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

By

MUHAMAD IMRAN BIN AZIZ @ AWANG

FINAL PROJECT REPORT

Submitted to the Electrical & Electronics Engineering Programme in Partial Fulfillment of the Requirements for the Degree Bachelor of Engineering (Hons) (Electrical & Electronics Engineering)

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CERTIFICATION OF APPROVAL

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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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بِسُم ٱللَّهِ ٱلرَّحْمَنِ ٱلرَّحِيم

In the name of Allah, The Beneficent, The Merciful.

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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
ТА	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.

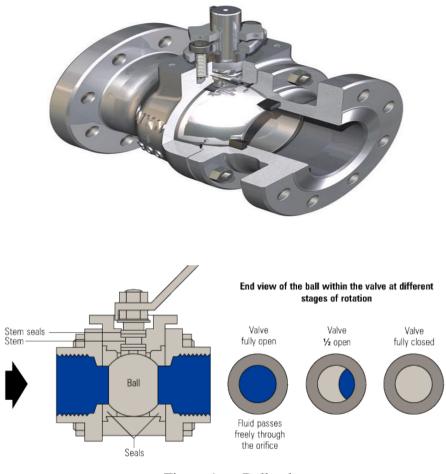


Figure 1 : Ball valves

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 (λ D) 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:

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	

Table 2: Valve failure mode

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.

Help Pipe Model Fittings & Logses Insulation Design Alerts Optional Notes Status Size Pipe Material: PVC Image: Cylindrical Pipe Image: Cylindrical Pipe	um <u>b</u> er: 28 a <u>m</u> e: Pipe opy D <u>a</u> ta From Pipe	e	Upstream Junction: 28 Downstream Junction: 24 Copy Previous	Cancel
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Data Set	🔲 ID Reduction (Scali	ng): 🛛 🛛 🕺 (optional)		
C Unspectified C Standard D.00006 inches	Data Set			

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.

Pump Specifications	X
Num <u>b</u> er: 3 Na <u>m</u> e: Pump Database List: Copy Data From J <u>c</u> t	Upstream Pipe: 1 Downstream Pipe: 3 Elevation Cancel Inlet: Inches Outlet: Inches Utel: Image: Same as Inlet
Pump Model Variable Speed Pump Model Pump Curve Volumetric Flow Rate Fixed Mass Flow Rate Fixed Head Rise Fixed Pressure Rise Fixed	Iransient Optional Cost Notes Status
Nominal Efficiency:	liter/min Percent (optional) feet (optional)

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.

Valve Specifications				X
Number: 12 Name: Test Valve Database List: Copy Data From Jgt	Optional Notes Status	Outlet:	12 13 ches 💽 Same as Inlet	K Cancel Jump <u>H</u> elp
Valve Data Source Handbook Data User Specified Loss Model C Cv (Constant)	Cv Data Cv Data	-		
 K Eactor (Constant) K Factor (Variable) <u>R</u>esistance Curve 	C From % Open Lable (on Optional tab)			
Basis Area for Loss Model	Base Area from Pipe 12: 0.173679 feet2 (D = 5.643 inch			deg. F

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**eXtended Time Simulation to model dynamic system behavior of PST in real time operation.

CHAPTER 3

METHODOLOGY

3.1 Procedure Identifications

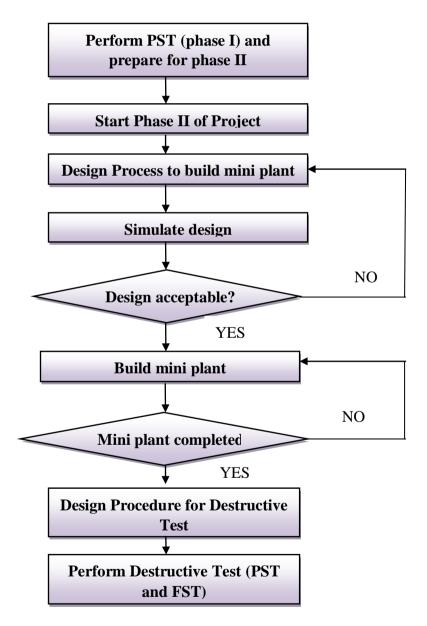


Figure 7 : Flow Chart of FYP1 and FYP2

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.

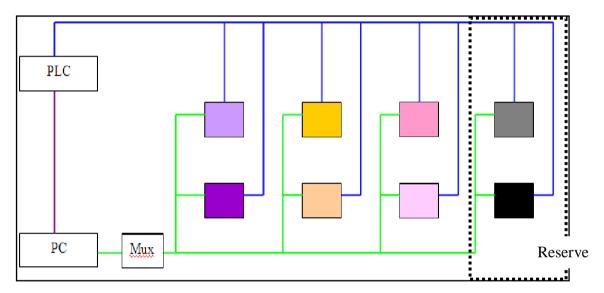


Figure 8 : Hardware connection between the valve, PLC and the PC

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 2^{nd} 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

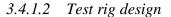
One of the requirements for PST by PETRONAS Group Technology Solution (GTS) is PST done in real medium will have only small effect on process medium or production. Test done in real medium could also ensure that PST could be performs 90 days without fail as in first phase. So new test rig with real medium 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



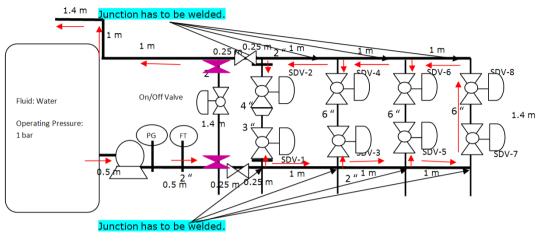


Figure 9 :

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 m l = 0.5 + 0.5 + 0.25 + 0.25 + 3 + 3 + 0.25 + 0.25 + 1 + 2.4 = 11.4 m $A = \pi r^2 = \pi (0.0254)^2 = 0.00203 \text{m}^2$ $V = \text{Al} = 0.00203 \text{x} 11.4 = 0.023142 \text{ m}^3$

