PARTIAL STROKE TEST OF EMERGENCY SHUTDOWN VALVE - METSO NELES

by

Siti Farhana Bt Sudarman

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical and Electronics Engineering)

DECEMBER 2009

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

PARTIAL STROKE TEST OF EMERGENCY SHUTDOWN VALVE - METSO NELES

by

Siti Farhana Bt Sudarman

A Project Dissertation submitted to the
Electrical and Electronics Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
(ELECTRICAL AND ELECTRONICS ENGINEERING)

Approved by,

(ASSOC. PROF. DR. NORDIN B. SAAD)
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

December 2009

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.

(SITI FARHANA BT SUDARMAN)

ABSTRACT

Potential disasters at an industrial processing plant may include an accident resulting in a massive release of toxic materials, an uncontrollable reactant, a devastating explosion or any combination of the above. All processing plant must be guarded from all potential disaster scenarios. Therefore , emergency shutdown valves has to be sure be operated with fault-free as the valves are kept idle in open position for long periods and are designed to close and keep tight in case of a hazard occur. Regular checking has to be performed in order to guarantee the function of the valves. Emergency Shutdown valves have been tested at unit turnaround, using a Full Stroke Testing and Partial Stroke Testing to demonstrate the performance. The scope of this project is to verify the technology needed for Full Stroke Testing and Partial Stroke Testing in order to ensure the performance of the Emergency Shutdown valve. The testing is simulated by using WideField2 Software (YOKOGAWA) for Full Stroke Test and FieldCare Software (Metso Neles) for Partial Stroke Test. Partial Stroke Testing can be a good complement to Full Stroke Testing as it reduces the required Full Stroke Testing frequency and associated operational impact. Partial Stroke Testing will detect failure of Emergency Shutdown valves without disturbing the process flow. Testing is conducted for sixth times. The valve status and its response to mechanical movement during the test are monitored. Valve performance trend is analyzed after each partial stroke test to find whether there is any potential of valve failure. The result of valve test, pneumatics test, breakdown pressure and load factor are being taken into consideration in analyzing the performance of the emergency shutdown valve.

ACKNOWLEDGEMENT

Alhamdulillah, with my greatest gratitude to the Almighty Allah for His gracious blessings throughout the completion of my Final Year Project duration undertaken.

My deepest thankfulness would be to my supervisor, Assoc. Prof. Dr. Nordin Bin Saad for all his guidance and endless support throughout the Final Year Project I and Final Year Project II courses. Without his guidance and advice, I would not reach this far. Also to Mr. Azhar, the Lab technician who had helped me a lot through the entire period of this project.

Next in line is the Metso Engineers Mr Ivan Goh, Mr Adrian Oon and Mr Tan Jee Yong who were very helpful to guide and train me throughout the project. Without their help and training, this project would not be a success.

Not to forget are my fellow friends, who have been very helpful to assist me in this project. Special thanks to my family for their love, support and motivation for me to achieve the best in my life.

Finally, I would like to thank everybody who were directly or indirectly involved in contributing to the successful completion of my Final Year Project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

FST	Full Stroke Testing
PST	Partial Stroke Testing
VG	ValvGuard
PLC	Programmable Logic Controller
RCI	Remote Communication Interface
HART	Highway Addressable Remote Transducer
SIL	Safety Integrity Level
PFD	Probability of Failure in Demand
DCS	Distributed Control System
ESD	Emergency Shutdown
FDT	Field Device Tool

CHAPTER 1
INTRODUCTION

1.1 Background of Project

Industries are concern to plant safety in order to reduce the risk of massive release of toxic materials, having an uncontrollable fire or a devastating explosion or any combination of the above that can cause accident in the plants. Thus, the proper functions of safety valves must be checked to guard against all these potential disaster scenarios. Emergency shutdown valves are the most important components in the safety loop (sensor, safety logic and final element), because most of the problems that occur are related to the functionality of the final element (valve) [1].

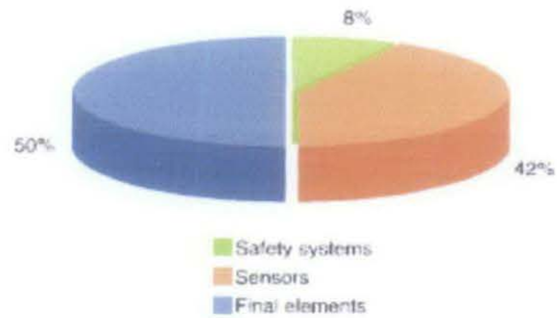


Figure 1: Safety loop failure sources

Safety valves are operated only in trip situations. But when safety hazards occur, it is essential to ensure that the valves can operate with fault-free. However, because these safety valves are rarely cycled, there is always concern whether the valves will operate when it is needed. In practice, unless these valves are periodically stroked, there is always a possibility that the valves will not work when called upon to do so [2].

Therefore the only way to ensure the performance of safety valves is by periodically stroking the valves. Traditionally (old technology), valves have been tested using a Full Stroke Testing at unit turnaround to demonstrate the performance. But this test involves executing plant shutdown. An option to a Full Stroke Testing is a Partial Stroke Testing. The test involves moving the valve a minimum of 20 percent without stopping the production, thus unnecessary process shutdowns are avoided.

This project study is intended to conduct a Full Stroke Testing (FST) and Partial Stroke Testing (PST) on Emergency Shutdown valves to ensure proper operation in Emergency Shutdown valves services. This project involves testing of the valve by using Programmable Logic Controller (WideField) for FST and FieldCare Software (Metso Neles) for PST. Metso Neles Automation has been designed to improve the control of industrial processes by maximizing the availability of valves, minimizing the variability of control loops and also increasing and maintaining plant safety. Metso has developed a digital valve monitoring device called Neles ValvGuard to test and prove by on-line testing the safety of Emergency valve. The Neles ValvGuard system automatically tests the valves based on programmed testing interval. The valves can make test strokes between every minute up to once a year or more if so desired [3].

1.2 Problem Statement

Quarter-turn valves (Ball Valve or Butterfly Valve) have a known tendency to stick when not used for a long periods. This is the normal operation of most safety instrumented systems: dormant where the valve is inactive unless emergency occurs. Due to long passive period the valves may do unexpected operations and thus cause an emergency situation or a nuisance trip. The valves need to be periodically stroke to ensure their performances. Traditional method of testing such valves would be to close them fully (FST). Because FST stops production, it can only been done when the process is down which is very costly and cause disturbance to the process flow.

Therefore, PST can be a good complement to FST as it partially closes the valves without the need to shutdown the plant to detect the various failure modes. It reduces the required FST frequency and associated operational impact [4]. PST will detect failure of Emergency Shutdown valves without disturbing the process flow. It is one of the most effective techniques for enabling a single valve to achieve Safety Integrity Level (SIL) 2 performance-or possibly even SIL 3 [5]. Thus it seems to be the solution to ensure the safety standard is achieved. Based on the OREDA data, the maximum percentage of the failures that can be detected by a PST is 70%.The remaining 30% of the failures can only be detected using a FST [6].

This project is proposed by PETRONAS Group Technology Solution (PGTS) due to the failure on PST that operation team had experienced during conducting a shutdown process at the plant. The shutdown valves that were supposed to partially stroked, have became fully stroked (fully closed) and caused the production to be stopped. As a result, PETRONAS lost millions of ringgit. Therefore the study of PST and FST performance must be done in order to overcome this problem.

1.3 Objective

This project is collaboration between Universiti Teknologi PETRONAS (UTP) and the Improvement Working Group (IWG) SKG14 of PETRONAS. The objective of this project is to conduct a study of ESD Valve performances when it is partially stroked with 10% - 20% closing. Two different valves are being tested using vendor's software. The performance of two different valves is studied and compared the technology used for FST and PST.

This project is divided into two phases. Phase I involve developing the Programmable Logic Controller (PLC) programming and conduct the PST and FST without load. The testing need to be done based on PETRONAS testing specification which requires 90 days of testing or 540 strokes.

Phase II involves study of the failures mode of the valves during the test period. Failure mode which cover the mechanical failure mode, pneumatics failure mode and electronics failure mode will be introduced. PST and FST will be done with load (liquid).The performance of the ESD valves will be analyzed and various aspects of valve failures will be observed. Phase II will only start when phase I is completed.

1.4 Scope of Study

The scope of this study is to verify the technology needed for FST and PST in order to ensure the performance of the ESD valve. There are three vendors involved which are Metso Neles (FieldCare), Fisher (AMS Valvelink) and Masoneilan (Valvue ESD). Testing is done on six different valves by using three different software in order to compare the performance and reliability of each software to conduct the testing. In this report, testing is done using Metso Neles. Controllers are developed by the vendors which are FieldCare Software (Metso Neles) for PST and WideField2 Software (YOKOGAWA) for FST. ESD valve is tested using the software in order to guarantee that the valve can operate with fault free when safety hazards occur.

In this report, only phase I will be completed which involved valve testing. Two different valves are used which is Ball Valve and Butterfly Valve. Both valves are tested and performance of each valve is analyzed. There are two different tests:

i) Valve test which physically moves the valve by desired stroke size. The requirements that have been agreed:
   - Valve Travel: 20% with pressure step 0.05 Bar.
   - 5 times PST & 1 times PST & FST.
   - 90 days of testing or 540 strokes.

ii) Pneumatic test, which measures the pressure change through the spool valve.

CHAPTER 2
LITERATURE REVIEW

2.1 Emergency Shutdown (ESD) Valve

Emergency shutdown valves or safety valves are used to protect processes, personnel and the environment against process disruption. It will automatically close in the event of an emergency to prevent the loss of handled media [7]. Emergency shutdown valves are the final line of defense and are critical to minimizing the chance of potential disasters during process upsets. It is an actuated valve installed in a pipeline, isolates a process unit from an upstream or downstream (gaseous or liquid) inventory upon activation of the process unit alarm and shutdown system [8]. In this project, two valves have been used as shut down valve which are Ball Valve and Butterfly Valve.

2.1.1 Ball Valve

Ball valves are flow valves that are quarter-turn and straight through apparatuses. These valves allow for shut-off or purposes of control. It has a round closure element that contains a matching pair of rounded seats. These seats allow necessary sealing to take place [9].

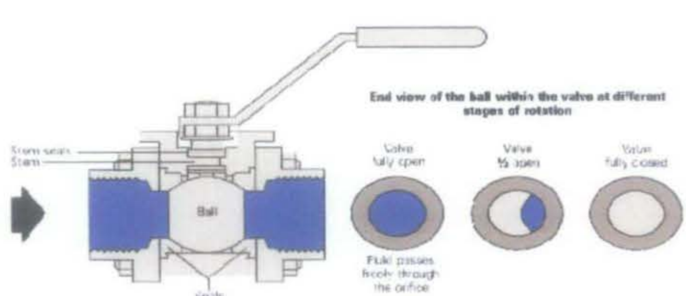


Figure 2: Ball Valve

Figure 3: Metso Neles Ball Valve

2.1.2 Butterfly Valve

A butterfly valve is also a quarter-turn valves. The "butterfly" is 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. The valve may also be opened incrementally to regulate flow [10].

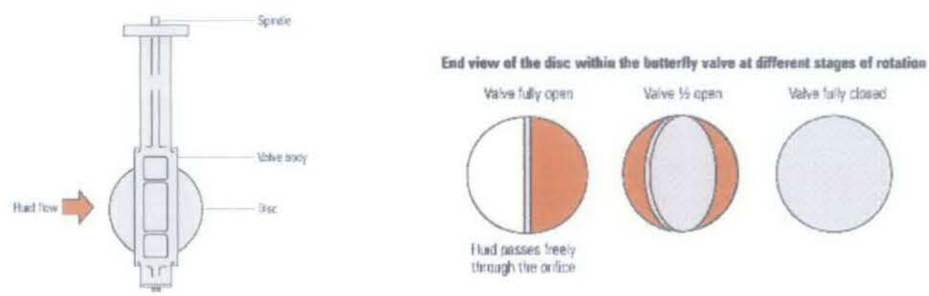


Figure 4: Butterfly Valve

Figure 5: Metso Neles Butterfly Valve

2.2 Full Stroke Testing (FST)

Full Stroke Testing is used to demonstrate the performance of Emergency Shutdown Valve at unit turnarounds. Improvements in mechanical reliability and predictive and preventive maintenance programs have permitted the turnarounds from two to three years to extend to five or more years. Due to extend turnarounds periods, Emergency Shutdown valves are expected to go longer between function test and provide the same level of protection performance. To overcome the safety system performance degradation due to longer testing intervals, online testing of safety-related valves is conducted which requires additional facilities and possible production impacting procedures. This may cause reducing production rates, monitoring defined process variables, or executing a shutdown. FST can only be done when the plant is shutdown because the valves need to be closed fully. FST detects the remainders of the failure modes (30% of failure).

As mention earlier, Programmable Logic Controller (PLC) is used to conduct the FST. PLC is developed using WideField2 Software (YOKOGAWA).

2.2.1 Programmable Logic Controller (PLC)

A Programmable Logic Controller (PLC) is an industrial computer control system that continuously monitors the state of input devices and makes decisions based upon a custom program, to control the state of output devices. PLC's were invented as less expensive replacements for older automated systems that would use hundreds or thousands of relays and timers. The advantages of using PLC are:

i) Cost effective for controlling complex systems.
ii) Flexible and can be reapplied to control other systems easily.
iii) Computational abilities allow more sophisticated control.
iv) Trouble shooting aids make programming easier and reduce downtime.

PLC is a digital operated electronics system, designed for industrial environment. It implements specific functions such as logic, sequencing, timing, counting and arithmetic to control the outputs. The function of PLC is scanning of a program which means running through all conditions within a guaranteed period. A PLC consists of following main parts:

i) Inputs

ii) Central Processing Unit

iii) Outputs

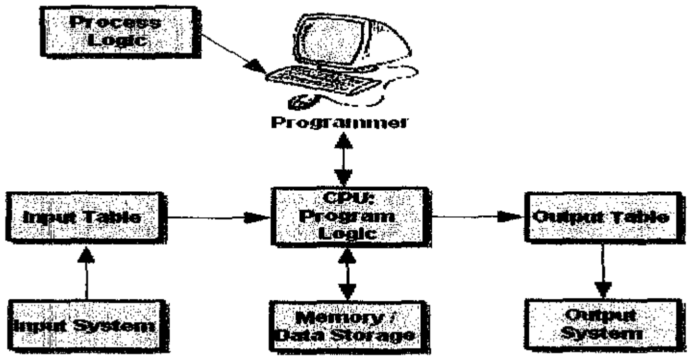


Figure 6: PLC Program

Table 1: PLC input and output devices

INPUT	OUTPUT
Sensing Devices	Valves
Switches and Pushbuttons	Solenoids
Limit Switches	Actuators

The operation of the PLC system is simple and straightforward. The Process or CPU completes three processes:

i) Scans, or reads, from the input devices

ii) Executes or "solves" the program logic

iii) Updates, or writes, to the output devices

In this project, PLC is used for Start-up and FST purpose. Compare to other vendors, Metso has the simplest PLC program because both of the valves only need to used analog input as the start-up and FST signal. PLC is developed using WideField2 software.

2.2.2 WideField2 Software

WideField2 introduces new functions like program modularization, local devices, component macros and "structures" for defining structures of devices, to realize further modularization of programs and device structures.

