The result during steady state indicates test rig condition when there is no PST or FST perform, work just like in normal plant operation. Transient state is very useful when valve opening need to be varies according to times as in PST. Test rig condition during transient state simulation will represent result when PST performed.

3.5.1 AFT Fathom simulation step.

The objective of the simulation is to verify whether the design could work operate smoothly when construction process completed. The objectives of the simulation are:

1. To verify volume of water tank could contain enough water to supply the whole system when PST performed.
2. To verify pump's flow rate sufficient to drive the fluid from tank to pump and feed back to tank.
3. To observe the pressure drop effect caused by pipe constriction, different pipe and valve sizing and PST performed.
4. To simulate PST on model design and observe the effect.

3.5.1.1 Steady state simulation.

Start by setup system properties, using water as medium and using drag and drop process, connect each component by pipes with known length value (*Refer figure 10*).Fill all required pipe and valve parameters based on design specification.

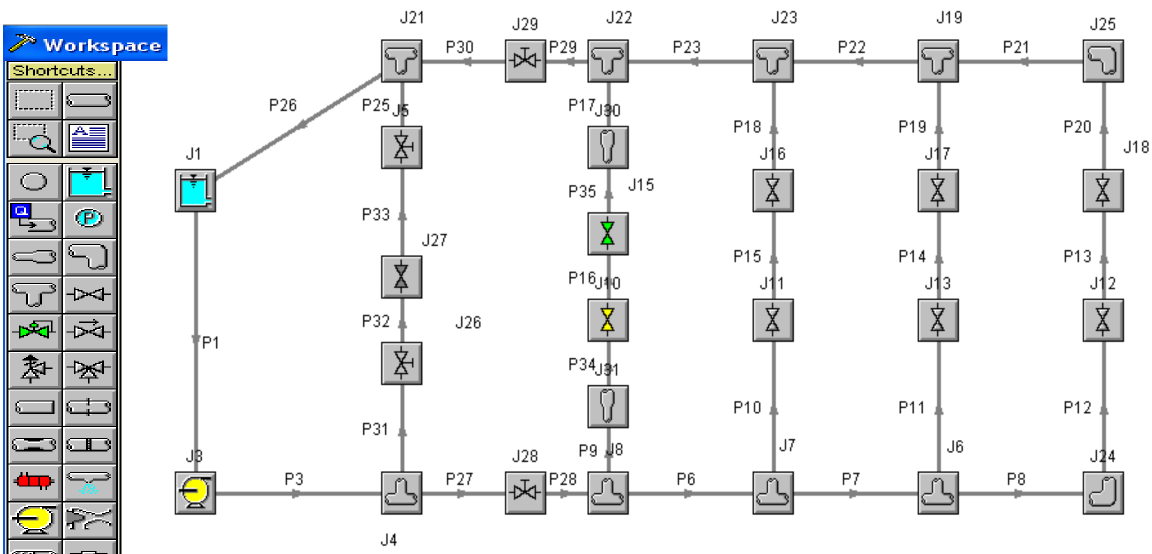


Figure 10 : Full simulation Schematic

As only two main type of ESD valve used, valve model could be set to be either butterfly or ball valve regardless of its manufacturer (Rotork Mesoneilan Metso or Fisher) (*Refer to Figure 11*).

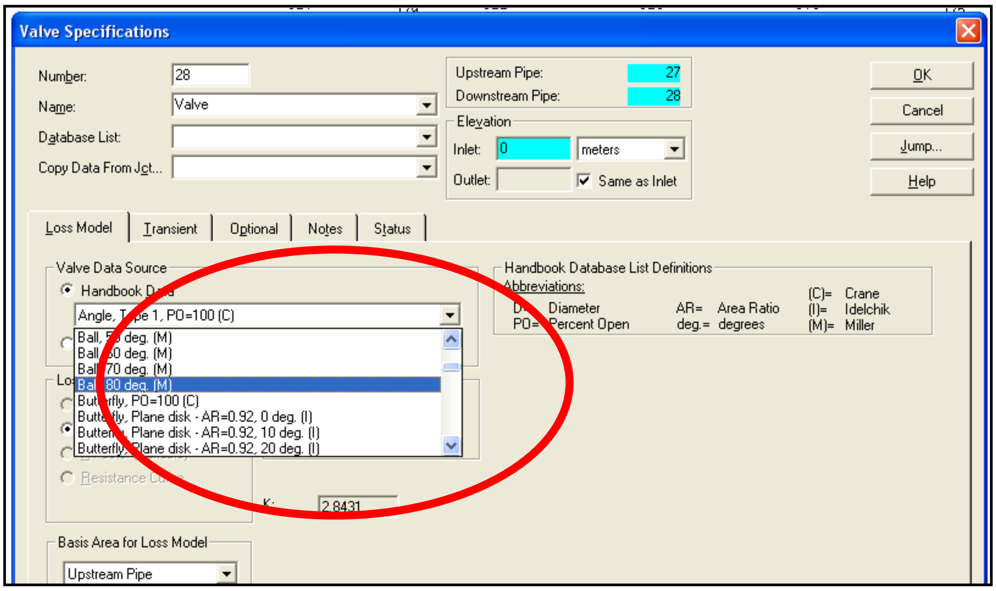


Figure 11 : Valve configure base on its type

i. Set valve opening to 100% or 80% to observe how test rig will perform when there is no PST performed or when PST performed.

ii. Set output analysis parameter to be volumetric flow rate, pressure loss static, pressure stagnation inlet and outlet and velocity.

iii. Start the simulation by click Start button on menu toolbar.

iv. After simulation process complete view output and choose quick graph to view overall output parameter changes.

3.5.1.2 Transient state simulation.

Only a slight change needs to be done for Transient State simulation. Set simulation to Transient at menu and set value of valve opening according to times. Then set simulation time to be more than PST cycle so that effect of PST could be observe .

Valve set to travel 20% in 60 second from 100% opening to 80% then return back to original position. Three PST cycle will be simulate.

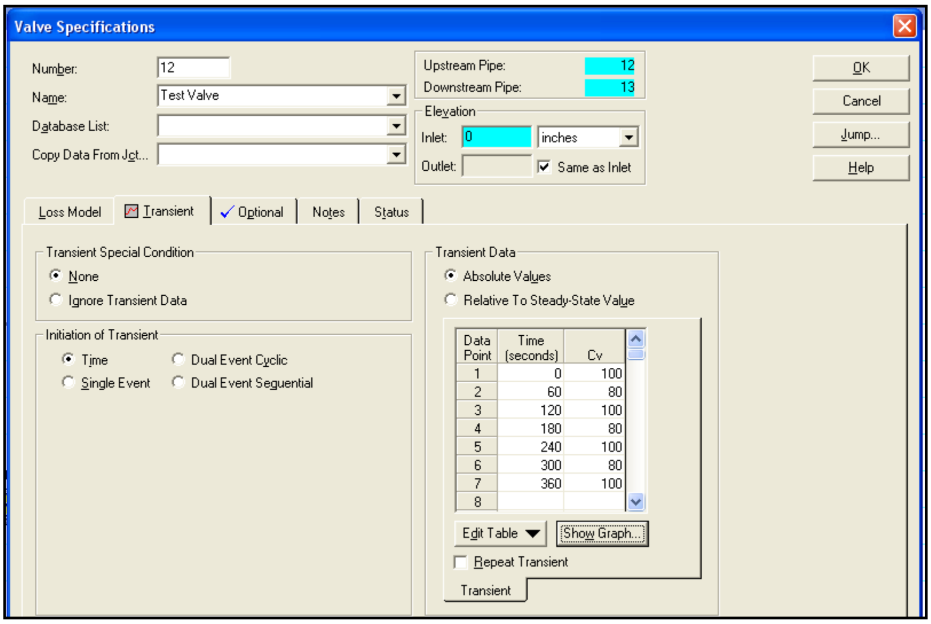


Figure 12 :Valve opening base on time

Figure 13 : Valve opening set by predetermine value

CHAPTER 4

RESULT AND DISCUSSION

4.1 DATA GATHERING AND ANALYSIS.

4.1.1 PST and FST without process medium

Testing has been done for 90 day with 5 PST and 1 FST every day without process medium condition. Result show that PST could operate in 90 days period without fail.

Below is some sample result from the testing.

Ball Valve PST

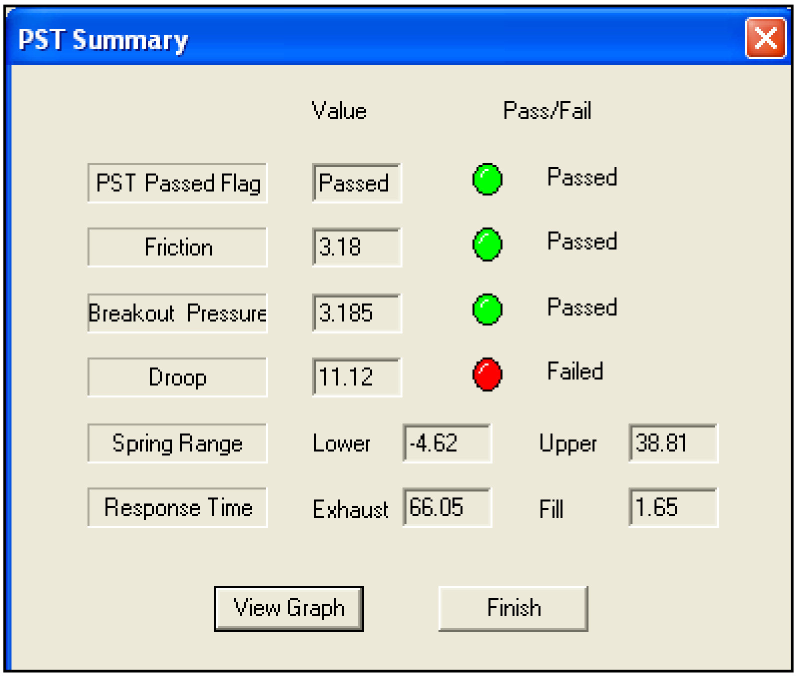


Figure 14 : Ball Valve PST summary

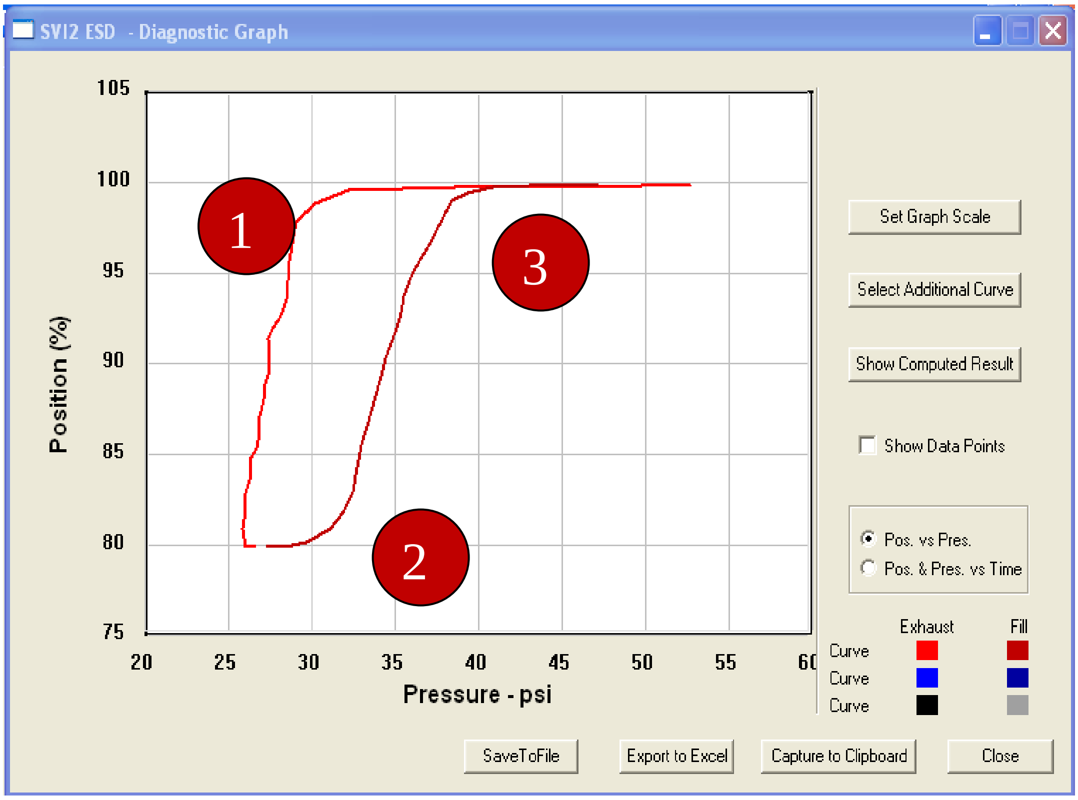
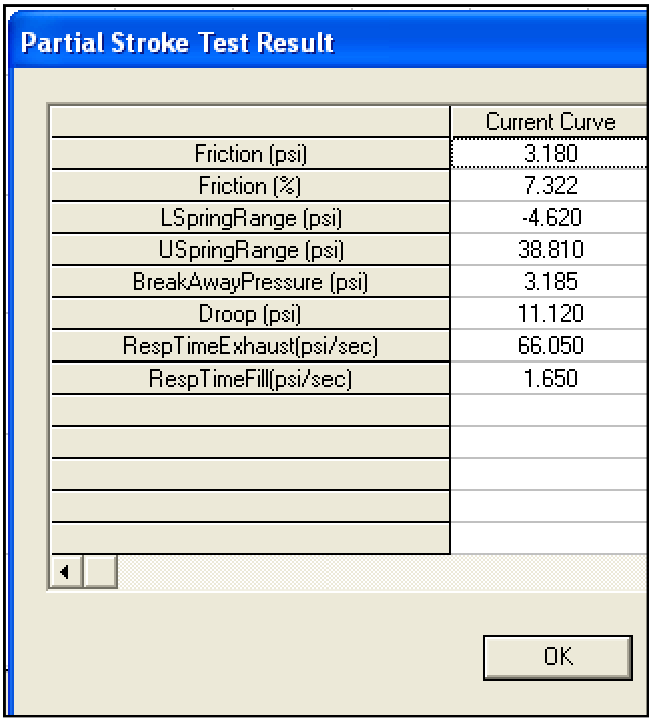


Figure 15 : Ball Valve Diagnostic graph



Partial Stroke Test Result

	Current Curve
Friction (psi)	3.180
Friction (%)	7.322
LSpringRange (psi)	-4.620
USpringRange (psi)	38.810
BreakAwayPressure (psi)	3.185
Droop (psi)	11.120
RespTimeExhaust(psi/sec)	66.050
RespTimeFill(psi/sec)	1.650

