A STUDY OF PARTIAL STROKE TEST FOR EMERGENCY SHUTDOWN SYSTEM USING MASONEILAN VALVE

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ELECTRICAL & ELECTRONICS ENGINEERING
UNIVERSITI TEKNOLOGI PETRONAS
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A STUDY OF PARTIAL STROKE TEST (PST) FOR EMERGENCY SHUTDOWN VALVE (ESD) USING MASONEILAN VALVE

By

Nik Abdul Aziz bin Nik Mustafa

FINAL PROJECT REPORT

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CERTIFICATION OF APPROVAL

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Approved by,

(Assoc Prof Dr Nordin Saad)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

June 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 and/or persons.

NIK ABDUL AZIZ BIN NIK MUSTAFA

ABSTRACT

The project titled, **Implementation and evaluation of Partial Stroke Test for Emergency Shutdown Valve** is collaboration between Universiti Teknologi PETRONAS (UTP) and PETRONAS Group Technology Solutions (PGTS). This report presents the progress and the future development of the work in Partial Stroke Testing. Partial Stroke Test is a good complement to Full Stroke Testing (FST). During the FST operators will monitor the testing to confirm that the valve has reached the desire position and to ensure the valve reached in specific time to establish the integrity of the valve's operating mechanism. The FST even though can perform a high diagnostic coverage factor (90-95%) and conveys a trouble free operation and, however, it leads to process interruption and labor-intensive manual work. Therefore, the objective is to develop a controller to execute various test sequences for a Partial Stroke Valve Testing and Full Stroke Valve Testing in repetitive modes, as required in the testing requirements. Specifically, the PLC is to provide the signal for a Full Stroke Testing (FST) execution, while the vendor's software is programmed to perform Partial Stroke Testing (PST). More specifically the important element of the test is to seek verification that the FST would override the PST if both are executed at the same time, as well as to study the effect of valve design to the overall performance of the PST. This project is part of the Improvement Working Group (IWG) of Skill Group 14 (SKG14).. The outcome of this project in the form of the performance results analysis and report would be used in implementation of PETRONAS plants.

ABSTRACT

The project titled, **Implementation and evaluation of Partial Stroke Test for Emergency Shutdown Valve** is collaboration between Universiti Teknologi PETRONAS (UTP) and PETRONAS Group Technology Solutions (PGTS). This report presents the progress and the future development of the work in Partial Stroke Testing. Partial Stroke Test is a good complement to Full Stroke Testing (FST). During the FST operators will monitor the testing to confirm that the valve has reached the desire position and to ensure the valve reached in specific time to establish the integrity of the valve's operating mechanism. The FST even though can perform a high diagnostic coverage factor (90-95%) and conveys a trouble free operation and, however, it leads to process interruption and labor-intensive manual work. Therefore, the objective is to develop a controller to execute various test sequences for a Partial Stroke Valve Testing and Full Stroke Valve Testing in repetitive modes, as required in the testing requirements. Specifically, the PLC is to provide the signal for a Full Stroke Testing (FST) execution, while the vendor's software is programmed to perform Partial Stroke Testing (PST). More specifically the important element of the test is to seek verification that the FST would override the PST if both are executed at the same time, as well as to study the effect of valve design to the overall performance of the PST. This project is part of the Improvement Working Group (IWG) of Skill Group 14 (SKG14).. The outcome of this project in the form of the performance results analysis and report would be used in implementation of PETRONAS plants.

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All praise to Allah the Almighty, who has helped and gave me the courage and strength to complete the project dissertation of Final Year Project. With His Grace and Mercy, this endeavour is now a success.

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LIST OF ABREVIATIONS

ESD	Emergency Shutdown
PST	Partial Stroke Testing
FST	Full Stroke Test
PLC	Programmable Logic Controller
SIL	Safety Integrity Level
DCS	Distributed Control System
HART	Highway Addressable Remote Transducer
PC	Personal Computer
SV	Spool Valve
FDT	Field Device Tool
UTP	Universiti Teknologi Petronas
IWG	Improvement Working Group
SKG14	Skill Group 14
PFD	Probability of Failure on Demand

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In industrial operation, the valves that perform safety function are mentioned as emergency shutdown valve. These valves are separated from the normal operating valve and are employed to provide safety shutdown. Emergency Shutdown System (ESD) is a system implemented to protect people, instrument and also environment if unnecessary actions happen in the field. The unnecessary action may cause dangerous to everybody and also give a great impact to production profit. For instance, the ESD system will act simultaneously when power trip occurred in plant to prevent serious injury to the people and environment. Since the used of ESD valves are not frequently exercised, this can reduce the reliability of these valves to perform safety function. Nowadays, Partial Stroke Test was implemented to ensure the system reliability and safety when unexpected actions hitting the processing plant. Researchers have shown that the application of ESD is very broad all around the world including oil and gas operation. [1]

PST is a method whereby a portion of the valve is being tested at a more frequent interval than a full test rate, an accelerated (partial) proof test while FST is in opposite form. For FST (Full Stroke Test), the method was implemented in full swing and require shutdown of the plant.

1.2 Problem Statement

A number of failures in Partial Stroke Test (PST) around the world have given rise to concern on reliability of PST. Based on the research done, it was stated that the most difficult part of SIL compliance is the testing final element especially emergency block valves. [2] For the past thirty years, the turnarounds were done every two to three years. Due to mechanical reliability and preventive maintenance program, the turnarounds have been extended to every five to six years whereby increased the production. Previously, the performance of valve tested using Full Stroke Test during turnaround. Since this method will interrupt the process flow, a new improved technology using Partial Stroke Test was practiced all over the world to improve the weakness of FST

By definition emergency shutdown valves are designed to take the process to a safe state if certain, pre-specified operating limits are exceeded. The major problem with these valves relates to the fact that they typically operate in one static position for long periods of time and only move in an emergency situation. This condition gives a great tendency to the valve by not functioning properly. In a condition, when the valves are not operated regularly, the valve tends to stick in one position for a long time. This will contribute to the failure of emergency shutdown valves to perform their job. The sticking problem may caused by the dirt clogging and also corrosion in process nature. In fact, by exercising the valve more frequently, we can reduce the dirt build-up and increase the valve ability in sustaining the safety.

Therefore, Partial Stroke Test is the best practice can be implemented to demolish those entire problems. PST can be the best solution to replace FST in our industry where it gives assurances to prevent the valve failure. It also proves that, PST can be done without the need of process shutdown and not affecting the process flow.

1.3 Objective

The main objective in this project is to test the ability of Masoneilan Ball and Butterfly valves while doing Partial Stroke Test. The testing conducted using two different types of mode which are Partial Stroke Test and Full Stroke Test. During the testing, these valves performance will be captured to measure the accuracy of the device. It is followed by analysis of data in the end of testing. The project consists of two different phases to be implemented which is Phase 1 and Phase 2. Phase 1 was completed in previous semester by stroking the valve in a range of 90 days using dry test. In phase 2, the project is emphasize to test the ESD valve using stress test Some framework has been started in Phase 2 to demonstrate the mission. Several objectives for the project are summarized by words below:

a. To analyze the performance of using Masoneilan's valve in performing Partial Stroke Test

b. To execute Full Stroke Test to simulate real shutdown.

c. To execute Full Stroke Test (FST) and simultaneously Partial Stroke Test (PST) in simulate real shutdown.

d. To monitor performance of ball valve and butterfly while doing Partial Stroke Test.

e. To start the new phase of Destructive Test and monitoring the effect of disturbance to the valve performance.

1.4 Scope of Study

The scope of work for this project is to simulate a working model for full stroke testing by using a controller. This simulation would then be translated into a PLC programmer and executed on the control valves with real-time analysis. The control valves would be set to execute daily partial stroke testing by using respective vendor database software. Some aspects of the controller to be looked at are the safety, performance, power requirement, efficiency and reliability

Therefore, student needs to acquire some knowledge in term of technical work in doing the project. A basic understanding of PLC is important in this field as PLC will be used as medium of communication between the valves. Besides, the ability of interpreting ladder diagram is also essential in this project. This research also requires student to have a small picture of process control in order to aid them understand the background of the project. In this project, the ESD Masoneilan valves is tested conform to the standard specified by PETRONAS. Two different valves are used which is Ball and Butterfly valve. These valves are tested and performance of each valve is analyzed. In testing, the valve movement is being stroked to desired amount of stroke size.

The requirement that have been agreed:

- Valve Travel: Minimum by 20% and Maximum by 30%
- 5 times PST and 1 times PST and FST
- 90 days of testing or 540 strokes

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Emergency Shutdown System

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. [3]

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. These valves allow for shut-off or purposes of control.

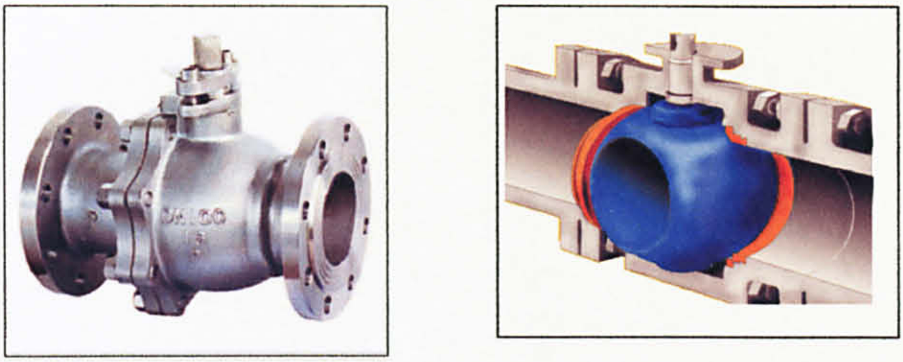

Figure 1: Ball valves

2.1.4 *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. [4]

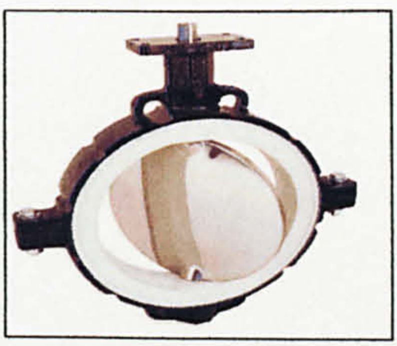

Figure 2: Butterfly valve

2.2 Masoneilan SVI II ESD Partial Stroke Test Device

Figure 3: SVI II ESD Partial Stroke Device

The SVI II ESD is the latest technology in emergency shutdown valve automation and in-service valve partial stroking. The SVI II ESD is a product extension of the successful and highly reliable SVI II AP valve positioner. The product, SIL3 compliant in accordance with IEC61508 per TUV, is suitable for use in safety instrumented functions. The designated function of 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 ideal as it is SIL3 while at 4mA, allowing the device to execute the safety function while still being active. The benefits are substantial such as capturing shutdown events as a full-proof test, allowing continuous HART® communications during a trip, providing local panel annunciation using the built-in discrete outputs, etc [5].

The SVI II ESD is a smart ESD valve device with partial stroking functionality. It includes self-diagnostics and is designed to annunciate a fault via its built-in discrete output (DO) or using the HART® protocol. The SVI II ESD device can be used with single or double acting actuators. Four possible launching methods for partial valve stroke test (PVST) are standard. For safety instrumented systems usage it is assumed that annunciation is performed via discrete output or HART® interface. The safety input can either be a 4/20mA current loop (trip when current <= 5.6mA) or a 24Vdc discrete input (trip on 0Vdc). Power to the unit is supplied by the 4/20mA current loop, except in a 2-wire discrete input configuration, in which case the power is supplied by the 24V input [5]. The SVI II ESD provides more than 70 possible alarm/warnings including:

- Valve Stuck Open / Closed
- Feedback Linkage Drift
- Pneumatic Train Integrity
- Air Supply Low / High
- Breakout Force Exceeded

The database-driven companion software, ValVue® ESD, continuously monitors the health of the ESD valves and provides a global view of the health of all ESD valves in a plant, facilitating the planning and resources to properly maintain ESD valves. The database driven ValVue ESD software provides for the SVI II ESD setup, device alarms and PST settings, partial stroke test execution and monitoring the installed base of ESD valves. The PST signatures are automatically stored in software database with the built-in PST Monitor. Additionally, the software allows for Proof Testing signatures, stroking speed calculation signatures. The diagnostic analysis is graphically plotted over time to easily identify performance degradation.