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}

$$\begin{split} \dot{V} &= \frac{V}{t} \\ t &= \frac{V}{\dot{V}} = \frac{0.086982}{0.045} = 1.933 min = 115.98s \approx 120s \\ t_{testing} &= 80s \\ \# \text{Total time required} &= t + t_{testing} = 120 + 80 = 200s = 3.333 min \\ \therefore \ minimum \ volume \ tank \ required} &= V_{piping} = 0.045 \ m^3/min \times 3.333 min \\ &= 0.14985 m^3 \end{split}$$

Check back the volume of the tank with the specified r and h

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

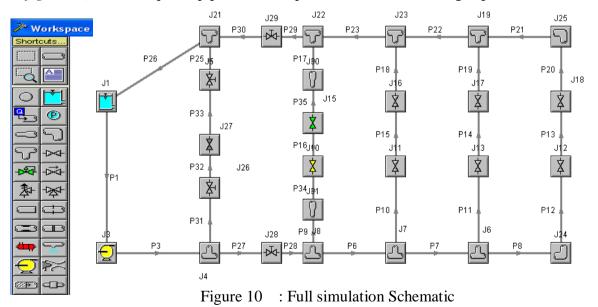
3.5.1 AFT Fathom simulation step.

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.



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*).

Valve Specifications		
Number: 28 Name: Valve Database List: Image:	Upstream Pipe: 27 Downstream Pipe: 28 Elegation Inlet: 0 meters Outlet: Same as Inlet	<u>O</u> K Cancel Jump <u>H</u> elp
Loss Model Iransient Optional Notes Status Valve Data Source Handbook Dus Angle, Tucle 1, P0=100 (C) Ball, 50 deg, (M) Ball 70 deg, (M) Ball 70 deg, (M) Ball 70 deg, (M) But effy, PD=100 (C) Butterfy, PD=100 (C) Butterfy, PD=100 (C) Butterfy, Plane disk - AR=0.32, 10 deg, (I) Butterfy, Plane disk - AR=0.32, 20 deg, (I) Basis Area for Loss Model Upstream Pipe 	Handbook Database List Definitions <u>Abbreviations:</u> (C)= Cran D Diameter AR= Area Ratio (I)= Idelc P0= Rercent Open deg = degrees (M)= Mille	chik

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.

Valve Specification	3		
Num <u>b</u> er: Na <u>m</u> e: D <u>a</u> tabase List: Copy Data From J <u>o</u> t	12 Test Valve	Upstream Pipe: 12 Downstream Pipe: 13 Elevation Inlet: 0 inches v Dutlet: Same as Inlet	<u>D</u> K Cancel Jump <u>H</u> elp
Transient Special C <u>None</u> Ignore Transier Initiation of Transier <u>Time</u>	t Data	Transient Data • Absolute Values • Relative To Steady-State Value <u>Data</u> Time Point (seconds) Cv <u>1</u> 0 100 <u>2</u> 60 80 <u>3</u> 120 100 <u>4</u> 1800 80 <u>5</u> 240 100 <u>6</u> 300 80 <u>7</u> 360 100 <u>8</u> <u>Edit</u> Table <u>[Show Graph]</u> <u>Bepeat</u> Transient Transient	

Figure 12 :Valve opening base on time

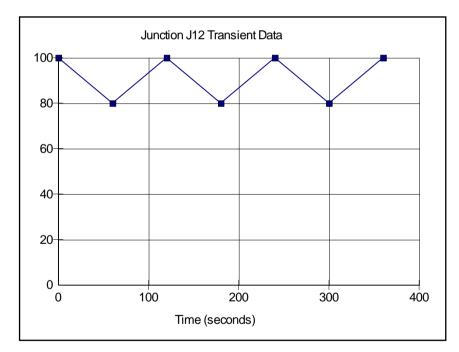


Figure 13 : Valve opening set by predetermine value

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
------	-------	-----

PST Summary						
	Value Pas		iss/Fail			
PST Passed Flag	Passed	0	Passed	l		
Friction	3.18	0	Passed	l		
Breakout Pressure	3.185	0	Passed	l		
Droop	11.12		Failed			
Spring Range	Lower -	4.62	Upper	38.81		
Response Time	Exhaust 6	6.05	Fill	1.65		
View Graph Finish						

Figure 14 : Ball Valve PST summary

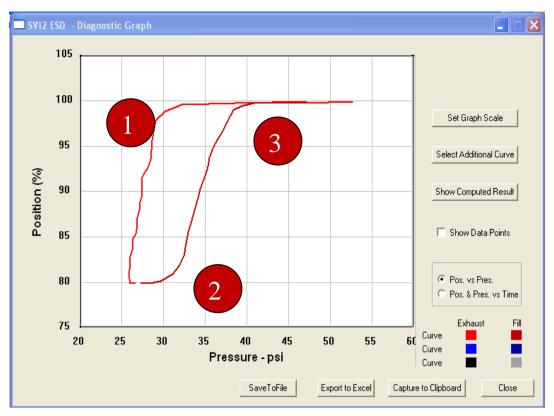


Figure 15 : Ball Valve Diagnostic graph

Partial Stroke Test Result					
	Current Curve				
Edelfers (e.e.)					
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				
	ОК				

Figure 16 : Ball Valve PST result

Butterfly valve PST

PST Summary					X	
	Value	F	Pass/Fail			
PST Passed Flag	Passed	0	Passec	I		
Friction	3.535	0	Passec	I		
Breakout Pressure	3.23	0	Passec	I		
Droop	15.635	0	Failed			
Spring Range Besponse Time	Lower F	-5.105	Upper	47.98		
Response Time	Exhaust 🖡	86.9	Fill	11.95		
View Graph Finish						