OK

Figure 16 : Ball Valve PST result

Butterfly valve PST

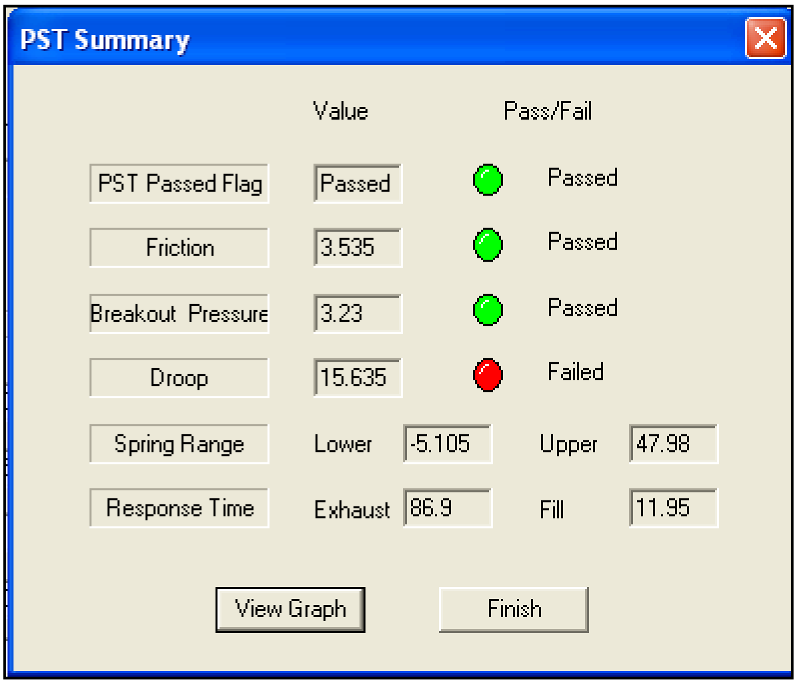


Figure 17 : Butterfly Valve PST summary

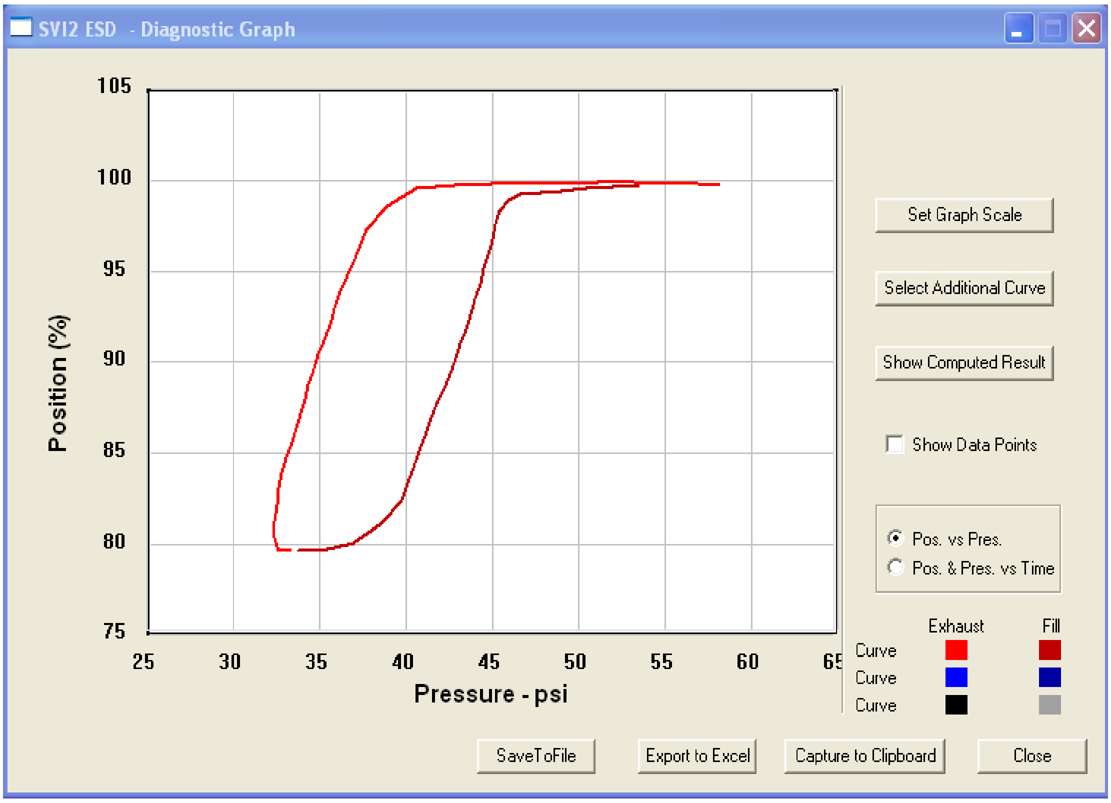


Figure 18 : Butterfly Valve Diagnostic graph

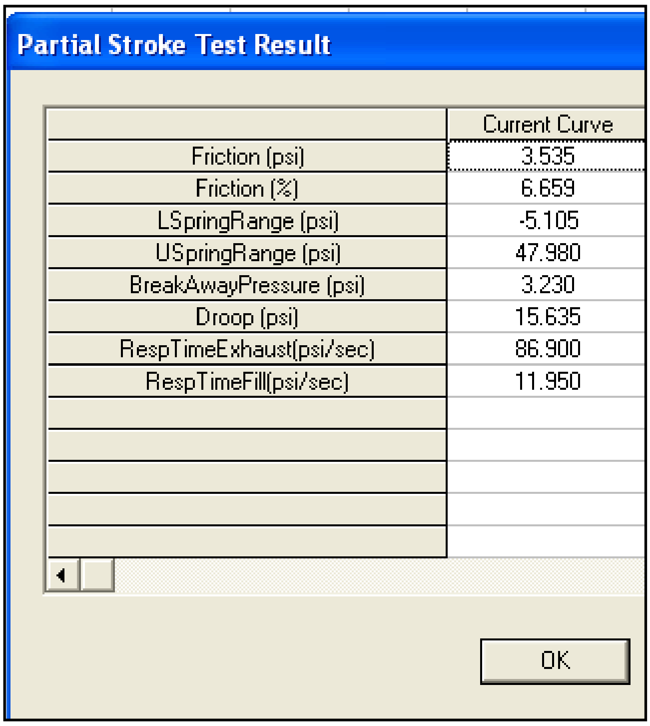


Figure 19　: Butterfly Valve PST result

FST+PST

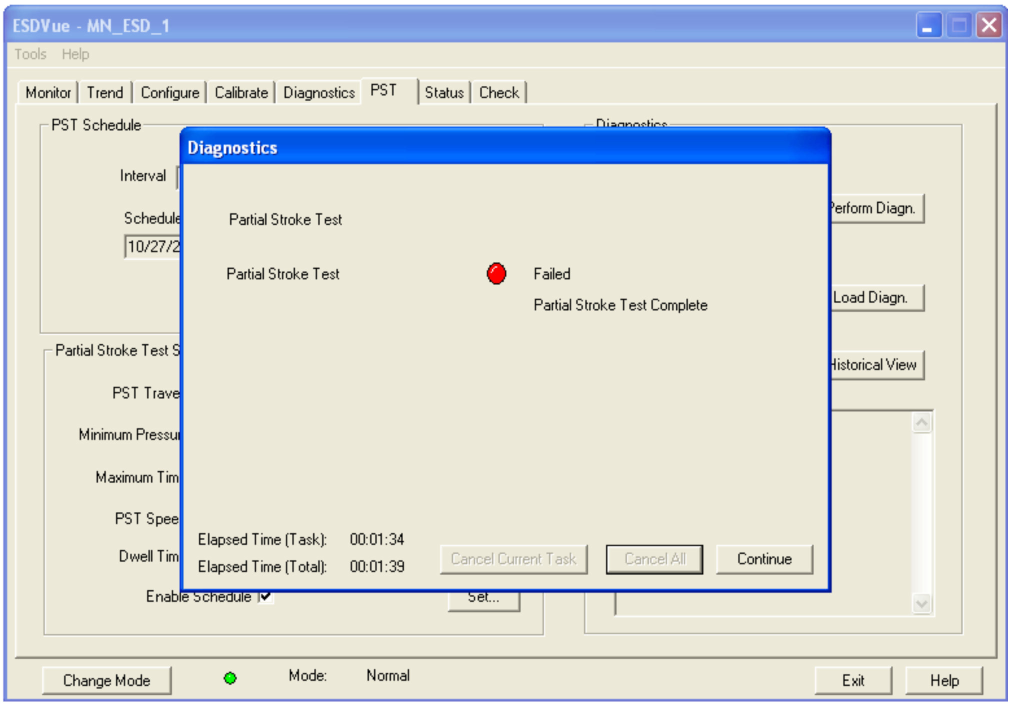


Figure 20　: Result of FST overrides PST

During PST, valve will move from 100% to certain opening specified by user slowly and will travel back to it original position (100%) in predetermined period of times (*Refer figure 15*).

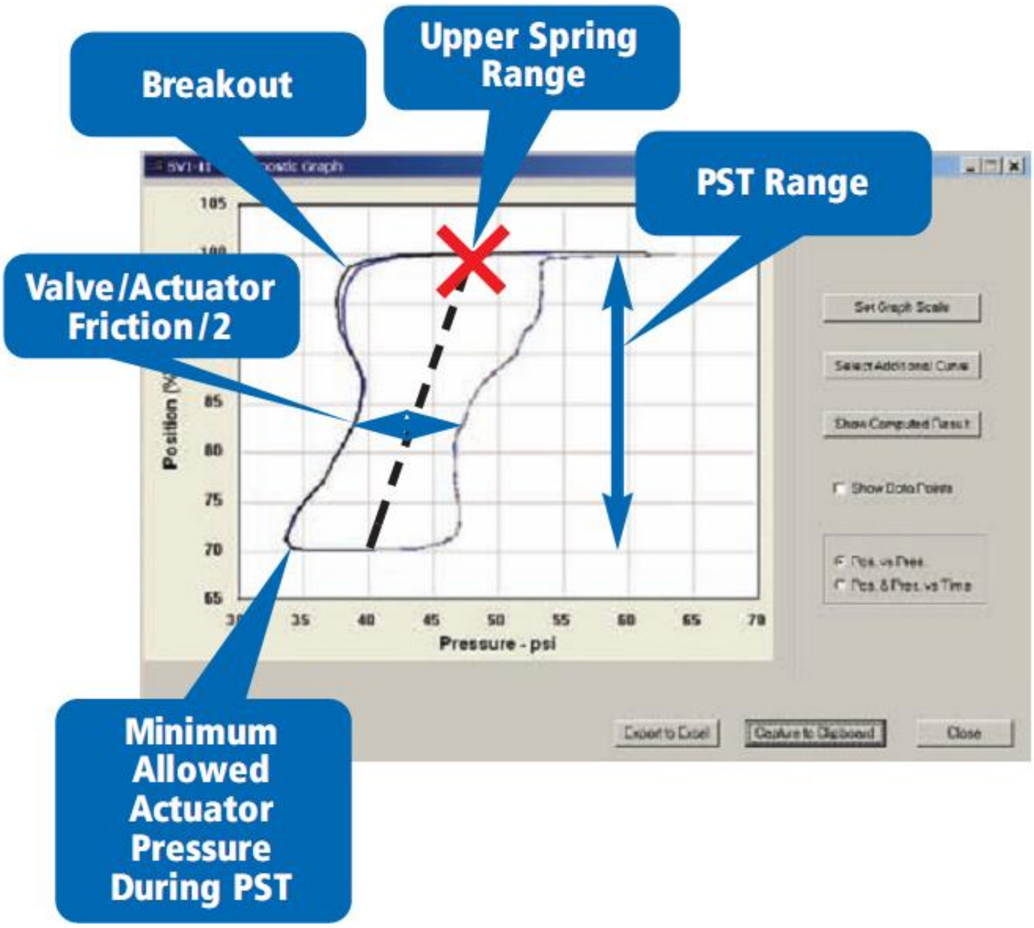


Figure 21 : Graph diagnosis

The result from Butterfly and ball valve is almost the same. The only different is that butterfly valve has smooth movement with least amount of friction. Droop limit is air limit pressure base on regulators. During 90 days simulation droop flag show failed result for a couple number of days. Droop fail flag give indication that there is not enough air supply volume feed to the SVI II ESD. The instrument air line could be clogged or there is not enough supply from air compressor.

4.1.2 PST and FST simulation with process medium.

4.1.2.1 Steady State

Part of the simulation objective is to ensure that water (process medium) in tank will be sufficient throughout the piping and the tested valve. This can be achieve by simulate the mini plant base on the longest route for the liquid to flow (*refer to Figure 22*). Theoretically if water volume is sufficient for the longest route, the volume could be more than enough for the shorter length route.

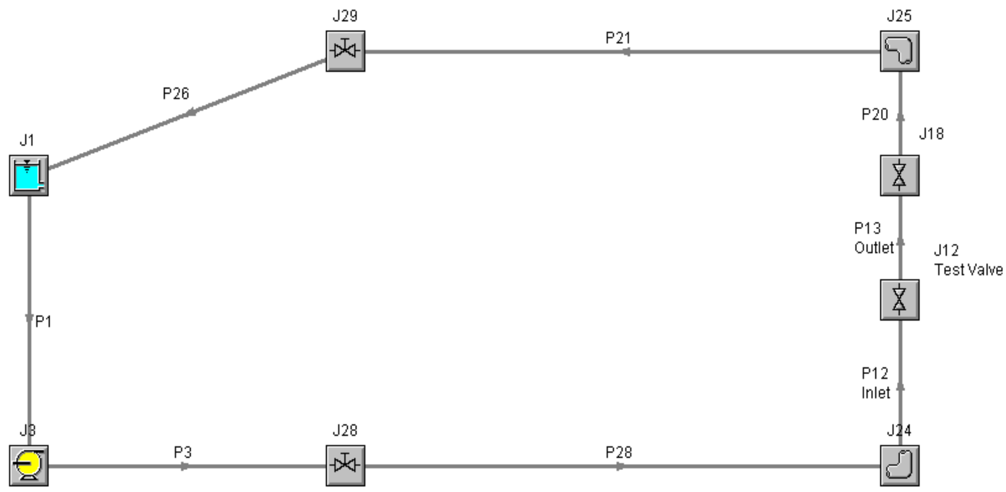


Figure 22 : Longest fluid path route simulation

Result for this simulation shows that the water in tank is more than enough to fill the longest route (*Refer to table 5*).As indicate in the table ,during steady state condition flow rate fixed to 45liter/min .From the table bellow we could also conclude that tested valve give slight restriction to water flow as water flow throughout the route almost constant. As for the fluid velocity, there is significant loss as it passing through 6 inch pipe.

$$v = \frac{Q}{A}$$

V=Velocity of fluid

Q=Flow rate

A=Cross section area

Table 5 :Simulation result

Pipe	Name	Vol. Flow Rate (liter/min)	Velocity (feet/min)	Elevation Inlet (in)	Elevation Outlet	dP Stag. Total (psid)	dP Static Total (psid)	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
1	Pipe	45.00	71.195	[illegible]	[illegible]	[illegible]539797	-1.19539797	-1.27648	0.18755564	14.69	15.88
3	Pipe	45.00	71.195	0.000	0.000	0.00472994	0.00472994	0.00000	0.01094132	20.63	20.62
12	Inlet	45.00	9.150	6.000	6.000	0.00001275	0.00001275	0.00000	0.00002950	20.38	20.38
13	Outlet	45.00	9.150	6.000	6.000	0.00005101	0.00005101	0.00000	0.00011799	20.37	20.37
20	Pipe	45.00	9.150	6.000	6.000	0.00001275	0.00001275	0.00000	0.00002950	20.36	20.36
21	Pipe	45.00	71.195	2.000	0.000	-0.05667780	-0.05667780	-0.07205	0.03555930	20.49	20.55
26	Pipe	45.00	71.195	0.000	35.433	5.84591532	5.84591532	1.27648	10.57004351	20.53	14.69
28	Pi[illegible]	[illegible]	71.195	0.000	2.000	0.08742243	0.08742243	0.07205	0.03555930	20.61	20.52

Velocity

Flowrate

4.1.2.2 Transient state

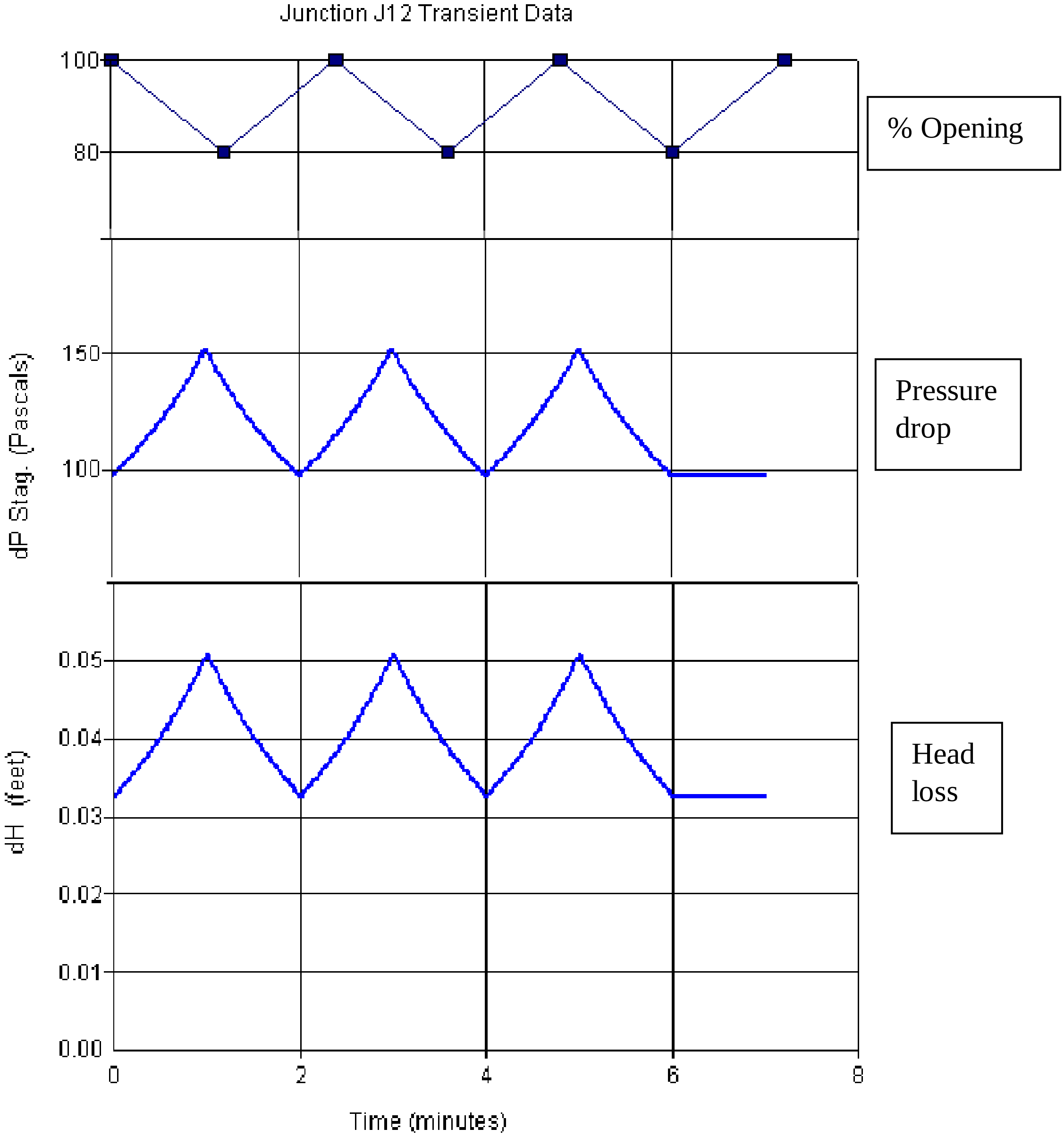
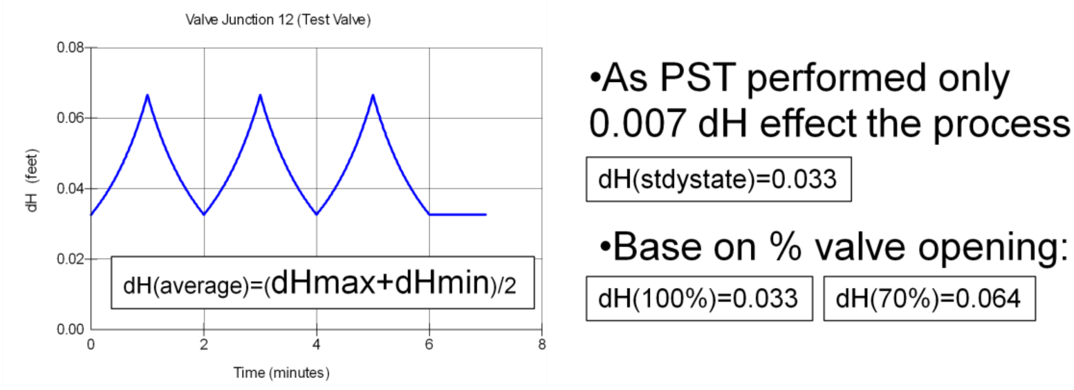