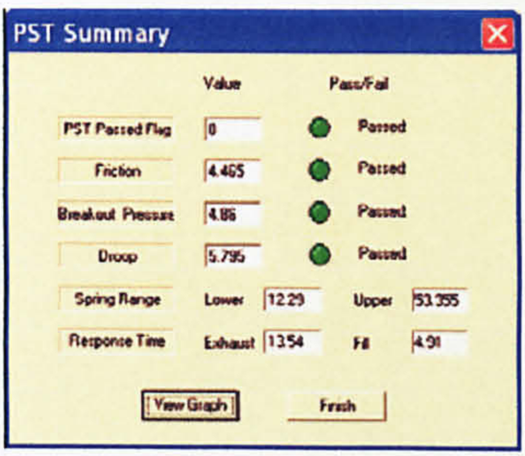

Figure 4: User friendly dashboard

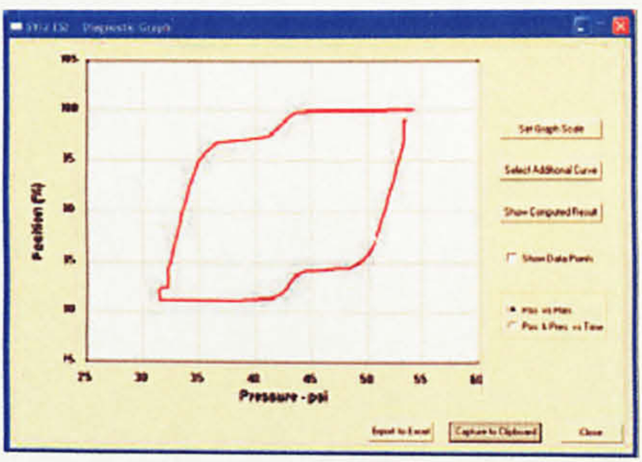

Figure 5: ESD Signature Data

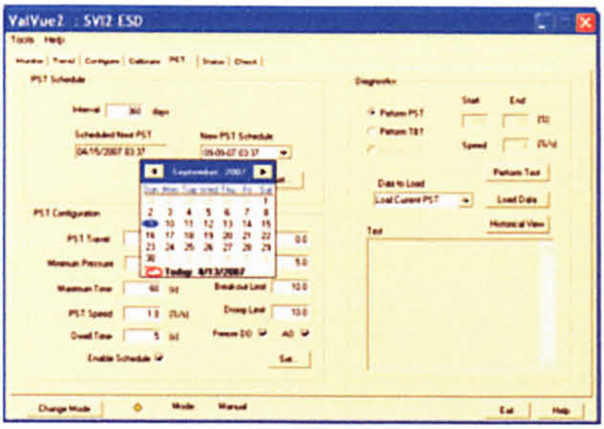

Figure 6: PST Configuration page

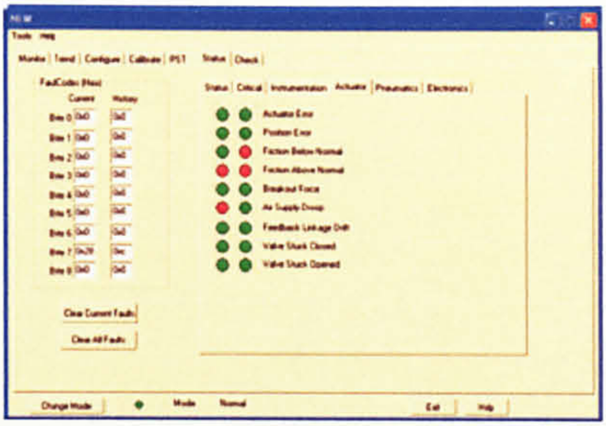

Figure 7: Valve Health Summary

2.2 Full Stroke Testing

Full Stroke Testing is practiced in industry to demonstrate the performance of Emergency Shutdown at unit turnaround. In processing plant, it contains many valves that perform safety function such as ESD. This valve has to do their function properly in critical condition because the consequences of failure will give tendency of massive disruption. Due to experiences happen on the field, if valves are not moving for a long period, there are possibility the valves would stick in one position and which is not good for operation. This problem happen might be because of corrosion and also dirt clogging around it since no movement being performed for a long time. On top of that, turnaround has been extended from two to three years to five or more years for mechanical reliability improvement and also preventive maintenance which also contributes to valve malfunction.

The best method to sustain the safety system due to performance degradation is by conducting online testing of safety related valves. It requires additional facilities and possible production impacting procedures. Apart from that, the process also gives amount of reduction of production rates because FST can only be implemented when the plant is shutdown.

2.3 Partial Stroke Testing

Partial Stroke test is a method whereby the safety valves are partially closed to certain percentage. The valve is partially closed in a while before it return to the initial position. The amount of valve stroking is considered small so that the impact on the process flow is negligible. This method is also applicable to demonstrate the performance of ESD valve without interrupting the process flow. PST basically provides a measure of confidence that valves are not stuck in one position by exercising the valve regularly. [6] The regular movement of valves can eradicate the dirt build up and reduce the tendency of valve being corroded. It is proved that, exercising the valve is important and necessary to overcome valve sticking. Unfortunately, PST also can deliver leaking problem to the valves when tested frequently. The leaking normally occurred between the valve and the house itself.

2.4 Programmable Logic Controller

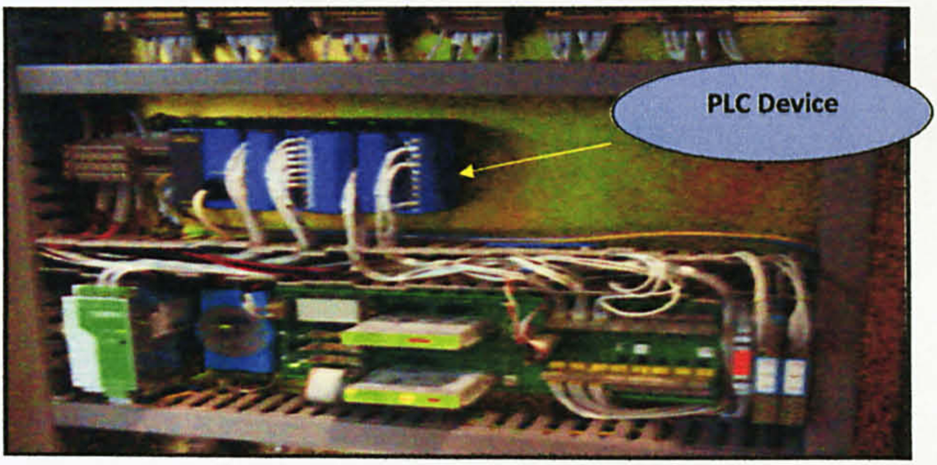

Figure 8: PLC device

PLC is an electronic system that operates using digital signal. Basically, the device was designed for use in industrial environment, which uses a programmable memory for internal storage, sequencing, counting and arithmetic to control through digital or analogue inputs/outputs. This device is immune to electrical noise and resistance to vibration and impact. For this project we are using PLC designed by Yokogawa technology. The PLC offers advantages as follow:-

- Cost effective for controlling complex system
- Computational abilities allow more sophisticated control
- Troubleshooting aids make programming easier and reduce downtime
- Reliable components make these likely to operate for years before failure

The specification of PLC used is shown in Table 5 below:

Table 1: PLC specification

Company Brand	**YOKOGAWA**
Model	F3SP08
SUFFIX	-OP
STYLE	S1
REV	15:02
SUPPLY	-
I/P	100-240 Vac
O/P	-
DATE	2007/07/04
SERIEL NO	F7G041069

2.4.1 System Hardware and Operation

A modular PLC system consists of the following major components:

- Rack
- Power supply module
- CPU (processor/memory)
- I/O modules

* Programming device

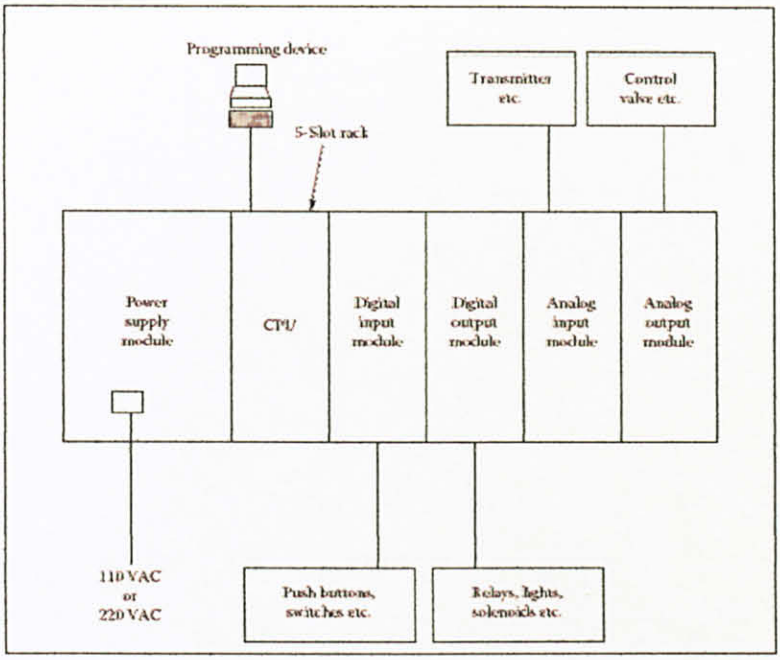

Figure 9: Modular PLC System

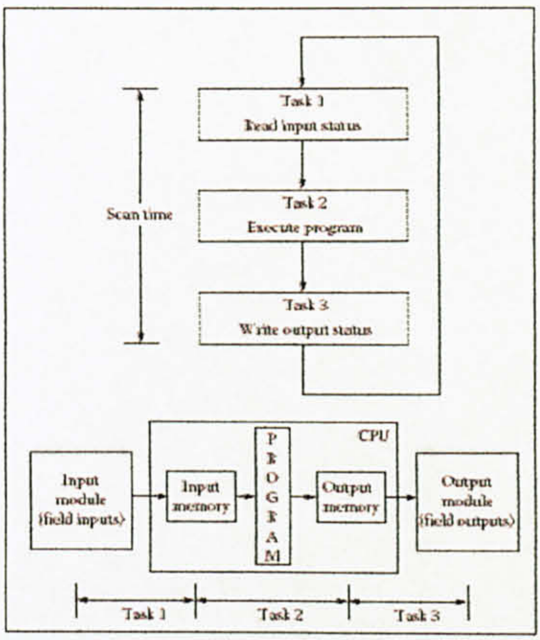

Figure 10: PLC Operation

Figure 6 shows a typical modular PLC system. A PLC is a sequential device; i.e., it performs one task after another [7]. Figure 7 shows how a conventional PLC system operates. There are three major tasks that a PLC performs, in the following order:

- Task 1: Read inputs. PLC checks status of its inputs to see if they are on or off and updates its memory with their current value.
- Task 2: Program execution. PLC executes program instructions one by one sequentially and stores the results of program execution in the memory for use later in task 3.
- Task 3: Write outputs. PLC updates status of its outputs based on the results of program execution stored in task 2.

After PLC executes task 3 it goes back to execute task 1 again. The total time taken by a PLC to perform these three tasks is called the PLC scan time. Scan time depends on CPU clock speed, user program length, and number of I/Os. Typically scan time is in milliseconds. The smaller the scan time, the faster the updates of the I/O and the program execution. [8]

As a general guide, PLC scan time should be less than half the time it takes the fastest changing input signal to change in the system. The following are the functions of a PLC:

Measure : Measure process values, both discrete and continuous

Command : Execute logic and control programs

Regulation : Control field devices

Communication: Communicate with other PLCs, remote I/Os, MMIs, and other network peripherals

The PLC that is used for this project is manufactured by Yokogawa. The FA-M3 Controller's configuration includes base module, power supply module, CPU module, I/O module and special module. The PLC is supported with WideField2 software which will be very helpful in constructing the ladder logic diagram.

CHAPTER 3

METHODOLOGY

3.1 Procedure Identification

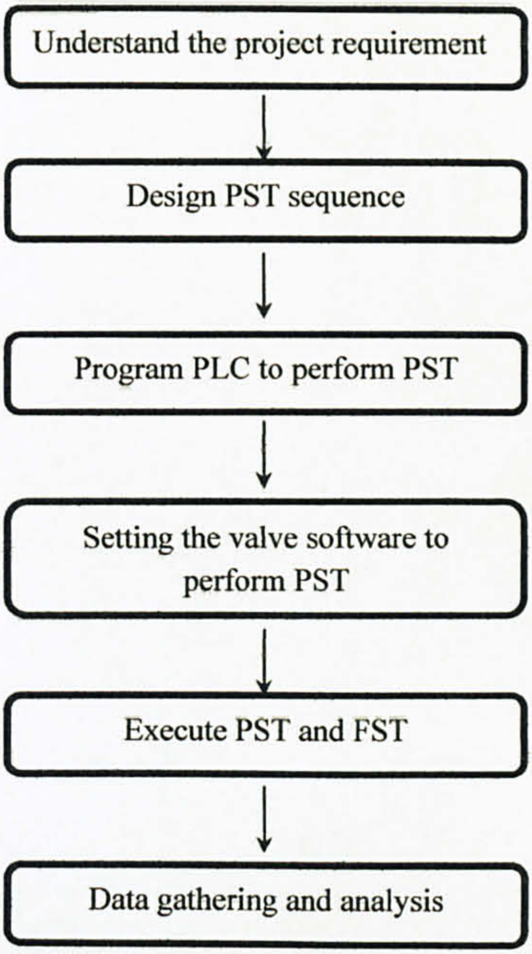

Figure 11: Flow chart of procedure Identification

The flowchart represents the steps and procedures undertaken at beginning of process till to the end of the work. The detail activities will further elaborate in proceeding chapter. The procedure of how the testing was implemented is being attached in Appendix for reference.

3.1.1 Understand the project requirement

This technical project generally collaboration between PETRONAS Group Technical Solutions (GTS) and Universiti Teknologi PETRONAS (UTP). Apart from that, this project also being involved by some of the vendors. For instance, Fisher, Metso Automation, Masoneilan and Yokogawa Electric Corporation. All the parties play their respective role for the success of the project. Each vendor supplied the ESD valve consisted of ball and butterfly valve, while Yokogawa provided the PLC for this project. The idea of this project was pointed out by PETRONAS GTS as a part of their research. For that reason, a requirement has been specified by them which the PST has to be executed 6 times a day, including 1 time PST coincides with PST. The data will be collected by running 90 days of valve stroking.