Figure 17 : Butterfly Valve PST summary

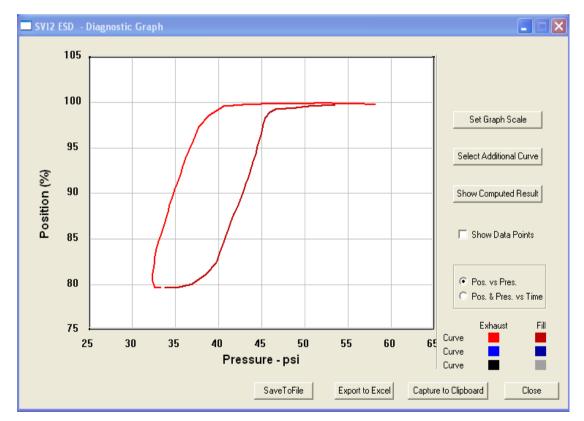


Figure 18 : Butterfly Valve Diagnostic graph

	Current Curv
Friction (psi)	3.535
Friction (%)	6.659
LSpringRange (psi)	-5.105
USpringRange (psi)	47.980
BreakAwayPressure (psi)	3.230
Droop (psi)	15.635
RespTimeExhaust(psi/sec)	86.900
RespTimeFill(psi/sec)	11.950

Figure 19 : Butterfly Valve PST result



ESDVue - MN_ESD_1						
Tools Help						
Monitor Trend Configu	ire Calibrate Diagnostic	ps PST s	Status Check	:]		
PST Schedule				- Diagnostics		
	Diagnostics					
Interval						
Schedule	Partial Stroke Test					Perform Diagn.
10/27/2						
	Partial Stroke Test		0	Failed		
				Partial Stroke Test Complete		Load Diagn.
– Partial Stroke Test S						
Fartial Stroke Lest S						Historical View
PST Trave						
Minimum Pressu						
Maximum Tim						
PST Spee						
Dwell Tim		00:01:34	Cancel Cur	rent Task Cancel All	Continue	
Encle		00:01:39				
Enable	e Schedule 🔽		Set			✓
Change Mode	👴 Mode:	Normal				Exit Help

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*).

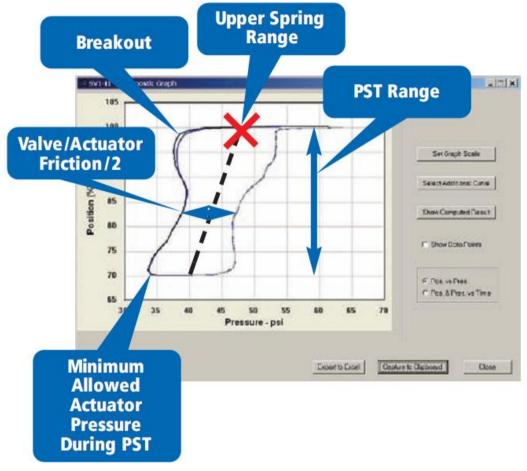


Figure 21 : Graph diagnosis

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.

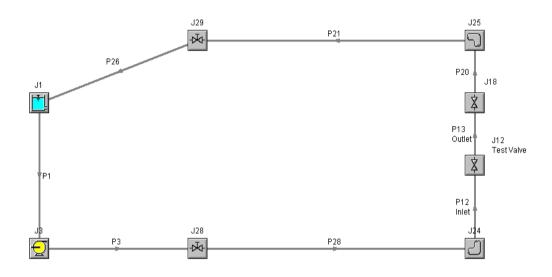


Figure 22 : Longest fluid path route simulation

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

Pipes											
Pipe	Name	Vol. Flow Rate (liter/min)	Velocity (Neet/min)	Elevation	Elevation	dP Stag. Total sid)	dP Static Total (psid)	dP Gravity (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
1	Pipe	45.00	71 195	vei	ocity	9539797	-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	owrate	71.195	0.000	2.000	0.08742243	0.08742243	0.07205	0.03555930	20.61	20.52

Table 5:Simulation result

4.1.2.2 Transient state

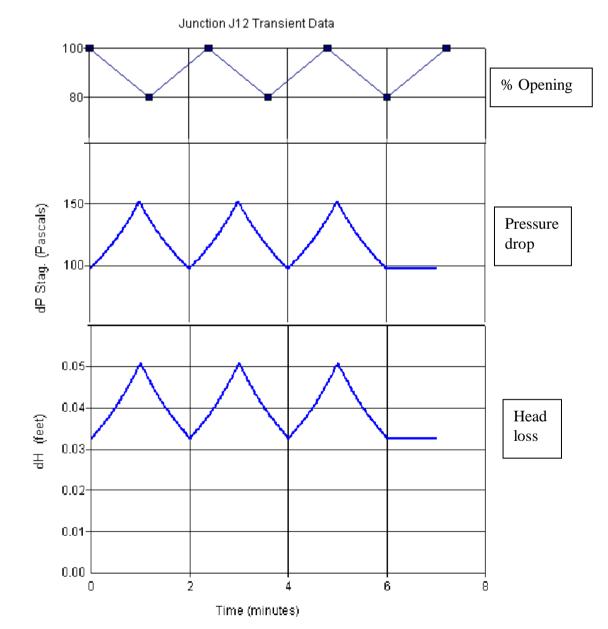
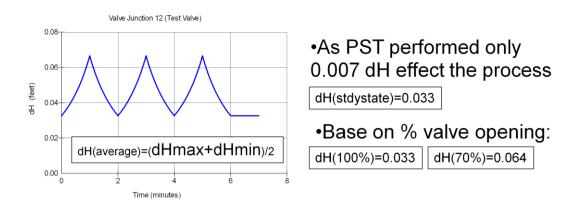


Figure 23 :Opening valve relation with pressure and head loss



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:

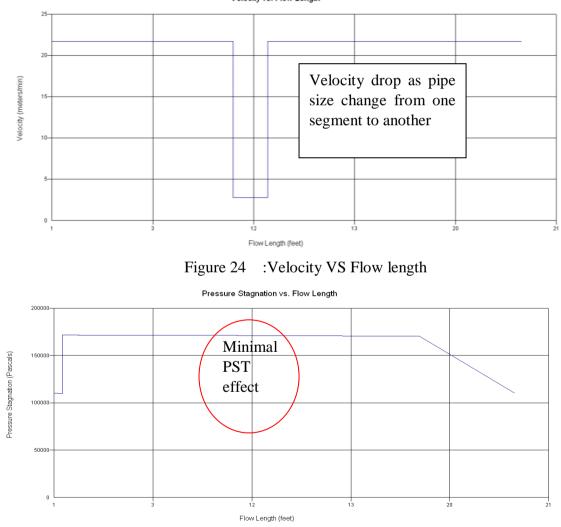


Figure 25 :Pressure stagnation VS Flow length

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.