Figure 23 :Opening valve relation with pressure and head loss



The result shows that PST has only minimal effect on process medium pressure indicated by head loss and pressure drop. The PST effect could be view more clearly by plotting medium properties (pressure and volumetric flow rate) against pipe length starting from water reservoir. Below are some of the plotting results:

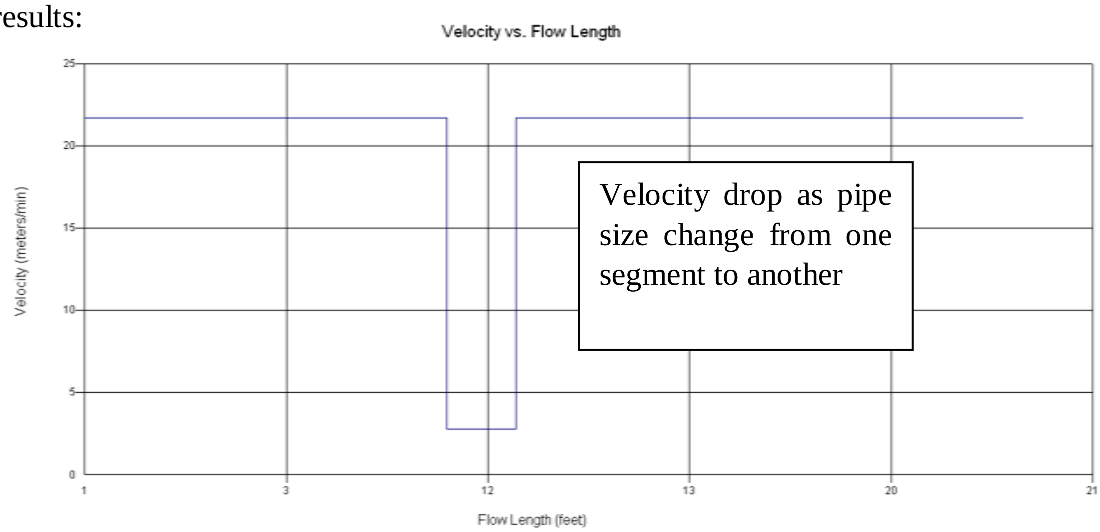


Figure 24 :Velocity VS Flow length

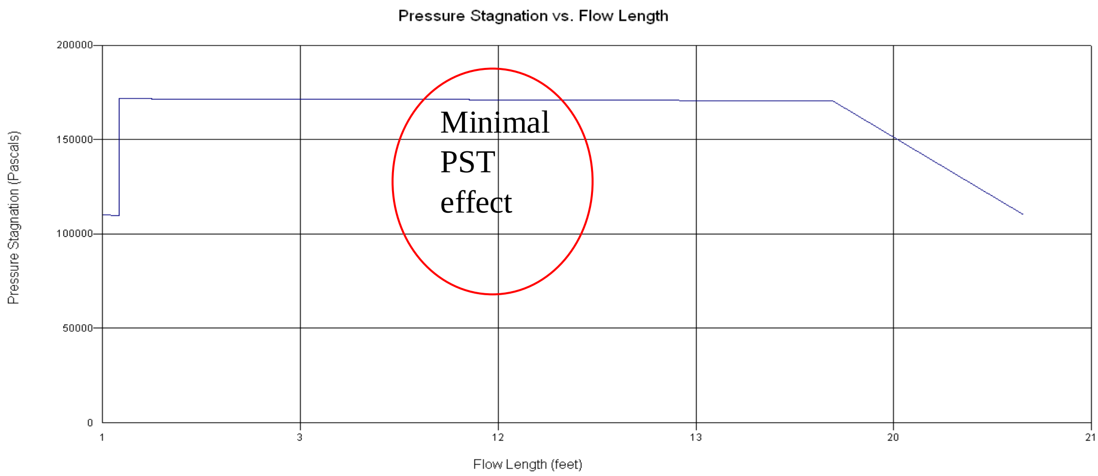


Figure 25 :Pressure stagnation VS Flow length

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions.

Masoneilan Ball valve and Butterfly valve have both successfully tested in normal lab condition without medium passing through the valve. This guarantee that PST device SVI® II ESD can work properly in 90 days period but without considering process medium. The main findings from this project are as follows:

- The PST is a robust method to provide confidence that a valve especially emergency shutdown valves will be at task to perform when needed
- The PST provide preventive, corrective and diagnostics aspect for valve
- A schedule valve maintenances and check-up is essential in dislodge dirt build-up, sticking and maintaining overall valve health.

Design for second phase PST has been done and successfully simulated using AFT Fathom software. Result show design acceptable and could proceed with construction of test rig.

5.2 Recommendations.

Some improvement can be made to the current design so that test rig system more stable and PST could be performed effectively.

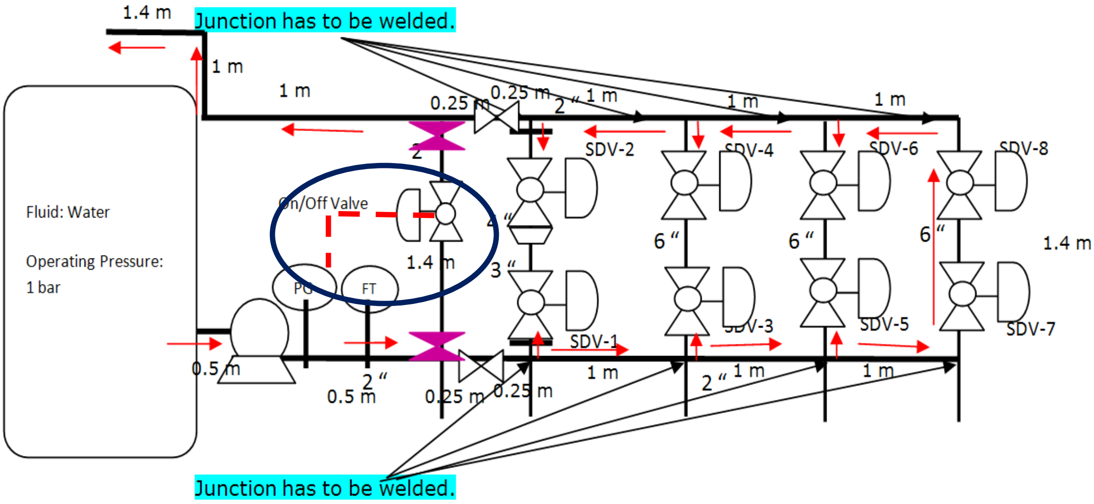


Figure 26 :Test rig modification

One of the improvements that can be added to current design is adding a control loop between Pressure transmitter and on/off valve. This addition will ensure overpressure would not happen if valve got stuck. Whenever pressure accumulate reach the allowable limit pressure, on/off valve will act as safety valve and divert all the liquid back to tank.

Another improvement that can be done is to have individual route or piping for each valve so whenever any valve got problem others will not be effected. Although this improvement can take a lot of space but it can ensure that PST could be perform smoothly.

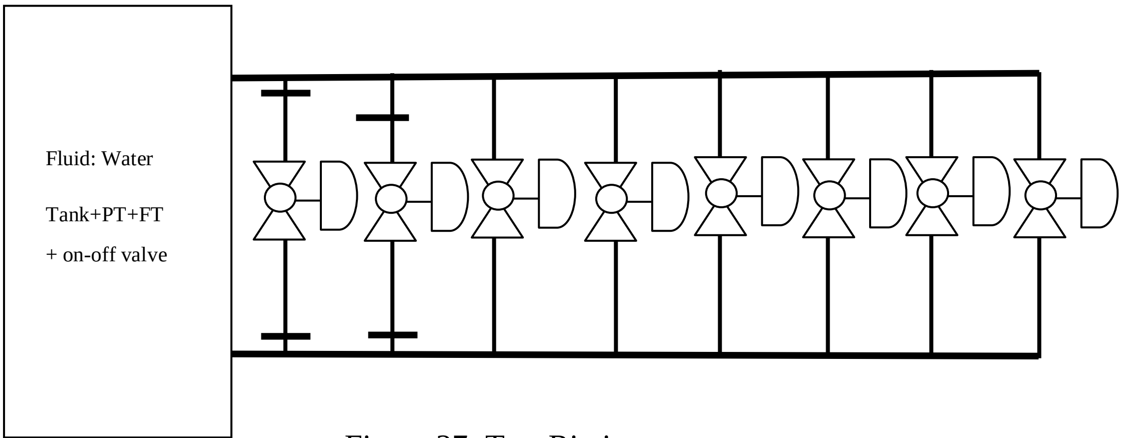


Figure 27: Test Rig improvement

REFERENCES

[1] Mccrea-Steele,Robin,2005,”Partial StrokeTesting,Implementing for the Right Reasons”,TUV Functionality,ISA EXPO 2005.

[2] Dresser-Masoneilan, Oct 2007“Getting started guide for valvue ESD”.

[3] Summers,Angela and Zachary,Brian,2000,”Partial Stroke Testing of Safety Block Valve”SIS-TECH Solution.

[4] Khairul,Sept 2009,”General Arrangement Layout”,ICPE Klang.

[5] Dresser-Masoneilan,2008,”Masoneilan SV II ESD”,Yokogawa Electric Corporation

[6] Cahill, Jim, 2007,” Partial-Stroke Tests, Proof Tests, and Smart Positioners in Safety Applications”, Emerson Process management.

[7] Apply Flow Technology Corporation,2008,”Fathom 7.0 Quick Start”

[8] http://www.neonindia.com/aft_fathom.htm

[9] http://www.aft.com/products/fathom

[10] http://www.aspentech.com/

APPENDICES

APPENDIX A

GANTT CHART

SEMESTER 1

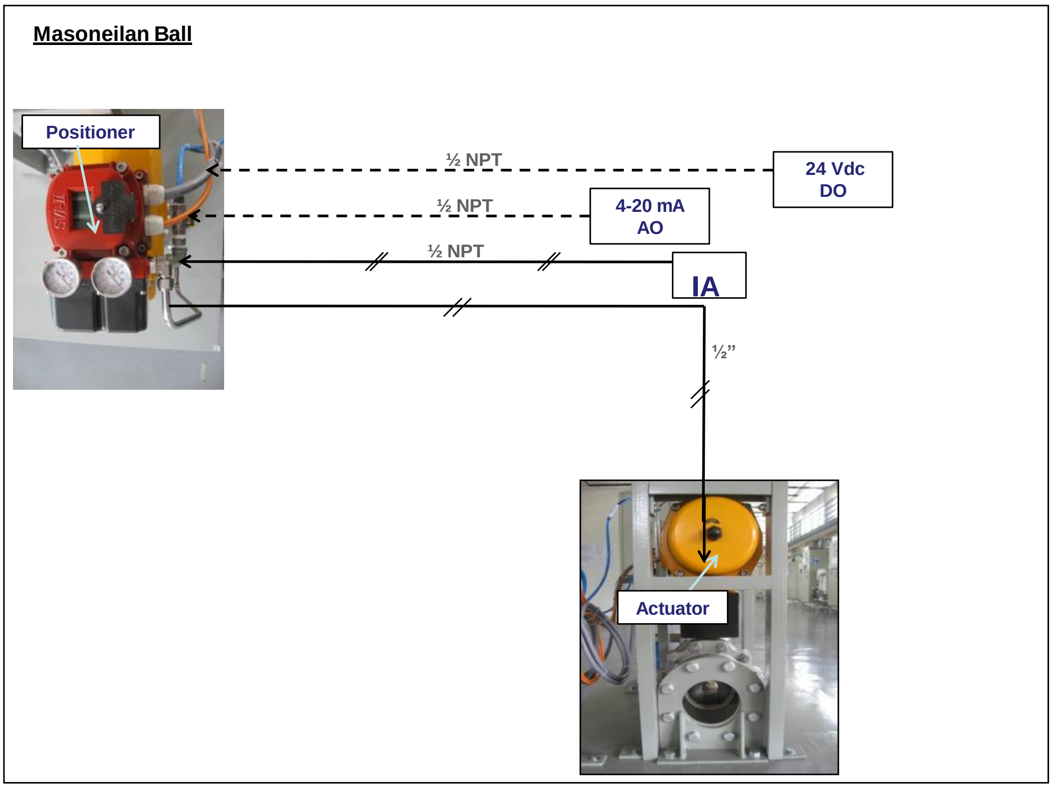
No	Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Selection of Project Title														
2.	Data Gathering on Title														
3.	Preliminary Report Submission														
4.	Conduct testing (FST and PST)														
5.	Detail Testing Procedures preparation.														
6.	Preparation for designing mini plant.														
7.	Submission Of Progress Report														
8.	Seminar														
9.	Result Gathering														
10.	Submission of Interim Report														
11.	Oral Presentation														

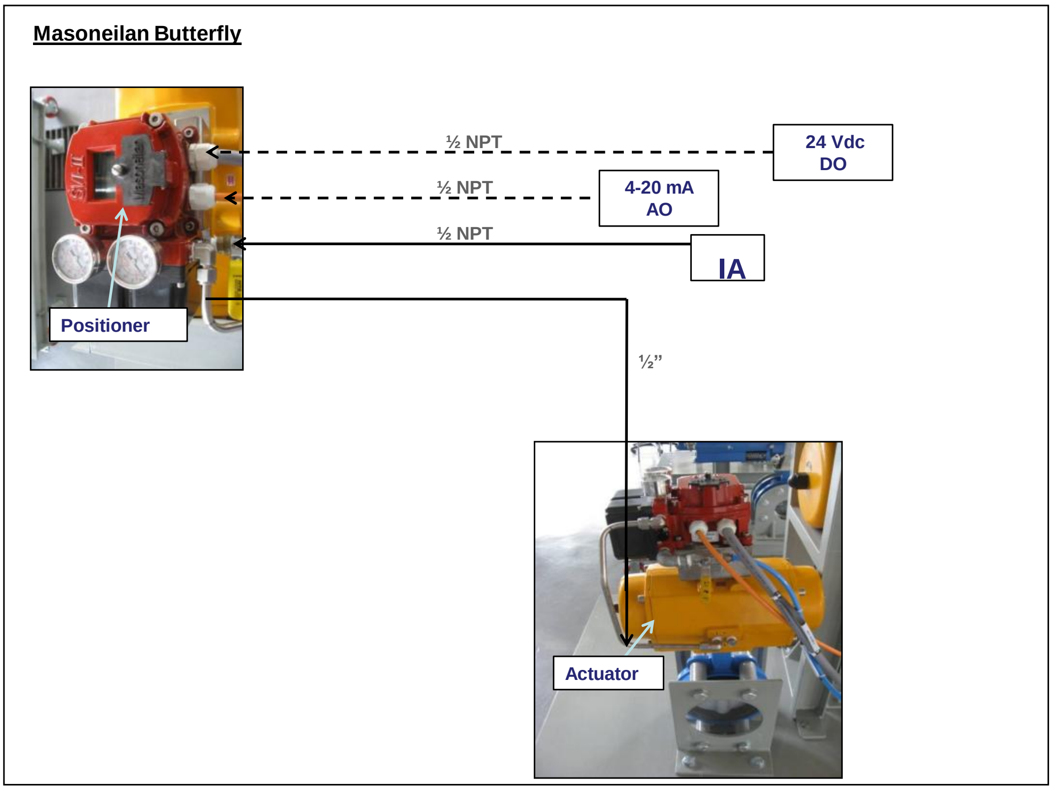
SEMESTER 2

No	Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Data gathering for simulation software	■	■	■	■	■	■	■	■	■	■	■	■	■	
2.	Design analysis	■	■	■	■										
3.	Simulate design using HYSIS				■	■	■	■							
4.	Simulate design using AFT Fathom							■	■	■	■	■	■	■	
5.	Submission of progress report 1				■										
6.	Design verification and recommendation											■			
7.	Submission of progress report 2								■						
8.	Poster Exhibition											■			
9.	Submission of Draft Report														■
10.	Oral Presentation	**6-10 December 2010**													
11.	Submission of Dissertation	**23 December 2010**													