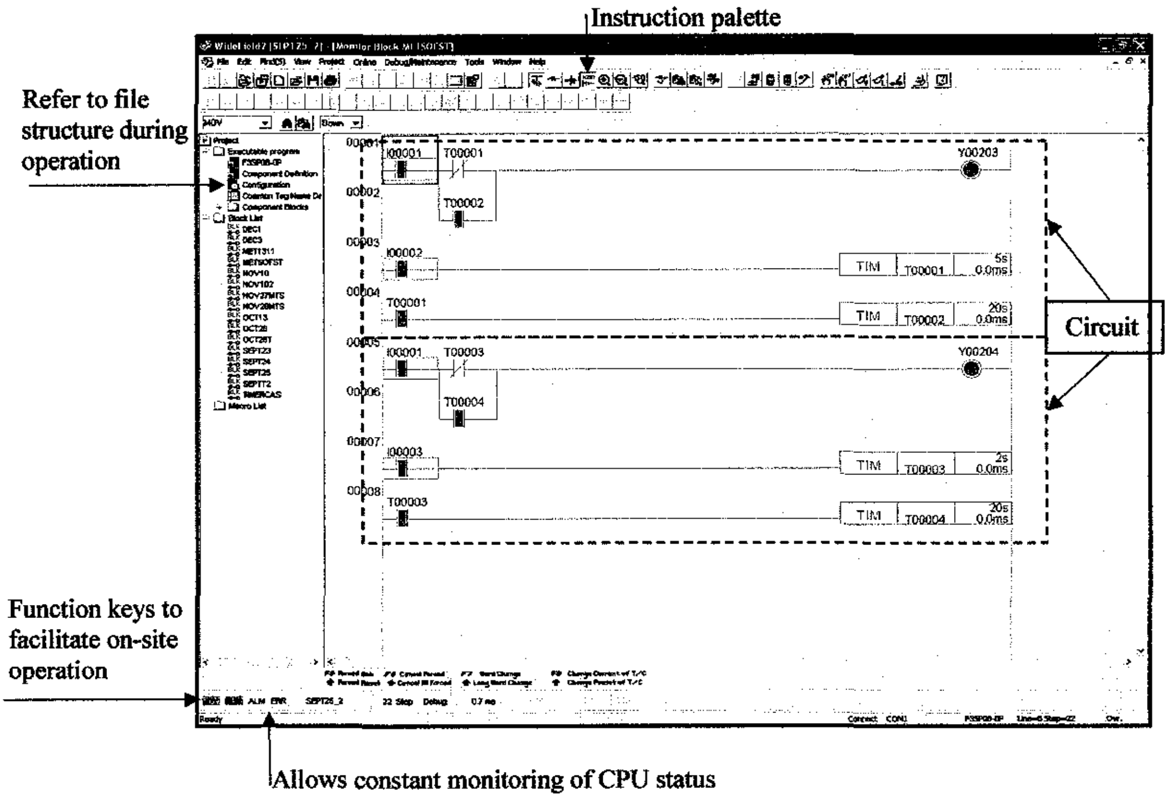


Figure 7: Programmable Logic Controller (WideField 2 Software)

PLC program is used during the testing period to fully open the ESD valves at the beginning of the testing and to conduct the FST. The operation of the PLC is shown in the following table.

Table 2: PLC operation for Ball Valve

	DEVICE	NAME	DESCRIPTION
Ball Valve	Output relay, Y	Y00203	Represent Ball valve
	Internal relay, I	I00001	Used as a start-up signal for the both valves Forced Set I00001 in order to move both valves from fully closed to fully opened. PST can only be done when valve is in fully opened condition.
		I00002	Used to send FST signal for ball valve Forced Set I00002 to conduct FST on ball valve (valve will move to fully closed)
	Timer, T	T00001	After I00002 is forced set, T00001 will be triggered. Timer will be activated for 5 seconds before FST signal is sent to ball valve. Ball valve will be closed fully.
		T00002	T00001 signal will forced set T00002. Timer will be activated for 20 seconds before sending a signal for ball valve to move back to its initial position (from fully closed to fully opened).

Table 3: PLC operation for Butterfly Valve

	DEVICE	NAME	DESCRIPTION
Butterfly Valve	Output relay, Y	Y00204	Represent Butterfly valve
	Internal relay, I	I00001	Used as a start-up signal for the both valves Forced Set I00001 in order to move both valves from fully closed to fully opened. PST can only be done when valve is in fully opened condition.
		I00003	Used to send FST signal for butterfly valve Forced Set I00003 to conduct FST on butterfly valve (valve will move to fully closed)
	Timer, T	T00003	After I00003 is forced set, T00003 will be triggered. Timer will be activated for 2 seconds before FST signal is sent to butterfly valve. Butterfly valve will be closed fully.
		T00004	T00003 signal will forced set T00003. Timer will be activated for 20 seconds before sending a signal for butterfly valve to move back to its initial position (from fully closed to fully opened).

2.3 Partial Stroke Testing (PST)

Partial Stroke Testing means to partially close a valve, and then return it to the initial position. The valve movement is so small that the impact on the process flow or pressure is negligible, but the valve movement may still be sufficient to reveal different types of dangerous failures. PST is introduced to detect failures without disturbing the process, that otherwise require functional tests [11]. It is important in order to make sure that the emergency shutdown valve can perform its safety function when hazards occur. PST tests a portion of the valve failure modes. The remainders of the failure modes are tested using a FST.

PST can be used to supplement the FST to reduce the FST interval required to achieve Safety Integrity Level (SIL). FieldCare Software is used for PST, developed by Metso Neles (vendor). The Neles ValvGuard system automatically tests the valves based on programmed testing interval. The valves can make test strokes between every minute up to once a year or more if so desired. In this project, the test is set to be conducted every 15 minutes testing interval for 90 days.

2.3.1 Safety Integrity Level (SIL)

Safety integrity level (SIL) is one of three possible discrete integrity levels (SIL 1, 2, or 3) of safety instrumented systems. SILs are defined in terms of their probability of failure on demand. PST is one of the most effective techniques for enabling a single valve to achieve SIL 2 performance-or possibly even SIL 3. The statistical measure of availability in an emergency is called the Probability of Failure in Demand (PFD). For individual components, PFD can be measured using the following equation, which is well known and widely used in industry [5].

Probability of Failure in Demand (PFD) equation:

$$\mathbf{PFD} = \mathbf{DC} \times \lambda_d \times \frac{TI_{PST}}{2}) + (1 - \mathbf{DC}) \times \lambda_d \times \frac{TI_{FST}}{2}$$

Using 70% as the breakdown of the dangerous failure rate, λ_d, the equation for the PFD can be written as follows:

$$\mathbf{PFD} = 0.7\lambda_d \times \frac{TI_{PST}}{2}) + 0.3\lambda_d \times \frac{TI_{FST}}{2}$$

DC = Diagnostic Coverage Factor

λ_d = Dangerous Failure Rate = 1/MTBF(Mean Time Between Dangerous Failure)

TI_{PST} = Testing Interval for Partial Stroke Test (On- line test)

TI_{FST} = Testing Interval for Full Stroke Test (Off-line)

PFD calculations consist of two parts: on-line testing and off-line testing. When dealing with safety valves, the on-line diagnostics part relates to PST and the off-line part to periodic maintenance. With frequent on-line testing, better diagnostic coverage, shorter mean times for repair and good communication methods, it is possible to achieve lower PFD [5].

2.3.2 Neles ValvGuard concept

Metso Automation's Neles ValvGuard™ system is intended to be used on applications where automated ESD valve testing is needed. Neles ValvGuard takes care of this testing automatically, using PST where the ESD valve is closed only partially and not affecting the flow in the pipeline. Whereas traditional systems require testing while the process is completely shutdown, with Neles Valve guard the valve performance is tested and monitor automatically on continuous, real – time basis, without disturbing the process. A clear signal will be given to the control room of the status valve (OK, testing, alarm). Based on information data, plant production can be optimized and predictive maintenance plans can be made if needed.

The ValvGuard system can check the condition of the whole valve package by PST conducted whilst the plant is running. In addition, ValvGuard performs a separate pneumatic test which verifies all components and the system integrity up to a change of air pressure in the actuator. Testing, logging and reporting can be automated centralized and simplified. Malfunctions and alerts are transmitted in real time to the Distributed Control System (DCS). ValvGuard can be installed to existing valves or incorporated in new installations. Automated valve testing done by the ValvGuard system adds value by both lowering maintenance costs and increasing safety.

The Neles ValvGuard System consists of three components: VG800 field device, Remote Control Interface (RCI) and Metso Automation FieldCare condition monitoring and configuration software.

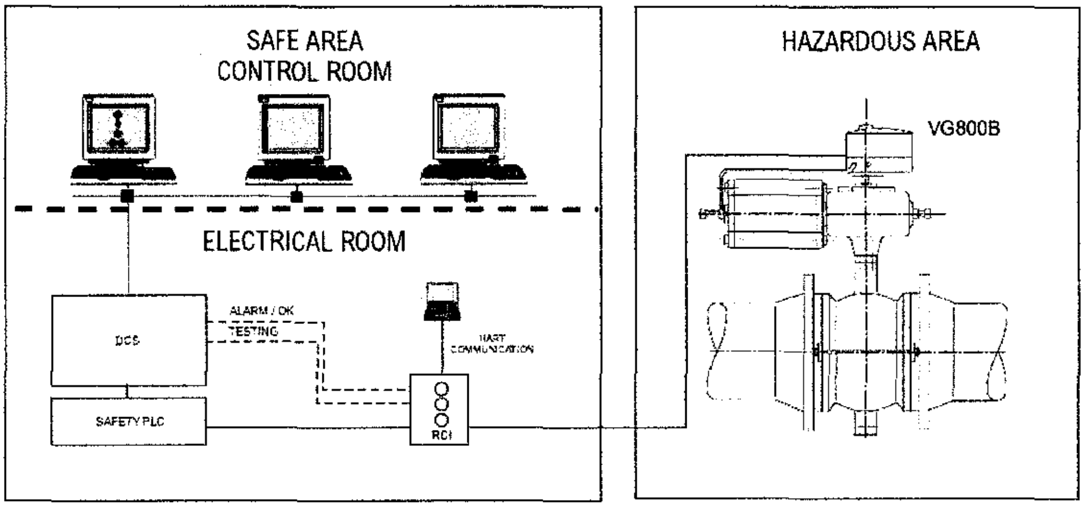


Figure 8: Neles ValvGuard system components

2.3.3 VG800

VG800 is used in the field in the hazardous areas together with a pneumatic actuator and an ESD valve. It has a microcontroller and onboard memory to perform partial stroke tests and collect diagnostics information. ValvGuard also includes internal pneumatics such as solenoid valve, which is used to perform the safety function. The spool valve can be programmed to perform a functional pneumatics test periodically and it is very important for the safety point of view. It has been estimated that solenoid valves cause about 30% of all the final element failures (OREDA). Also, the safety function of Neles ValvGuard is based only on the binary signal from the safety system and not dependent on the onboard electronics. If an emergency signal occurs during testing, ValvGuard automatically bypasses the test procedure and performs the desired safety function [2].

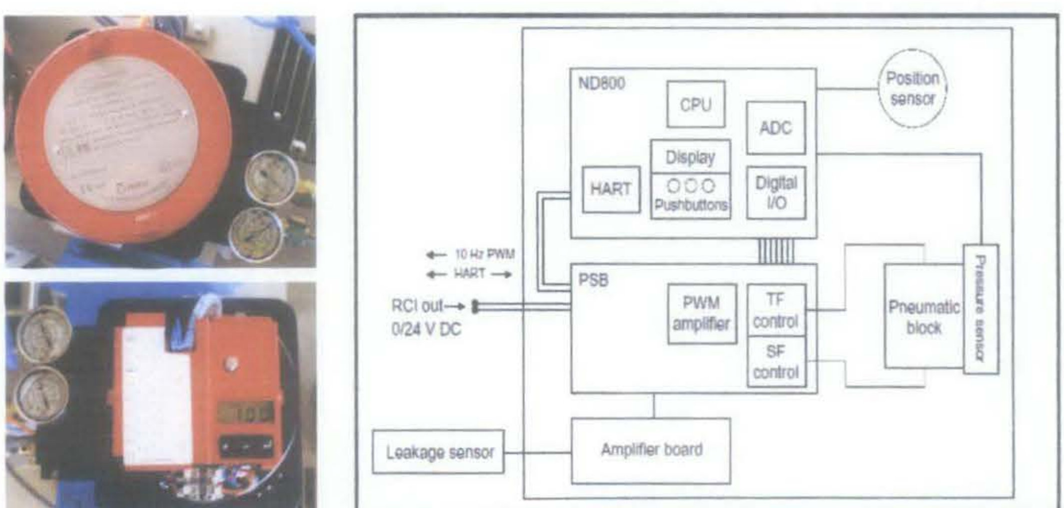


Figure 9: Neles ValvGuard

Neles ValvGuard is actually an operating system rather than a discreet component, smart technology enables programmable functions and communication between the control room and the remote device fitted to the ESD valve in the field. The VG800 field device contains a micro controller and is powered by 24 VDC supply from the plant control room.

2.3.4 Remote Communication Interface (RCI)

Remote Communication Interface (RCI) is located in the safe area, normally in the cross-connection room. RCI is connected between the safety system and the field device. Its function is to provide HART communication for the configuration and condition monitoring software as well as the status information to DCS. RCI includes two HART independent status relays, which can be hardwired to the DCS to provide the status information of the VG800. Also, three LEDs (green, orange, red) to show the OK, testing or alarm status [2]. There are two binary relay outputs in the RCI unit, which in real-time indicate the status of the safety related valve. The relay outputs can be connected to the plant automation system in order to get an alarm directly to the control room. The RCI unit also permits communication between a control room PC and the VG800 using the HART® communication protocol [4].

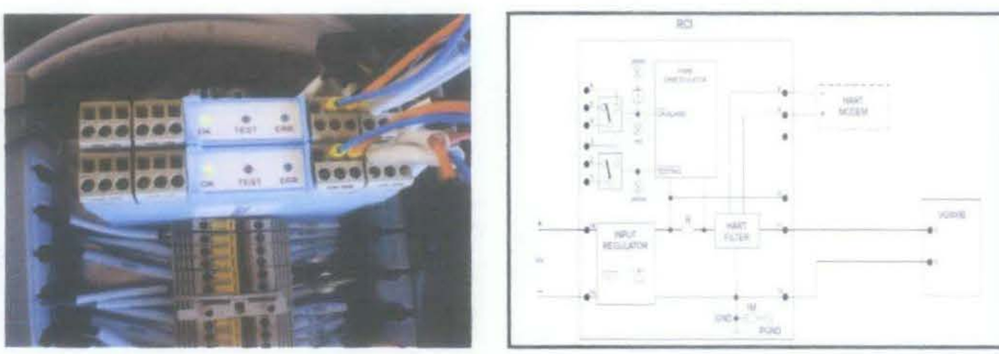


Figure 10: Remote Control Interface (RCI) Connection Diagram

2.3.4 HART Server

HART is Highway Addressable Remote Transducer, designed to compliment traditional 4-20mA analog signaling. HART Protocol supports two way digital communications for process measurement and control devices. Applications include remote process variable interrogation, cyclical access to process data, parameter setting and diagnostics. HART server is like the communication interface to allow the ESD valves to communicate with the PST Software.