3.2.2 Development of the Partial Stroke Testing Sequences

The PST sequences is determined and presented in the form of a truth table. Since there are two types of valves (ball / butterfly valves) from three different manufacturers, the valves are numbered accordingly to create randomness in the truth table.

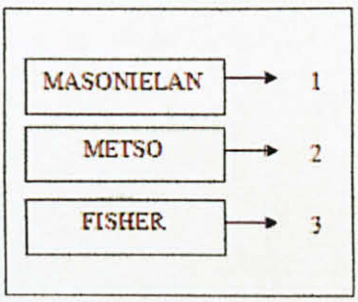

Figure 12: Numbering configuration for ball valve

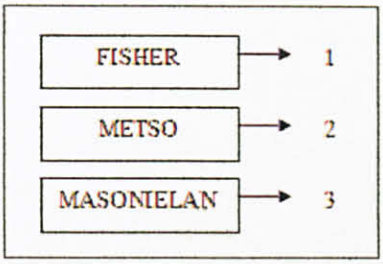

Figure 13: Numbering configuration for butterfly valve

From the numbering configuration that has been determined, the next step is to construct the truth table, as seen in Table 1.

Table 2: Truth table for valves

Ball			Butterfly		
Maso	Metso	Fisher	Fisher	Metso	Maso
0	0	1	0	0	1
0	1	0	0	1	0
0	1	1	0	1	1
1	0	0	1	0	0
1	0	1	1	0	1
1	1	0	1	1	0

The sequences are arranged according to the valve type, as seen in Table 2:-

Table 3: PST sequences developed from the truth table

F-Ball	**x**		**x**		**x**	
F-B/fly				**x**	**x**	**x**
Met-Ball		**x**	**x**			**x**
Met-B/fly		**x**	**x**			**x**
Mas-Ball				**x**	**x**	**x**
Mas-B/fly	**x**		**x**		**x**	

Table 3 shows that each valve will only do PST 3 times a day. Some modification is needed so that the each valve will execute PST 6 times daily. Thus, the modified PST sequences are as seen in Table 3:-

Table 4: PST sequences for 24 hours

Time	Day 1											
F-Ball	x		x		x			x		x		x
F-B/fly				x	x	x	x	x	x			
Met-Ball		x	x			x	x			x	x	
Met-B/fly		x	x			x	x			x	x	
Mas-Ball				x	x	x	x	x	x			
Mas-B/fly	x		x		x			x		x		x

Should be notice that the shaded area is where the PLC receives both FST and PST signals. In this situation, according to the requirement the FST will overwrite the PST.

The development of the sequences was done during the initial stage of this project. After getting a more in-depth understanding of the matter, the sequences were followed loosely thereafter. The reason was because the Partial Stroke Testing is executed by the respective vendor database-driven software, and the software can only be run one-at-a-time on the desktop PC. Hence, it was decided the sequences would be scheduled according to the manufacturer's particular valves. In retrospect, this form of scheduling is less confusing as each person assigned to the valves can perform their own testing at his/her preferred time of the day, which would not clash with other duties such as attending lectures, tutorials, and self-study.

3.2 Project work flow

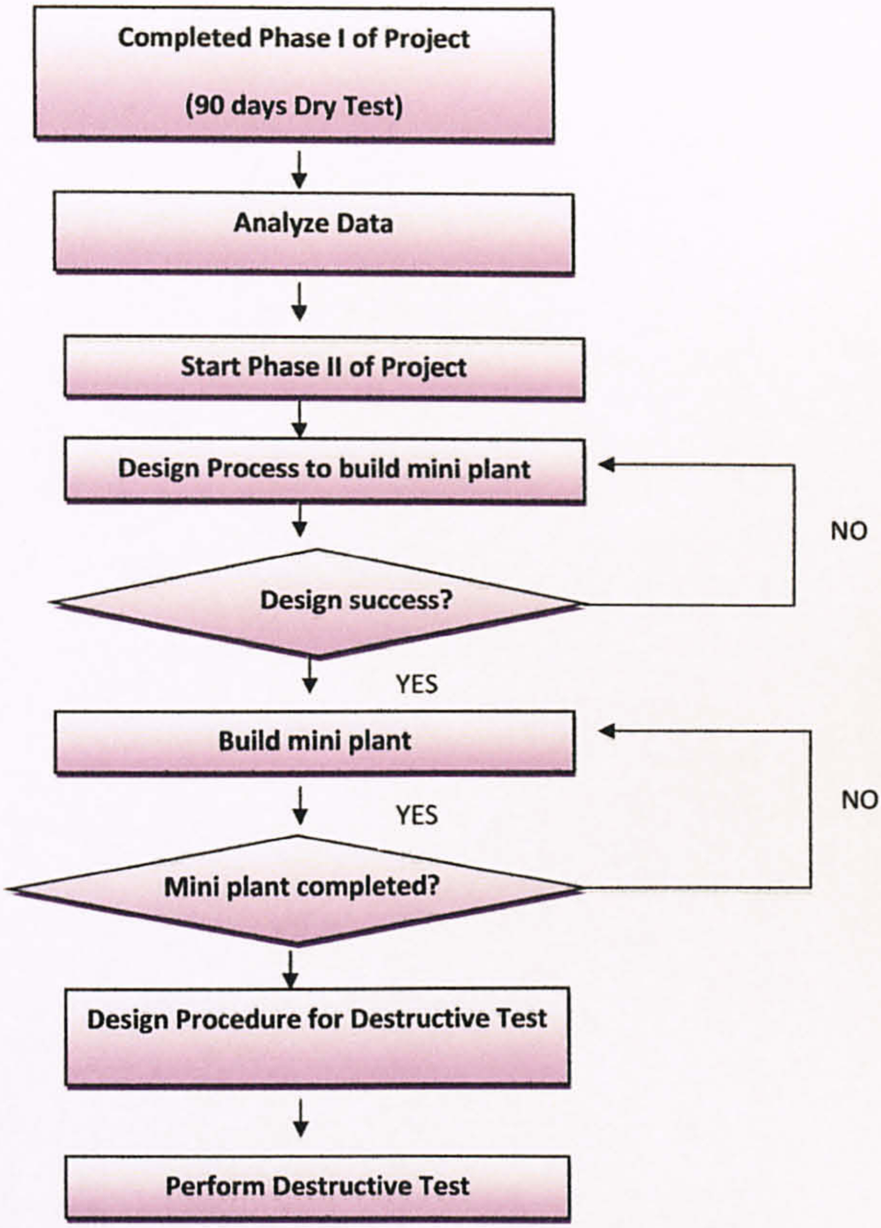

Figure 14: Project flow diagram

3.3 Hardware preparation

This project involves six valves from three 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.

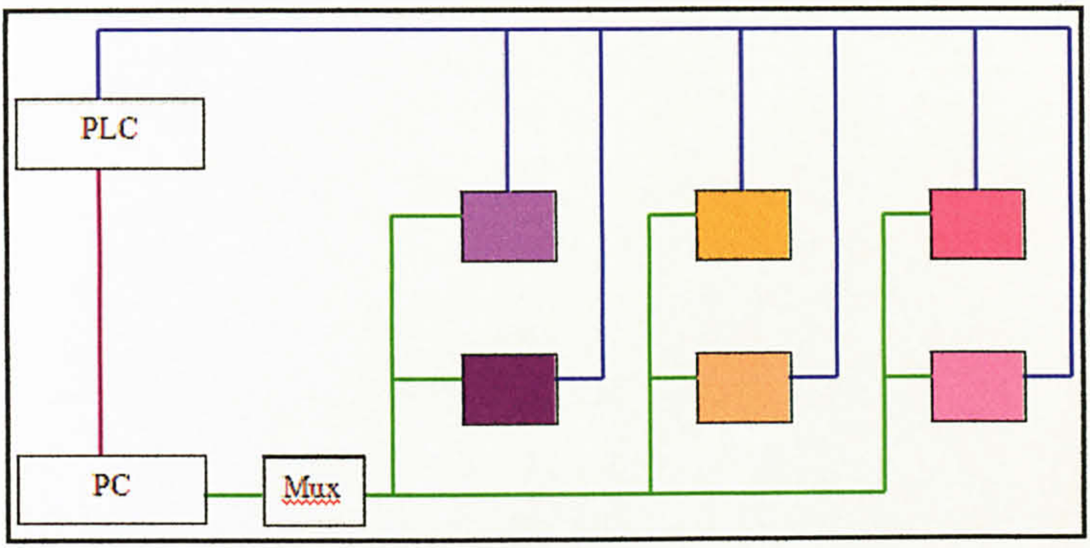

Figure 15: Hardware connection between the valve, PLC and the PC

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

Table 5: Valve size specification

Vendor	Valve		Software
	Ball	**Butterfly**	
Masoneilan	6 inch	6 inch	Valvue ESD
Fisher	6 inch	3 inch	AMS Valvelink
Metso Neles	6 inch	4 inch	Fieldcare

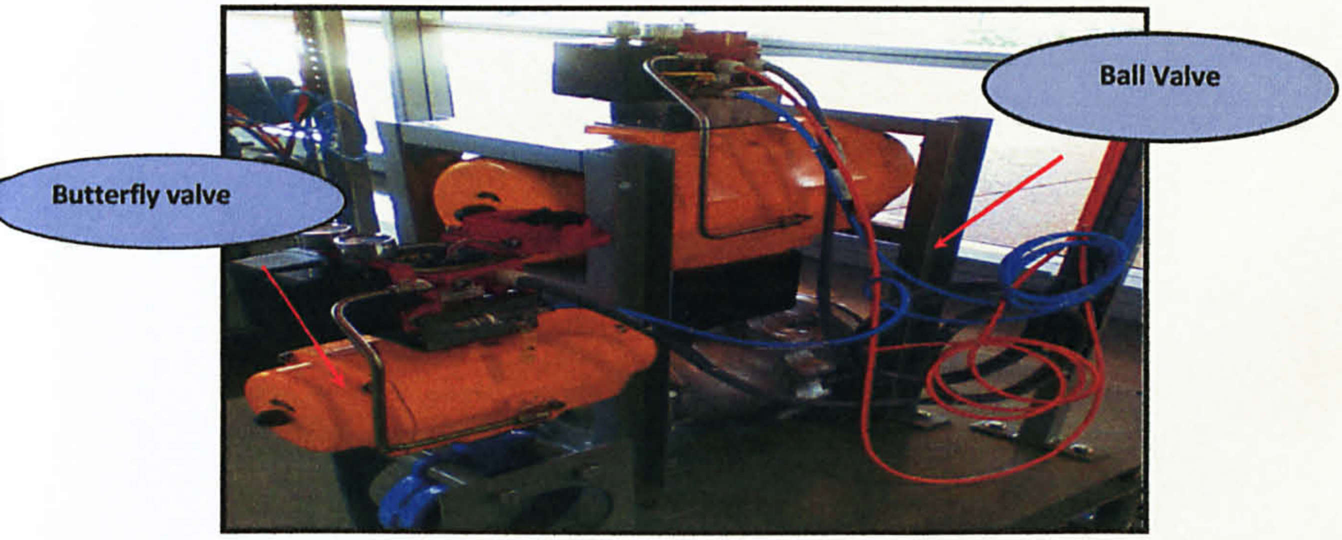

Figure 16: Masoneilan ESD valves installed in platform skid

3.4 Programmable Logic Controller Programming

There are two methods of programming language – text and graphic language. The text languages are the Instruction List and the Structured Text type. The examples of graphic languages are Sequential Function Charts, Function Block Diagrams and Ladder Logic.

Different PLC can support different languages. There are certain types of PLC that can support more than one language. These languages have their own limitation, and they complement one another to provide programmers with more programming power.

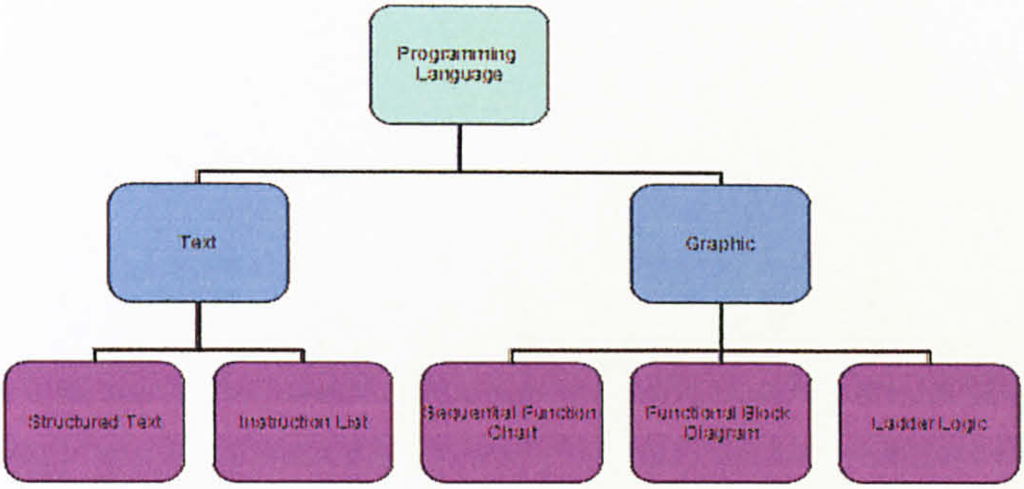

Figure 17: Type of programming languages

1. Structured Text

   High-level structured language designed for automation process. Statements can be used to assign values to the variables.

2. Instruction List

   Low-level programming language for smaller applications or for optimization parts of an application. It is much more like assembly language programming.