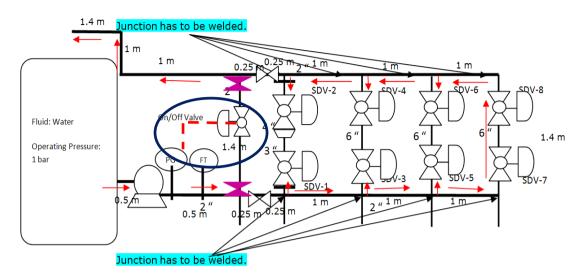


Figure 26 :Test rig modification

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.

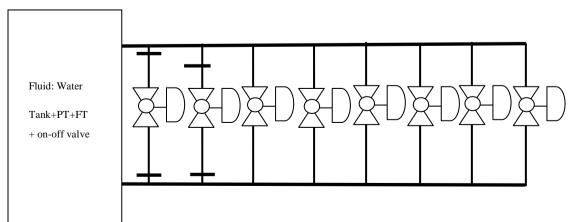


Figure 27: Test Rig improvement

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

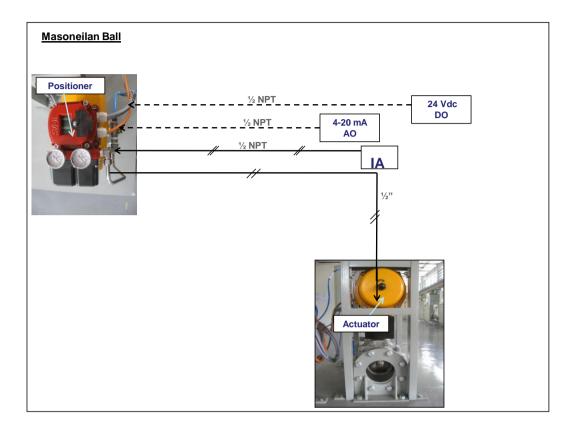
SEMESTER 1

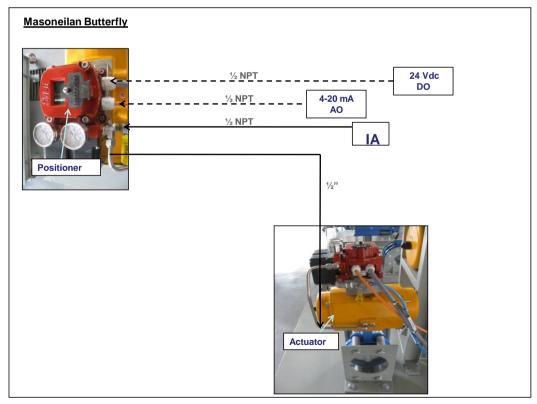
No	Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Selection of Project Title														
2.	Data Gathering on Title														
3.	Preliminary Report Submission														
4.	Conduct testing (FST and PST)														
5.	Detail Testing Procedures preparation.														
6.	Preparation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

SEMESTER 2

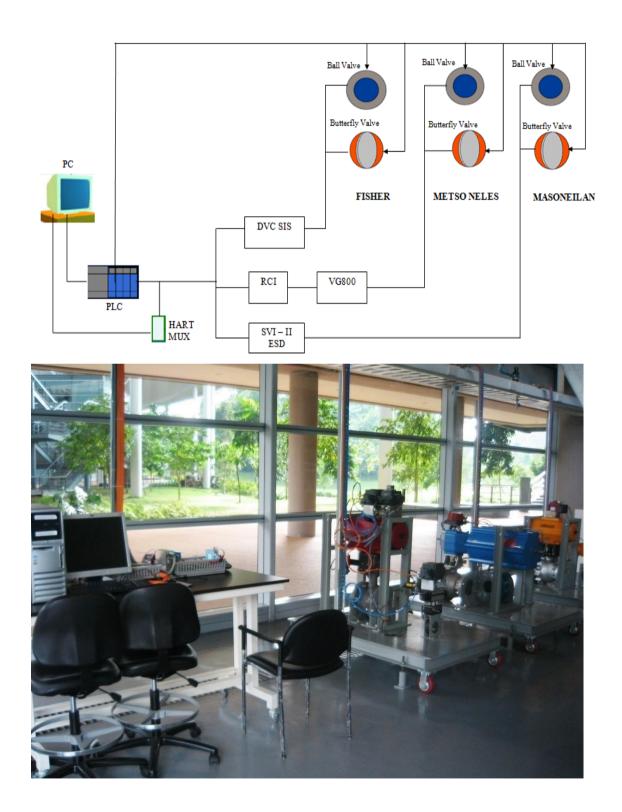
No	Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Data gathering for simulation software														
2.	Design analysis														
3.	Simulate design using HYSIS						l	l							
4.	Simulate design using AFT Fathom														
5.	Submission of progress report 1														
6.	Design verification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

🎨 WideField2		
File Edit Find(S) View Online	Debug/Maintenance	Tools Window H
New Project(M)	Ctd+Shift+N	
Open Project(H)	Ctrl+Shift+O	
Close Project	Chill Shift re	T/≫ ≓
Save Project	Ctrl+Shift+S	
Save Project As	Ctrl+Shift+A	
Downgrade and Save Project	Alt+Ctrl+V	

5. Select folder "masotest" and click Open

Open Project Project C Fam3p	.it	▼ ← ₺ ₫ ▥-	?
Project Fam3p AIAO FISHER FISHER PST MASO masotest 1	METSO PST PSTV2 SEPT25_2 test TESTAZA1	TESTING1 testing2 TIMERCA2 VALVE1 WFSample	
			2 Open Cancel

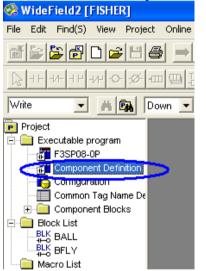
6. Then, Select "FISHER" folder and click Open

Open Project	? 🛛
Project FISHER PST 💌 🖙 î 🗊	
	Open Cancel

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

Open Project	? 🛛
Project FISHER - C C C C C C C C C C C C C C C C C C	File Name FISHER.YPJT Date Changed 2010/04/08 13:05:02 CPU Type F3SP08-0P Title
	Open Cancel