APPENDIX B

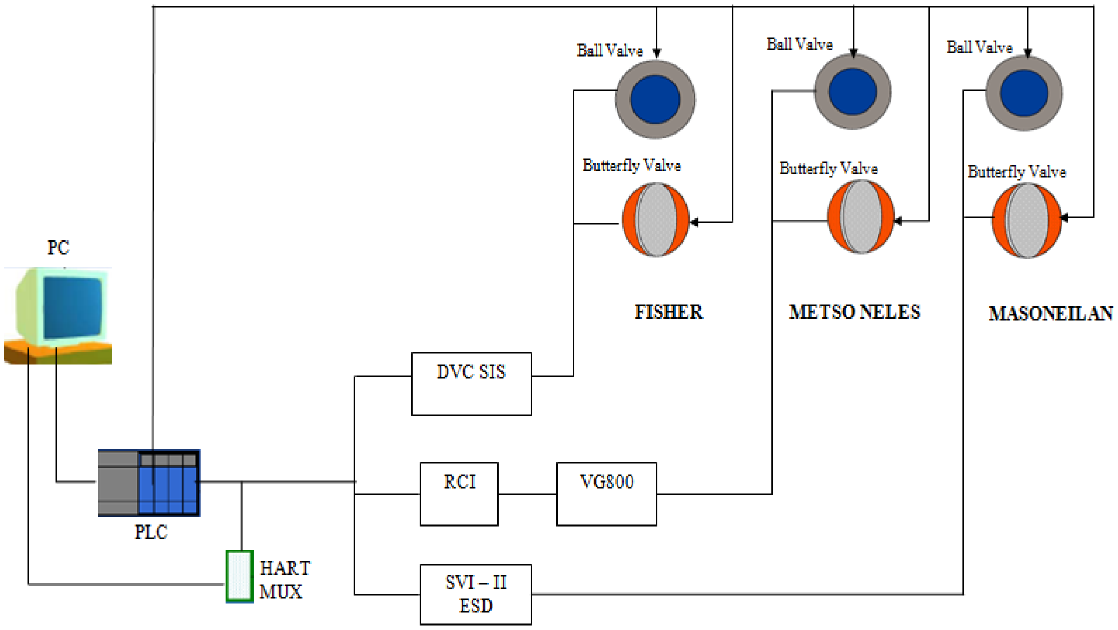
PST DEVICE CONFIGURATION





APPENDIX C

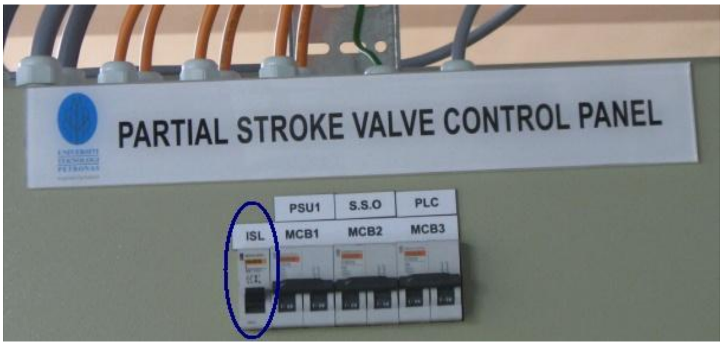
HARDWARE CONFIGURATION



APPENDIX D

PROCEDURE TO PERFORM PST FOR MASONEILAN VALVE

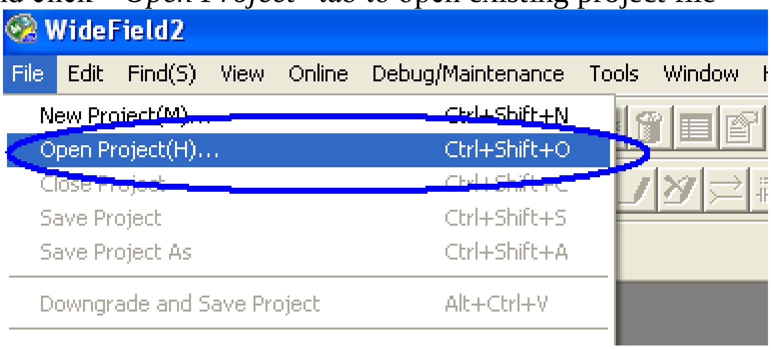
1. Switch on the ISL switch on the Control Panel.



2. Check instrument air supply to the valve is in open condition.

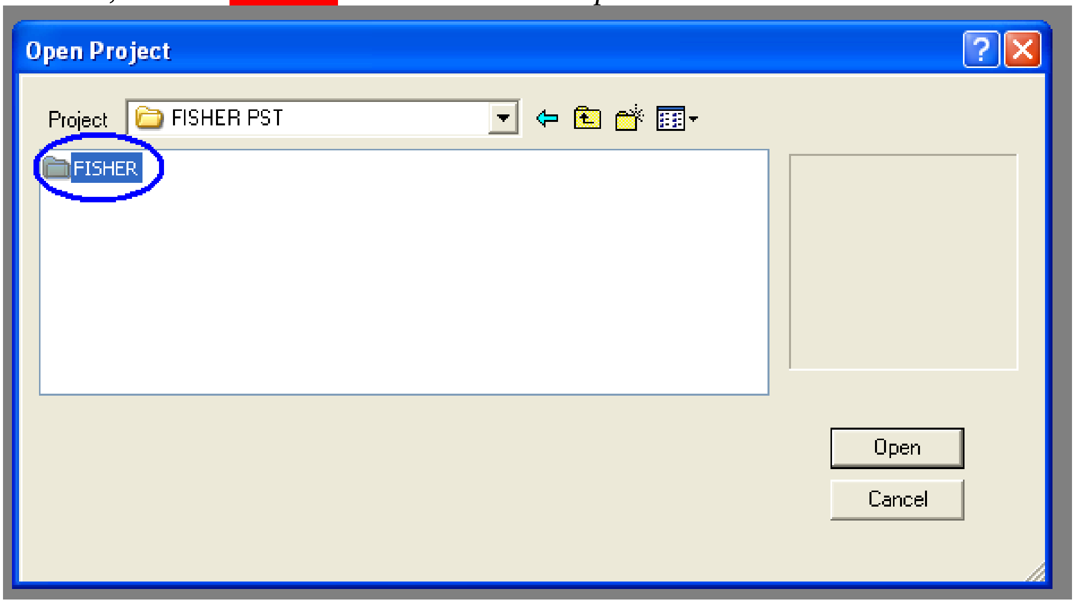
3. To start using the program. Select and double click on *WideField2 Icon* to start using PLC program-Wide Field Software by Yokogawa.

4. Select and click "*Open Project*" tab to open existing project file

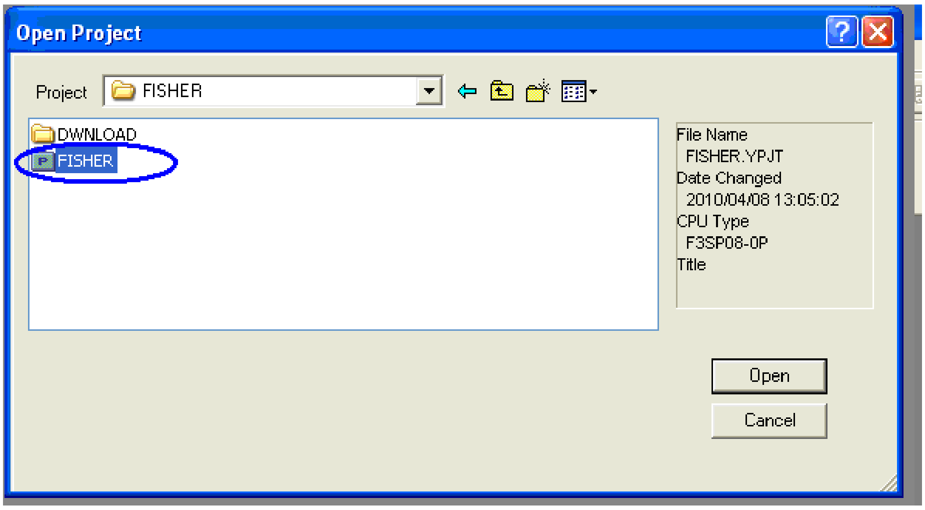


5. Select folder "*masotest*" and click *Open*

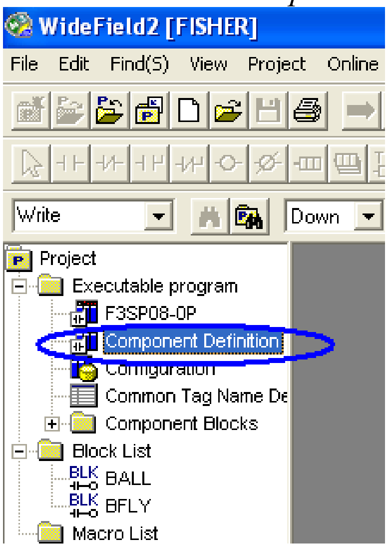
6. Then, Select "*FISHER*" folder and click *Open*



7. Next, select *"FISHER"* folder and click *Open*

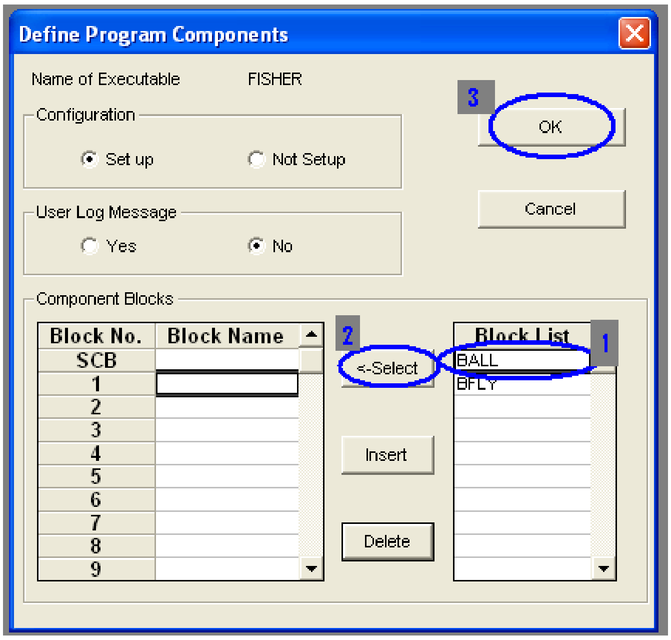


8. Select and double click on *"Component Definition"*



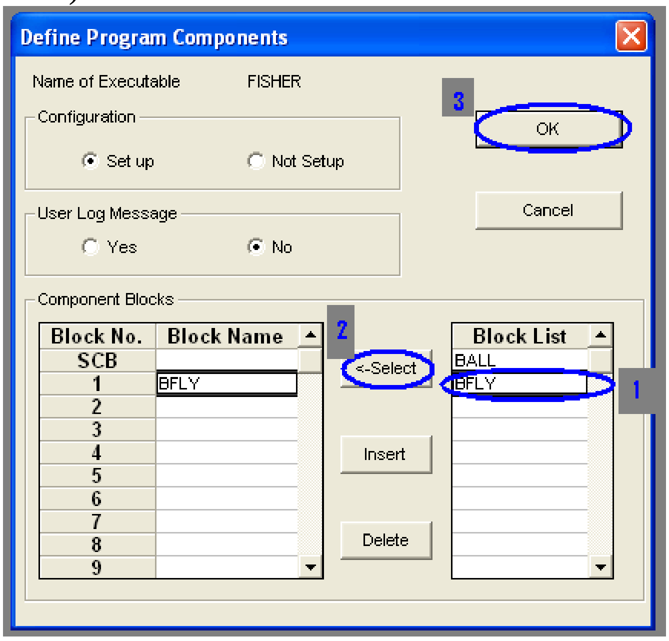
8a.To test Masoneilan Ball Valve:

- Select *"BALL"* from *"Block List"*, click *"Select"* (which will appear under *"Block Name"*) and then click *"OK"*

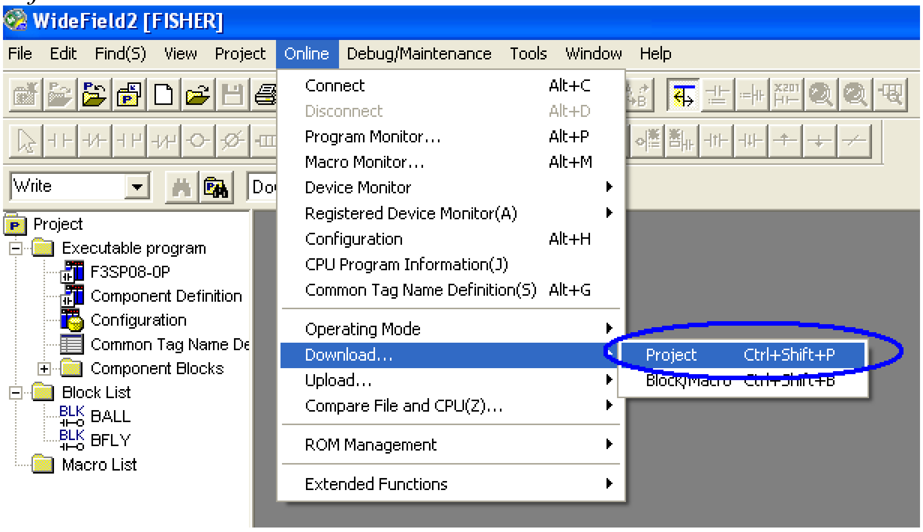


8b.To test Masoneilan Butterfly Valve:

- Select *"BFLY"* from *"Block List"*, click *"Select"* (which will appear under *"Block Name"*) and then click *"OK"*

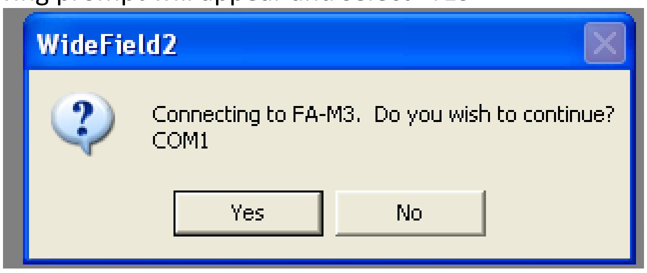


9. To download project file. Go to *"Online"*, select *"Download"* and click on *"Project"*

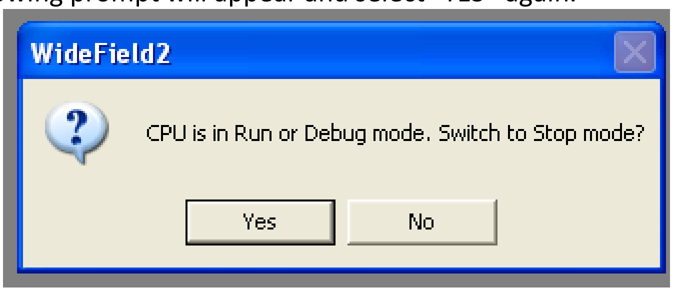


10. The following prompt will appear and select *"YES"*

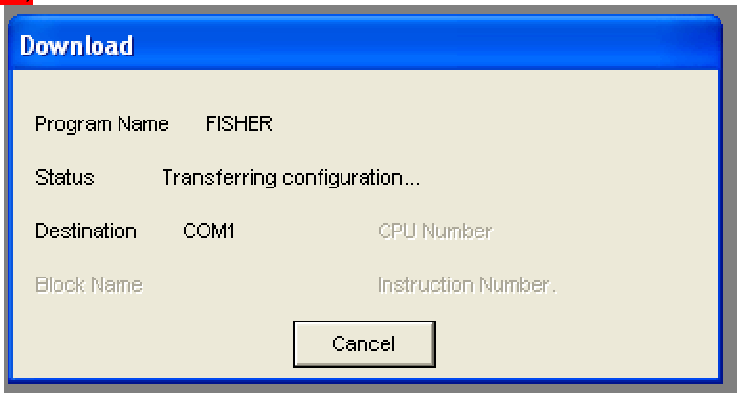
11. Next the following prompt will appear and select *"YES"*



12. Next the following prompt will appear and select *"YES"* again.

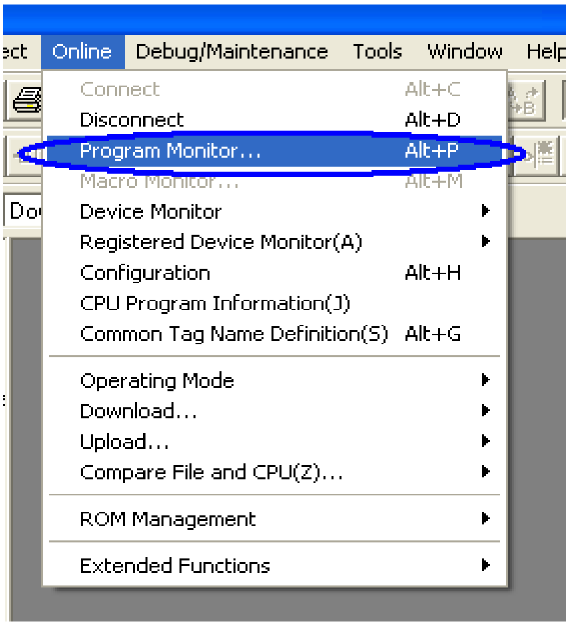


13. Transferring configuration will start to download and the following prompt will appear. (Masoneilan)



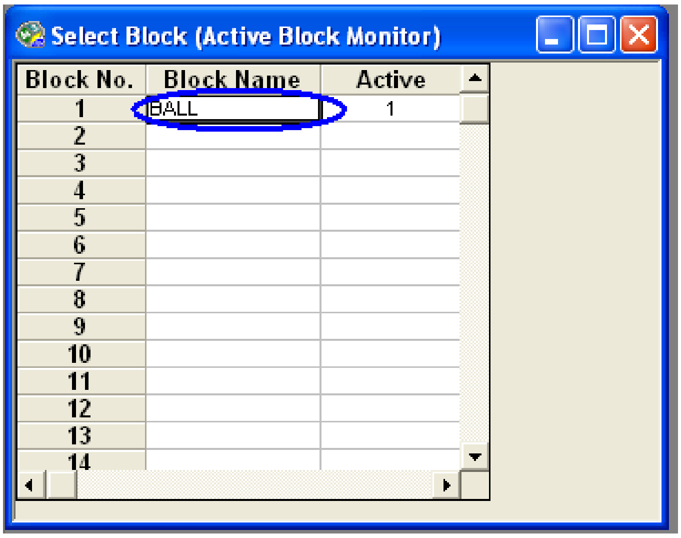
14. Wait until transfer configuration completed. Then, the following prompt will appear. Select *"YES"*

15. Next, to start program monitor. Go to *"Online"* and select *"Program Monitor"*.

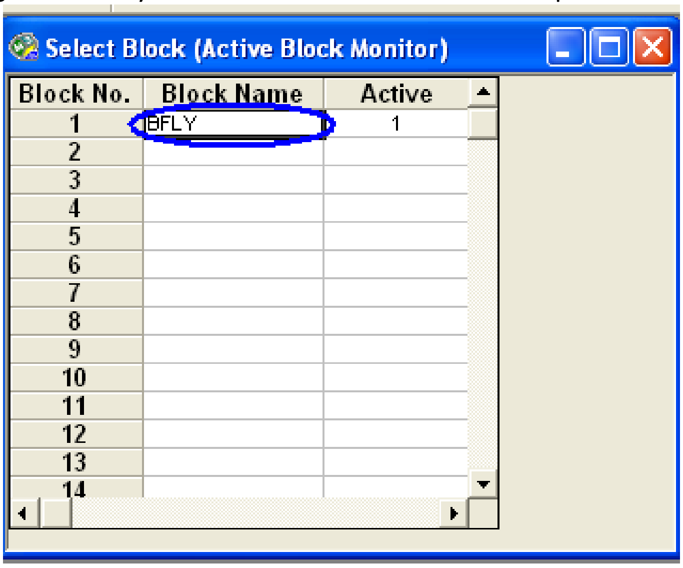


16. Next, the following block will appear.

a) For testing of Ball Valve: Double click on *"BALL"* to upload the ladder diagram.