2.3.5 FieldCare

Metso Automation FieldCare is used for configuration and condition monitoring of the VG800 field device. Data collected during testing is automatically posted to a database, which can be accessed by authorized personnel. FieldCare is based on Field Device Tool (FDT) technology, the open standard independent of device or system supplier. Field Device Tool (FDT) is a standardized interface specification that allows the integration of intelligent devices into, for example, asset management and process control systems. It provides accurate information flow during commissioning, operation or maintenance of a production process. FieldCare provides a single tool to manage any device in any communication protocol. Online data flow from all devices is visualized through an innovative colour-coded alert system and a series of selective alarms which provides a clear view of process performance. This allows early, easy problem recognition. FieldCare software is used to interrogate, configure and collect data when connected to VG800.

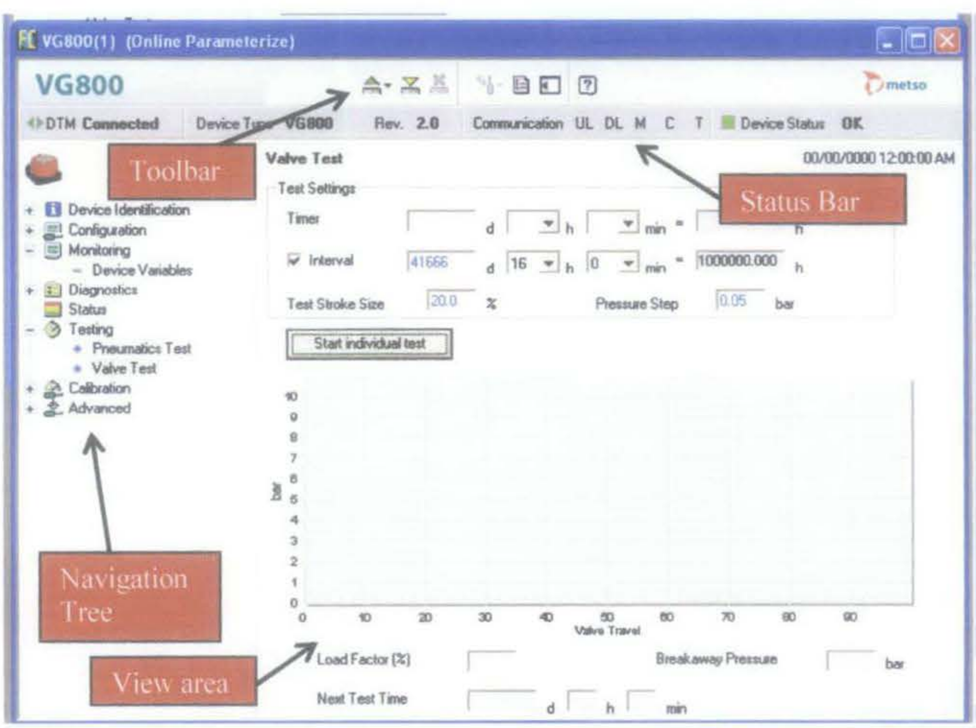


Figure 11: FieldCare Software User Interface

CHAPTER 3

METHODOLOGY

3.1 Procedure Identification

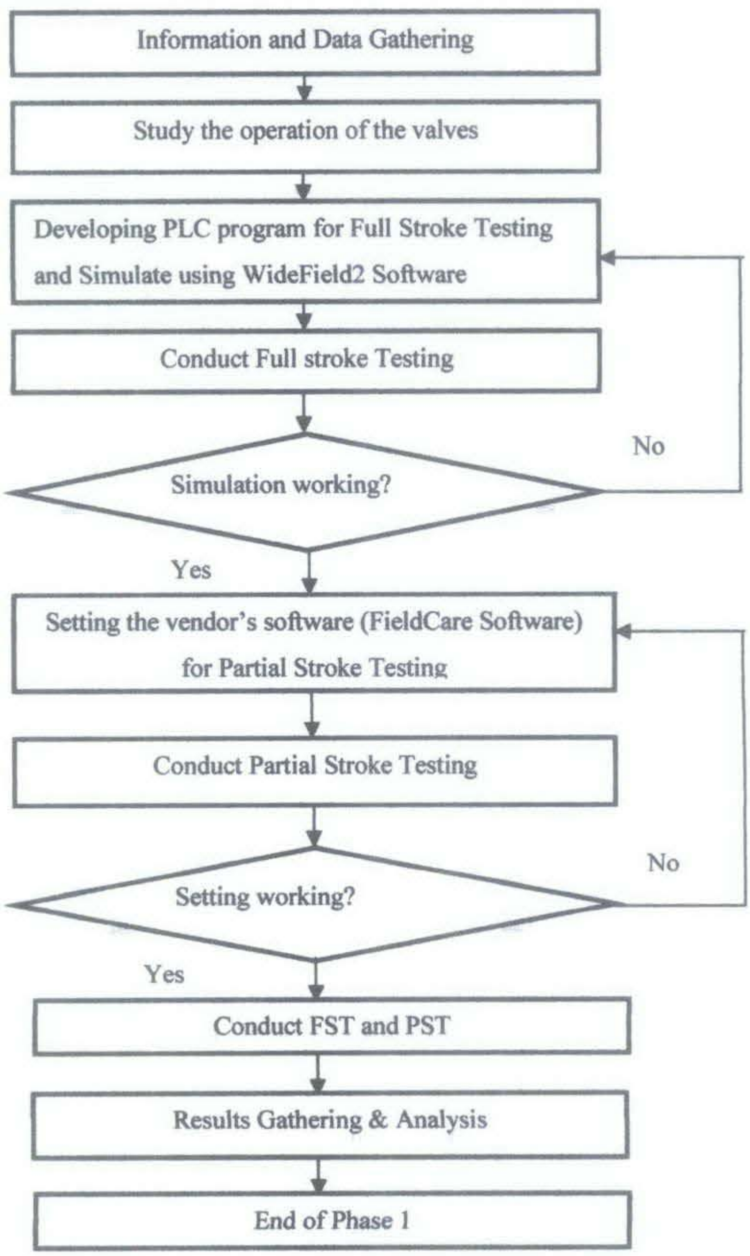


Figure 12: Project flow planning for both semesters

3.2 Testing Procedure

Both valves (Ball valve and Butterfly valve) will be tested for six strokes at interval 15 minutes between each stroke. The valve status and its response to mechanical movement during the test are monitored. Valve performance trend is analyzed after each partial stroke test to find whether there is any potential of valve failure.

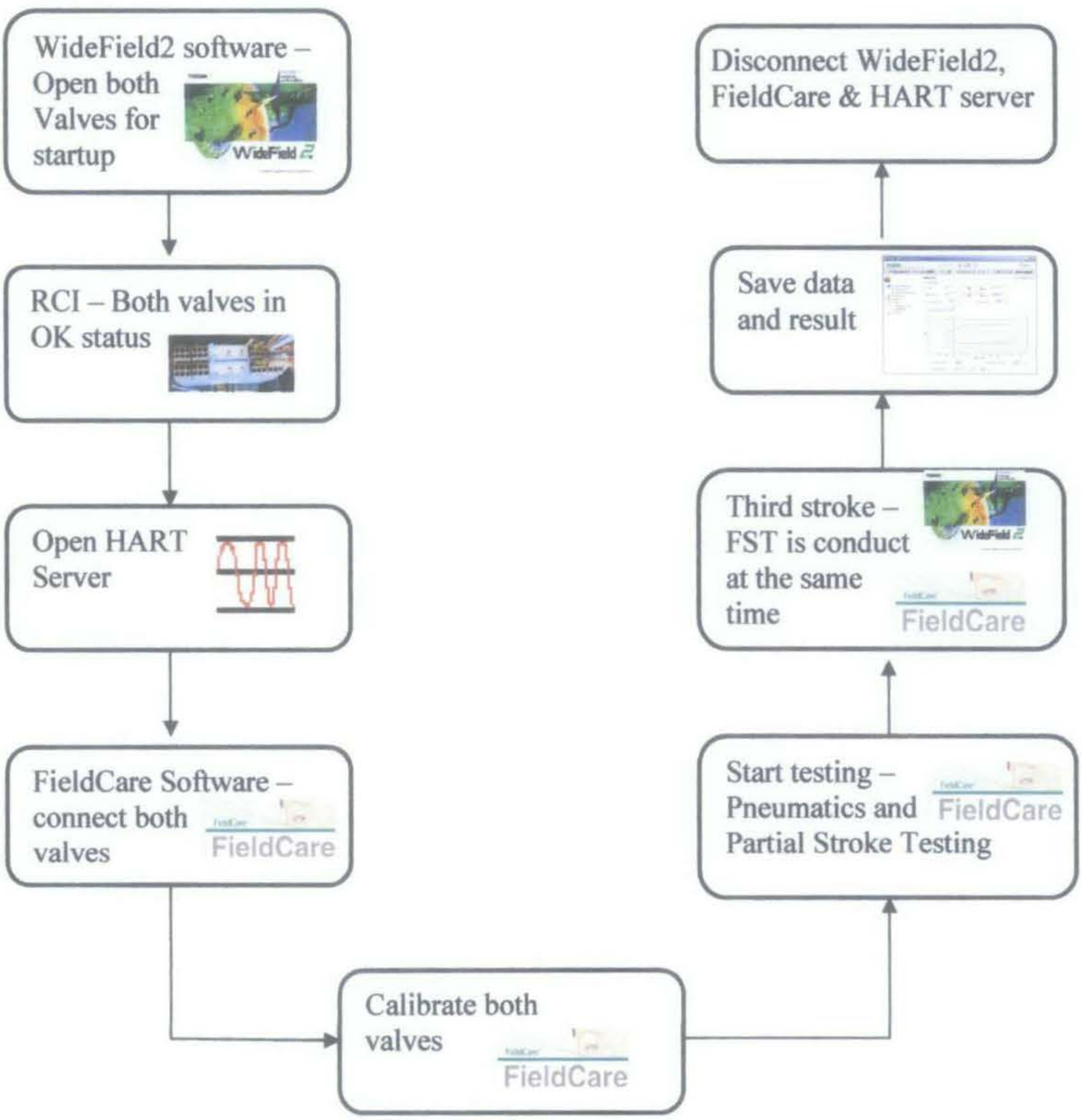


Figure 13: Testing flow for the project

3.3 Tools and Equipments

Tools and equipments required for this project are:

- ESD Valves – consist of Ball valve and Butterfly valve

Figure 14: Ball Valve and Butterfly Valve

Device Specification

Table 4: Valve size

Vendor	Valve		Software
	Ball	Butterfly	
Metso Neles	6 inch	4 inch	FieldCare
Fisher	6 inch	4 inch	AMS Valvelink
Mesoneilan	6 inch	4 inch	Valvue ESD

Table 5: Ball Valve Specification

Positioner Information			
Device Type	VG800	**Manufacturer**	Metso Automation
Device ID	1410103	**SW Revision**	2
HW Revision	1	**Final Assembly Number**	0
Device Serial Number	2008-02-9300	**Position Sensor Serial Number**	834550
Assembly Related			
Valve Acting Type	Rotary		
Rotation Direction to Fail Safe	Clockwise		
Fail Safe Action	Close		

Table 6: Butterfly Valve Specification

Positioner Information			
Device Type	VG800	**Manufacturer**	Metso Automation
Device ID	1410066	**SW Revision**	2
HW Revision	1	**Final Assembly Number**	0
Device Serial Number	2007-50-9201	**Position Sensor Serial Number**	834561
Assembly Related			
Valve Acting Type	Rotary		
Rotation Direction to Fail Safe	Clockwise		
Fail Safe Action	Close		

- PLC device - used for startup program and control the FST

Figure 15: Programmable Logic Controller (PLC)

Table 7: PLC specifications

Company	YOKOGAWA (made in Japan)
Model	F3SP08
SUFFIX	-OP
STYLE	S1
REV	15:02
SUPPLY	-
I/P	100 -240 V_{AC}
O/P	-
DATE	2007/07/04
NO	F7G041069

- VG800 – enables programmable functions and communication between the control room and the ESD valve in the field

Device Specification

Table 8: Device Alert Settings

	Ball Valve	**Butterfly Valve**
Test Timeout (s)	90.0	90.0
Test Warning Time (s)	2.0	2.0
Position Error Tolerance (%)	10.0	10.0
Supply Pressure HIGH Alarm Limit	7.5 barG	7.5 barG
Supply Pressure LOW Alarm Limit	3 barG	3 barG
Pressure Peak	0 barG	0 barG
Pressure Peak Tolerance (%)	30.0	30.0
Pressure Recovery Time (s)	5.0	5.0
Valve Test Pressure Low Limit	0 barG	0 barG

Table 9: Statistical Alert Settings

	Ball Valve	**Butterfly Valve**
Load Factor Limit HIGH	100	100
Load Factor Limit LOW	0	0
Breakaway Pressure Limit HIGH	8 bar	8 bar
Breakaway Pressure Limit LOW	0 bar	0 bar
Leakage Alarm Limit (mV)	3200	3200
Valve Test No. Limit	1,000 000	1,000 000
Pneumatics Test No. Limit	1,000 000	1,000 000

3.4 Software

- WideField2 Software – develop by vendor YOKOGAWA to simulate FST. The steps to connect WideField2 software as in Appendix IV.

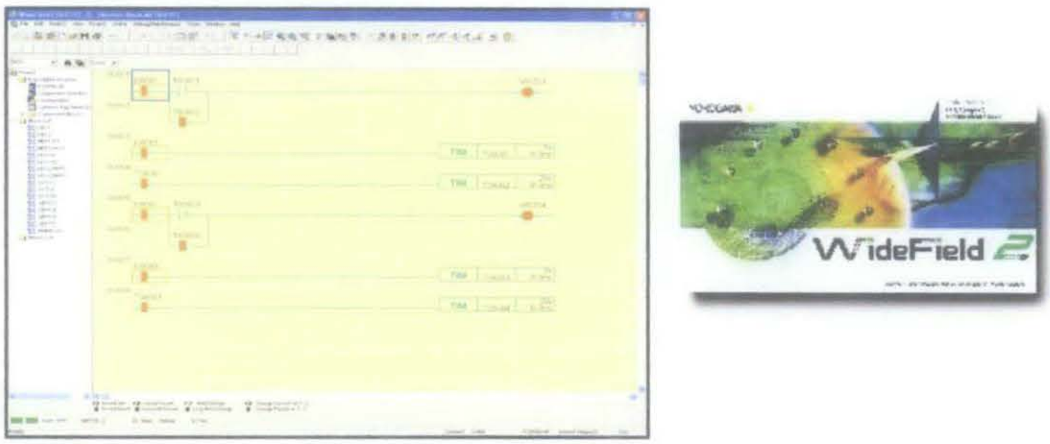


Figure 16: WideField2 Software

- FieldCare Software – develop by Metso Neles for PST and collect diagnostics information. The steps to connect FieldCare Software as in Appendix V.