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*"

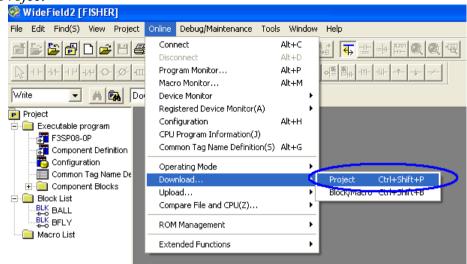
Name of Executa	ible	FISHER		2		
-Configuration				0	ОК	
					UN	
 Set up 		C Not Setu	q			
-User Log Messa	ne				Cancel	1
	ige			-		
C Yes		No				
Component Bloc		ame 🔺	2	F	Rlack List	
Component Bloc Block No. SCB 1		ame 🔺	2 <-Select			1
Block No. SCB 1 2		ame 🔺	2 <-Select	BA	L	1
Block No. SCB 1 2 3		ame 🔺		BA	L	1
Block No. SCB 1 2 3 4		ame 🔺	2 <-Select	BA	L	1
Block No. SCB 1 2 3 4 5		ame 🔺		BA	L	
Block No. SCB 1 2 3 4		ame 🔺	Insert	BA	L	
Block No. SCB 1 2 3 4 5 6		ame •		BA	L	1

8b.To test Masoneilan Butterfly Valve:

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

Define Progra	m Components 🛛 🔀
Name of Execut	
Configuration -	З
Set up	
User Log Mess	age Cancel
C Yes	No
	xs
Block No.	Block Name 🔺 🙎 🛛 🖌 🔺
SCB	<-Select BALL
23	
4	Insert
5	
6	
7	
8	Delete
9	▼ ▼

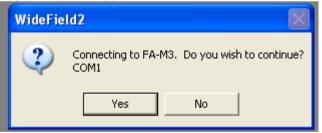
9. To download project file. Go to "Online", select "Download" and click on "Project"



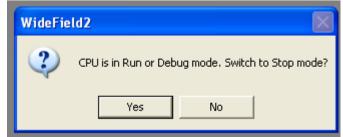
10. The following prompt will appear and select "YES"

lo

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



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



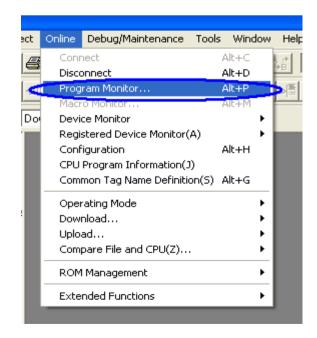
13. Transferring configuration will start to download and the following prompt will appear. (Masoneilan)

Program Name F	ISHER	
Status Trans	ferring configuration	
Destination COM	M1 CPU Number	
Block Name	Instruction Number.	

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

Download	
Program Name	WideField2
Status Op	Download is completed. Switch to Run mode?
Destination	
Block Name	Yes No
	Cancel

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.

😪 Select Bl	lock (Active Blo	ck Monitor)		
	Block Name	Active		
1 <	BALL	D 1		
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14			그	
		•		

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

🧟 Select Bl	ock (Active Bloc	k Monitor)		
	Block Name	Active	•	
	BFLY) 1		
2				
3				
4				
5				
6				
7				
8				
9			_	
10				
11				
12				
13			_	
14			_	
L			·	

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

For Ball Valve as follows:

Monitor	Block:BALI										
00001											
	Power	Failure	Conditi	on-1st (cycle- m	odule 5					
00002											
	M00035						WRITE	\$0	6	503	
								\$0	6	503	
00003	Unner	imit an	d Lowe	r Limit S	Setting 4	& 20 m	A 1st c	lce			
	opper		Lone		Journy 4	~ 20 m					
00004	M00035										
							WRITE	10000	6	540	
00005											
							WRITE	0	6	541	
00006									0	041	
00006	M00033										
							WRITE	D00001	6	1	
00007											
00008											
	100002								MOV	0	D000
00009										0	0000
00005	100020								MOV		
		İ							MUV	10000	D000
00010											Y002
											Ø
00011		1									
	100022								MOV	3000	D000
										3000	0000

For Butterfly Valve as follows:

	Block:BFLY							
00001	моооз5			 WRITE	\$0	6	504	1
00002	M00035	 		WRITE	10000	6	550	1
00003				WRITE	0	6	551	1
00004	M00033	 	 	 		0	551	
00005	100002	 	 	 WRITE	D00001	6	2	1
00006		 	 	 		MOV	0	D00001
	100020	 	 	 		MOV	10000	D00001
00007		 	 	 				Y00202

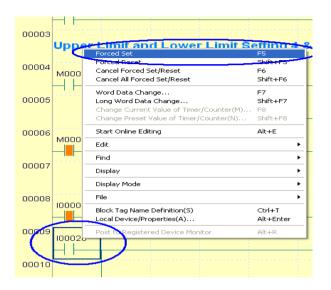
18. Ensure M00033, I00002, I00020 and M00033, I00002 for ball valve and butterfly valve respectively are "Forced Set". The symbol for set and reset is as follows:

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".

00001							
Pow	er Failure Condition- 1st	cycle- module	e 5				
00002							
M000	35		WRITE	\$0	6	503	
00003				<u>۵</u> ۵	0	003	
	er Limit and Lower Limit \$	Setting 4 & 20	mA 1st cv	/lce			
- PP		, , , , , , , , , , , , , , , , , , ,					
00004 M000	35						
			WRITE	10000	6	540	
00005							
	Forced Set		WRITE	0	6	541	
00006	Forced Reset	Shift+F5					
M000	33 Cancel Forced Set/Reset Cancel All Forced Set/Reset	F6 Shift+F6	WRITE	D00001	6	1	
00007	Word Data Change	F7		D00001	0		
00007	Long Word Data Change Change Current Value of Timer/Counte	Shift+F7 er(M) F8					
	Change Preset Value of Timer/Counter						
00008 10000	Start Online Editing	Alt+E					
	Edit	,			MOV	0	DO
00009	Find	· ·					
10002		· ·		ſ	MOV	10000	DO
	Display Mode					10000	
00010	File						YOC
	Block Tag Name Definition(S) Local Device/Properties(A)	Ctrl+T Alt+Enter					-Ø
00011	2 Post to Registered Device Monitor	Alt+R					
					MOV	3000	DO

- 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.