3. Sequential Function Chart

   Use graphic to describe sequential operations. It is very useful for describing sequential type processes.

4. Functional Block Diagram

   Use in applications involving the flow of signals between control blocks

5. Ladder Logic Diagram

   It is the most popular and widely used programming. It applies Boolean mnemonics to represent the process, before converting into logic diagram.

Throughout this project the ladder logic language will be used for programming the PLC. The WideField2 software supports ladder logic diagram language, with easy navigation and user-friendly graphical user interface.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Result

Testing is performed conform to the criteria specified by PETRONAS. The Partial Stroke Testing project required the testing to be done in 90 days or 540 strokes. The aim is to ensure the accuracy of these ESD valve in delivering their function to perform shutdown in advance. In this range of 90 days, data has been collected for further feasibility study and validation. Each valve tested in six (6) times with combination method of PST as well as FST. During the test, the time estimated for each testing is 3 minutes approximately. For Mesoneilan, the testing is completed until 90 days of testing. The criteria required by PETRONAS have been fulfilled and the data obtained will be used for analysis.

4.2 PST Performance Parameters

Prior to performing the Partial Stroke Test (PST), a number of settings need to be configured first. The configuration is done on the Masoneilan ValVue ESD software. There are nine configurations per valve, as shown below:-

Table 6: Masoneilan PST valve specified setting

Parameters	Specified value	
Type of valves	**Ball valve**	**Butterfly valve**
PST Travel (%)	20.0	20.0
MaximumPressure (psi)	10.0	5.0
Maximum Time (s)	30	75
PST Speed (%/s)	**0.5**	**0.5**
Dwell Time (s)	4	4
Friction Low Limit	0.0	0.0
Friction High Limit	5.0	28.0
Breakout limit	15.0	28.0
Droop Limit	10.0	15.0

4.2.1 PST Travel

The allowed valve movement from full open position condition measured in percentage level. A typical value is 20% and the maximum allowed is 30%. The greater the travel range, the more accurate result obtained.

4.2.2 Minimum Pressure

The minimum pressure will allow the reduction in pressure in the valve's actuator in order to achieve the desired PST travel position. These values typically would be depending on the spring range and the valve hysteresis.

4.2.3 Maximum Time

Maximum time is referred to allowable amount of time taken before the PST aborts. This value can be determined by using the equation:

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

4.2.4 PST Speed

The valve speed is defined in % Travel per second. The speed travel particularly vary depends on the setting parameter that has been setup by the user. For this PST testing, the speed is fixed 0.5% per second.

4.2.5 Dwell time

Dwell time is the amount of time in seconds between the down ramp and the up ramp of valve stroke. The time in which a developer is in contact with the surface of the part. Drain time is considered to be part of the dwell time. Sometimes, its also described as an international time delay during which an intender is held against a material under load during a hardness test. Dwell time is used to ensure the accurate hardness ratings.

4.2.6 Breakout limit

The alarm threshold for the valve breakout force (force to initiate valve movement). This alarm is set if the analyzed friction from the PST test is more than this value.

4.2.7 Droop Limit

The droop limit data is showing the alarm threshold for air supply inlet droop. This alarm is set if the analyzed Air Supply Droop from PST test is more than this value. In simple, its means the allowable amount of valve drop during PST.

4.3 PST Summary

After each Partial Stroke Testing is performed diagnostically, the summary of the completed PST is collected to be compiled and analyzed. A typical summary would consist of:-

- PST Passed Flag
- Friction
- Breakout Pressure
- Droop
- Spring Range (Lower / Upper)
- Response Time (Exhaust / Fill)

The PST summary is a sum-up of the valve's performance during diagnostic testing. The friction, breakout pressure and droop values of each testing is recorded and the values should not exceed the limit that has been set in the PST Settings. If the values do exceed the aforementioned limits, it is considered as a failed PST. A screenshot of the PST summary is shown below:-

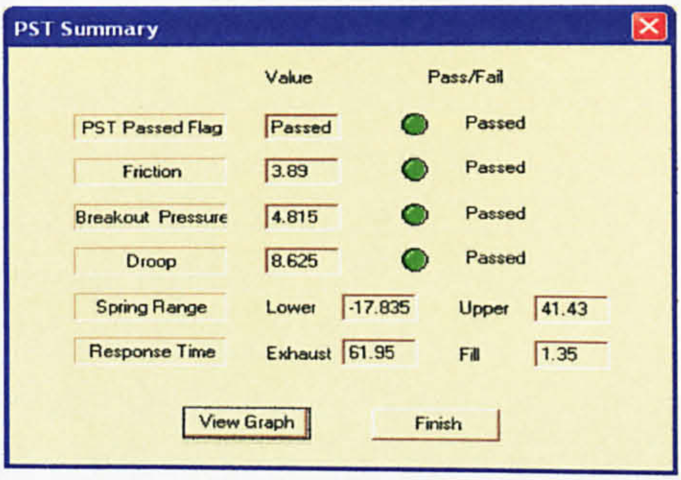

Figure 18: Screenshot of PST Summary

4.4 Valve Diagnostic

After each PST run, a diagnostic graph is displayed for further analysis. The graph will display the valve signature curve for the said PST. A typical valve signature curve for each type of valve is as follows:-

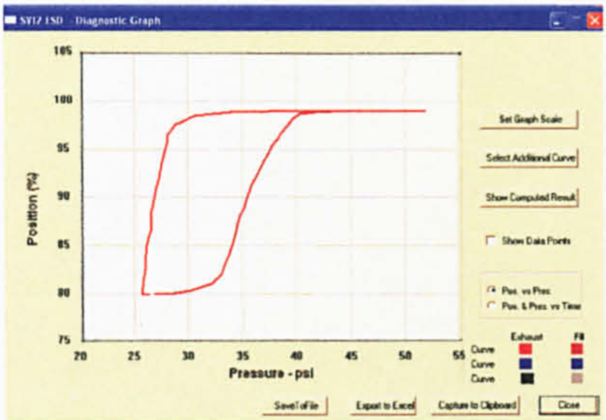

Figure 19: A typical ball valve signature curve

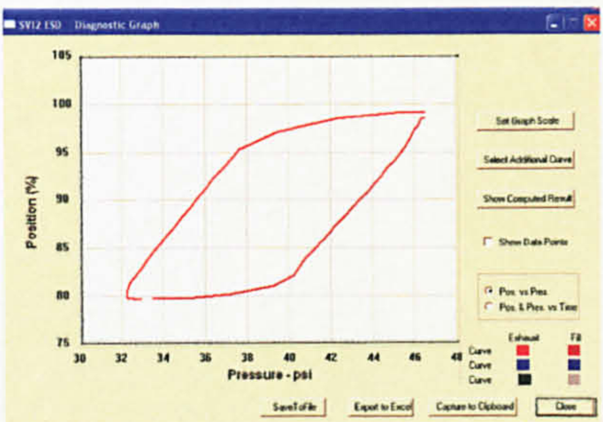

Figure 20: A typical butterfly valve signature curve

The diagnostic graph shows a Position (%) – Pressure (psi) graph depicting the movement of the valve as the PST is being performed pneumatically. During the first travel, the actuator of the valve would release the pneumatic air to close the valve at the pre-determined PST speed, decreasing the pressure inside the valve, into the position of the maximum PST travel. In the second travel, the actuator would be pumping in pneumatic air to open the valve back to its original fully-open state, while increasing the pressure inside the valve to its maximum. All Diagnostic Graph is included in the testing report page, in the Appendices.

During testing, the easiest way to detect a problem / malfunction in the valve is through the diagnostic graph. The most common problem detected during the whole period of testing is shown:-

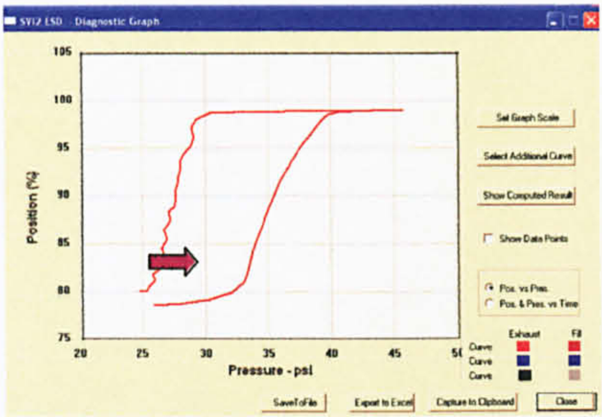

Figure 21: A ball valve signature that does not have a smooth curve

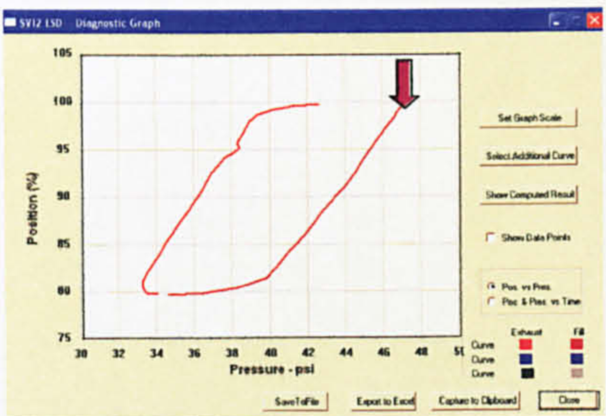

Figure 22: A butterfly valve signature with unconnected line

These problems are due to several known factors, such as there is a disturbance in the valve, the stem of the valve is sticking, and the spring action of the valve is not at the optimum. During the testing period, all diagnostic graph problems are recorded and compiled, so that the true performance of the valve can be accurately analyzed.

4.5 Data Analysis

4.5.1 Average Breakout Pressure

The breakout pressure data is the pressure supplied by the regulator to initiate the movement of the valve from its initial condition. For every single testing, the amount of pressure is varied depend on valve accuracy. The data was collected in order to find the deviation of the data from the true value that has been set at the beginning of experiment. The resulting graph for complete 90 days of testing is being presented in graph below.

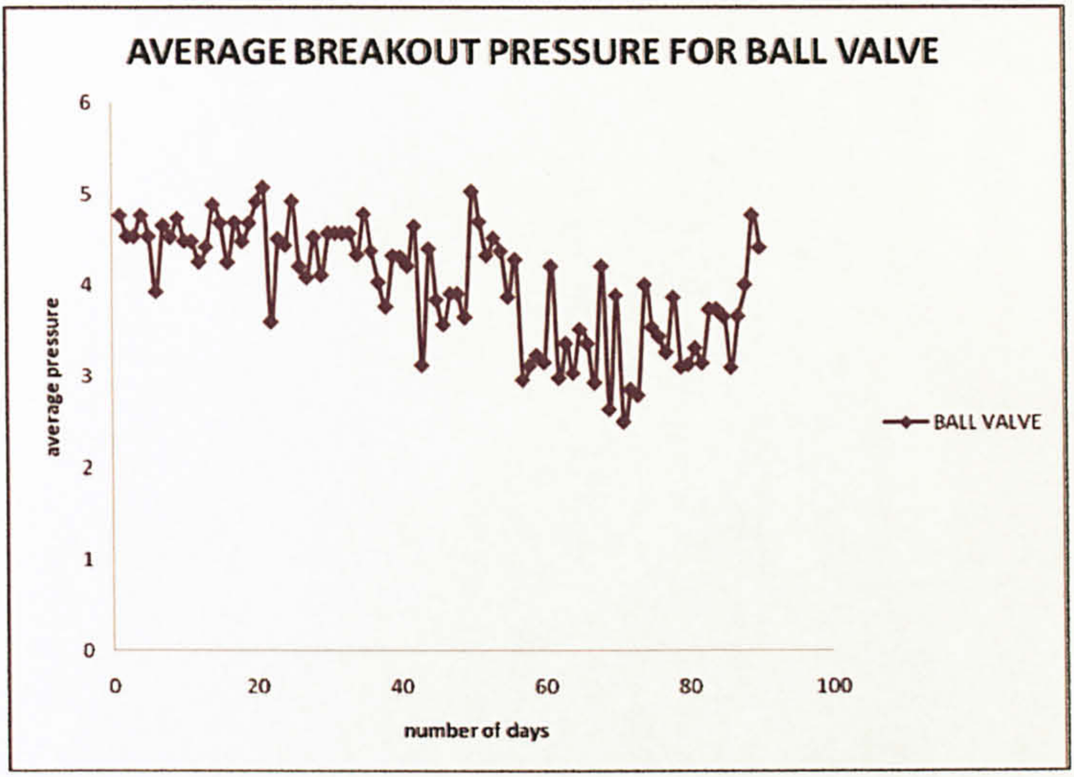

Figure 23: Average Breakout Pressure Graph (Ball valve)