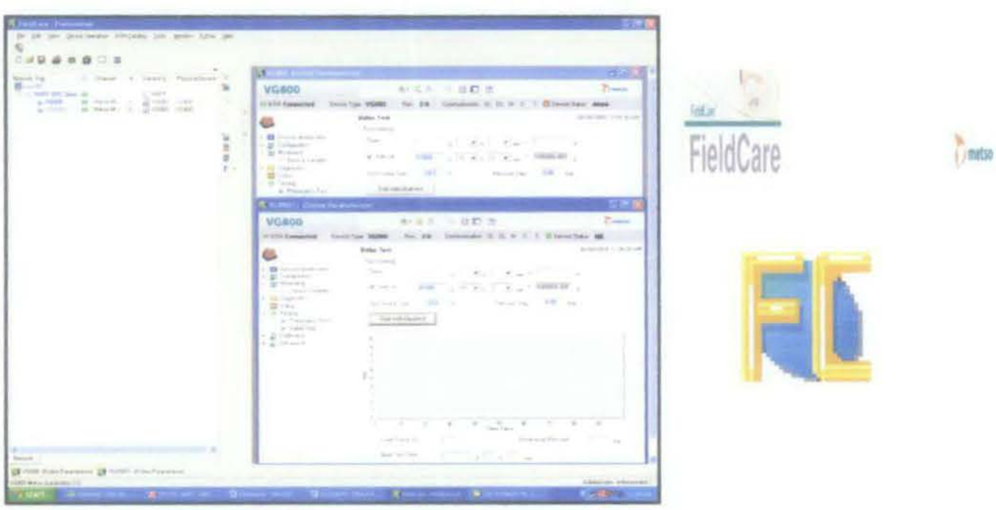


Figure 17: FieldCare Software

- HART Server – allow the ESD valves to communicate with the PST Software. The steps involve connecting HART server as in Appendix VI.

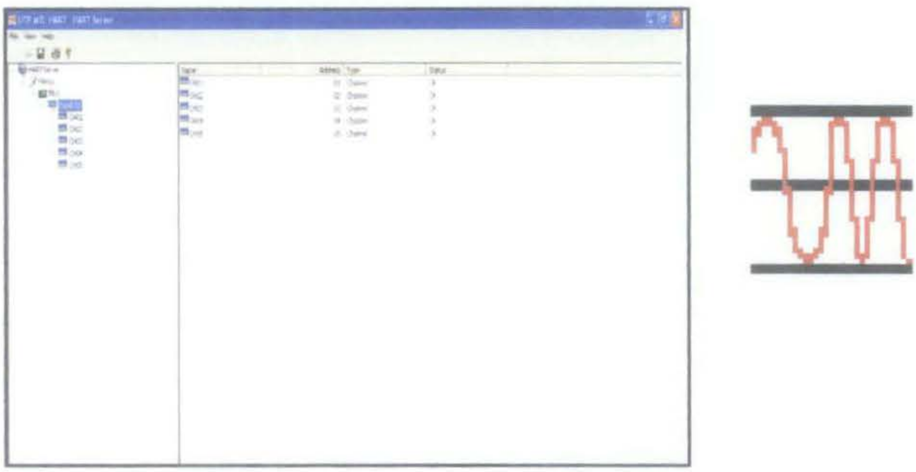


Figure 18: HART Server

CHAPTER 4

RESULT AND DISCUSSION

Testing is done according to the criteria specified by PETRONAS which are:

i) 90 days of testing or 540 strokes

ii) 6 times PST and 1 time FST daily, where the FST must be done simultaneously with any of the 6 times of PST

For Metso Neles, up until now the total days of testing are 91 days with different testing condition as table below:

Table 10: PST Condition

Testing condition (Pressure step, Stroke size)	**Days**
0.05 Bar, 20% closing	77
0.05 Bar, 30% closing	4
0.005 Bar, 20% closing	10

However in this report, data for testing with 0.05 bar pressure step and 20% test stroke size only will be taken into consideration. This is for apple to apple comparison purpose with other vendors (Fisher and Masoneilen) where the testing condition has to be standardized among all vendors.

Pressure step control the speed movement of the valve. The lower the value of pressure step, the slower the movement of the valve. 0.05 Bar pressure step means that the valve will be moved from its initial position to the desired position with pressure release or supply 0.05 Bar each time the valve is move. The valve will move from its initial position (fully open) to 80% opening. In other way, the valve is closed for 20% of its opening.

The valves are being tested sixth times at interval 15 minutes between each stroke shown in Figure 19.

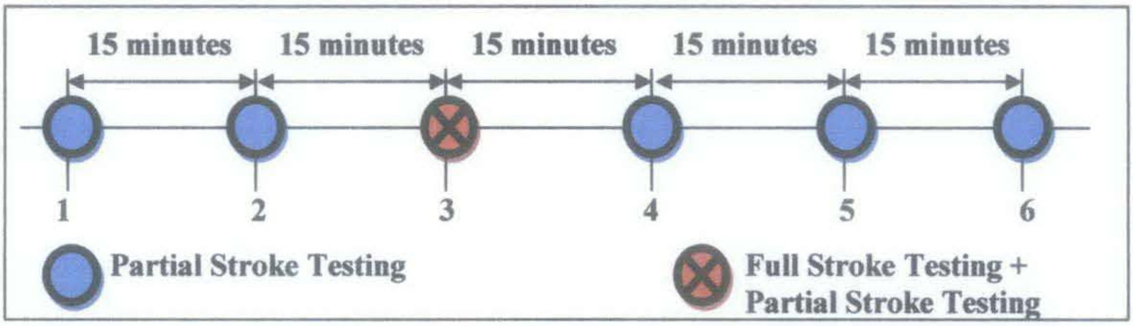


Figure 19: Testing interval for PST and FST for both valves

In this report the test result on day 77 only will be discussed in detailed. The performance of each valve will be analyzed based on the result obtained from the testing. There are four elements that will be taken into consideration in analyzing the performance of the ESD valve:

- Valve Test – PST and FST
- Breakaway Pressure
- Load Factor
- Pneumatic Test

The results of valve test determine packing problems, leakage in the pressurized pneumatic path to the actuator, valve sticking and actuator spring rate. The data points collected during partial stroke test will provide information about initial inertia force, required pressure to actual movement of valve travel, and sticking in shaft or bearing area.

The result for valve test has been sampled for every 10 day as in every test result the valve is showing consistence performance. There are 8 samples which are on day 1, day 10, day 20, day 30, day 40, day 50 and day 70. The sample results for Ball valve is in Appendix VII while the sample results for Butterfly valve is in Appendix VIII.

4.1 Result of Valve Test

Test Date : September 5th, 2009 (Day 77)

Valve : Metso Neles (Ball Valve and Butterfly Valve)

Time : 9:10 am – 10:30 am

Test stroke size: 20%

Pressure step : 0.05 Bar

4.1.1 Full Stroke Test (FST)

FST is done on the third stroke at the same time with PST for both valves. At the beginning, the valve received signal from the FieldCare Software to do PST. In the middle of the testing, PLC then sends a signal to the valve to do FST at the same time. Based on the observation, the valve followed the PLC instruction and started to do FST. The valve ignored the instruction given by the FieldCare Software and performs FST which the valve starts to close fully.

This indicates that if an emergency signal occurs during testing, ValvGuard will automatically bypasses the test procedure and performs the desired safety function. The valve will be fully close to prevent any loss to the handled media or any damage to the plan. The figures show the errors by FieldCare Software indicating that PST is failed and FST is done for Ball Valve and Butterfly Valve respectively.

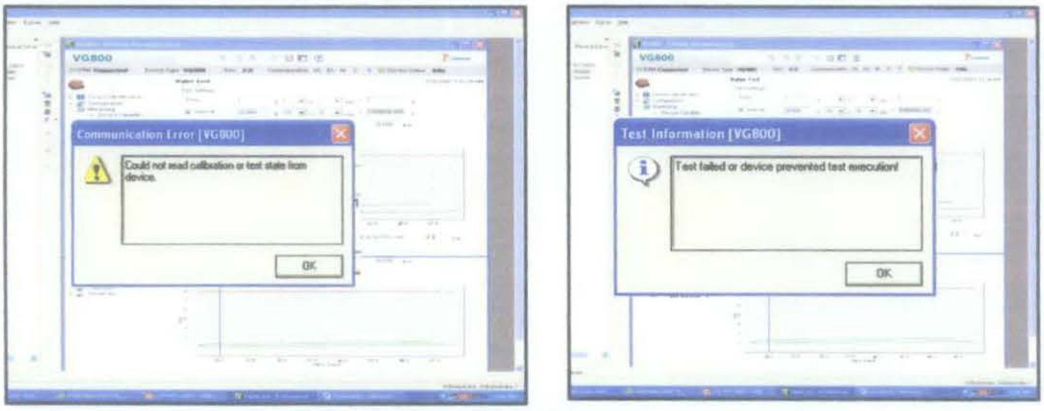


Figure 20: PST collide with FST (Ball Valve)

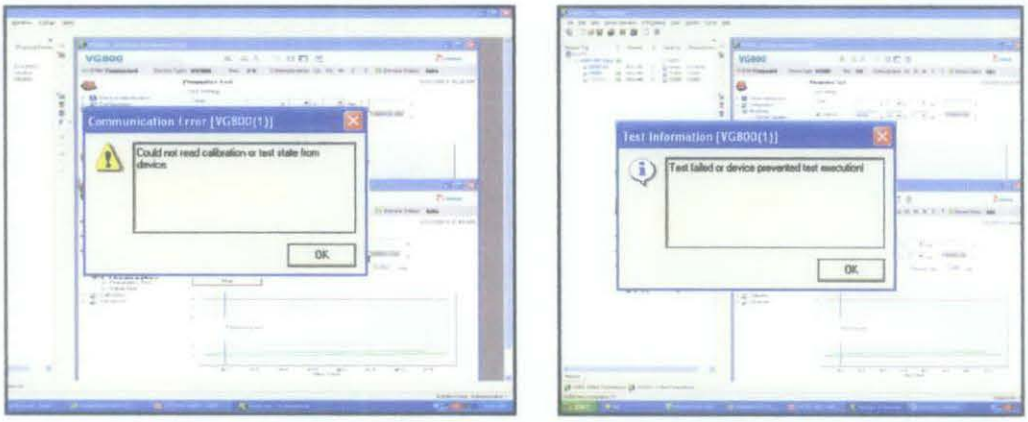


Figure 21: PST collide with FST (Butterfly Valve)

4.1.2 Partial Stroke Test (PST)

For Partial Stroke Testing, both valves are partially close by 20% of its opening with 0.05 Bar pressure step. The performance of both valves are tested and monitored automatically by using Neles ValvGuard and FieldCare software.

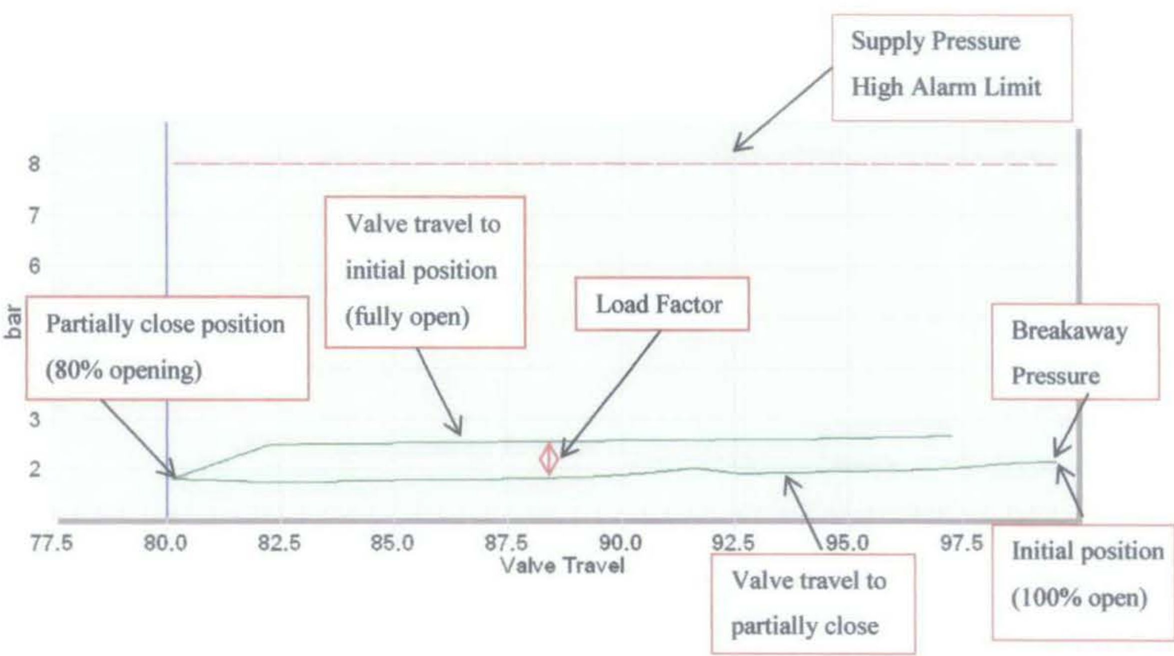


Figure 22: Valve test result of Partial Stroke Testing

4.1.2.1 Partial Stroke Test for Ball Valve

Observation:

First Partial Stroke Testing:

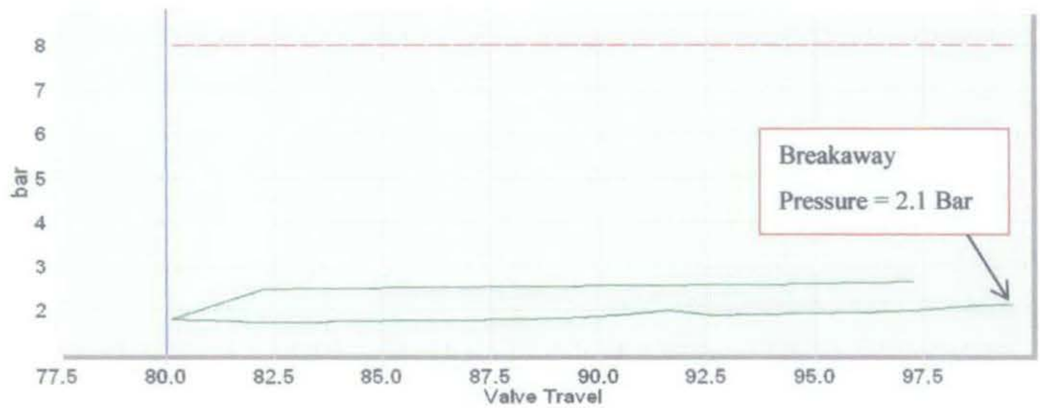


Figure 23: First Stroke of Ball Valve

Ball valve is closed partially by 20% during the testing and then returned to its initial condition (fully open) after few seconds. The actuator pressure decrease as the valve is partially closing (bottom line) and increase as the valve returns to its initial position (upper line). The breakaway pressure to initially move the valve to close is 2.1 Bar. First stroke is succeed without error.

Second Partial Stroke Testing :

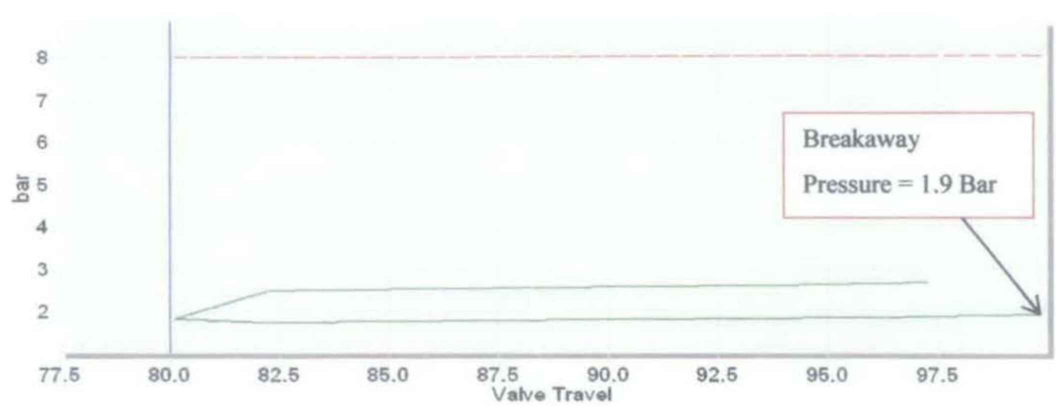


Figure 24: Second Stroke of Ball Valve

Partial Stroke Testing is programmed to be done at prefixed time intervals which is every 15 minutes. After 15 minutes, second PST is done. Breakaway pressure is 1.9 Bar. Second stroke is succeed without error.