Tool	/ue ESD - Looko s Help mnected Devices						
[DeviceID	Tag	Location	Last PST	Next PST	PST	
	6335463	OFFLINE	(there may be a severa Node	top device scanning	ing)		Select Find by Tag Re-Scan
			ValV	ue ESD			
					Exit		Help

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

ValVue ESD - Lookout Tools) 1 Set Options	nt Schedule					
Mux Setup Mux Reset 2	ag	Location	Last PST	Next PST	PST	
Burst Mode Control	DFFLINE	OFFLINE	01/01/2006 00:00	N/A	Pass	Select Find by Tag Re-Scan
	2	V	/alVue ESD			
				E	Exit	Help

23. *'Device Address'* popup will appear enter'1' value. Then click *''OK''*.

Device		Tag	Location	Last PST	Next PST	PST [
	6335463 8036594	OFFLINE MN_ESD_1	OFFLINE 0 21 109965 1 1 5 0 37. Device Addres Device Address Node:		N/A 04/22/2010 06:05	Pass Pass	Select Find by T
			Val\	/ue ESD			

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

alVue ESD - Looko ools)Help 1	ut					
Set Options	nt 2 Jule					
Mux Setup Mux Reset	ag	Location	Last PST	Next PST	PST	
Burst Mode Control	FFLINE	OFFLINE	01/01/2006 00:00	N/A	Pass	Select Find by Tag Re-Scan
	7	Va	IVue ESD			Help

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

35. Multiplexo	r Setup	
Tag Descriptor	MUX MUX	
Retry Count Preamble Count Scan Age Time (sec.)	5 30	Master Mode
-Search Method C Polling Addre C One Device I Multidrop	ss 0 only	Scan Option Scanning OFF Scan Cmd 1 Scan Cmd 2 Scan Cmd 3
¢	ок	Cancel

26. Go back to Valvue ESD Lookout dialog box and click "Re-Scan".

out					
Plant Schedule					
Tag	Location	Last PST	Next PST	PST	[
OFFLINE	OFFLINE	01/01/2006 00:00	N/A	Pass	Select Find by Tag Re-Scan
	V	alVue ESD	E	xit	Help
	Plant Schedule Tag OFFLINE	Plant Schedule	Plant Schedule	Plant Schedule Tag Location OFFLINE OFFLINE OFFLINE OFFLINE ValVue ESD	Tag Location Last PST Next PST PST OFFLINE 01/01/2006 00:00 N/A Pass

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.

	ESD - Looko	ut					
ols He							
		Plant Schedule	1			()	1
Devi	6335463	Tag OFFLINE	Location OFFLINE	Last PST 01/01/2006 00:00	Next PST N/A	PST Pass	
							Select Find by Tag Re-Scan
			v	alVue ESD			<u> </u>
					E	Exit	Help

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".

ols H Connec		Plant Schedule					
Dev	riceID	Tag	Location	Last PST	Next PST	PST	TI
秘	6335463	OFFLINE	OFFLINE	01/01/2006 00:00	N/A	Pass	
	8036594	MN_ESD_1	0 21 109965 1 1 5 0	04/21/2010 16:15	04/22/2010 06:05	Pass	1
							2 Select Find by Tag Re Scan
	<u>_</u>		Val\	/ue ESD	Exit		Help

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

ESDVue - MN_ESD_1	
Tools Help	_,
Monitor Trend Configure Calibrate Diagnostics PST Status Chec	k
SVI2 ESD	Signal (mA) 19.97 Pressure1 psi 53.28 Position (%) 99.2 Pressure2 psi 0.00
Masoneilan Tag MN_ESD_1 Descriptor PENAGA DRESSER Message MASONEILAN SVI II ESD DEMO UNIT	Pressure psi 53.28 Supply psi 53.43 I/P Current 0.96 Pilot Pres psi 16.85
Date 18 APR 2008 Assembly Number 0	99.2 Position (%) 99.2 Setpoint (%)
Status Additional Status Available Configuration Changed	New PST ESD Type: ASD New ESD Event PST in Progress ESDTripped No Communication
Change Mode 🛛 🔶 Mode: Normal	Exit Help

31. Select 'PST' parameter tab

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

ESDVue - MN_ESD_1									
Tools Help									
Monitor Trend Configure Calibrate Diagnostics PST Status Check									
PST Schedule Diagnostics									
Interval 1 days Scheduled Next PST New PST Schedule N/A 01-01-70 08:00 Set	Perform PST Perform Diagn. Perform TBT Diagnostics to Load Load Current PST Load Diagn.								
Partial Stroke Test Settings	Historical View								
PST Travel 2000 (%) Friction Low Limit 0.0	Test								
Minimum Pressure 10.0 (psi) Friction High Limit 5.0									
Maximum Time 30 (s) Breakout Limit 15.0									
PST Speed 0.5 (%/s) Droop Limit 10.0									
Dwell Time 4 (s) Freeze DO 💌 AO 🗖									
Enable Schedule 🔽									
Change Mode 🛛 🔶 Mode: Normal	Exit Help								

32. Click on *"Perform Diagnostic.*"

ESDVue - MN_ESD_1			
Tools Help			
Monitor Trend Configure Calibrate [Diagnostics PST Status Check		
PST Schedule		Diagnostics	
Interval 1 days Scheduled Next PST N/A	New PST Schedule 01-01-70 08:00	Perform PST Perform TBT	Prtom Diagn.
	Set	Diagnostics to Load	Load Diagn.
Partial Stroke Test Settings			Historical View
PST Travel 2000 (%) Friction Low Limit 0.0	Test	
Minimum Pressure 10.0	(psi) Friction High Limit 5.0		
Maximum Time 30 (s) Breakout Limit 15.0		
PST Speed 0.5 (%/s) Droop Limit 10.0		
Dwell Time 4 (s) Freeze DO 🔽 AO 🗖		
Enable Schedule 🥅	Set		
Change Mode 🛛 🗢	Mode: Normal		Exit Help