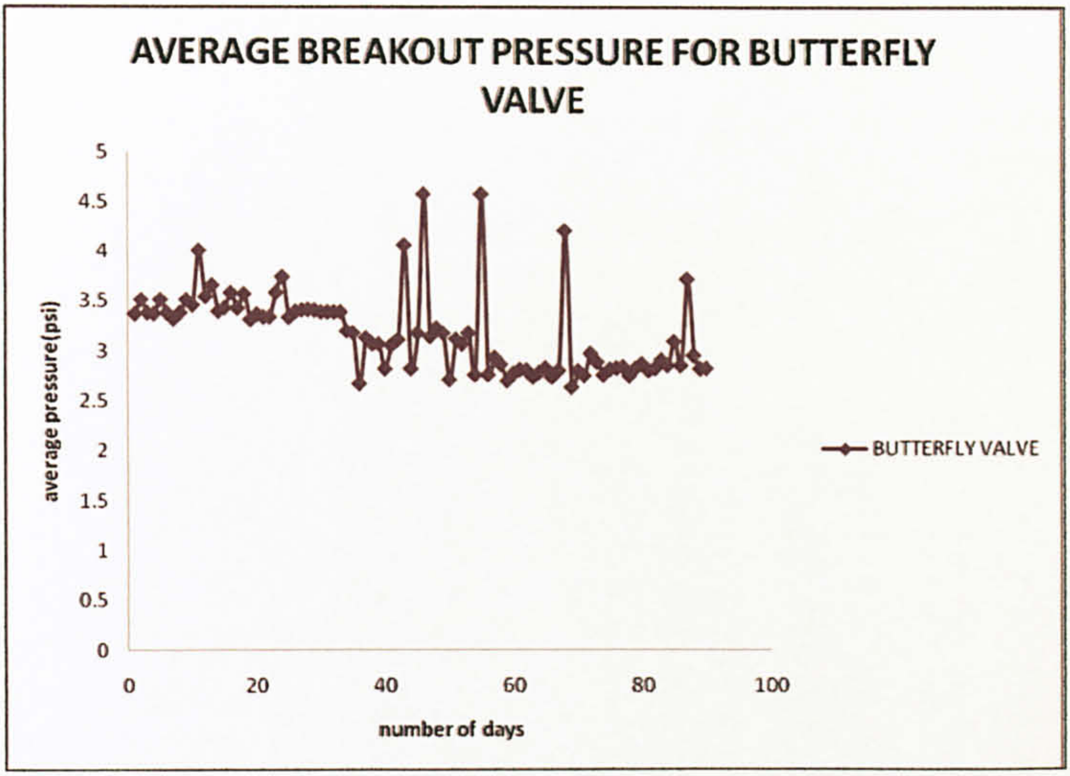

Figure 24: Average Breakout Pressure (Butterfly valve)

Table 7: Average data of breakout pressure (psi)

VALVE/DAY	BALL	BUTTERFLY	VALVE/DAY	BALL	BUTTERFLY
DAY 1	4.765	3.372	DAY 46	3.57	4.571
DAY 2	4.535	3.513	DAY 47	3.908	3.142
DAY 3	4.535	3.382	DAY 48	3.909	3.229
DAY 4	4.765	3.372	DAY 49	3.65	3.181
DAY 5	4.535	3.513	DAY 50	5.025	2.715
DAY 6	3.931	3.382	DAY 51	4.693	3.12
DAY 7	4.651	3.319	DAY 52	4.325	3.069
DAY 8	4.525	3.382	DAY 53	4.515	3.183
DAY 9	4.731	3.512	DAY 54	4.372	2.764
DAY 10	4.484	3.458	DAY 55	3.871	4.571
DAY 11	4.479	4.004	DAY 56	4.278	2.766
DAY 12	4.252	3.542	DAY 57	2.961	2.936
DAY 13	4.417	3.658	DAY 58	3.12	2.869
DAY 14	4.879	3.396	DAY 59	3.233	2.703
DAY 15	4.679	3.43	DAY 60	3.158	2.778
DAY 16	4.247	3.583	DAY 61	4.206	2.818
DAY 17	4.683	3.428	DAY 62	2.983	2.814

DAY 18	4.477	3.571	DAY 63	3.362	2.742
DAY 19	4.676	3.314	DAY 64	3.039	2.789
DAY 20	4.912	3.367	DAY 65	3.518	2.835
DAY 21	5.065	3.34	DAY 66	3.362	2.742
DAY 22	3.6	3.34	DAY 67	2.932	2.811
DAY 23	4.506	3.585	DAY 68	4.206	4.206
DAY 24	4.436	3.741	DAY 69	2.641	2.641
DAY 25	4.918	3.336	DAY 70	3.892	2.806
DAY 26	4.204	3.393	DAY 71	2.505	2.759
DAY 27	4.083	3.409	DAY 72	2.856	2.978
DAY 28	4.525	3.414	DAY 73	2.795	2.893
DAY 29	4.109	3.408	DAY 74	4.006	2.765
DAY 30	4.567	3.389	DAY 75	3.541	2.821
DAY 31	4.567	3.389	DAY 76	3.439	2.834
DAY 32	4.567	3.389	DAY 77	3.266	2.846
DAY 33	4.567	3.389	DAY 78	3.866	2.755
DAY 34	4.33	3.2	DAY 79	3.107	2.829
DAY 35	4.778	3.183	DAY 80	3.131	2.874
DAY 36	4.372	2.673	DAY 81	3.311	2.808
DAY 37	4.032	3.132	DAY 82	3.148	2.829
DAY 38	3.763	3.069	DAY 83	3.732	2.915
DAY 39	4.319	3.07	DAY 84	3.734	2.859
DAY 40	4.306	2.824	DAY 85	3.653	3.098
DAY 41	4.209	3.056	DAY 86	3.097	2.86
DAY 42	4.642	3.112	DAY 87	3.657	3.72
DAY 43	3.127	4.06	DAY 88	4.004	2.957
DAY 44	4.397	2.827	DAY 89	4.765	2.827
DAY 45	3.839	3.181	DAY 90	4.408	2.831

From the graph, it shows the breakout pressure of Ball valve us higher compared to pressure supplied to Butterfly valve. This is because the measurement of physical features in Ball valve is bigger rather than Butterfly valve. However, some error occurred during the testing which data drifted from initial value. It was assumed that there were mechanical errors happened inside the device that tends to give error value. The error relatively small and rarely exist can be negligible since it does not disturb the process. Therefore, the best way to resolve this situation is by recalibrates the device time to time. This would maintain the device accuracy in delivering function. For this breakout pressure data, the ranges of pressure being supplied by these valves are between 2.5psi-

5.0psi. Both of valves consumed different volume of pressure between each other. The butterfly valve used smaller amount of pressure compared to the Ball valve.

4.5.2 Average Droop Data

The droop data is representing 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. [9]

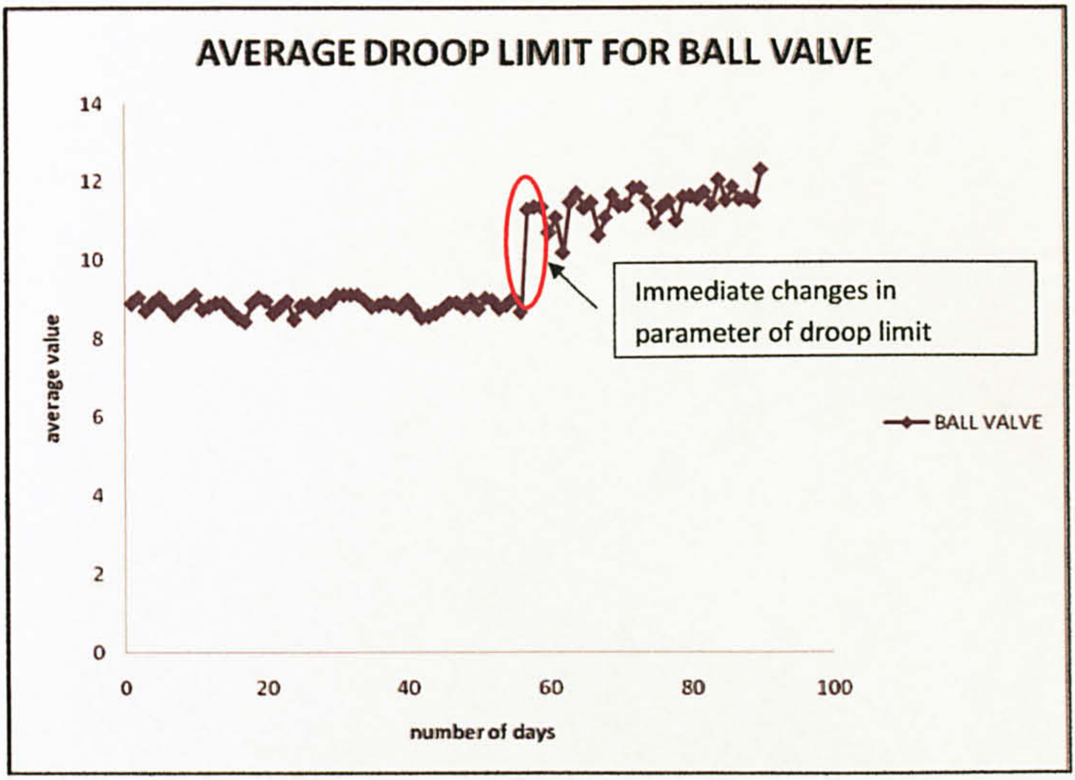

Figure 25: Average Droop Limit Graph (Ball Valve)

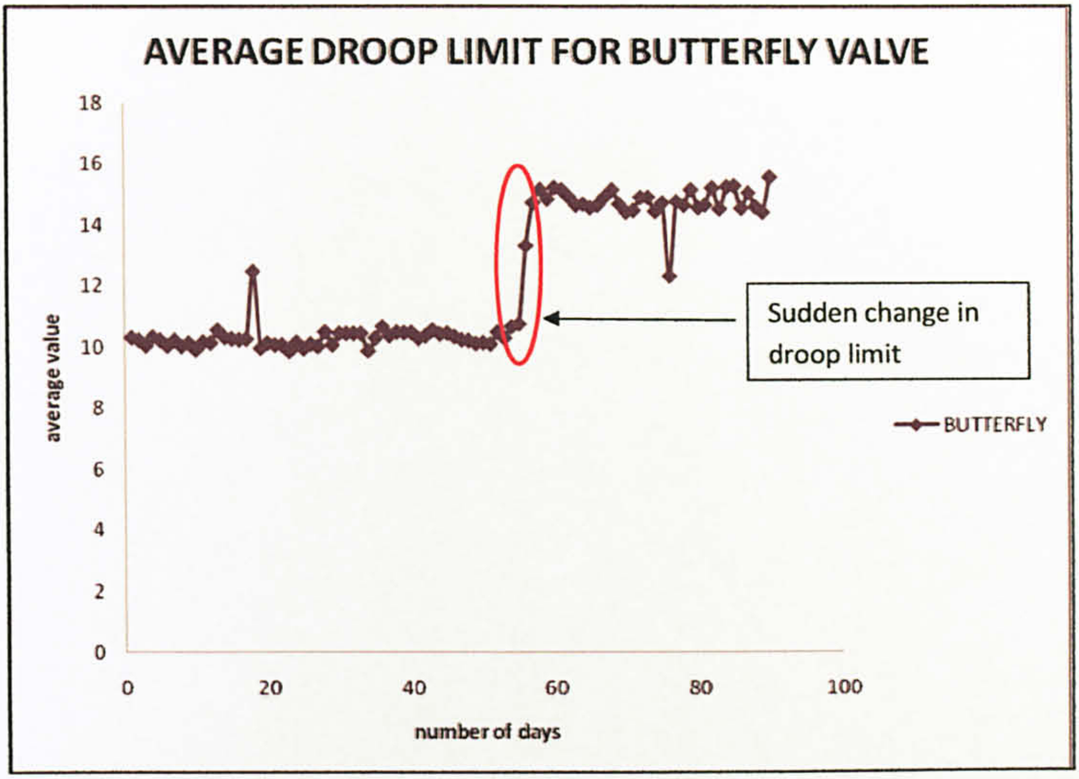

Figure 26: Average Droop Graph (Butterfly valve)

Table 8: Tabulated Average Droop Limit

VALVE /DAY	BALL	BUTTERFLY	VALVE/DAY	BALL	BUTTERFLY
DAY 1	8.885	10.32	DAY 46	8.899	10.34
DAY 2	9.043	10.24	DAY 47	8.909	10.24
DAY 3	8.699	10.05	DAY 48	8.783	10.22
DAY 4	8.885	10.34	DAY 49	8.98	10.12
DAY 5	9.043	10.24	DAY 50	8.733	10.15
DAY 6	8.812	10.05	DAY 51	9.02	10.1
DAY 7	8.612	10.23	DAY 52	8.964	10.49
DAY 8	8.804	10.03	DAY 53	8.752	10.3
DAY 9	8.923	10.14	DAY 54	8.837	10.67
DAY 10	9.104	9.91	DAY 55	9.021	10.76
DAY 11	8.727	10.17	DAY 56	8.662	13.31
DAY 12	8.801	10.15	DAY 57	11.28	14.71
DAY 13	8.891	10.56	DAY 58	11.35	15.15

DAY 14	8.884	10.32	DAY 59	11.35	14.83
DAY 15	8.688	10.28	DAY 60	10.69	15.21
DAY 16	8.534	10.25	DAY 61	11.08	15.14
DAY 17	8.427	10.27	DAY 62	10.18	14.9
DAY 18	8.877	12.48	DAY 63	11.46	14.63
DAY 19	9.041	9.971	DAY 64	11.69	14.67
DAY 20	8.946	10.14	DAY 65	11.32	14.55
DAY 21	8.632	10.08	DAY 66	11.46	14.63
DAY 22	8.789	10.08	DAY 67	10.62	14.9
DAY 23	8.95	9.857	DAY 68	11.08	15.14
DAY 24	8.482	10.17	DAY 69	11.64	14.67
DAY 25	8.821	9.943	DAY 70	11.37	14.4
DAY 26	8.878	10.11	DAY 71	11.39	14.46
DAY 27	8.687	10.03	DAY 72	11.82	14.89
DAY 28	8.877	10.5	DAY 73	11.82	14.89
DAY 29	8.894	10.08	DAY 74	11.49	14.43
DAY 30	9.103	10.45	DAY 75	10.92	14.71
DAY 31	9.103	10.45	DAY 76	11.33	12.32
DAY 32	9.103	10.45	DAY 77	11.48	14.75
DAY 33	9.103	10.45	DAY 78	10.97	14.63
DAY 34	8.964	9.881	DAY 79	11.58	15.14
DAY 35	8.8	10.3	DAY 80	11.61	14.55
DAY 36	8.837	10.67	DAY 81	11.54	14.64
DAY 37	8.919	10.37	DAY 82	11.71	15.2
DAY 38	8.839	10.49	DAY 83	11.39	14.51
DAY 39	8.777	10.47	DAY 84	12.02	15.24
DAY 40	8.978	10.48	DAY 85	11.49	15.27
DAY 41	8.763	10.28	DAY 86	11.84	14.53
DAY 42	8.532	10.36	DAY 87	11.52	15.04
DAY 43	8.564	10.56	DAY 88	11.57	14.58
DAY 44	8.638	10.43	DAY 89	11.47	14.4
DAY 45	8.741	10.46	DAY 90	12.28	15.55

The graph 25&26 shows the average droop for Ball and Butterfly valve. It revealed that the average droop for Butterfly valve is higher than Ball valve. The droop limit for Ball valve is set at 10psi while the droop limit for Butterfly valve is 15 psi. However, Ball valve droop is always exceeded the specified limit. The data is slightly higher than the limit of 10psi that has been specified by PETRONAS. Most of the time, the indicator will declare the droop for Ball valve is in failure mode. The failure of the droop is not affecting the PST testing since the testing is still running without any problem. Meanwhile, there is no problem related to Butterfly valve. The valve has achieved the standard needed since the output result shows the droop limit is under the limit set.