Third Partial Stroke Testing

At the third stroke, PST is done together with FST. Since ball valve is instructed to do FST at the middle of PST, Fieldcare software will show error indicate that PST is failed as in Figure 20. This means that FST is done successfully.

Forth Partial Stroke Testing :

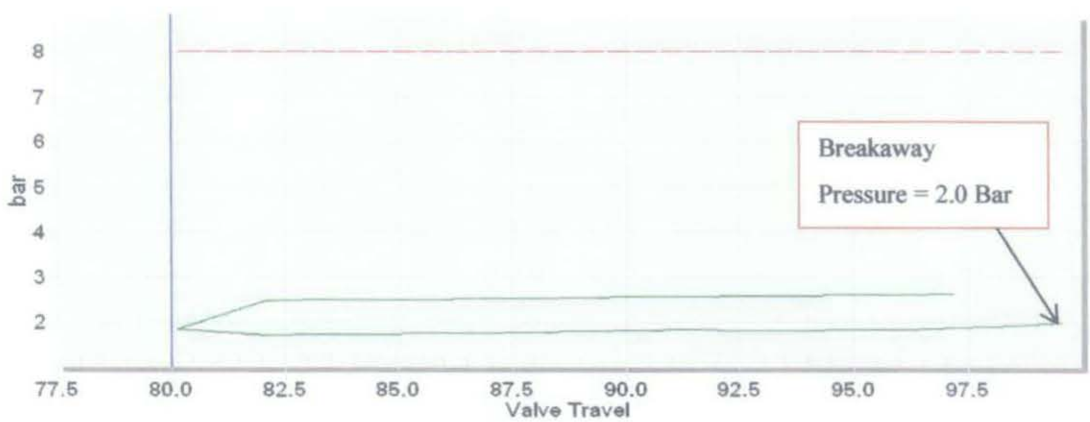


Figure 25: Forth Stroke of Ball Valve

After FST is done, the valve returns to its initial position (fully open). 15 minutes after last stroke, the valve begin to do the forth PST. The respond is the same as second PST. Breakaway pressure is 2.1 Bar. Forth stroke is done without error.

Fifth Partial Stroke Testing :

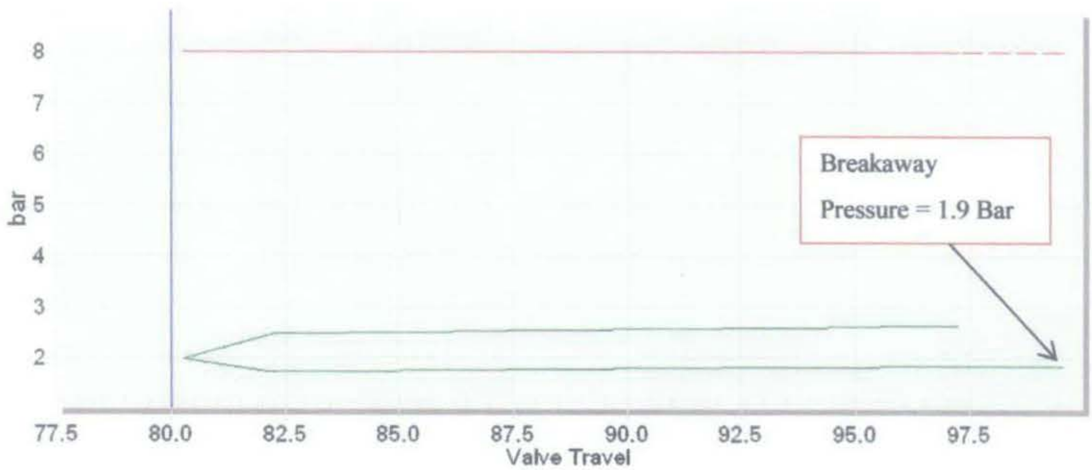


Figure 26: Fifth Stroke of Ball Valve

The result of fifth PST is the same as previous PST. The valve maintains its performance as emergency shutdown valve. Breakaway pressure is 1.9 Bar. Forth stroke is done without error.

Sixth Partial Stroke Testing :

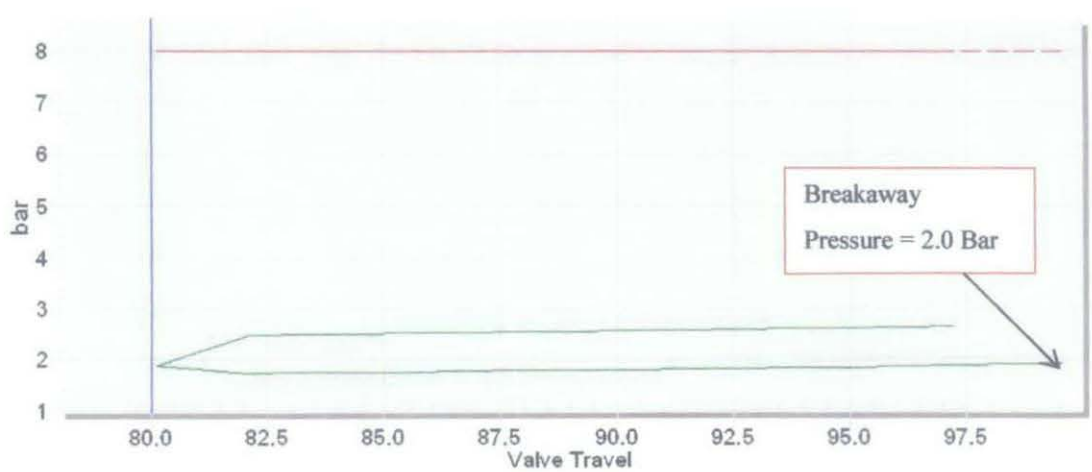


Figure 27: Sixth Stroke of Ball Valve

This is the last PST of ball valve. The response is the same with all the previous PST. Breakaway pressure is 2.0 Bar. Sixth stroke is done without error.

4.1.2.2 Partial Stroke Test for Butterfly Valve

The response for butterfly valve is similar to the ball valve, the difference is in the load factor (different in pressure when the valve is partially closing and pressure when valve is opening back), which is slightly smaller compared to Ball valve.

Observation:

First Partial Stroke Testing:

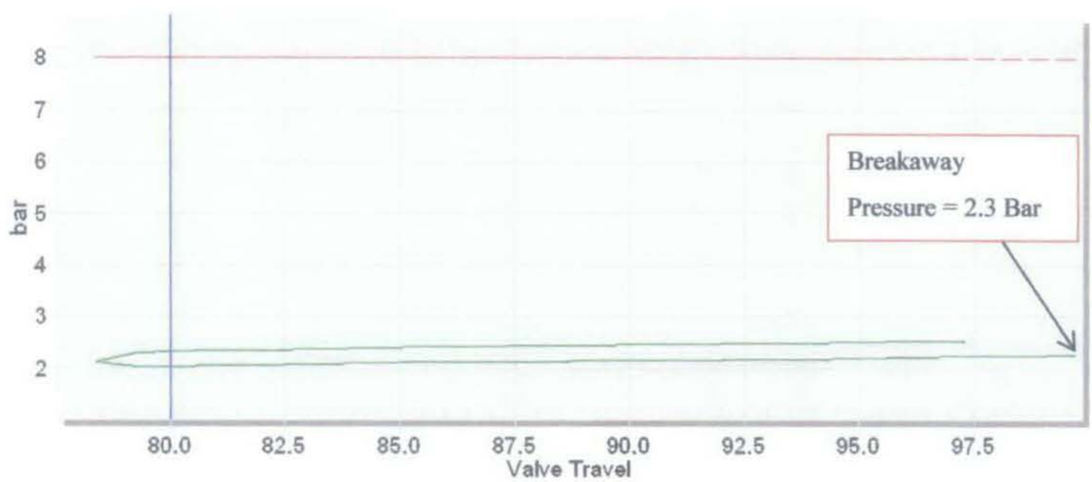


Figure 28: First Stroke Testing of Butterfly Valve

Butterfly valve is closed partially by 20% during the testing and then returned to its initial condition (fully open) after few seconds. The response is the same where the actuator pressure decrease the valve is partially closing (bottom line) and increase as the valve returns to its initial position (upper line). There is some overshoot in the movement of valve, which the valve exceed the closing by 1.5% (78.5% opening). Breakaway pressure is 2.3 Bar. First stroke is done without error.

Second Partial Stroke Testing :

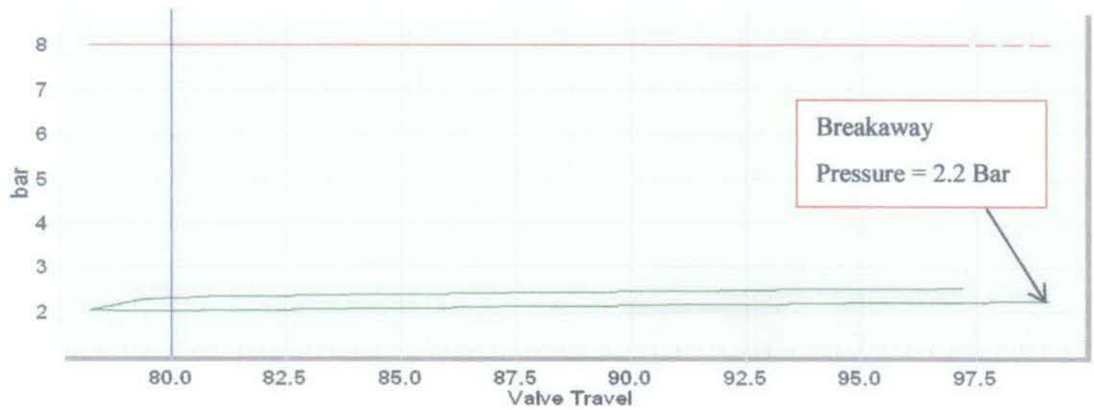


Figure 29: Second Stroke Testing of Butterfly Valve

After 15 minutes, second PST is done. The respond is the same as first PST. There is overshoot in the movement of valve, which the valve exceed the closing by 1.75% (78.25% opening). Breakaway pressure is 2.2 Bar. Second stroke is done without error

Third Partial Stroke Testing

At the third stroke, PST is done together with FST. Since butterfly valve is instructed to do FST at the middle of PST, Fieldcare software will show error indicate that PST is failed as in Figure 21. This means that FST is done successfully.

Forth Partial Stroke Testing :

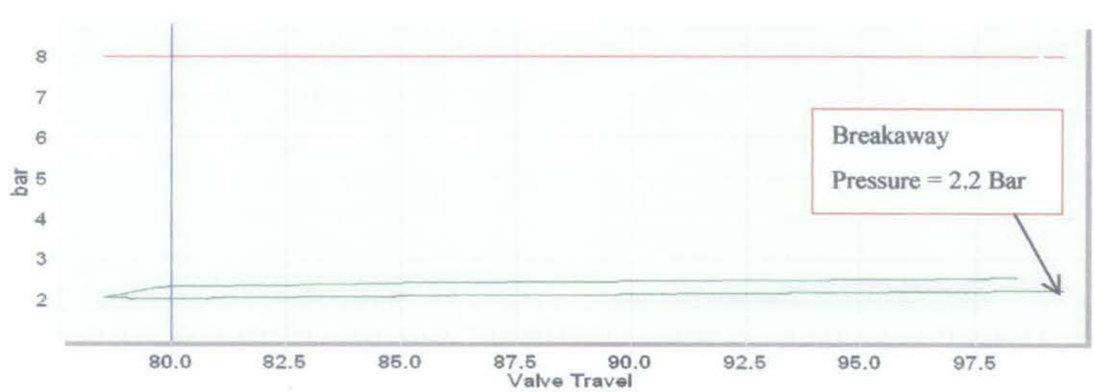


Figure 30: Forth Stroke Testing of Butterfly Valve

After FST is done, the valve returns to its initial position (fully open). 15 minutes after last stroke, the valve begin to do the forth PST. The respond is the same as second PST. There is overshoot in the movement of valve, which the valve exceed the closing by 1.5% (78.5% opening). Breakaway pressure is 2.2 Bar. Forth stroke is done without error.

Fifth Partial Stroke Testing :

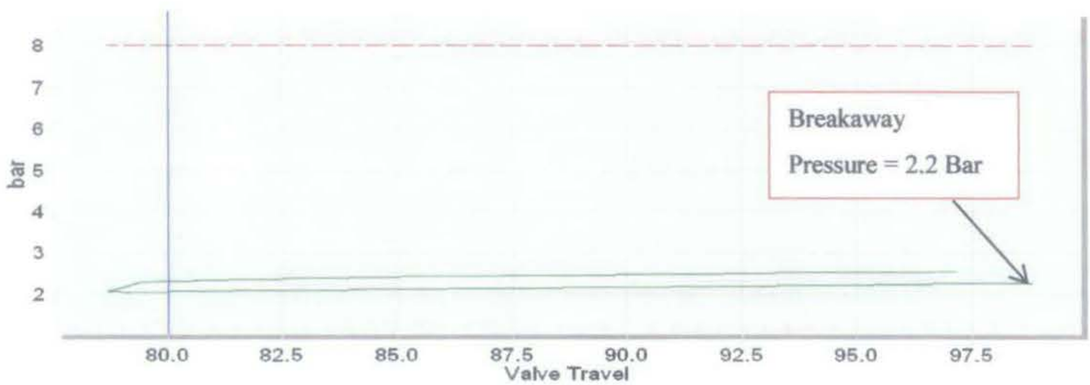


Figure 31: Fifth Stroke Testing of Butterfly Valve

The result of fifth PST is the same as previous PST. The overshoot is 1.5% exceed the closing (78.5% opening). Breakaway pressure is 2.2 Bar. Fifth stroke is done without error.

Sixth Partial Stroke Testing :

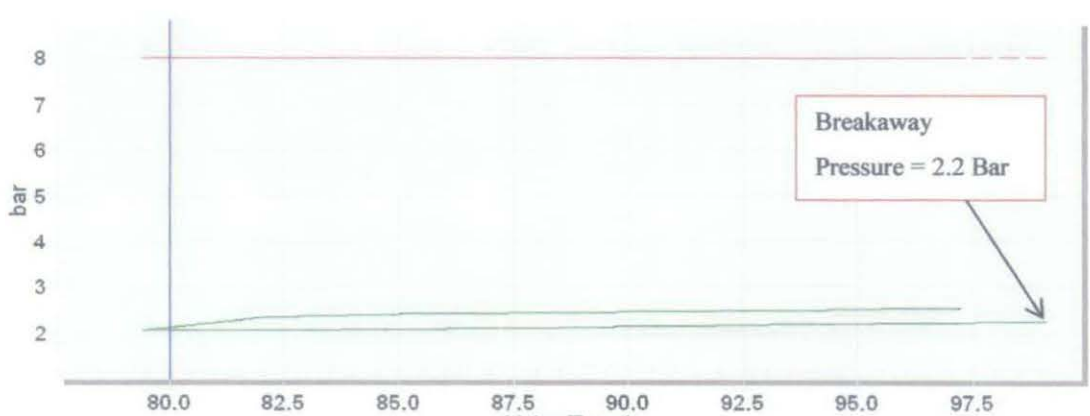


Figure 32: Sixth Stroke Testing of Butterfly Valve

Figure 32 is graph for the last PST of butterfly valve. The overshoot is slightly smaller which is 0.5% exceed the closing (79.5% opening). Breakaway pressure is 2.2 Bar. Sixth stroke is done without error.