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

	re Calibrate Diagnostics PST Status Check	
PST Schedule	Diagnostics	
Interval		
Schedule	Partial Stroke Test	erform Diagn.
04/22/2		
	Partial Stroke Test 🥚 Running	Load Diagn.
		Load Diagn.
Partial Stroke Test S		listorical View
PST Trave		
Minimum Pressur		
Maximum Time		
PST Spee		
	Elapsed Time (Task): 00:00:14	Continue
Dwell Tim	Elapsed Time (Total). 00:00:17	CONTINUE
Enable	Schedule 🗹	~

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

ESDVue - MN_ESD_1				
Tools Help		Dor 1		
Monitor Trend Configu	ire Calibrate Diagnostic	» PST [Status Check	1
PST Schedule	Diagnostics			
Interval [
Schedule	Partial Stroke Test			erform Diagn.
N/A				
	Partial Stroke Test		Loading Pst Data	
				Load Diagn.
Partial Stroke Test S				listorical View
PST Trave				listorical view
Minimum Pressur				
Maximum Timi				
PST Spee	Elapsed Time (Task):	00:02:31		
Dwell Tim	Elapsed Time (Total):	00:02:34	Cancel Current Task Cancel All Continue	
Enable	e Schedule 🗖		Set	
			,	
Change Mode	Mode:	Normal		Exit Help

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

ESDVue - MN_ESD_1									
Tools Help	· · · · · · · · · · · · · · · · · · ·								
	ure Calibrate Diagnostics PST Status Check								
PST Schedule	PST Schedule Diagnostics								
Interval [
Schedule	Partial Stroke Test	'erform Diagn.							
N/A	Partial Stroke Test								
	Partial Stroke Test Partial Stroke Test Complete	Load Diagn.							
Partial Stroke Test S		listorical View							
PST Trave									
Minimum Pressur		<u>~</u>							
Maximum Tim									
PST Spee	Elapsed Time (Task): 00:02:33								
Dwell Tim		e							
Enabl	e Schedule								
Change Mode	Mode: Normal	Exit Help							

36. Click "Continue".

Diagnostics	
Partial Stroke Test	
Partial Stroke Test	 Finished Partial Stroke Test Complete
Elapsed Time (Task): 00:02:33 Elapsed Time (Total): 00:02:36	Cancel Current Task Cancel All Continue

37. This prompt will appear. It displays the Summary Analysis1) Butterfly Valve

PST Summary						
	Value		Pass/Fail			
PST Passed Flag	Passed	0) Passed	I		
Friction	3.38	0) Passed	I		
Breakout Pressure	4.545	0) Passed	I		
Droop	9.42	0) Passed	I		
Spring Range	Lower	-17.355	Upper	41.135		
Response Time	Exhaust	51.4	Fill	1.4		
View Graph Finish						

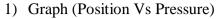
2) Ball Valve

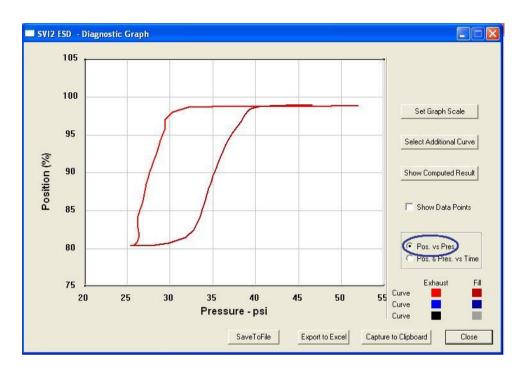
PST Summary		
	Value	Pass/Fail
PST Passed Flag	Passed	Passed
Friction	3.035	Passed
Breakout Pressure	3.045	Passed
Droop	11.35	🥚 Failed
Spring Range	Lower 7.16	Upper 37.79
Response Time	Exhaust 64.25	Fill 1.9
View	Graph	Finish

38. Next click "View Graph".

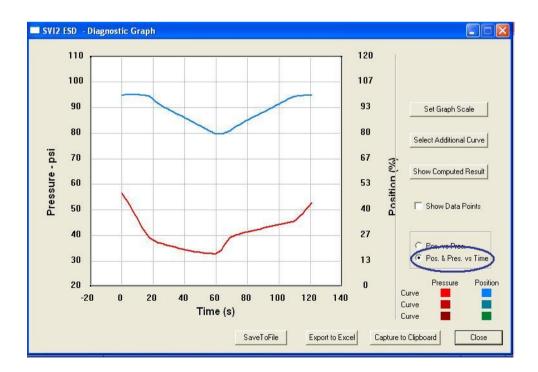
PST Summary					×
	Value	Pas	s/Fail		
PST Passed Flag	Passed	0	Passed	I.	
Friction	3.38		Passed	l	
Breakout Pressure	4.545		Passed	E.	
Droop	9.42		Passed	E.	
Spring Range	Lower 17	7.355	Upper	41.135	į.
Response Time	Exhaust 51	.4	Fill	1.4	į.
View	Graph	Finish			

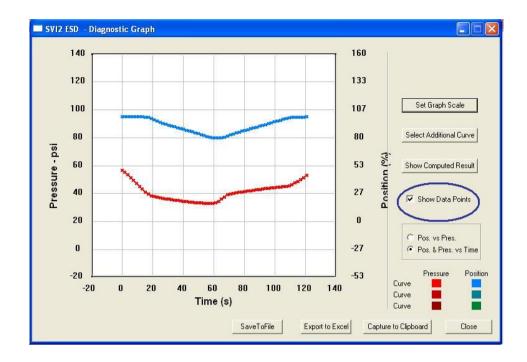
39. The following prompt will appear. It displays the Testing Measurement Graph.





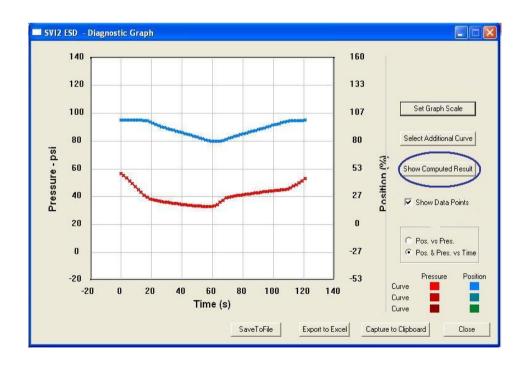
2) Graph (Position (Blue Color) and Pressure (Red Color) Vs Time)





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.