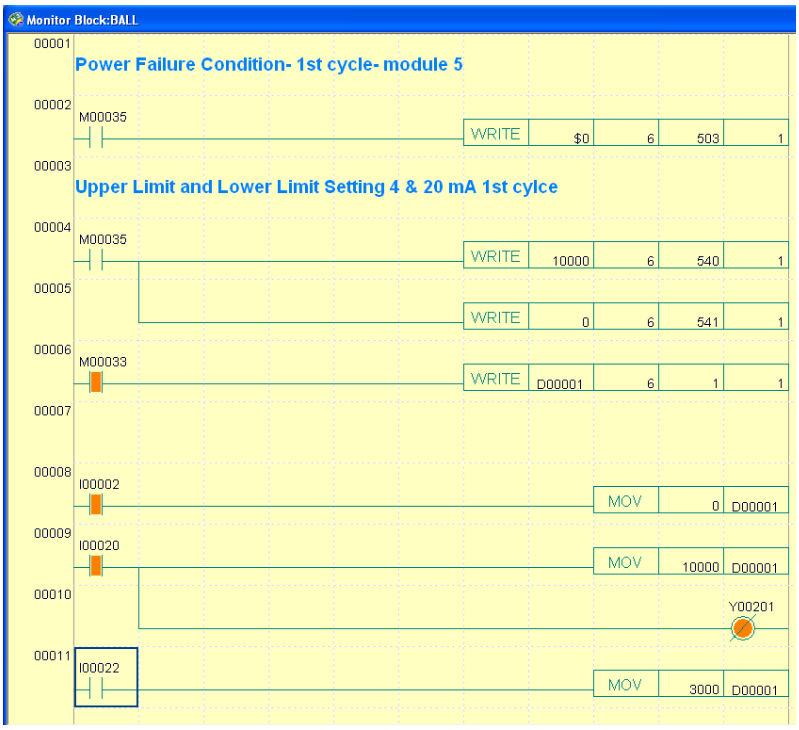


b) For testing of Butterfly valve: Double click on *"BFLY"* to upload the ladder diagram.

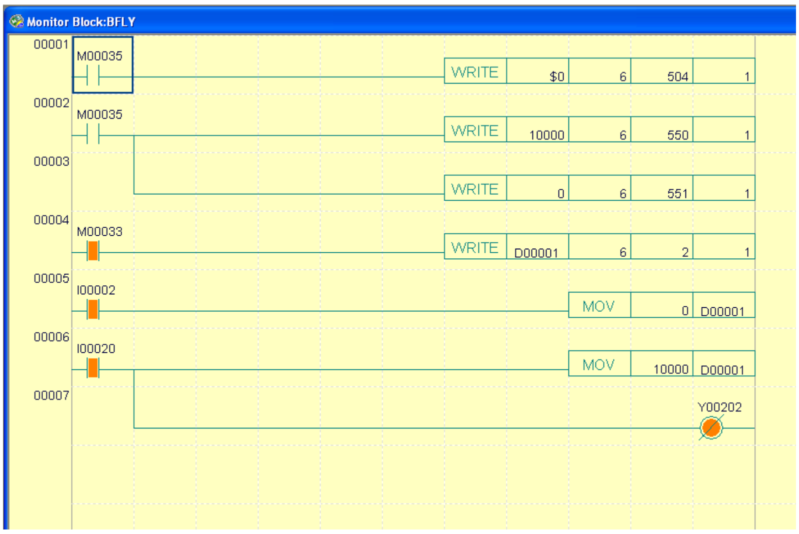


17. Upon successful uploading the ladder diagram will be displayed.

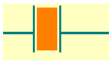
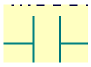
For Ball Valve as follows:



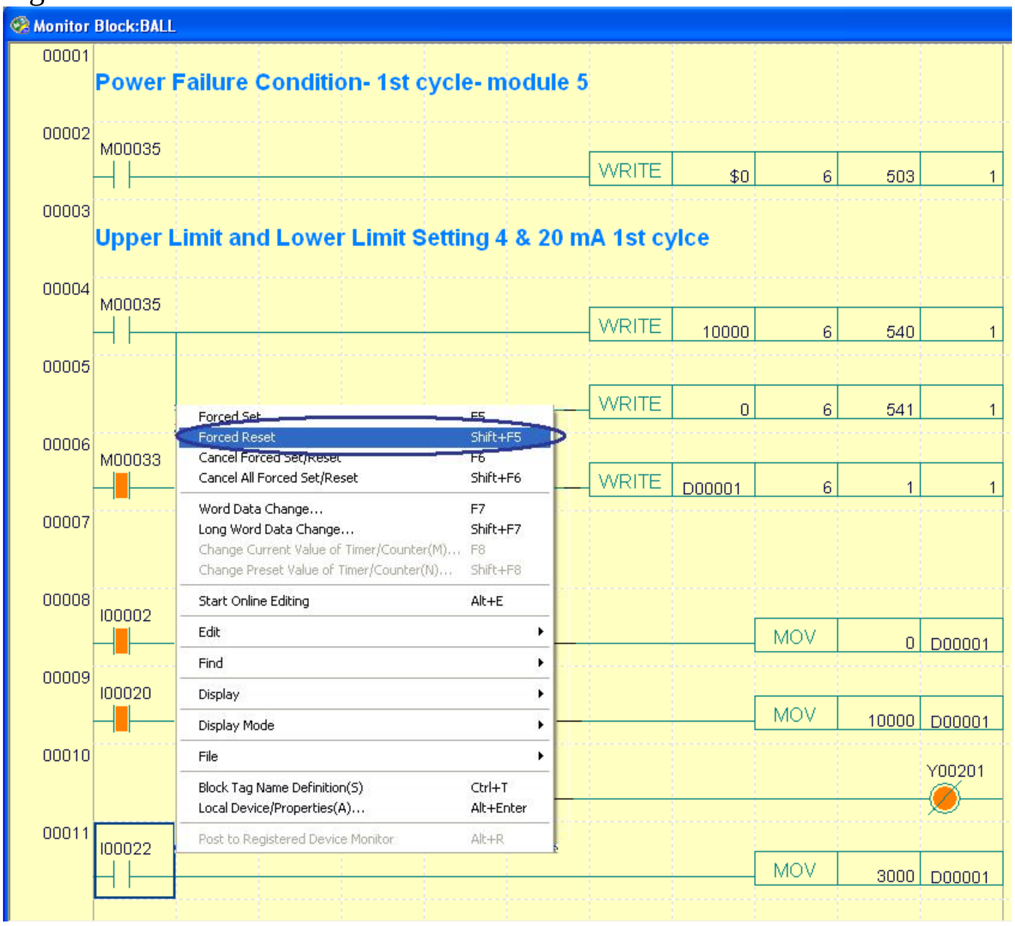
For Butterfly Valve as follows:



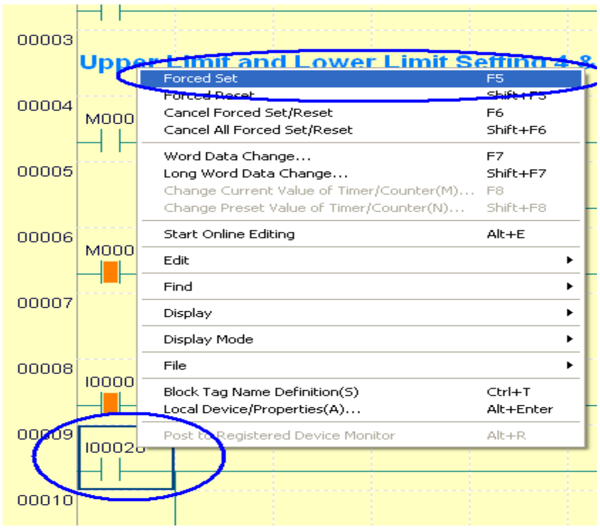
18. Ensure M00033, I00002, I00020 and M00033, I00002 for ball valve and butterfly valve respectively are "Forced Set". The symbol for set and reset is as follows:

SET	RESET
	

19. Valve is put to open position to stimulate normal operation. To initiate opening of the valve,
    1. For ball valve :
        - Right click at I00022 and select "Forced Reset".

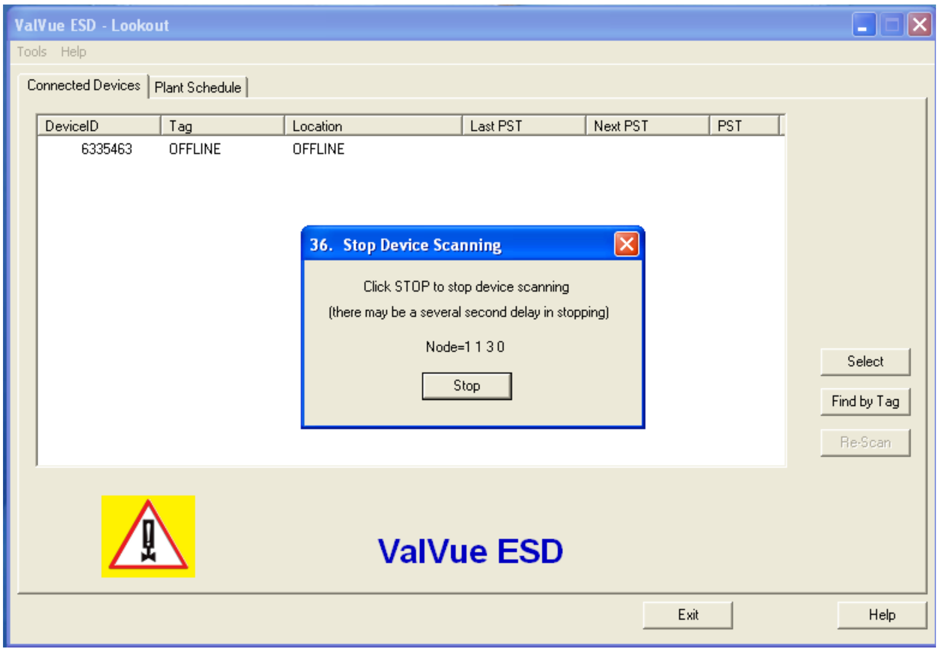


2. For butterfly valve :
   - Right click at I00020 and select “Forced Set”.

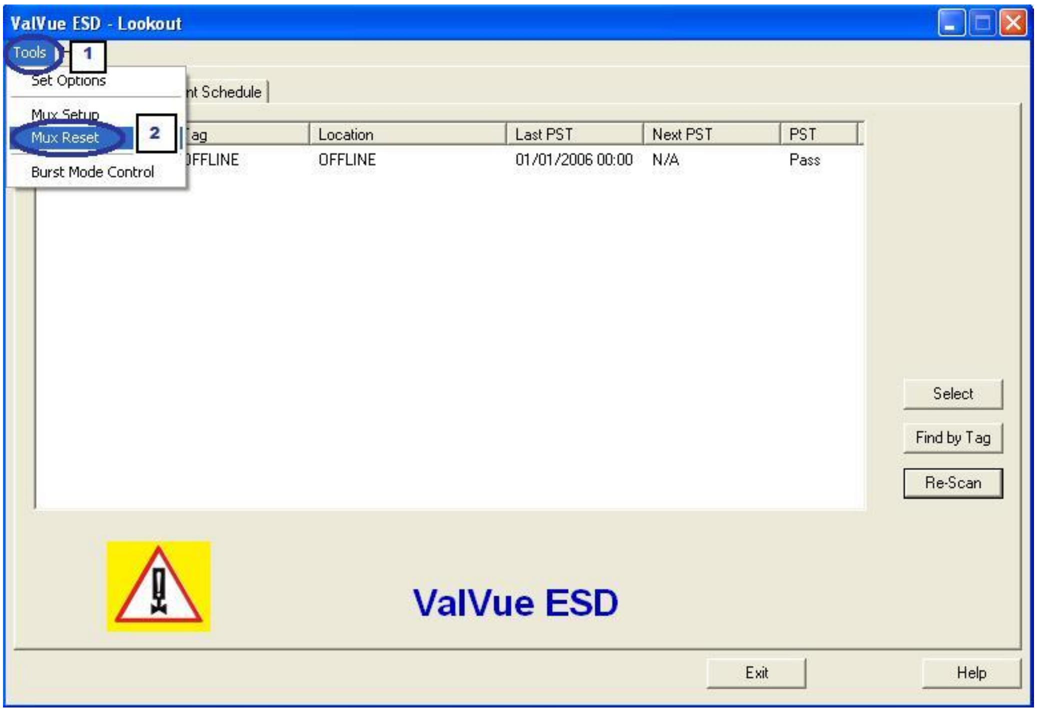


20. Then proceed to open AMS Valvue ESD Software. To start using the program. Select and double click on “Valvue ESD” Icon.

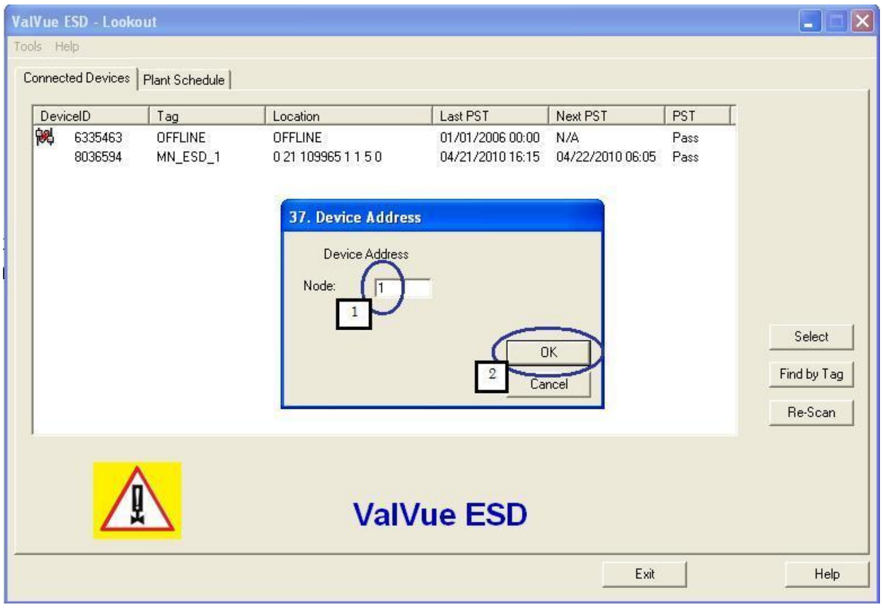
21. Valvue ESD Lookout window will appear.