4.1.2.3 Discussion

PST valve movement mechanism

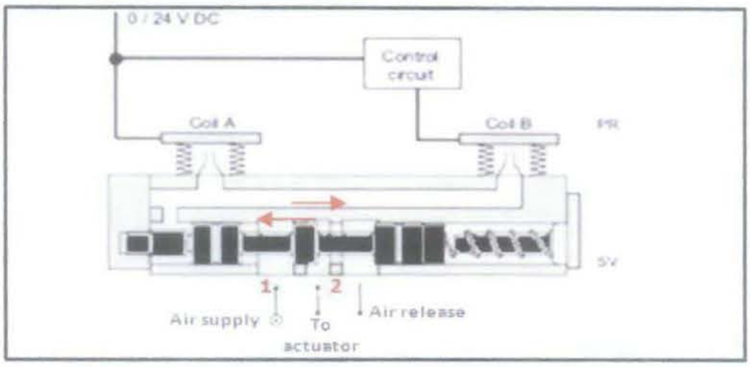


Figure 33: Solenoid Valve

The 24 VDC supply power the prestage (PR) redundant coils (A and B) which control the air pressure on the spool valve (SV) in such a position that keeps the SV return spring compressed as Figure 33 above. The SV is arranged so that the actuator air supply is maintained on the actuator in opposition to the actuator return spring to keep the ESD valve open or close. During the PST, the microcontroller in the VG800 will operate the ESD valve. The microcontroller takes power from the 24 VDC supply which is applied to PR coil (B). Microcontroller is able to isolate PR coil (B) from the power supply causing the voltage to drop to zero. This de-energizes both PR coils and vents the pressure on the SV. The SV return spring move the SV to position 1, shut off the air supply. As a result, the air inside the actuator is released. The actuator spring then closes the ESD valve. As the ESD valve begins to close, the position sensor monitors the valve position. When the valve reaches the pre programmed travel point (20% closing), the microcontroller will energizes the PR coil (B). This will compress back the SV return spring caused the SV to move to position 2. Air supply pressure is applied to the actuator which will move the valve to initial position (fully open) [12].

Graph of PST

As actuator pressure decreases, the valve travels to the closed position (20% closing), represented by the bottom line. As the actuator pressure increases, the valve open back to its initial position (fully open), represented by the upper line.

In this test, "Valve Signature" plot will be analyzed. This plot shows the integrity of the valve body and actuator assemblies. "Y" axis represents the input (Actuator Pressure) while "X" axis represent the output (Valve Travel). By plotting the data in this fashion, any increase or decrease in force can be observed by a vertical change on the graph.

At the beginning, the pressure is lower because both ESD valves are air to open valve. It requires air in order to move the valve to open position. Since the valve is initially in open position, air will be release in order to close the valve. Thus the pressure is drop. When the valve has partially closed (PST is done), it will travel back to its initial position (fully open). Air is required to open the valve back to 100%. Hence, the pressure increases. The other reason why the actuator pressure is lower when the valve is closing compared to pressure when valve is opening is to overcome the friction forces in the valve. The actuator pressure becomes higher when the valve is moving back to 100% (fully open) means that the difference in the pressures when the valve is moving to opposite directions is a direct result from the friction load in the valve.

There is no major problem arise during the testing. Based on the valve test results, the result for each stroke shows quite similar pattern and consistent between them. This means that the valves are in good condition and show reliable performance as ESD valve.

4.1.3 Breakaway pressure

The following graph is the result of Breakaway pressure for Ball valve and Butterfly valve for 77 days.

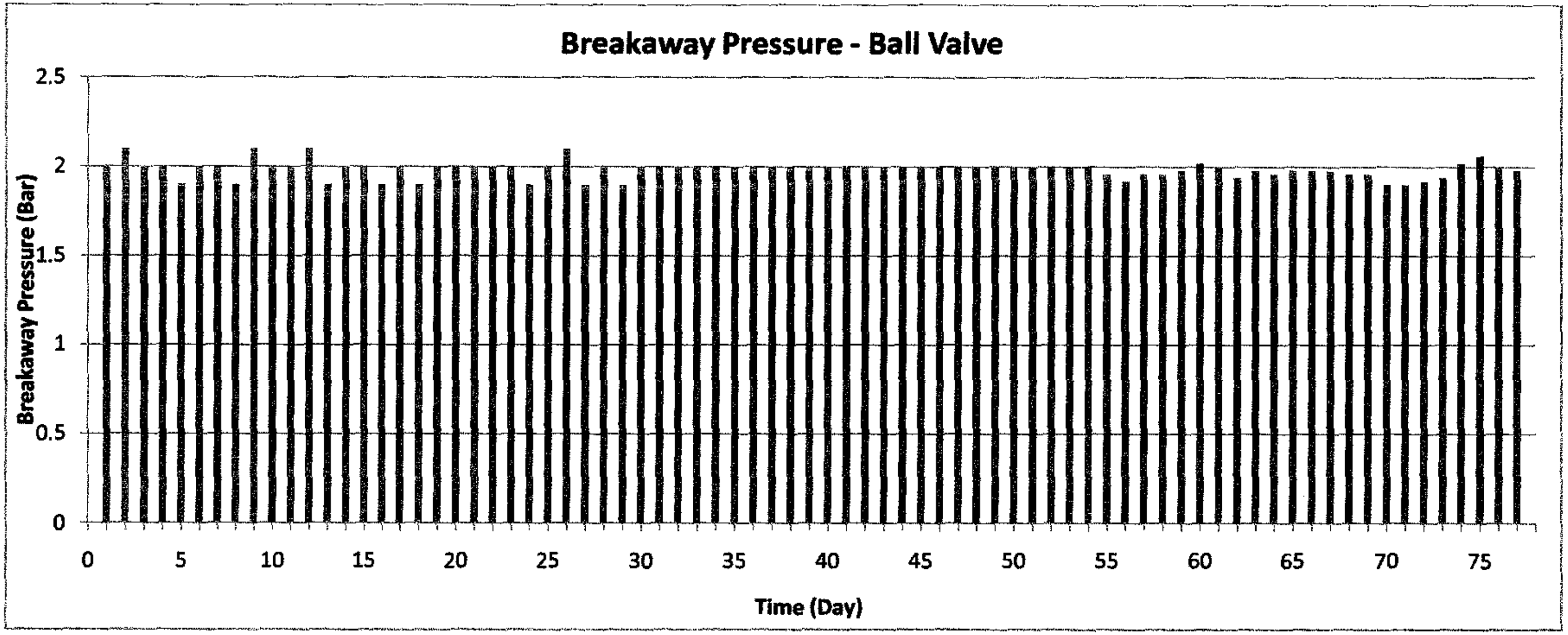


Figure 34: Breakaway Pressure for Ball Valve

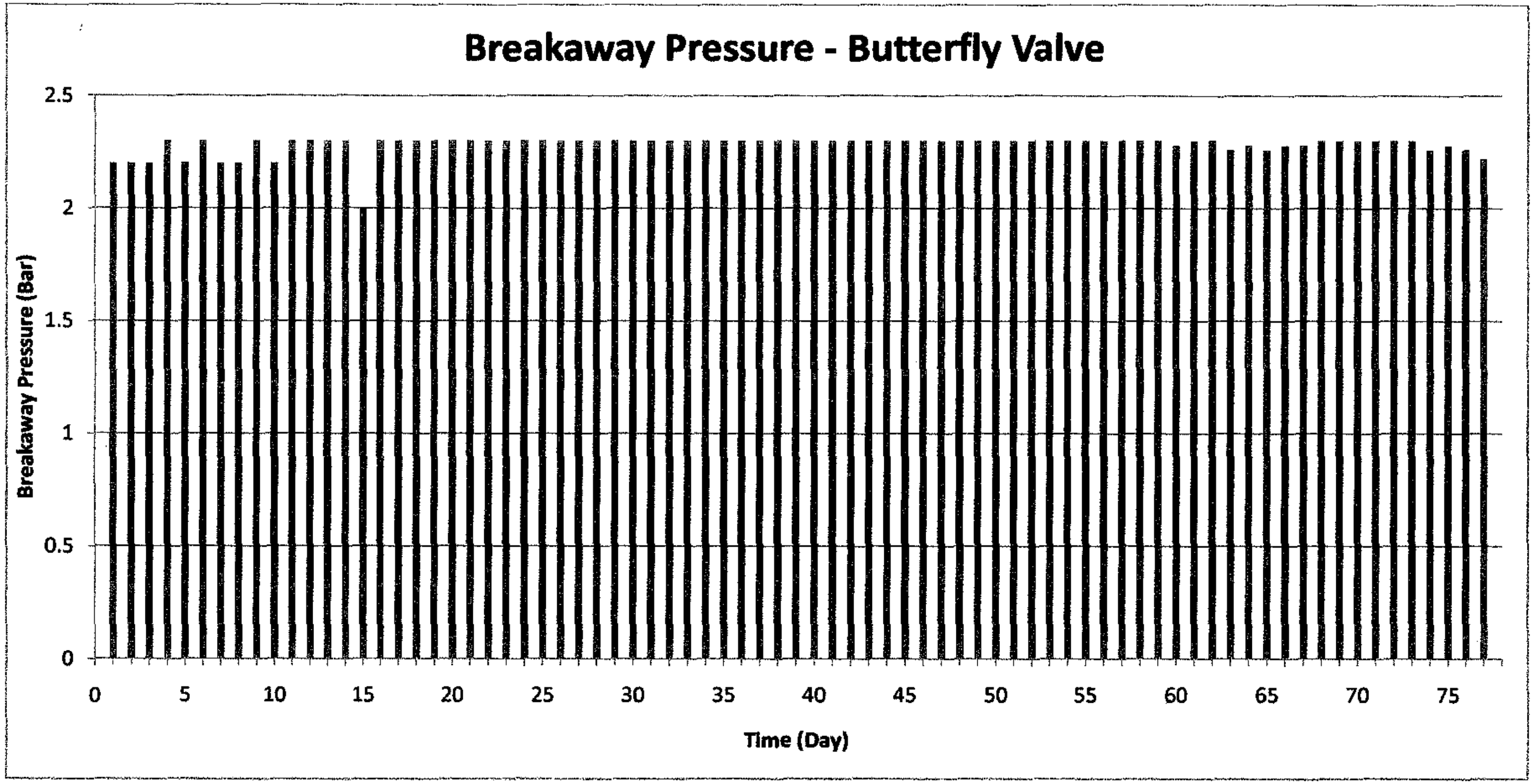


Figure 35: Breakaway Pressure for Butterfly Valve

Breakaway pressure indicates the pressure measurement level at which the valve starts to move during a valve test. The trend data is calculated and updated every time a valve test is performed. The breakaway pressure trend can be used to analyze valve load changes and predict future behavior of safety valve.

The breakaway pressure for ball valves is almost the same which is around 2.0 Bar while for butterfly valve is 2.2 Bar. This means that amount of pressure needs to be supplied in order for the valve to start to move. At the first stroke, the breakaway pressure is higher because the valve is sticky due to not been move for a while, thus more pressure is needed to overcome friction force to make it moves. For next stroke, the movement of the valve has become smooth.

4.1.4 Load Factor

Load factor is the required torque divided by the available torque. As for example a value of 6 means that 6% of the torque given by the actuator output torque is needed to open the valve. The opening load factor should be below 50 to allow some safety margin in the selection. In this report, load factor values are taken starting day 56 onwards. Below shows the load factor graph for Ball valve and Butterfly valve respectively.

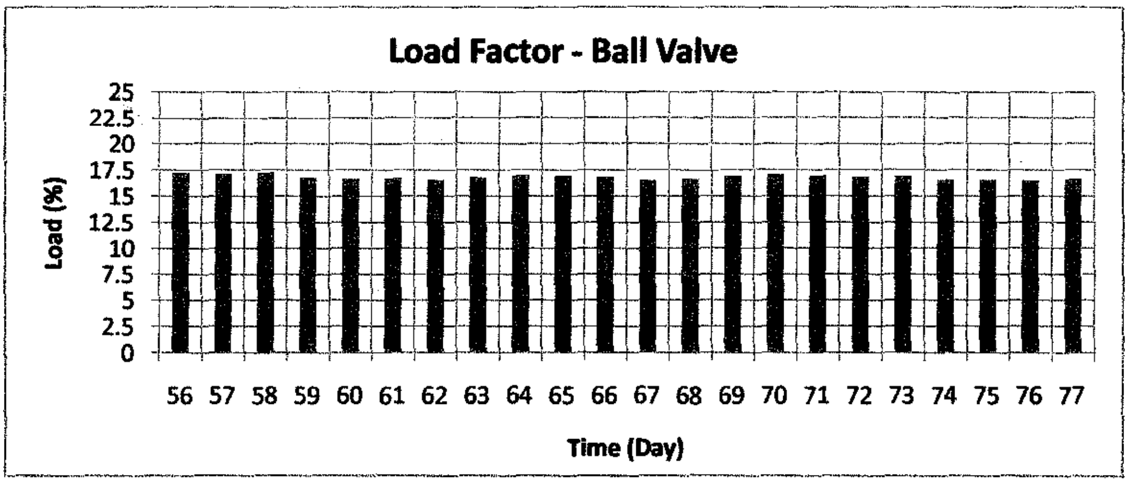


Figure 36: Load Factor for Ball Valve

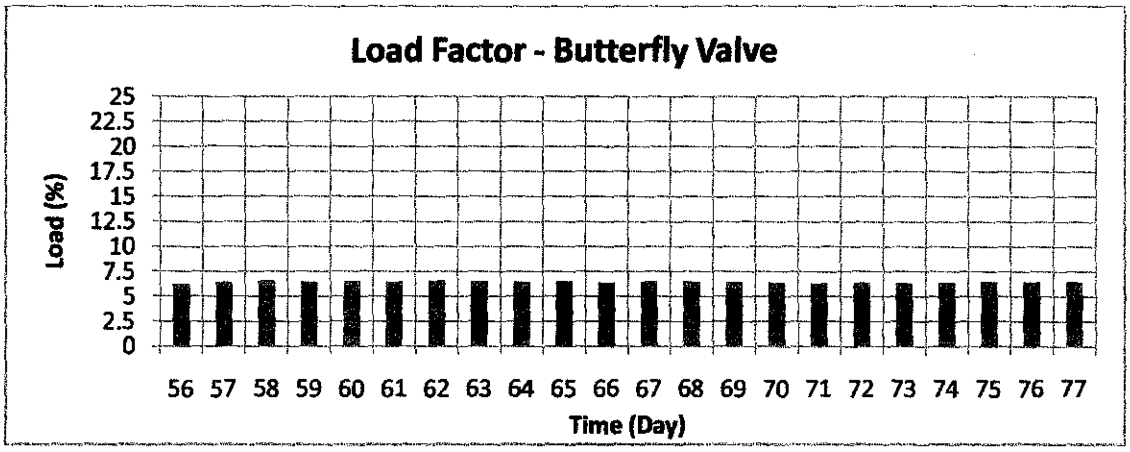


Figure 37: Load Factor for Butterfly Valve

When performing PST with ValvGuard, where additional measurements can be included, much more information can be obtained from the PST. This additional information can be used to increase the diagnostic coverage of PST. In ValvGuard in addition to the valve position measurement, there is an actuator cylinder pressure measurement, which enables to get the load factor trend graph retrieved from partial stroke test.