 SV12	ESD - D	iagnostic Graph				
	160			1	87	
	140	Partial Stroke Test Result			E	3
	120		Current Curve	Selected Curve1	Selected Cury	iph Scale
	100	Friction (psi) Friction (%) LSpringRange (psi)	3.320 6.838 -1.210			litional Curve
psi	80	USpringmange (psi) USpringRange (psi) BreakAwayPressure (psi)	47.345			
- e -	60	Droop (psi) RespTimeExhaust(psi/sec)	14.575 90.100			puted Result
Pressure - psi	40	RespTimeFill(psi/sec)	12.000			Data Points
	20					
	0	•			•	s Pres. Pres. vs Time
	-20		ОК			sure Position
-20Time (s)						1
			SaveToFile	Export to Excel	Capture to Clipboard	Close

- 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"*.

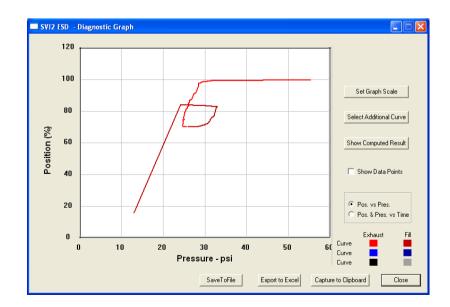
ESDVue - MN_ESD_1							
Tools Help							
Monitor Trend Configure Calibrate Diagnostics PST Status Check							
- PST Schedule	PST Schedule						
	Diagnostics						
Interval							
Schedule	Partial Stroke Test				'erform Diagn.		
04/22/2			•				
	Partial Stroke Test		•	Failed			
				Partial Stroke Test Complete	Load Diagn.		
⊢ Partial Stroke Test S							
					fistorical View		
PST Trave							
Minimum Pressur					<u> </u>		
Maximum Tim							
DOT 0							
PST Spee	Elapsed Lime (Lask):	00:02:18					
Dwell Tim	Elapsed Time (Total):	00:02:21	Cancel Cur	rent Task Cancel All Continu	Je		
Enabl	le Schedule 🔽		Set				
Characa Made Normal Evit Hala							
Change Mode	\ominus Mode:	Noma			Exit Help		

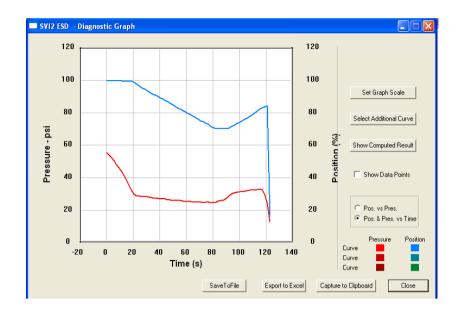
1.2) The following window will appear. Next, click on *"View Graph"*.

ESDVue - MN_ESD_1						
Tools Help						
Monitor Trend Configure Calibrate Diagnostics PST Status Check						
PST Schedule			Diagnostics			
Interval 1	T Summary					
Scheduled Next PST		Value	Pass/Fail	Perform Diagn.		
04/22/2010 23:28	PST Passed Flag	Failed	🥚 Failed			
	Friction	-0.005	🥚 Failed	▼ Load Diagn.		
Partial Stroke Test Settings	Breakout Pressure	0	Passed			
PST Travel 30	Droop	0	Passed	Historical View		
Minimum Pressure 10	Spring Range	Lower 15	Upper 15			
Maximum Time	Response Time	Exhaust 0	Fill 0			
PST Speed	View	Graph	Finish			
Dwell Time						
Enable Schedule 🔽		Set				
Change Mode	Mode: Normal			Exit Help		

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*".

ESDVue - MN_ESD_2			
Tools Help			
Monitor Trend Configu	re Calibrate Diagnostics PST	Status Check	
PST Schedule	Diagnostics	•. •	
Interval 🗍			
Schedule	Partial Stroke Test		erform Diagn.
N/A	Partial Stroke Test	O Running	
			Load Diagn.
Partial Stroke Test S			Historical View
PST Trave			
Minimum Pressur			
Maximum Tim			
PST Spee	Elapsed Time (Task): 00:01:43	\square	_
Dwell Tim	Elapsed Time (Total): 00:01:46	Cancel Current Task Cancel All Continue	£
Enable	Schedule 🦵	Set	
Change Mode	Mode: Normal		Exit Help

2.2) Next, click "*OK*".

ESDVue - MN_ESD_2					
Tools Help Monitor Trend Configure Calibrate Diagnostics PST Status Check					
PST Schedule	Diagnostics				
Interval	Diagnostics				
Schedule	Partial Stroke Test		erform Diagn.		
N/A	Partial Stroke Test	Running			
		ESDVue	Load Diagn.		
Partial Stroke Test S		Could not stop process	listorical View		
PST Trave		ОК			
Minimum Pressur					
Maximum Tim PST Speer					
Dwell Tim	Elapsed Time (Task): 00:02:24 Elapsed Time (Total): 00:02:27	Cancel Current Task Cancel All Continue	1		
Enable	Schedule	Set			
Change Mode	🔶 Mode: Disconr	nected	Exit Help		

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

ESDVue - MN_ESD_2 Tools Help		Z				
Monitor Trend Configure Calibrate Diagnostics PST Status Check						
PST Schedule	Diagnostics					
Interval						
Scheduk	Partial Stroke Test	erform Diagn.				
N/A	Partial Stroke Test 🥔 Canceled					
	Partial Stroke Test Did Not Complete	Load Diagn.				
⊢ Partial Stroke Test S						
		listorical View				
PST Trave						
Minimum Pressu						
Maximum Tim						
PST Spee	Elapsed Time (Task): 00:02:24	1				
Dwell Tim		_				
Enab	le Schedule					
Change Mode	Mode: Disconnected	Exit Help				