Meanwhile, based on the result obtained, it shows the valve having some problem because produced a sudden change value in parameter of average droop limit. The effect is being marked in the graph. As of now, there is no solid conclusion being made regard to the matters. Concern to the matters, a complaint has been raised to the vendor for further study to find the real causes that contribute to the deviation of data.

4.5.3 Average Friction

The graph below shows the average of friction calculated in 90 days of testing. The value of friction of Ball and Butterfly valve are significantly different because of different surface being contacted between these valves. In this case, Ball valve has the bigger area of contact that led to produce higher amount friction compared to Butterfly valve.

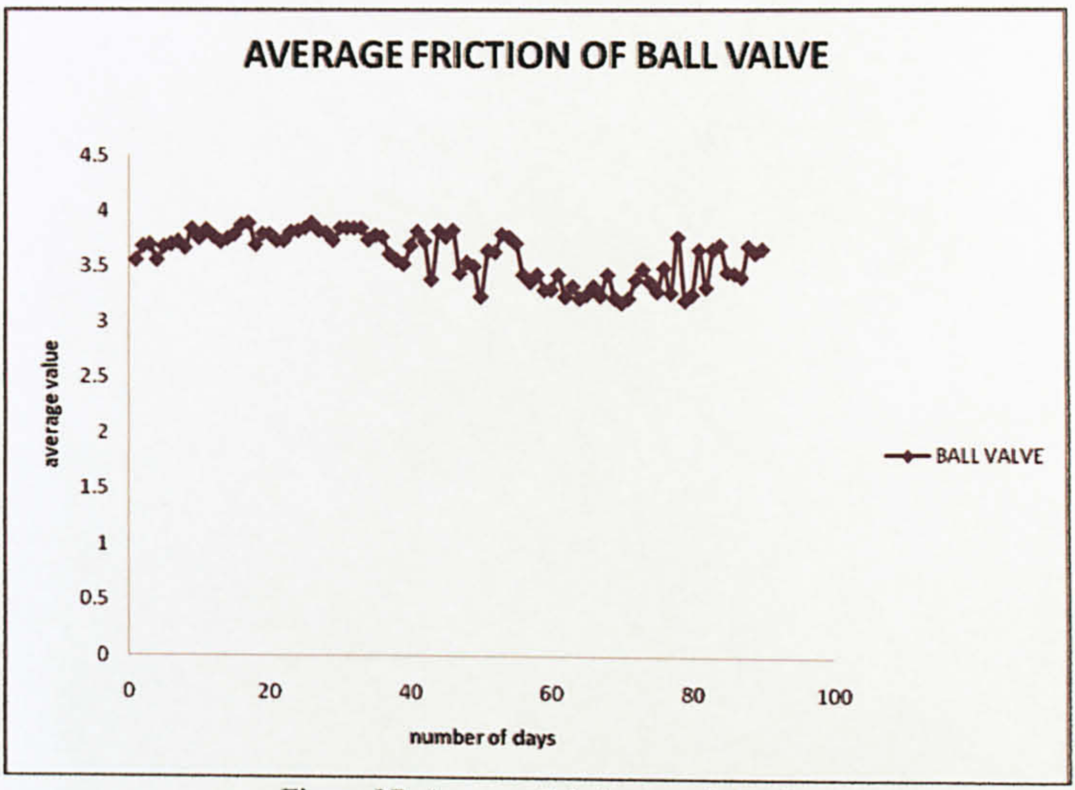

Figure 27: Average Friction graph (Ball valve)

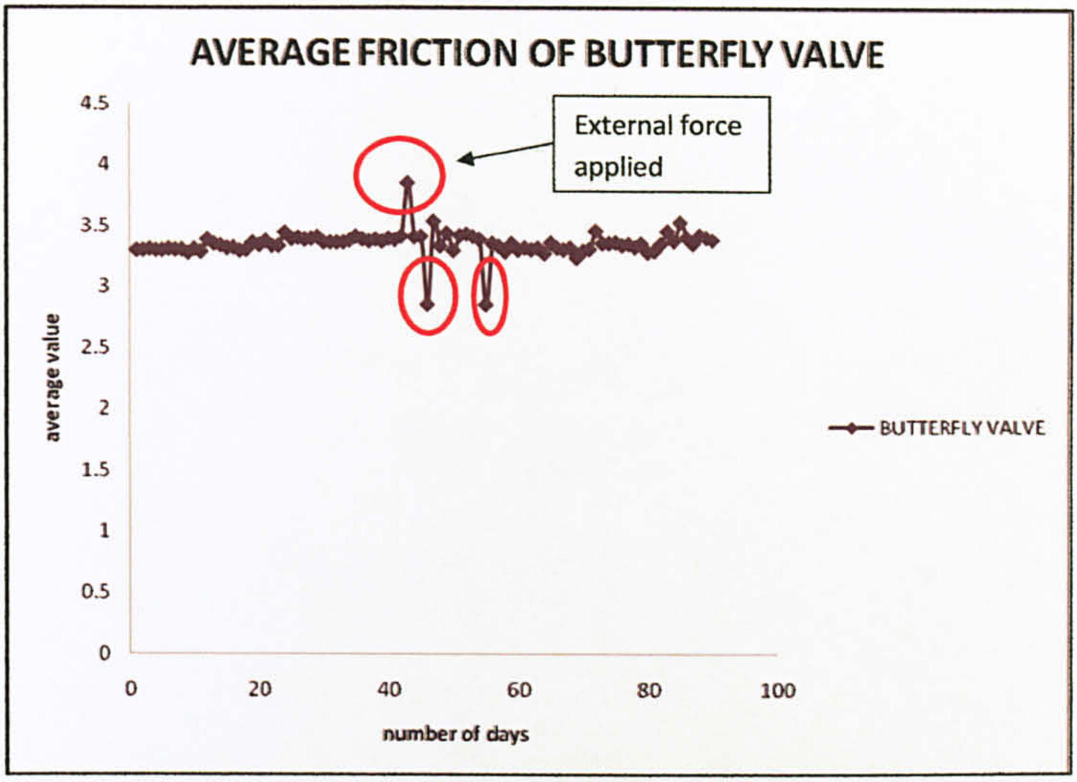

Figure 28: Average Friction graph (Butterfly valve)

Table 9: Average value of device friction

VALVE	BALL	BUTTERFLY	VALVE	BALL	BUTTERFLY
DAY 1	3.563	3.301	DAY 46	3.831	2.855
DAY 2	3.688	3.302	DAY 47	3.441	3.541
DAY 3	3.703	3.312	DAY 48	3.541	3.337
DAY 4	3.563	3.301	DAY 49	3.504	3.443
DAY 5	3.683	3.302	DAY 50	3.23	3.299
DAY 6	3.703	3.312	DAY 51	3.645	3.422
DAY 7	3.729	3.305	DAY 52	3.633	3.436
DAY 8	3.672	3.307	DAY 53	3.793	3.415
DAY 9	3.845	3.277	DAY 54	3.769	3.393
DAY 10	3.758	3.311	DAY 55	3.71	2.855
DAY 11	3.837	3.288	DAY 56	3.428	3.359
DAY 12	3.776	3.389	DAY 57	3.361	3.334
DAY 13	3.724	3.354	DAY 58	3.431	3.289
DAY 14	3.754	3.34	DAY 59	3.288	3.358
DAY 15	3.791	3.318	DAY 60	3.293	3.305
DAY 16	3.88	3.323	DAY 61	3.431	3.323
DAY 17	3.898	3.297	DAY 62	3.23	3.307
DAY 18	3.699	3.304	DAY 63	3.322	3.322

DAY 19	3.798	3.364	DAY 64	3.215	3.276
DAY 20	3.797	3.343	DAY 65	3.248	3.365
DAY 21	3.736	3.377	DAY 66	3.322	3.322
DAY 22	3.736	3.337	DAY 67	3.239	3.307
DAY 23	3.817	3.337	DAY 68	3.431	3.323
DAY 24	3.825	3.448	DAY 69	3.218	3.241
DAY 25	3.85	3.395	DAY 70	3.171	3.297
DAY 26	3.897	3.405	DAY 71	3.214	3.312
DAY 27	3.828	3.389	DAY 72	3.381	3.465
DAY 28	3.81	3.397	DAY 73	3.479	3.36
DAY 29	3.737	3.413	DAY 74	3.36	3.362
DAY 30	3.851	3.366	DAY 75	3.275	3.369
DAY 31	3.851	3.366	DAY 76	3.491	3.344
DAY 32	3.851	3.366	DAY 77	3.263	3.355
DAY 33	3.851	3.366	DAY 78	3.764	3.328
DAY 34	3.743	3.381	DAY 79	3.195	3.359
DAY 35	3.786	3.415	DAY 80	3.248	3.286
DAY 36	3.769	3.393	DAY 81	3.652	3.296
DAY 37	3.613	3.376	DAY 82	3.311	3.355
DAY 38	3.562	3.391	DAY 83	3.654	3.462
DAY 39	3.525	3.374	DAY 84	3.692	3.379
DAY 40	3.689	3.399	DAY 85	3.45	3.535
DAY 41	3.82	3.387	DAY 86	3.438	3.41
DAY 42	3.731	3.415	DAY 87	3.404	3.357
DAY 43	3.382	3.857	DAY 88	3.68	3.428
DAY 44	3.826	3.409	DAY 89	3.622	3.409
DAY 45	3.771	3.414	DAY 90	3.658	3.387

The butterfly valve just move using actuator attached to the valve and its consume little area of contact that related to friction. The advantage of getting friction data is to monitor the smoothness of valve movement during operation. It will indicate the speed the valve while of executing PST and FST in presence of friction.

From the data for butterfly valve,it shows there are some data are deviated from the parameters that has been set. This is happen because of intentional disturbance applied to the valve leave to study the effect of sudden external force to the valve performance. The effect has been highlighted in the graph and the result shows a high fluctuation in the data occured at the moment sudden intentional disturbance being applied. Practically, the sudden disturbance will raise up the average friction to the device.

4.5.4 Analysis of Valve Diagnostic

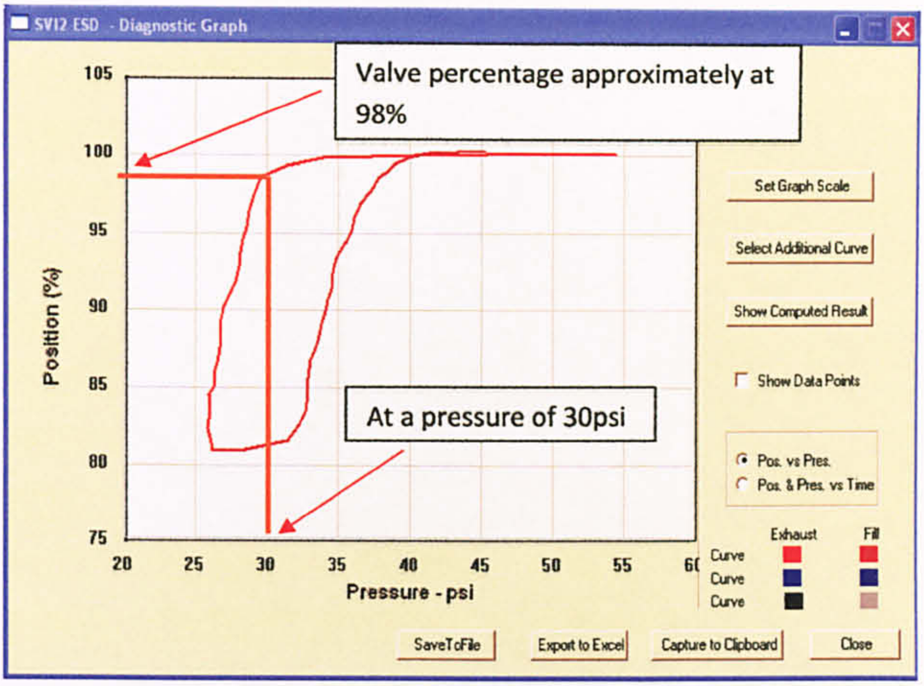

Figure 29: Graph of valve signature

For the analysis of valve signature, a percentage of valve position is measured at fixed point of 30psi. By doing the analysis, a trend of the valve movement will be revealed. The pattern of valve movement will shows how the valve signature varies during the 90 days of testing. From the graph obtained, the valve position is vary although the same pressure pressure applied to the valve.