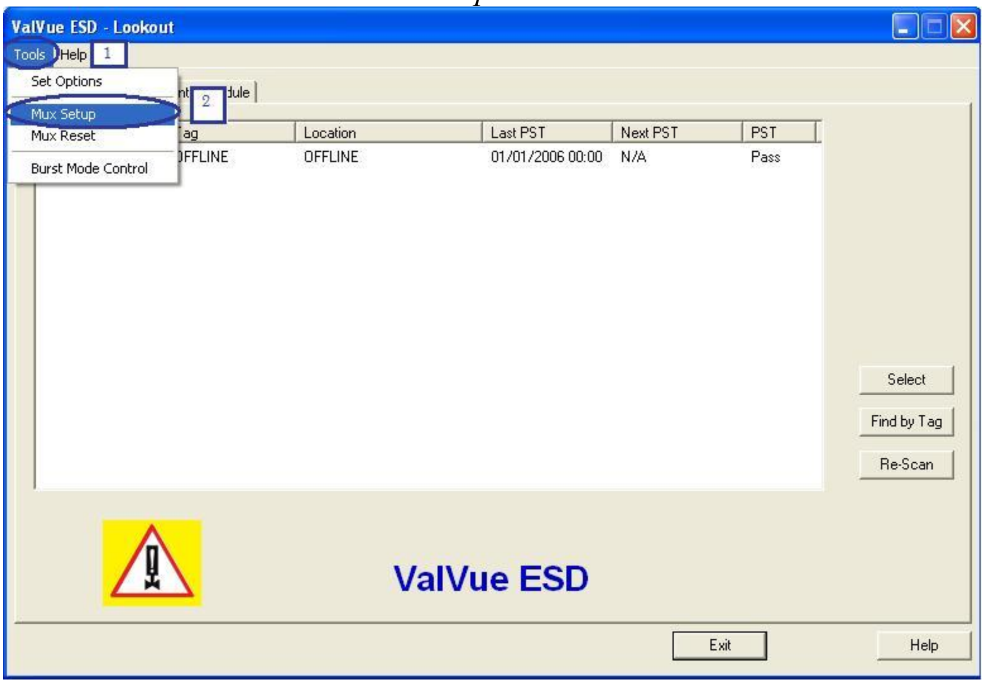
22. From ‘*Valvue ESD Lookout’*, go to 1)‘*Tools*’ menu and select 2)‘*Mux Reset’*.



23. *‘Device Address’* popup will appear enter‘1’ value.
Then click *“OK”*.

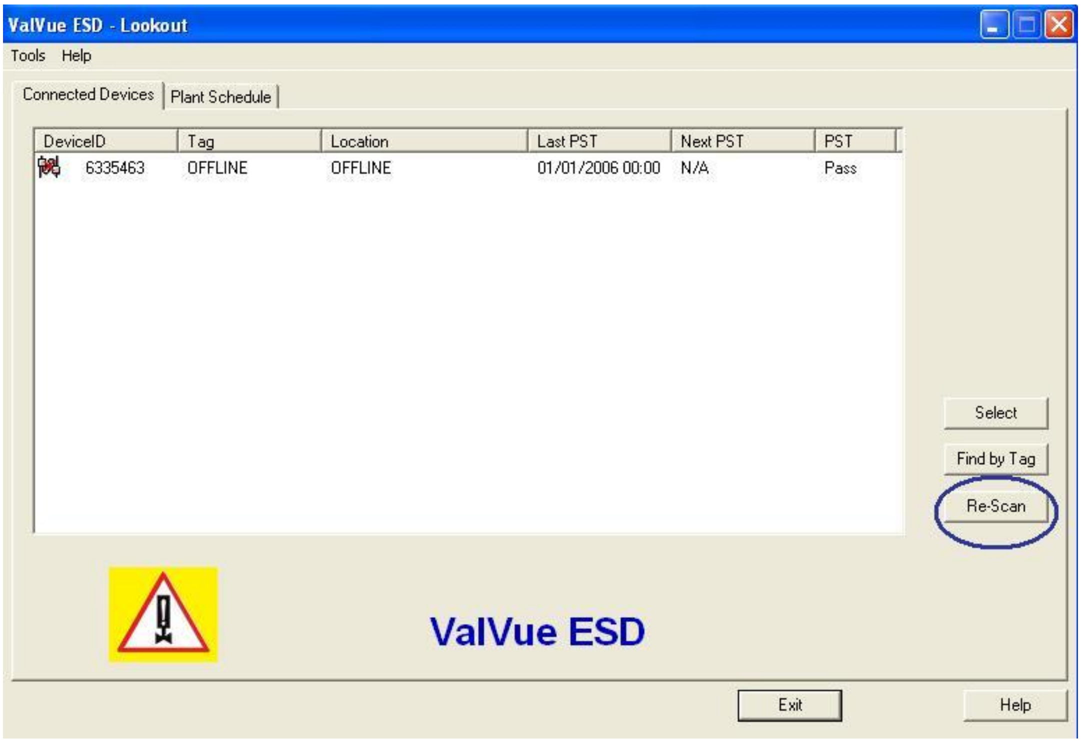


24. Go to *"Tools"* then select *"Mux Setup"*.



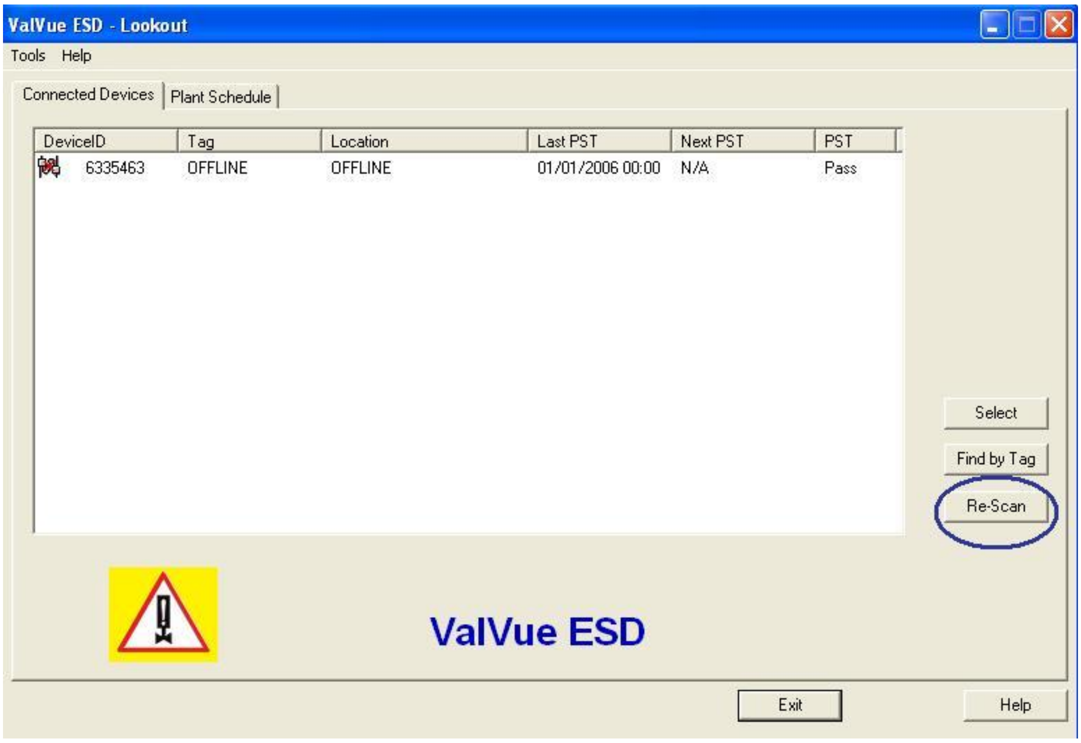
25. The following *"Multiplexor Setup"* window will appear.
Key in following data to '*Multiplexor Setup*' and click '*OK*' button.

26. Go back to *Valvue ESD Lookout* dialog box and click “*Re-Scan*”.

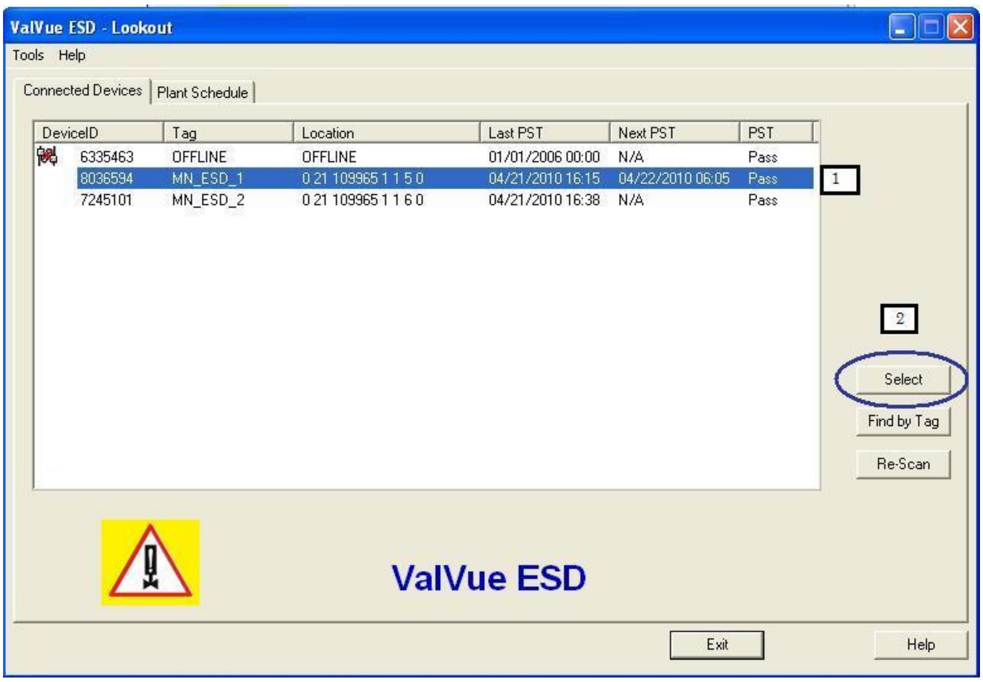


27. Wait until all A, B, C and D LEDs on ***MTL 4842*** (HART multiplexer in Partial Stroke Valve Control Panel) turn red.

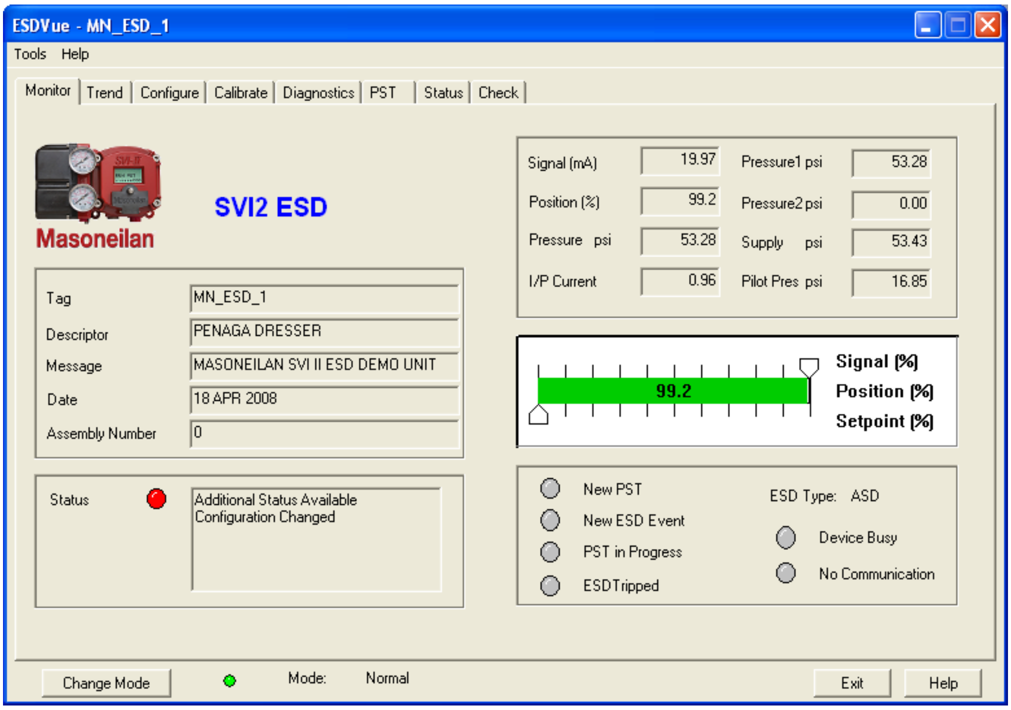
28. Then click *"Re-Scan"* again.



29. When the Masoneilan SVI II ESD is detected, it will be displayed on the ValVue ESD Lookout.
Click on the tag name required and click "*Select*".

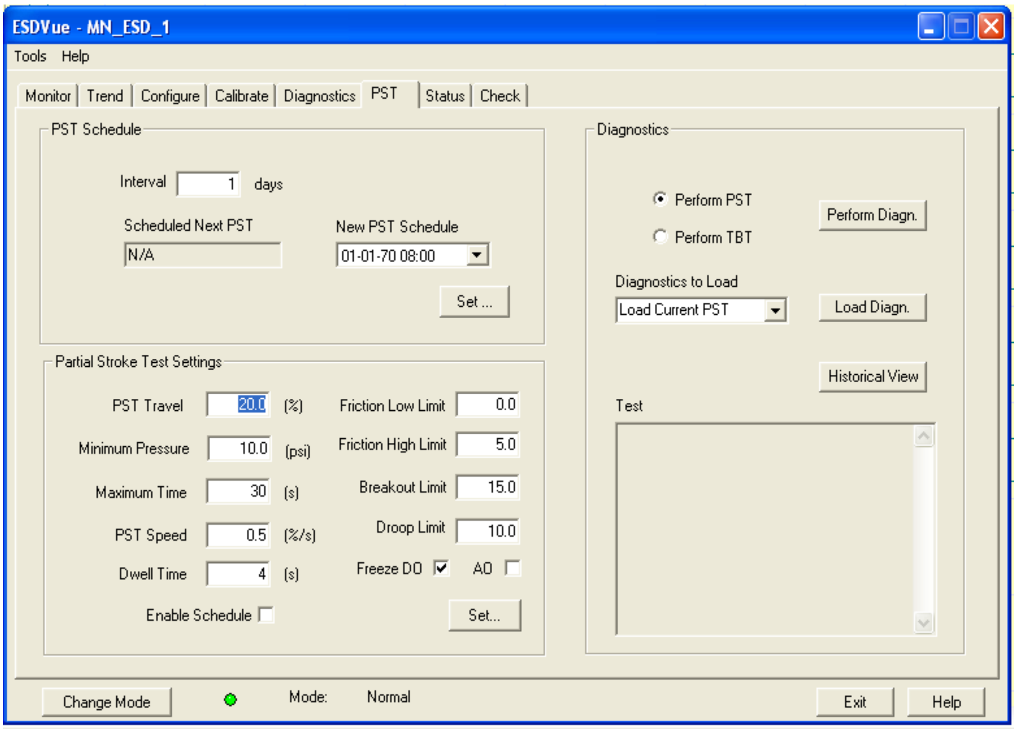


30. The following *ESDVue* prompt will appear for the particular unit.

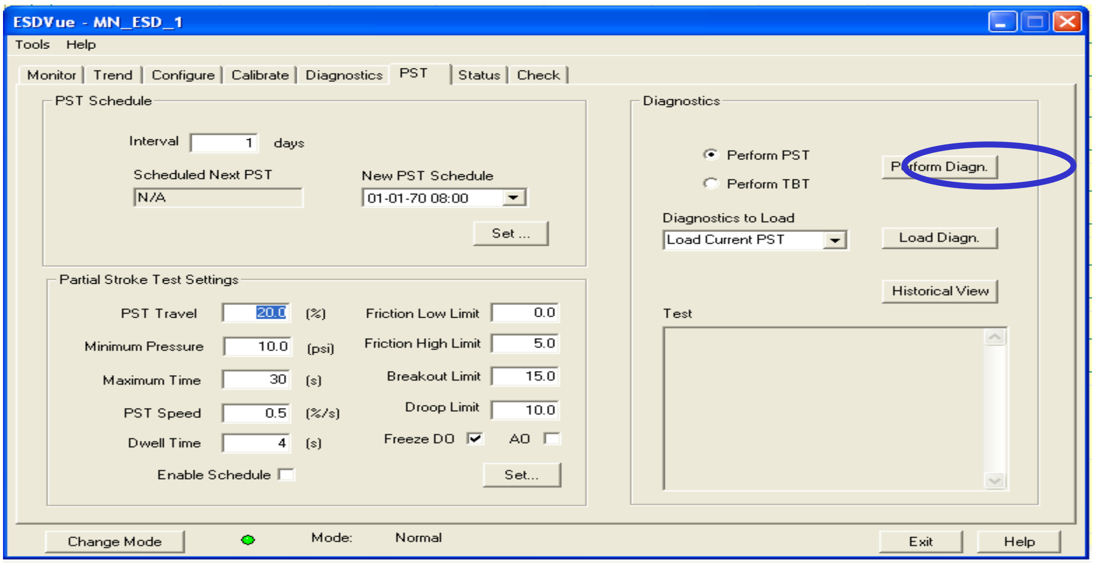


31. Select *'PST'* parameter tab

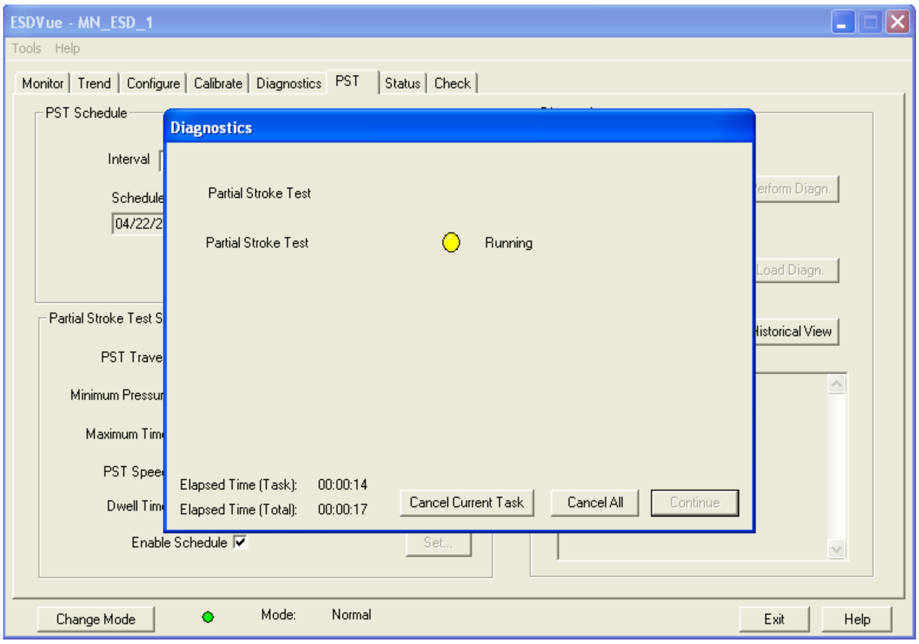
- Set *'PST Travel'* to *20%*
- Set *'PST Speed'* to *0.5 %/s*



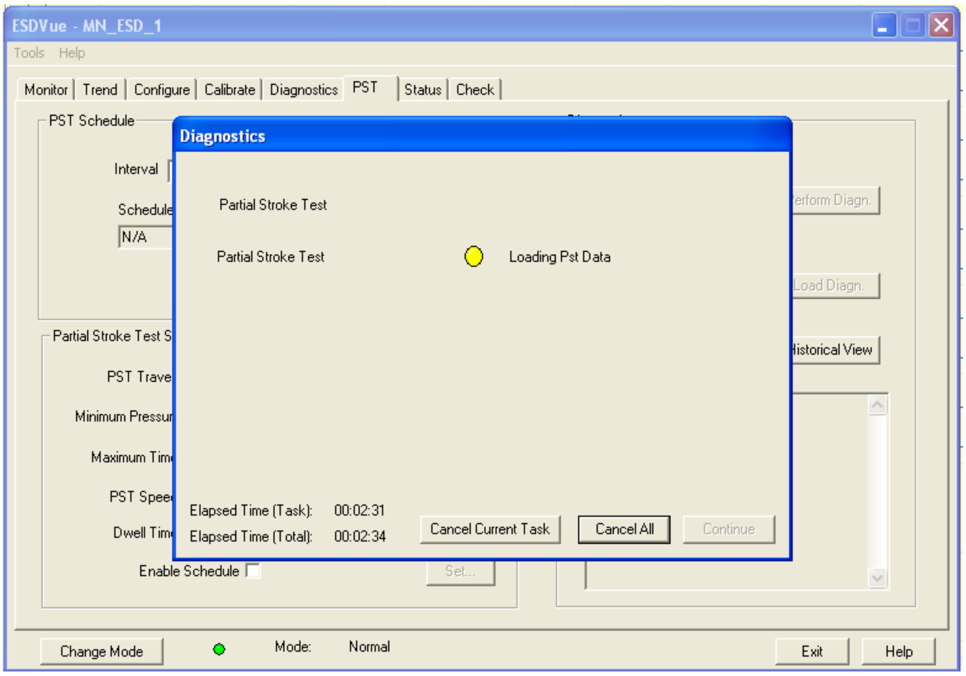
32. Click on *"Perform Diagnostic.*



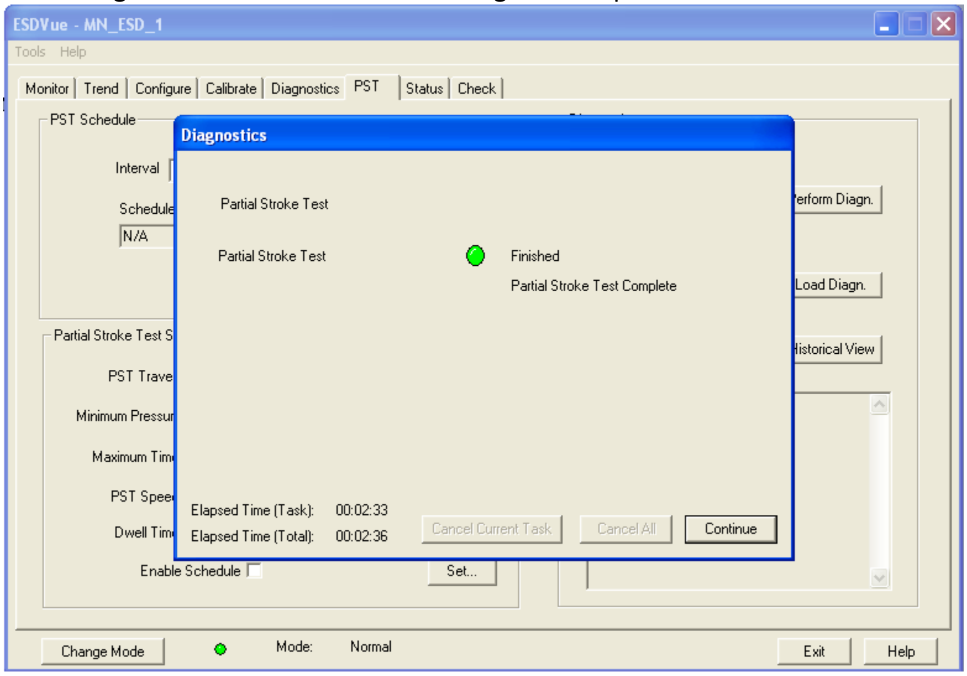
33. The following prompt will appear showing that the PST Testing is running.



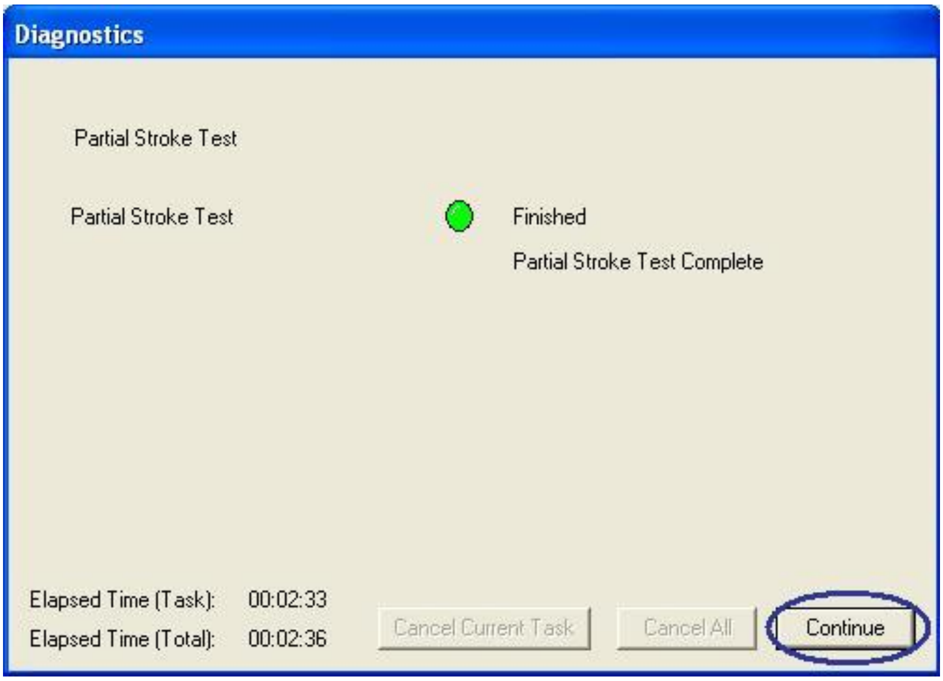
34. Next, this window shows that PST Data is being loaded.



35. The following window shows that PST Testing has completed.

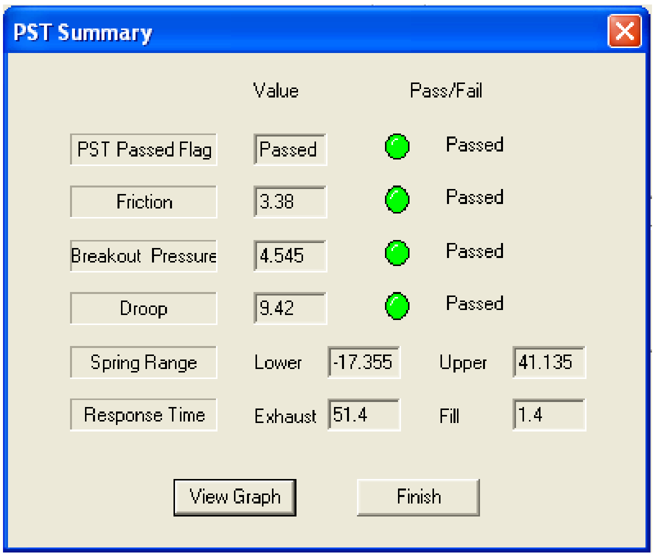


36. Click *“Continue”*.

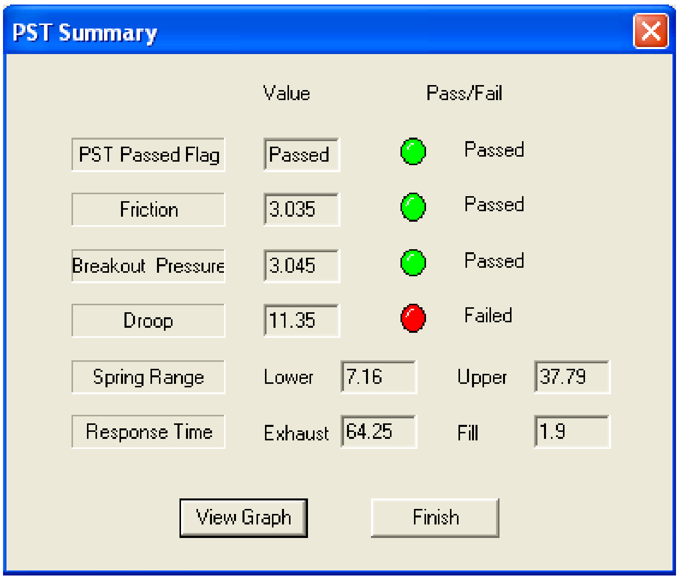


37. This prompt will appear. It displays the Summary Analysis

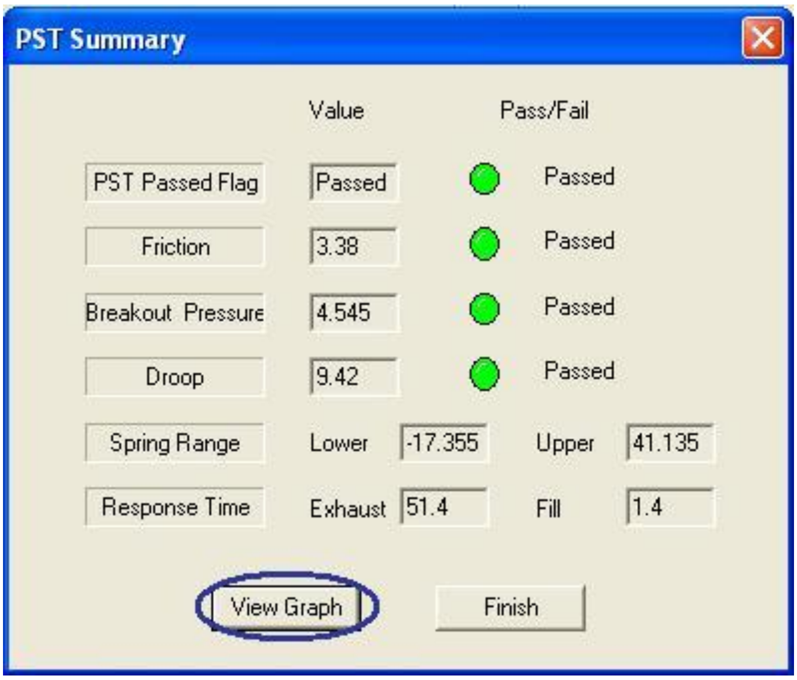
   1) Butterfly Valve



2) Ball Valve

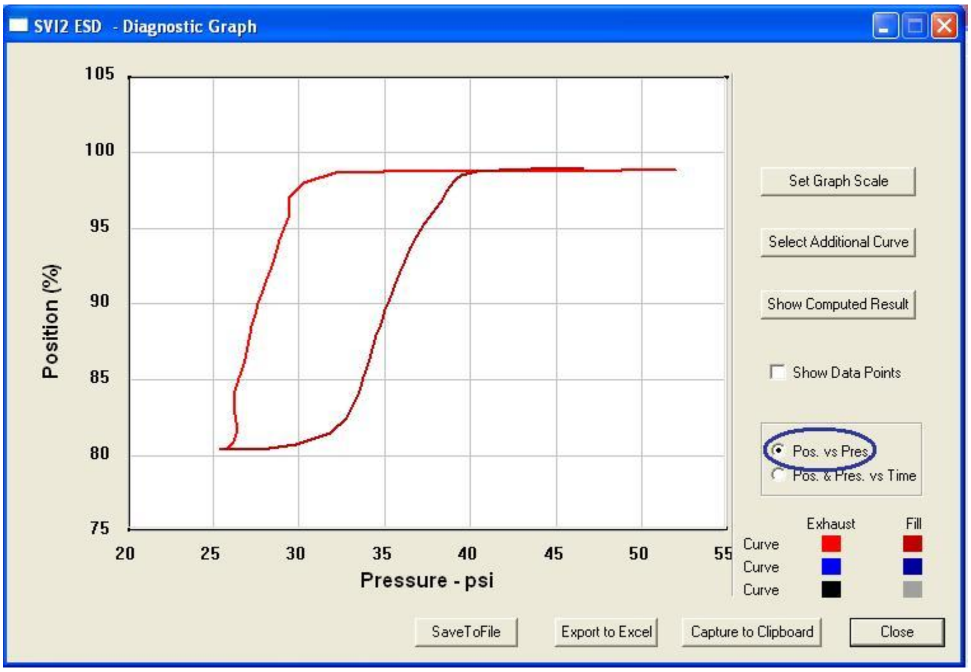


38. Next click *"View Graph".*

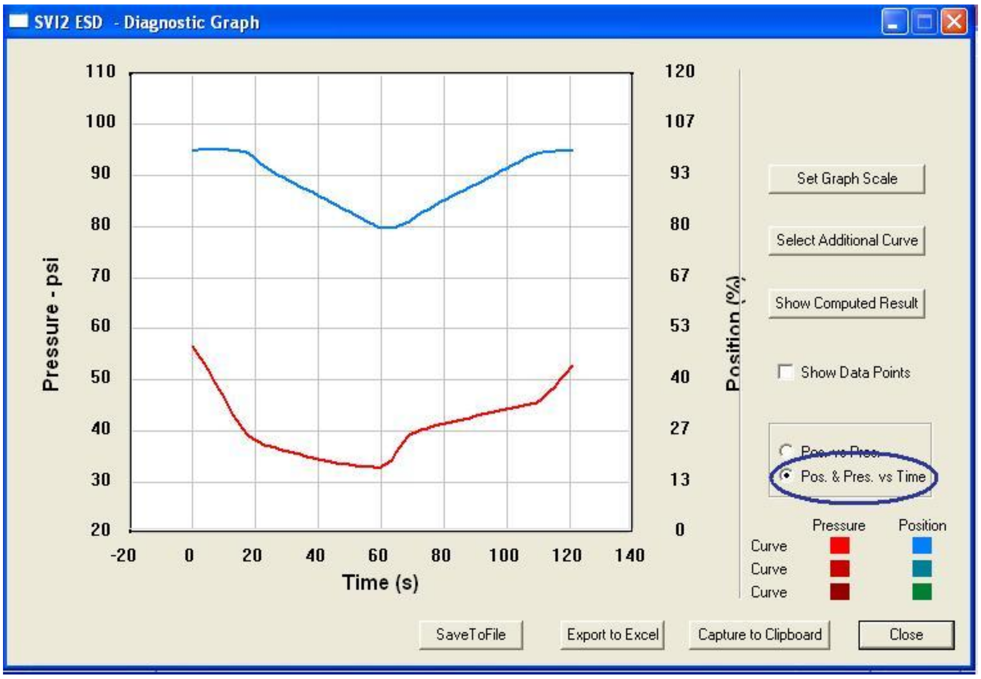


39. The following prompt will appear. It displays the Testing Measurement Graph.

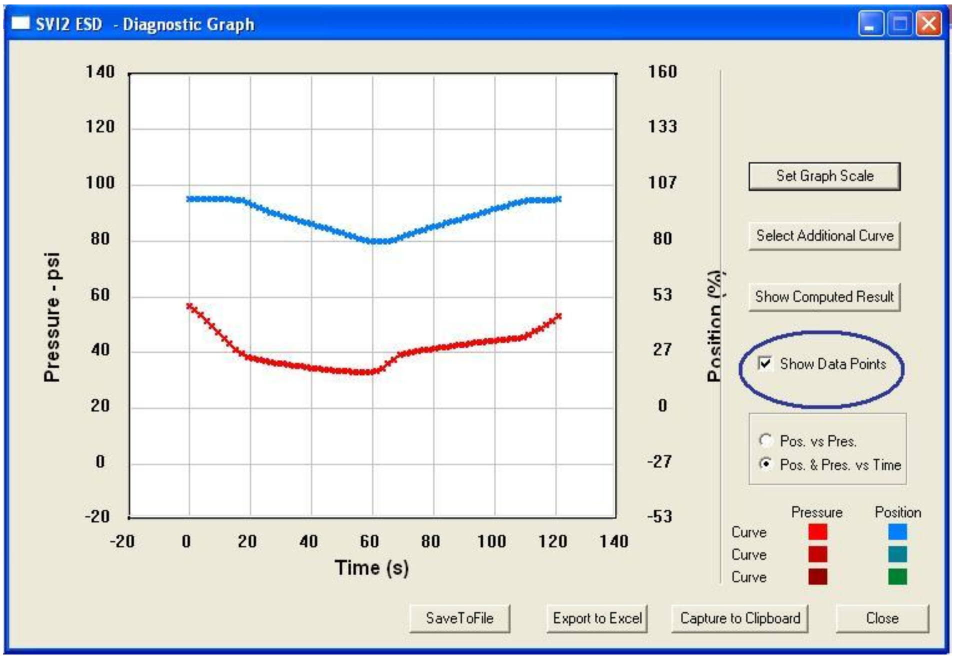
1) Graph (Position Vs Pressure)