Table 10: Percentage of valve position measured at 30 psi

Day	Position percentage at 30psi (%)
1	95
10	97
20	97
30	98
40	97
50	96
60	98
70	98
80	96
90	98

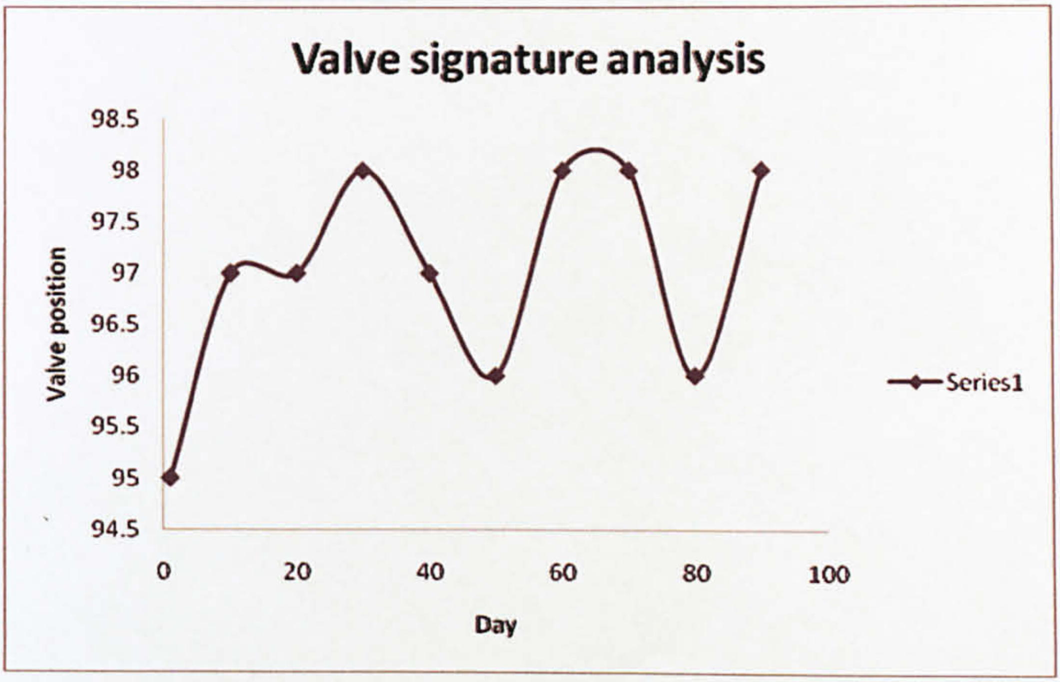

Figure 30: Valve diagnostic signature

4.6 PST and FST Failures Data

The data presented in Table 10 shows the overall PST and FST failures in a range of 90 days of testing. During entire process of valve testing, there are 4(four) days recorded to give interuption to the PST process. However, overall testing were completely tested and data has been tabulated. This failures happened not because of severe problems but sometimes its was related to the device communication itself. Troubleshooting was done to overcome those entire problem. The common problems occured might because of:

- The disturbance in the valve
- The stem of the valve is sticking led to limitation of movement
- The spring action is not in at the optimum to move the valve.
- Lack of signal communication between the output devices and engineering workstation

The solutions to these problems are to manually tighten the valve stem so that the pneumatic pressure would not be lost into the air, to regularly perform check-up on the valve before beginning testing, and to correspond with the vendor's representative to perform after-sales servicing and maintenance.

Table 11: Statistic of valve failures

VALVE	BALL VALVE						BUTTERFLY VALVE					
TEST	PST 1	PST 2	PST 3	PST 5	PST 5	PST+FST	PST 1	PST 2	PST 3	PST 4	PST 5	PST+FST
DAY 24												
DAY 42												
DAY 50												
DAY 70												

4.7 Work Progress in Phase II (Destructive Test)

As Phase 1 completed, this project need to face new method of testing in Phase 2 for futher verification. In previous phase, the main concern is to monitor valve performance using dry test without any distrurbance applied to the valves . Since all the data was succesfully collected and being analyzed, it assumed the Phase 1 completed and the requirement by PETRONAS is being fullfilled. Therefore some planing has been discussed covering the future work on Phase II. With some guidance from lecturer and personnel from GTS, several design being proposed and will further explained in detail below.

4.7.1 First Design

This is the first design proposed by PETRONAS for mini plant constrcution. Therefore, some discussion has been done among the team members to deepen our understanding regard to this design. In the figure,it shows 8(eight) different valves are placed in one loop with the existence of one bypass line.

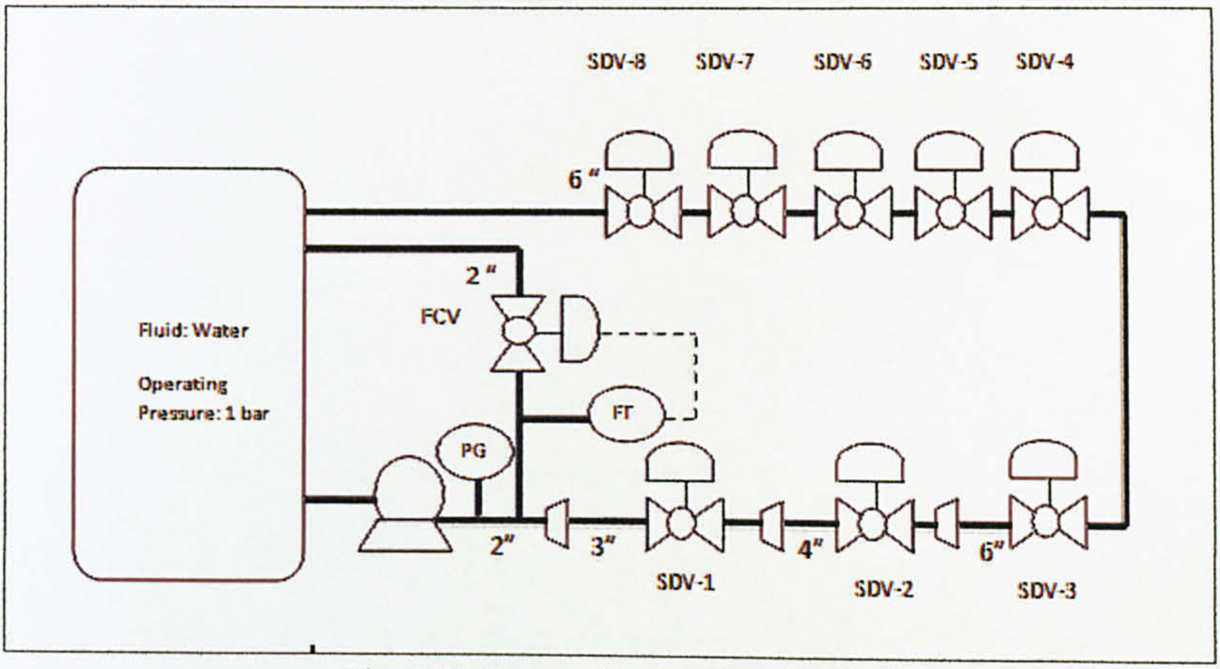

Figure 31: Proposed design for mini plant

Apart from that, there is also a pump installed in starting point of impulse line. The valve function is to channel out the water through impulse line before the water being circulated into closed tank after completing one cycle of circultion. Since, the different size of valves are used in the design, several reducers are needed to customize the impulse line for ease of installation. In term of arrangement, the valves are placed sequently from small size into the bigger size. Therefore, sufficient pressure from the beginning in the impulse line can be sustained until it reach the last point of piping. This design basically wants to allow the fluid passing through to the all valves. Some factors that have been highlight and have been taken care for the better design are:

a. Bypass line for all valves because if one of the valves is cannot be operated, the PST can still be continued.
b. The position of the valves whether to have an increasing diameter pipeline size or decreasing diameter pipeline size because it will affect the process operating pressure.
c. Piping material that has been chosen is PVC. The problem is can PVC pipe withstand the operating pressure which is 1 bar.
d. Pump rating and type of pump.
e. The different size of valves used in this project. Thus reducers need to be used. Thus how much pressure drop for each reducer should be taken care.

4.7.2 List of valves involved

The list of valve involved in this project are shown in Table 11 below..The valve comes with different sizing. As a result, the existence of reducer is needed in order to connect the valve respectively. As mention before, the new additional valve will be used for the new phase which is Rotork. The valve still in process of purchasing and will be received and installed shortly.

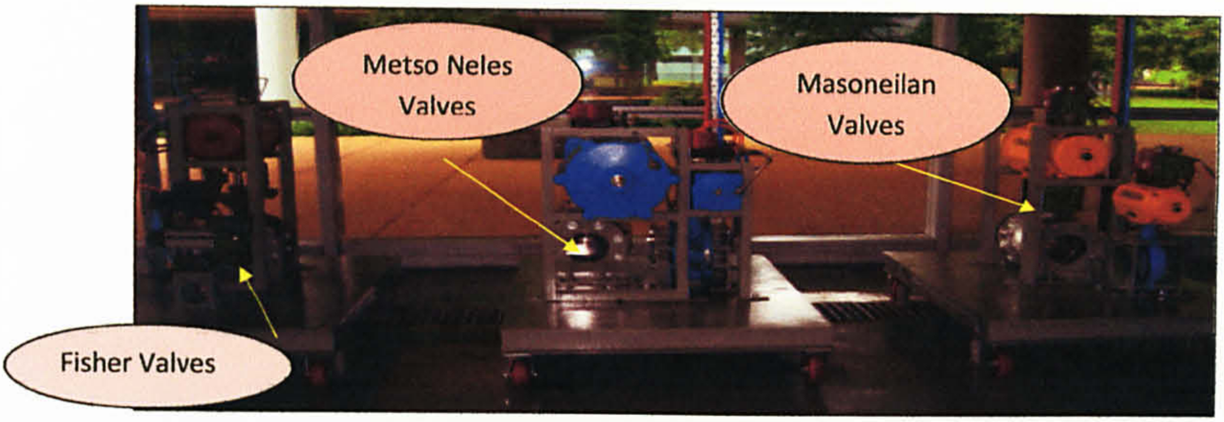

Figure 32: ESD valves in respective platfrom skid.

Table 12: List of valves with different sizing

Brand	Ball valve	Butterfly valve
Masoneilan	**6 inch**	**6 inch**
Metso Neles	**6 inch**	**4 inch**
Fisher	**6inch**	**3 inch**
Rotork	**6 inch**	**6 inch**

4.7.3 Second Draft of Mini Plant.

This design is created as an improvement version of the first design. There are some weaknesses in first design that require the team to do some modification prior to concern of safety. It was proved that, there will be a pressure drop between the valves at the moment water is pumping around the pipeline. The more the valves in the pipeline in one single loop led to give constraint to the flow of water. In fact, pressure drop would happen since the volumetric flow rate inside the impulse line is decreasing when the water reaches the final point of the loop. Due to that, this extended version created in other to cater the problem.

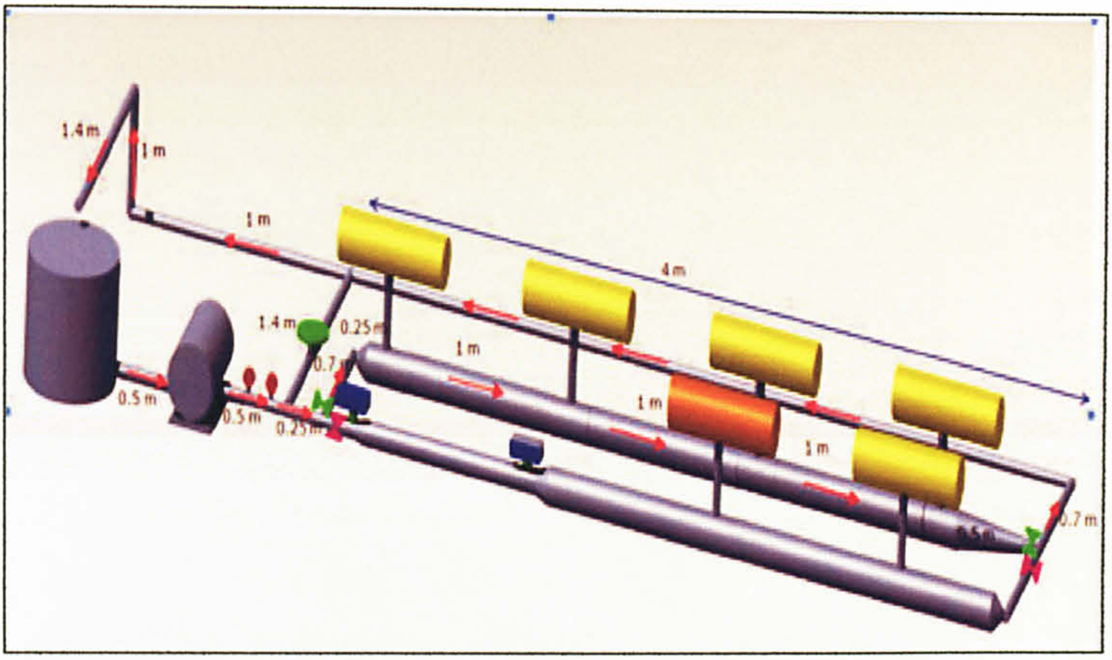

Figure 33: 3-D representation for improved design.

In this design, it was agreed that only four valves will be operate at one time when conducting the testing. There will be two separate loops in this extended design which only four valves are allowed in each loop. Therefore, two hand valves will be installed in each loop for isolation process and will be placed at the beginning and ending point of the loop.

4.7.4 Final Draft of mini plant

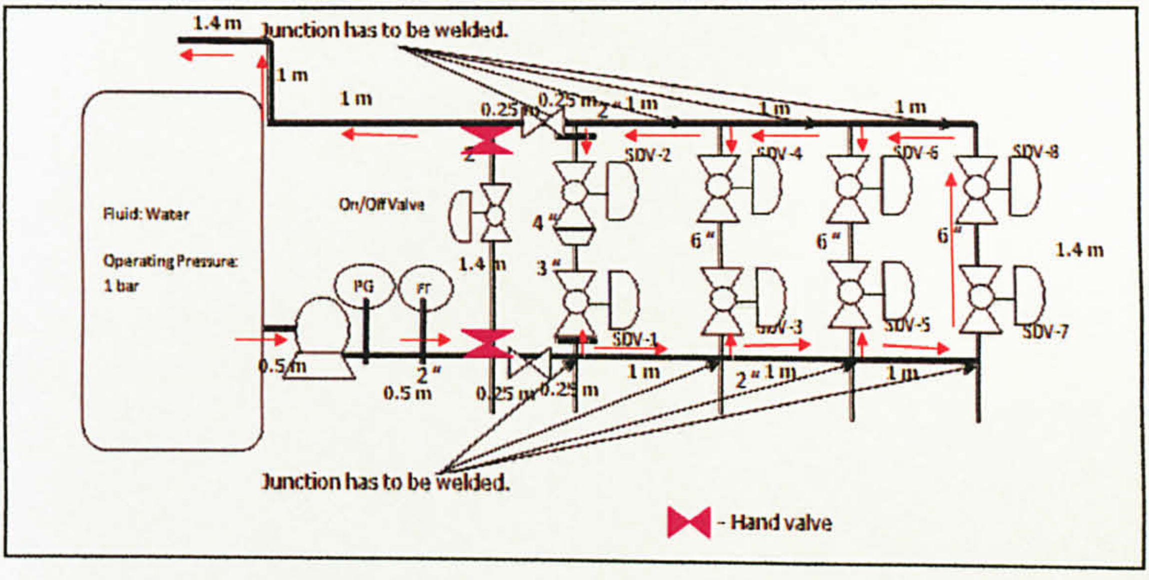

Figure 34: Updated design for mini plant

In this final draft, the valves located in parallel which on two valves in one single loop. By having such of arrangement, the constraint for the water flow decreased and led to reduce the amount of pressure drop in the pipeline. During the operation, one loop will be operated once at a one time. Besides, this design is also reliable because it will not affect the other valve when one of the valves is malfunction. Meaning that, when one valves is under maintenance, the testing for the other valves still can be continue. As in the design in second draft, there are also reducers needed for this design to connect the valve with different sizing.

In term of safety, there is pressure gauge and flow transmitter include in the design to prevent back pressure. Therefore when there is build up pressure in the impulse line, this equipment will detect the abnormal and release the excessive pressure through safety valve provided. Hence, the pump will be protected from any destruction at the moment of back pressure happened. The design calculation is shown below and the summary of the equipment also being provided for ease of understanding.

Design Calculation

This design then was created. The better specification of this design than the first design is that:

i. The water will not flow only in one path. For maintenance wise, it is easier because if using one single path, only one of the valves is out of service, it will affect all the other valves.
ii. Less cost.
iii. Easier for installation.

In addition, for this design, the tank size (radius and height) and the pump capacity has been calculated. The detail calculation is as below and referred to

Volume for 2" pipe diameter

$r = 1" = 0.0254$ m

$l = 0.5 + 0.5 + 0.25 + 0.25 + 3 + 3 + 0.25 + 0.25 + 1 + 2.4 = 11.4\,m$

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

$V = Al = 0.00203x11.4 = 0.023142\ m^3$

Volume for 6" pipe diameter

$r = 3" = 0.0762m$

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

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

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

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

For this project, a pump will be used to channel water from water tank into all the impulse line. The pump rating is sufficient to pump maximum volume water required for this project. The output pump is discharge pump is $45\, {}^{l}/_{min} = 0.045\, {}^{m^3}/_{min}$.

So then, volumetric flow rate is equal $\dot{V} = \frac{V}{t}$

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

This is the time when all the impulse line will be loaded by water before it circulate again into the tank. The time average needed is approximately 120s. Another time might be considered is the overall testing time. In order to complete one testing, we are required approximately about 80 second.

Thus, the total time required is

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

After the total time known, we estimate the minimum volume tank required is:

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

Summary of main equipment/material used

a. *Pump rating*

The pump rating for this design is 45 l / min which equal to 0.045 m^3/ min. The pump has been purchased and will be installed as the construction of the mini plant begins.

b. *Water tank*

The proposed water tank is 0.1963 m^3 which it is 1m in height and 0.25m in radius. The total volume of this tank is expect to supply sufficient amount of water throughout the impulse line

c. *Piping size*

There are standard size of pipe will be used in this design which are 2 inch and 6inch. The pipe size is shown in figure 32. 6inch pipe size is used to connect the impulse line from main piping to the valves.

d. *Safety valve*

Concern to issues of safety, the design required a safety valve to channel out excessive pressure in the impulse line when back pressure occurred.

e. *Pressure gauge and Flow Transmitter.*

If there any build up pressure in the piping, these device will automatically detect the situation. Then, a signal sent to safety valve in order to return the process in stable condition. Flow transmitter being placed as a way to prevent the pump. If the flow in the pipe line is in minimum, a signal will be sent to power off the pump immediately.

f. Reducer

Since there are different sizes of valve connected together in the plant, a reducer is needed to connect the pipe and valve in a firm connection.

g. Medium in the impulse line

Since this early phase of destructive test, PETRONAS proposed to use water as the medium in the impulse line. Water is regard as simple a material to interrupt the valve movement. Besides, water also can minimise the cost as the demand is everywhere and easy to handle.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATION

5.1 Conclusion

In conclusion, the performance of ball valve and butterfly valve are successfully tested. It provides a clear validation that, Partial Stroke Test is safe to be practiced in processing plant in response to enhance the valve reliability. It also proved that, Partial Stroke Testing (PST) is a realistic mean to ensure emergency block valves to function longer between full functional tests at unit turnaround, while still retaining the same level of protection performance. The PST sequence testing project is a testing ground for further implementation in PETRONAS plants.

This research also proved that, Partial Stroke Test gives a great tendency in boosting profit to the maximum level. This is because; there is no process shutdown during implementation of this stroking. PST also seems to be the best way to prevent these final elements from sticking and corrosion. Therefore, preventive and maintenance cost would decreased since the life time of valve is increasing. By any chances, it is hope Partial Stroke Test will eradicate all the safety issues that floating in industry.

For Phase II, the team only got chances to involve in designing the mini plant. It was a great exposure for the team to have a great collaboration with engineers and also lectures. Due to some constraint, the construction of new mini plant is unreliable to be constructed in this semester. However, the draft designed has been approved by PETRONAS and will pending the construction later. It hoped, by implementing this new phase would give more strong evidence to prove Partial Stroke Test is reliable to be implemented in the industry.

5.2 Recommendations

During the testing, there are some errors regarding to the valve parameters. By following the specification given by the vendors, the valve opening for PST should be 20%, but in real situation the valve range opening was more than 30%. Due to that, it was assumed there are some error occurred in the device that tends to give a drifted data. Therefore, a regular fixed maintenance is suggested to check the valve condition from time to time. By doing the maintenance, it gives a higher confidence the valves can perform job well.

As mentioned, the testing using dry test has been completely done in Phase 1 and the outcome of the experiment was successful. Hence, the other recommendation is to start the testing using destructive/stress test in order to realize more characteristic performance of the valve. Stress test will allow some flow to interrupt the valve movement therefore more accurate result can be obtained at the end of the experiment. In addition, apart from testing the destructive test, it's also suggested to identify how the age of the valve can influenced the valve performance. Therefore, after completed Phase 2, we hoped a new research on the valve age can be implemented as a continuation for this Partial Stroke Test project.

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APPENDICES

APPENDIX A

GANTT CHART

APPENDIX A

GANTT CHART for 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.	Testing procedures and identification														
5.	Conduct testing (FST and PST)														
6.	Submission Of Progress Report														
7.	Seminar														
8.	Result Gathering														
9.	Submission of Interim Report														
10.	Oral Presentation														

GANTT CHART for Semester 2

No	Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Preparation for designing mini plant in Phase 2														
2.	Consultation and data gathering														
3.	Continue to design process														
4.	Submission of Progress Report 1														
5.	Finalized design for mini plant														
6.	Submission of Progress Report 2														
7.	Poster Exhibition														
8.	Submission of Draft Report														
9.	Oral Presentation	**7 – 11 June 2010**													
10.	Submission of Dissertation	**25 June 2010**													

APPENDIX B

DEVICE CONFIGURATION

APPENDIX B

DEVICE CONFIGURATION

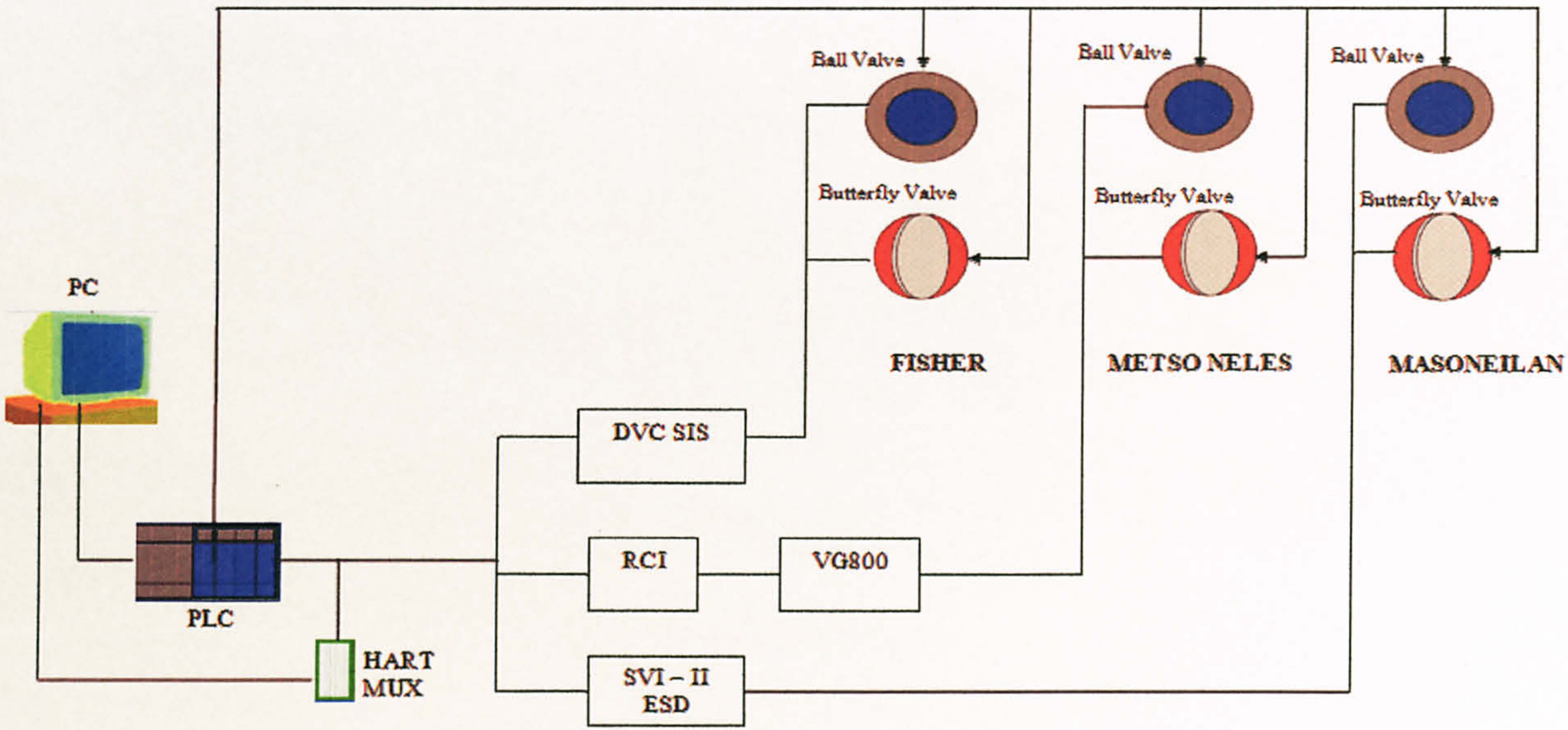

Figure 1: PST Project Device Configuration