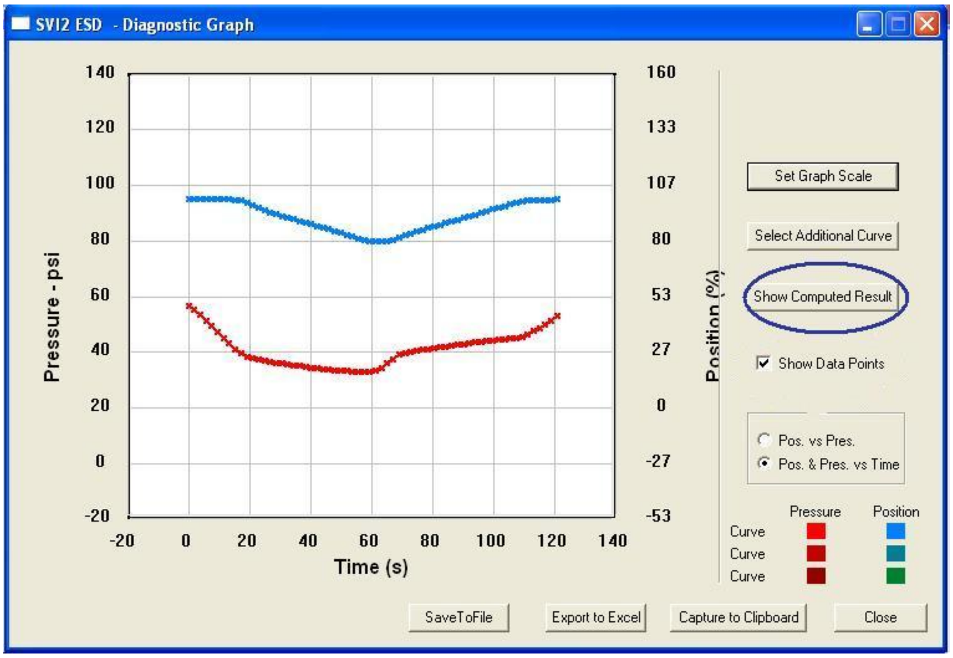
2) Graph (Position (Blue Color) and Pressure (Red Color) Vs Time)



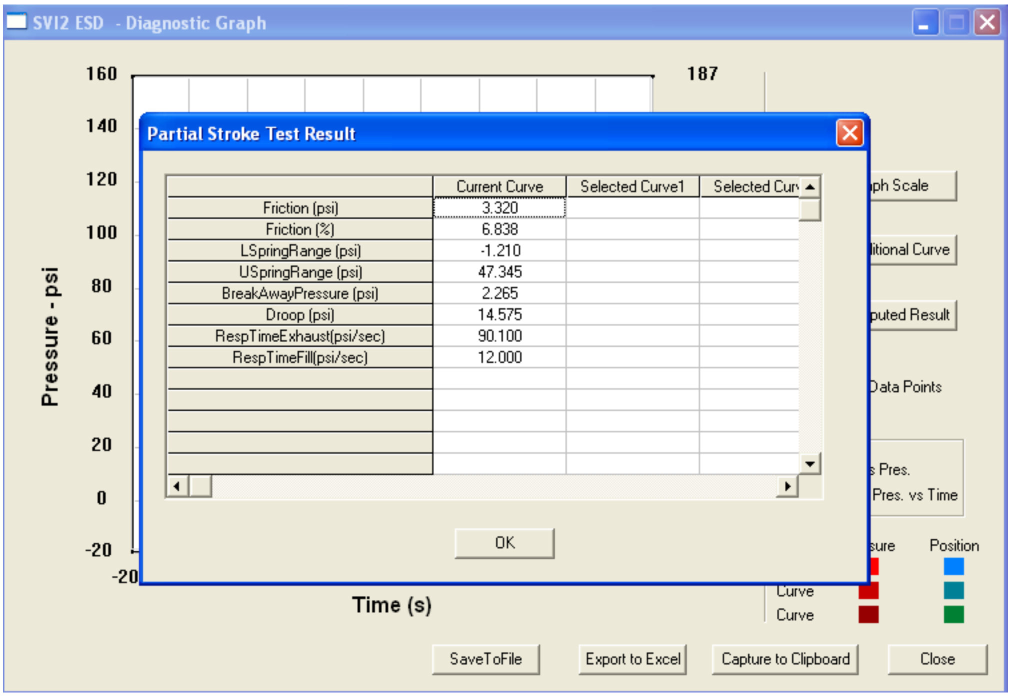
3) In order to see datapoints, tick on *"Show Data Points"*.



40. Click on *"Show Computed Result"* to display the test result.



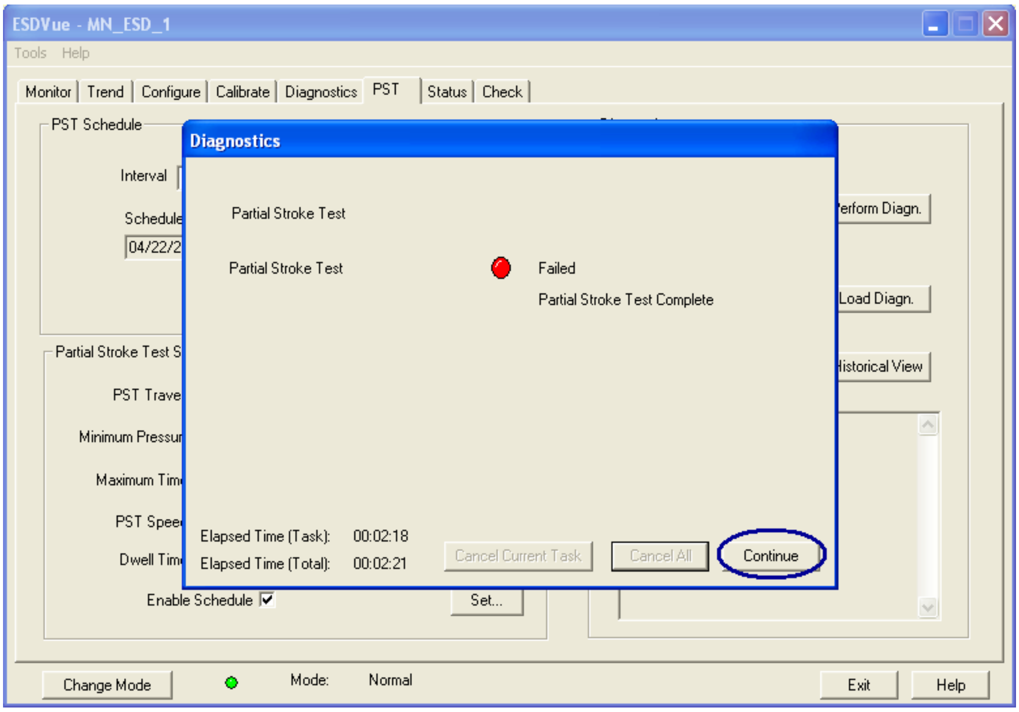
41. The following prompt will be displayed.



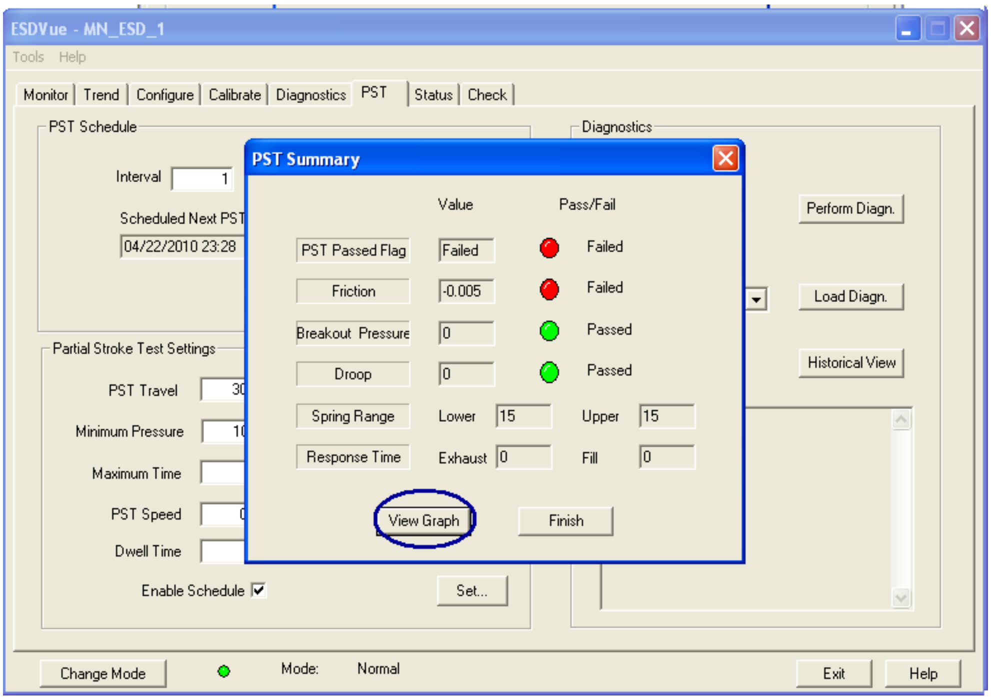
42. To perform FST while PST is running. Initiate FST from WideField when the valve travel reached 90% by initiating ;

1) "Forced Set" for Ball to the I00022.

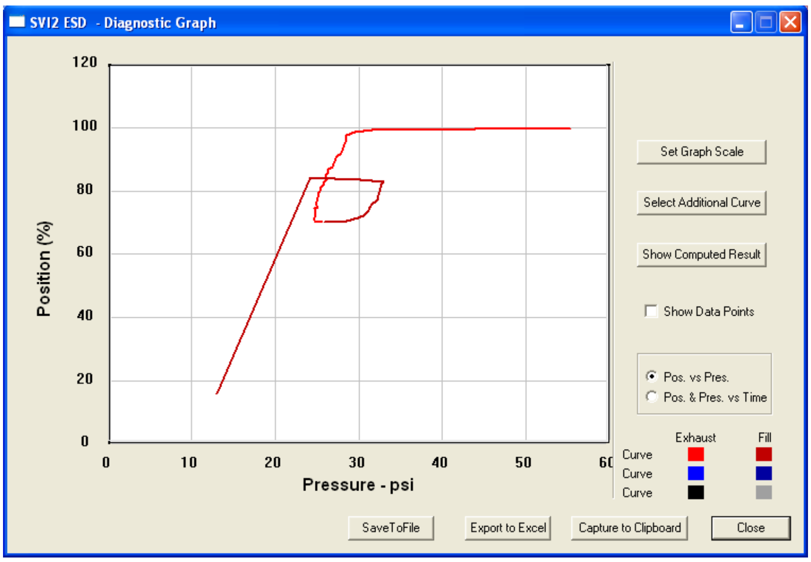
1.1) The following window will be displayed after initiating FST. Click *"Continue"*.



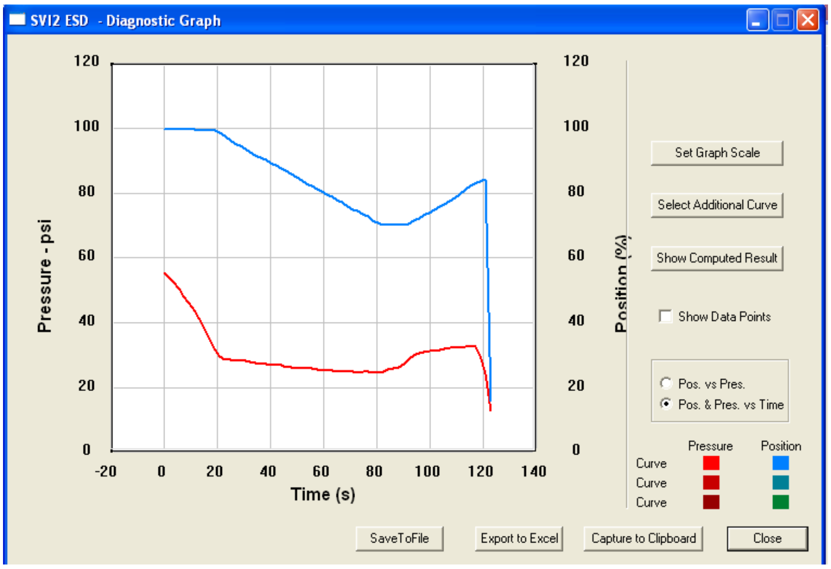
1.2) The following window will appear.
Next, click on *"View Graph"*.



1.3) The following graph will be displayed.
a) Graph (Position Vs Pressure)

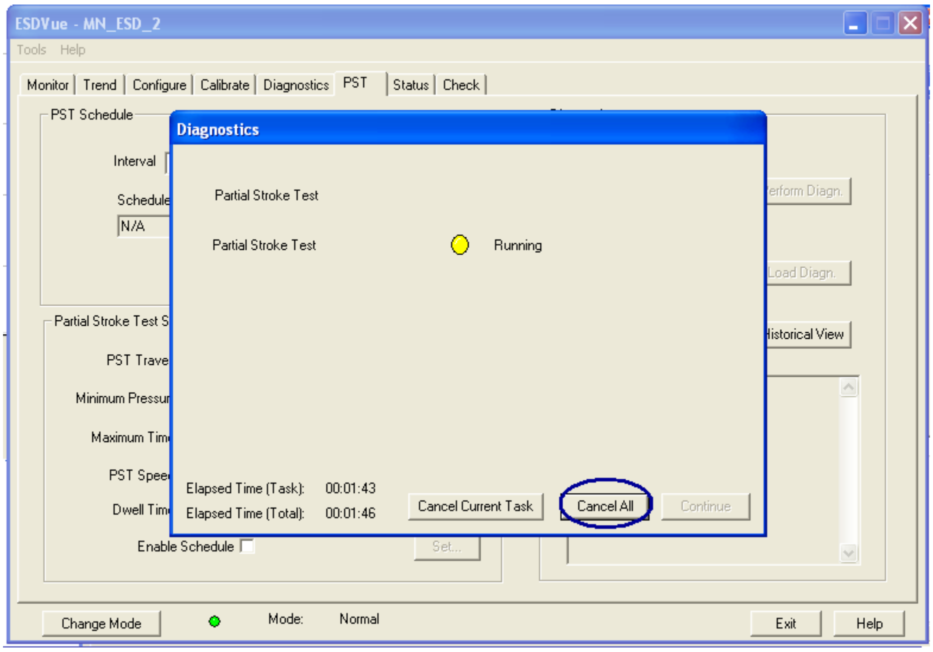


b) Graph (Position (Blue Color) and Pressure (Red Color) Vs Time)

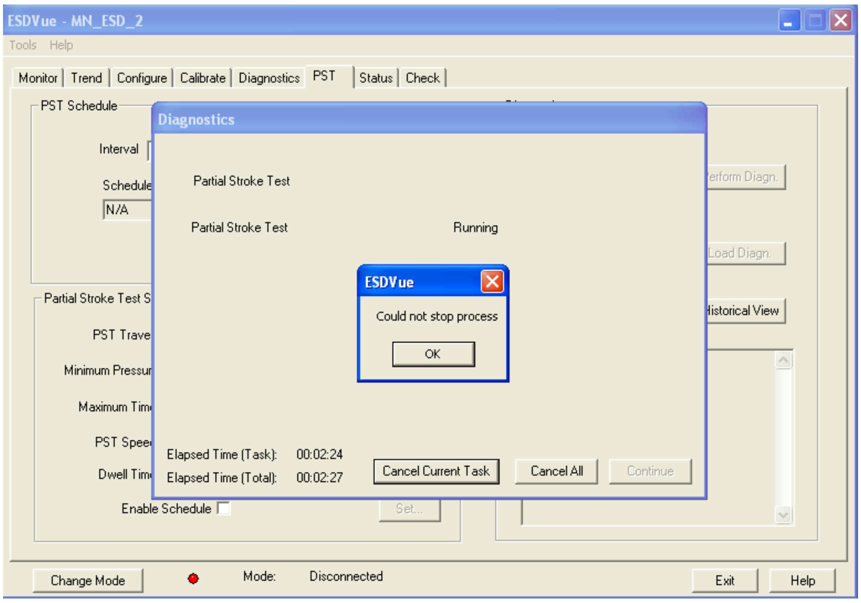


2) "Forced Reset" for Butterfly to the I00020.

2.1) The following window will be displayed once FST is initiated. Click *"Cancel All"*.



2.2) Next, click *"OK"*.



2.3) The following prompt will appear indicating Partial Stroke Test did not complete.