The load factor is calculated from PST data, which indicates the friction changes of the valve. A high load-factor value means increased friction due to an undersized actuator. This friction load is measured on every partial stroke test and stored to a history trend, comparison can be made between the valve friction load to a long time history and to the friction load when the valve was new. This gives a possibility to detect also emerging failures.

Ball valve load factor is higher because the design of ball valve which the valve is always in contact with the seats, thus it requires higher load factor to move the valve. While butterfly valve, it is only in contact with the seat when it is in fully closed position. Thus after the valve is move from fully closed position, it is easier to move the valve. As for PST, valve is in fully open to partially close, so valve is not in contact with the seat at the beginning result in lower load factor for butterfly valve.

4.2 Result of Pneumatic test

Pneumatic test measures the pressure change through the spool valve. Pneumatic test is done before PST. Pneumatic test verifies all components and the system integrity up to a change of air pressure in the actuator.

4.2.1 Pneumatic Test for Ball Valve

Observation:

First Pneumatic Test

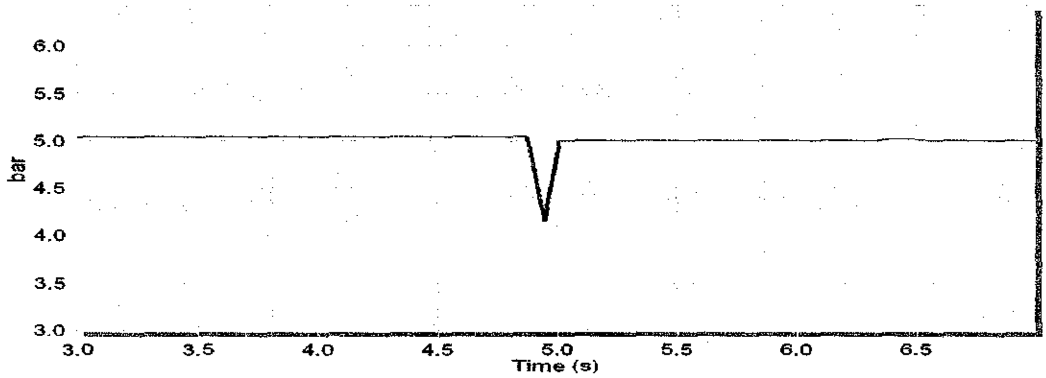


Figure 38: First Pneumatic Test of Ball Valve

Second Pneumatic Test

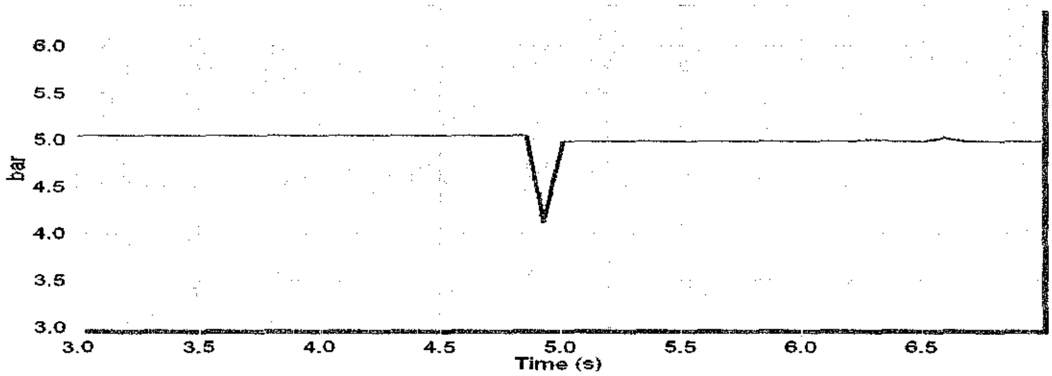


Figure 39: Second Pneumatic Test of Ball Valve

Third Pneumatic Test

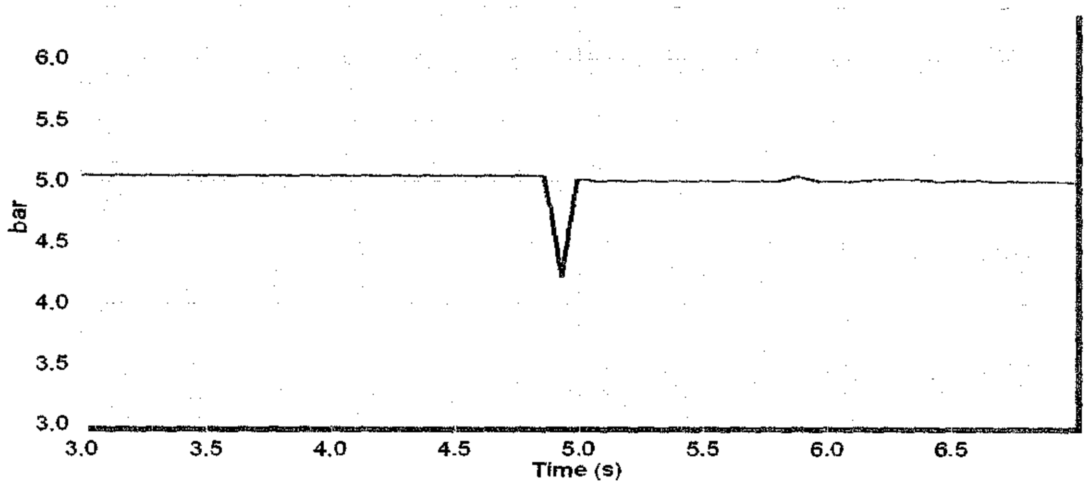


Figure 40: Third Pneumatic Test of Ball Valve

Forth Pneumatic Test

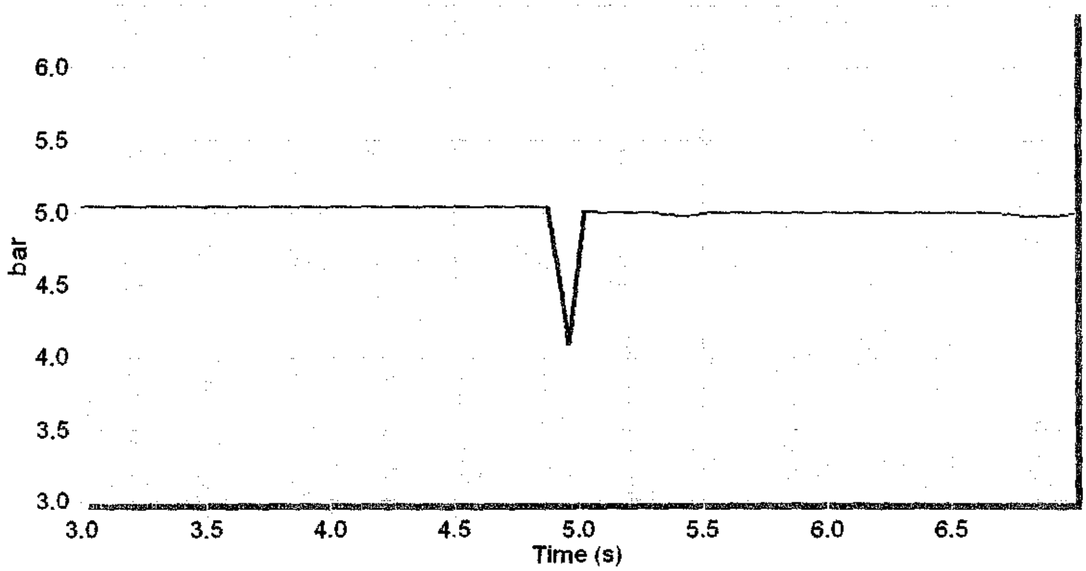


Figure 41: Forth Pneumatic Test of Ball Valve

Fifth Pneumatic Test

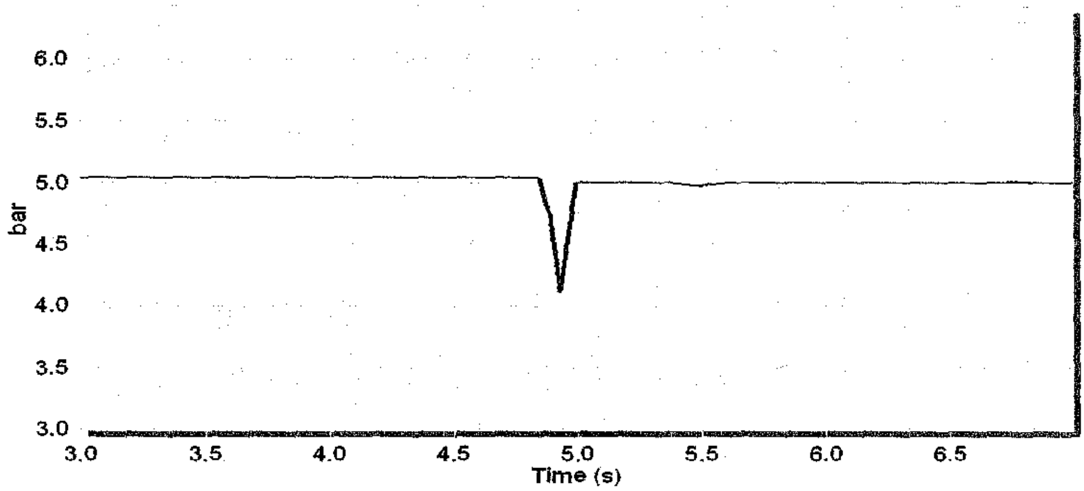


Figure 42: Fifth Pneumatic Test of Ball Valve

4.2.2 Pneumatic Test for Butterfly Valve

Observation:

First Pneumatic Test

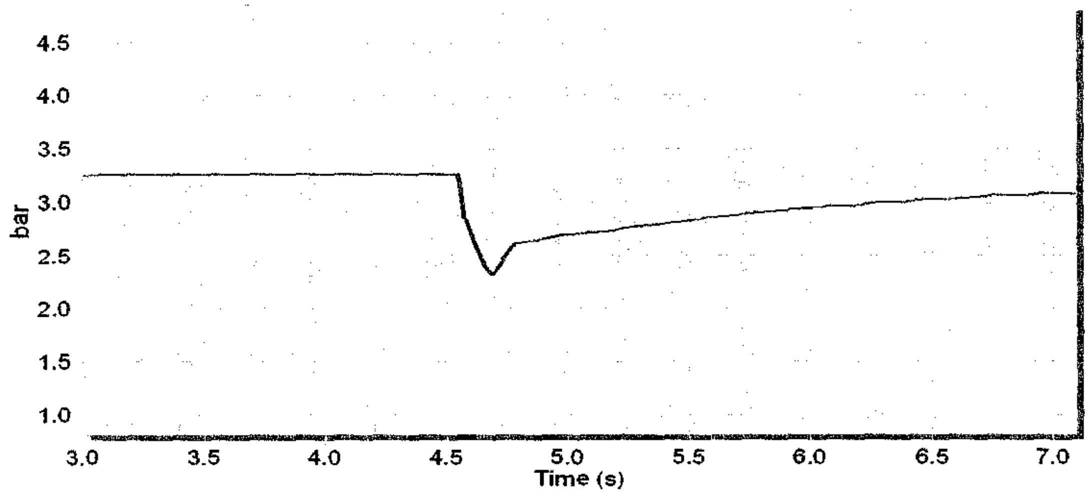


Figure 43: First Pneumatic Test of Butterfly Valve

Second Pneumatic Test

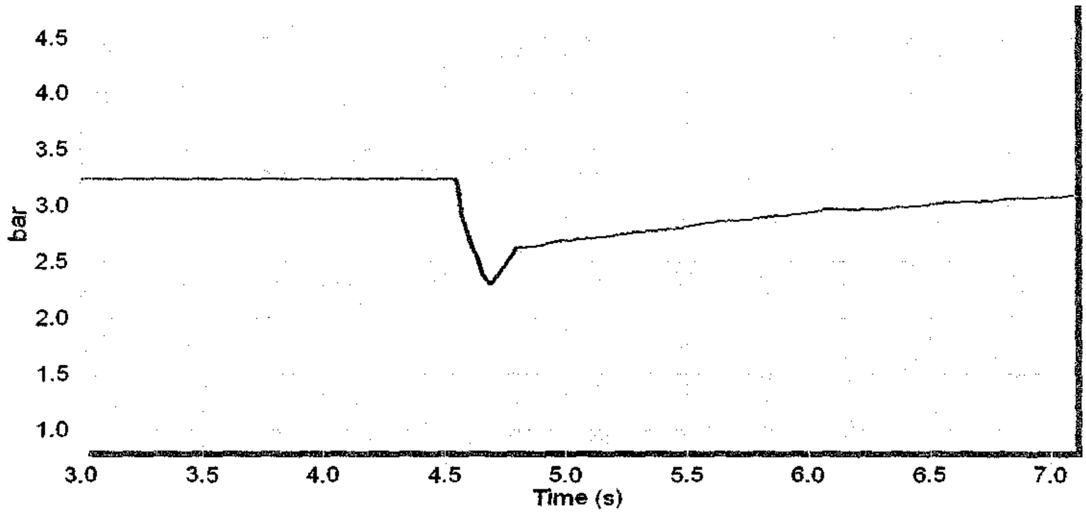


Figure 44: Second Pneumatic Test of Butterfly Valve

Third Pneumatic Test

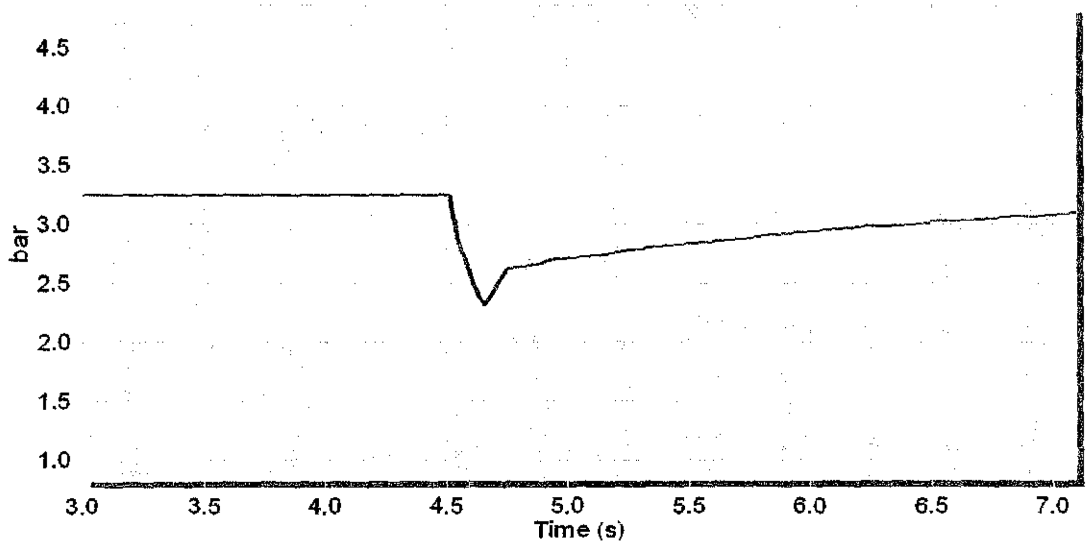


Figure 45: Third Pneumatic Test of Butterfly Valve

Forth Pneumatic Test

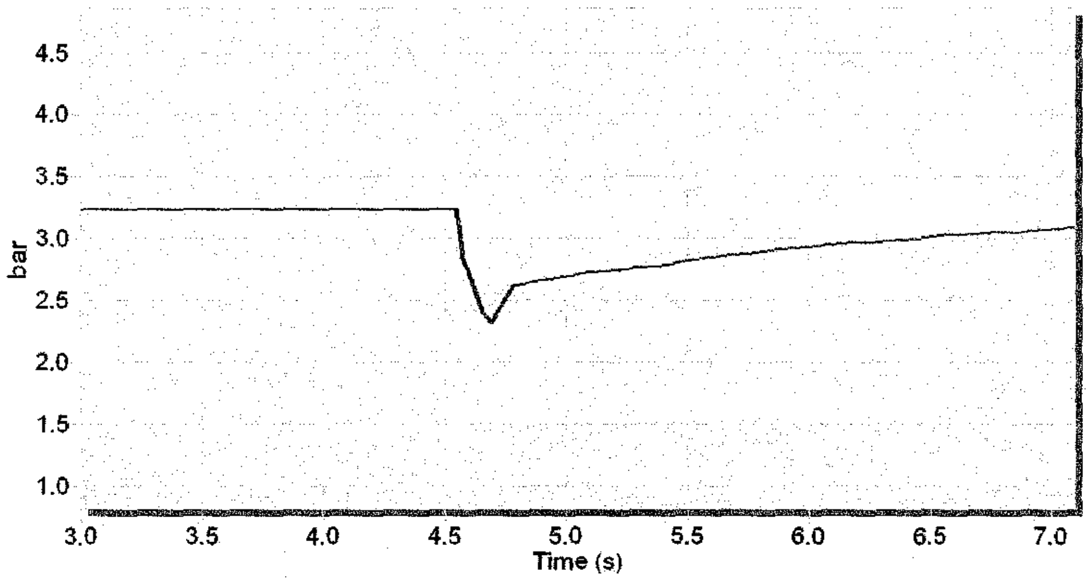


Figure 46: Forth Pneumatic Test of Butterfly Valve

Fifth Pneumatic Test

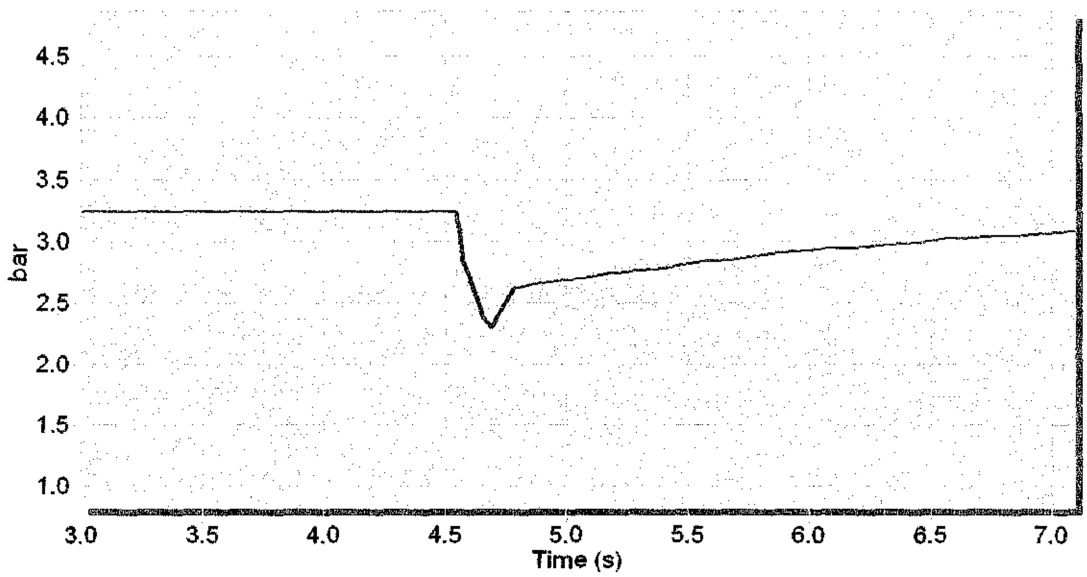


Figure 47: Fifth Pneumatic Test of Butterfly Valve

4.2.3 Discussion

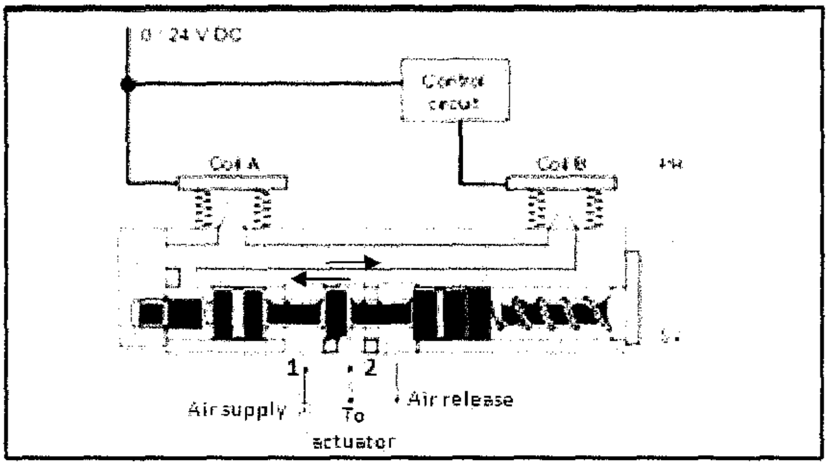


Figure 48: Solenoid Valve

The mechanism for pneumatics test is the same as PST. But pneumatics test does not involve movement of the valve. During the pneumatics test, power is switched to zero and de-energizes both PR coils and vents the pressure on the Solenoid valve (SV). The SV return spring move the SV to position 1, thus shut off the air supply and caused the air inside the actuator to be released. The release of air caused pressure to drop. Pressure sensor will sensed the pressure drop and activate the control circuit. Coil B is energized, compress back the SV return spring and caused the SV position to move to position 2. Air supply pressure is applied to the actuator which will increase back the pressure to its initial value [12].

The SV is pulsed for a split second but it is long enough so that the SV vents (verification that the solenoid valve is functional) and short enough so that the pressure will not drop until reaching its breakdown pressure that will cause the valve to move.

Pressure change through the spool valve is normal. It indicates that air pressure in the actuator is normal and all components are in a good condition.

4.3 Problem Encounter

During the project period, there are some problems occurred. The problems are:

1) Connection problem
2) Ball Valve error

4.3.1 Connection problem

The problem occurred after the contractor has installed the cabinet for all the wiring and devices. HART server cannot detect valvGuard (VG800) for both valve, thus there is no communication establish between computer and the VG800. While at FieldCare Software, it give error message indicate that the devices are not found. As a result, no testing can be done. This is caused by the wrong connection for RCI. So the VG800 cannot communicate with the HART Server. After the wiring connection is being corrected, the HART Server can detect both ValvGuard and testing can be done.

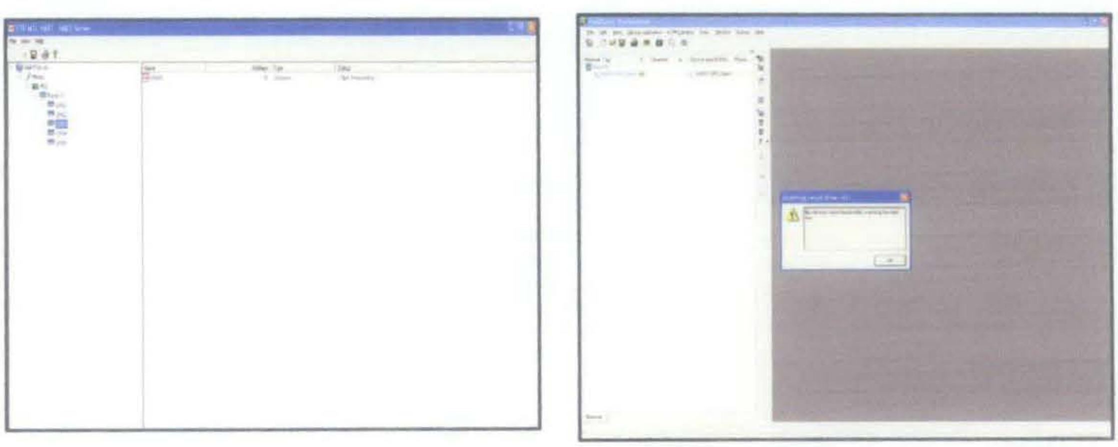


Figure 49: HART and FieldCare Error Identification

4.3.2 Ball Valve Error

On September 6th, 2009, ball valve gives error indicates that the PST is failed and Pneumatics Test is failed as in figure 51 and Figure 51. The engineers from Metso have come down to UTP to resolve the error. The problem is on the VG800 devices itself. So they have replaced the VG800 for ball valve with the new upgraded version of ValvGuard which is VG9000.

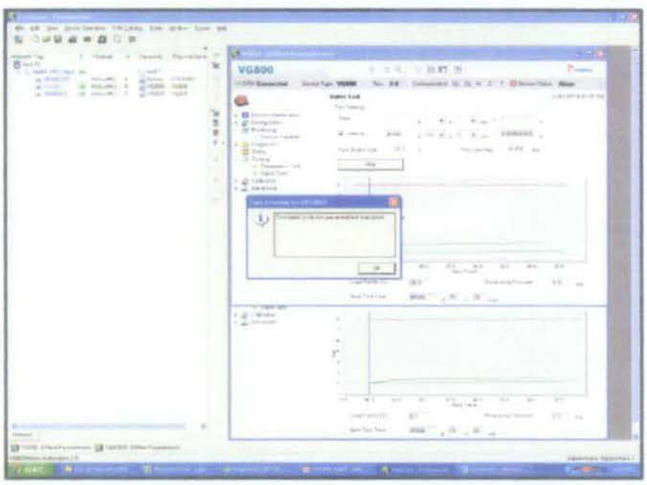


Figure 50: FieldCare indicates PST is Failed

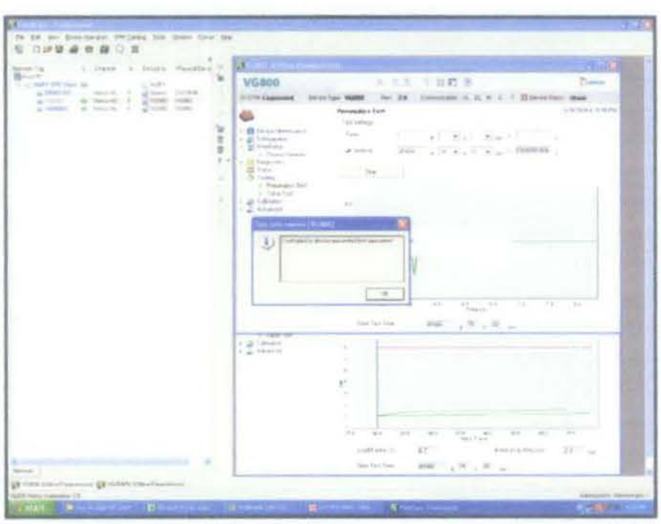


Figure 51: FieldCare indicates Pneumatics Test is Failed

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The first objective which to conduct a study on the performance of partially stroked on two different valves with 10% - 20% opening is completed. Neles ValvGuard and FieldCare software are used to conduct PST and monitoring system for Emergency Shutdown (ESD) valve. Ball valve and Butterfly valve are being tested for six times at interval time 15 minutes between each stroke in order to monitor the performance and consistency of the valves as ESD valves. PLC is used to conduct FST at the same time PST is been conducted. This to ensure that the valve will perform its safety functions when hazards occur. Final elements are moving mechanical devices, which operate in very difficult environmental conditions. This makes the need for regular valve testing and for testing while the process is running absolutely essential. Thus it can be conclude that PST can be a good complement to FST as it can be done without interfering with production and the process flow rate will not be affected.

From the result of valve test and pneumatic test, the graph and data obtained are valve travel graph, pneumatic test graph, load factor and breakaway pressure. These graphs are used to analyze the performance of the ESD valve. It can be conclude that the valve is in good condition and can perform as safety valve without faulty. Metso Neles has met the PETRONAS requirement for PST on ESD valves.

As PETRONAS policies, every new technology must be tested first before it can be implemented. Rather than conduct it in industry, the more convenient way is use third party as it is independent from the plant and further development can be done. Thus this project is done based on that reason.

5.2 Recommendations and Future Work

The air tubing for ball valve is small compared to its actuator size. The air tubing size for ball valve should be bigger so that the supply air is enough and the valve will move faster. As for now, ball valve takes longer time compared to butterfly valve for valve closing and opening.

Phase I will be completed at the end of November 2009. Comparison between each vendor's software will be made in order to obtain the best software to be implemented at the plant to conduct PST. However, there is no guideline of the criteria performance that is required by PETRONAS. Thus, it is difficult for students to do comparison between valves from different vendors since there are some limitations with the vendors' software. It would be helpful if PETRONAS could provide students the guideline so that the accurate comparison can be made.

Future Work for this project is the testing for Full Stroke and Partial Stroke Testing will be continued to complete phase I which is minimum 90 days of testing that required by PETRONAS. Currently there are 77 days of testing which include Valve Test and Pneumatics test. The performance of Emergency Shutdown Valve will be analyzed and compared from first day through 90 days of testing. Besides that, comparison with other vendors will also be made.

Phase II will start once Phase I is completed. The failures mode of the valves during the test period will be studied for further improvement of the project. Additional testing that required by PETRONAS will be conducted.

REFERENCES

[1] Sintef; Offshore Reliability Data Handbook; OREDA; 2002.

[2] Janne Laaksonen, Metso Automation, "SA Instrumentation & Control", *Automatic partial stroke testing prevents disasters,* September 2005

[3] *Improving Processing Plants Safety with Smart Emergency Valves and Web-Based Data Collection and Distribution.* http://www.sipi61508.com/ciks/makinen1.pdf

[4] *Partial-Stroke Testing of Safety Block Valves.* http://www.controleng.com/article/CA190350.html

[5] Juha Yli -Petä ys, "Flow Control ", *The value of safety valve,* Automation 3, 2008

[6] *Partial-Stroke Testing Of Block Valves.* http://www.sis-tech.com/downloads/partial stroke testing of block valves.pdf

[7] *Emergency shut-off valves (ESV).* http://flow-control.globalspec.com/IndustrialDirectory/ emergency_shut_down_valve

[8] *Shut down valve.* http://en.wikipedia.org/wiki/Shut_down_valve

[9] *More about Ball Valves.* http://www.thomasnet.com/about/ball-valves-90370206.html

[10] *Butterfly valve.* http://en.wikipedia.org/wiki/Butterfly_valve

[11] Mary Ann Lundteigen , Marvin Rausand., "Journal of Loss Prevention in the Process Industries", *Partial stroke testing of process shutdown valves: How to determine the test coverage,* Vol. 21, Issue 6, November 2008, pp. 579-588

[12] Metso Automation Inc. "Neles ValvGuard™ System, Series VG800B", *Installation, Maintenance and Operating Instructions, 9VGB70en,* Issue 8/05, Rev. 2.0

APPENDICES

APPENDIX I

Gantt Chart

Gantt chart for Semester 1

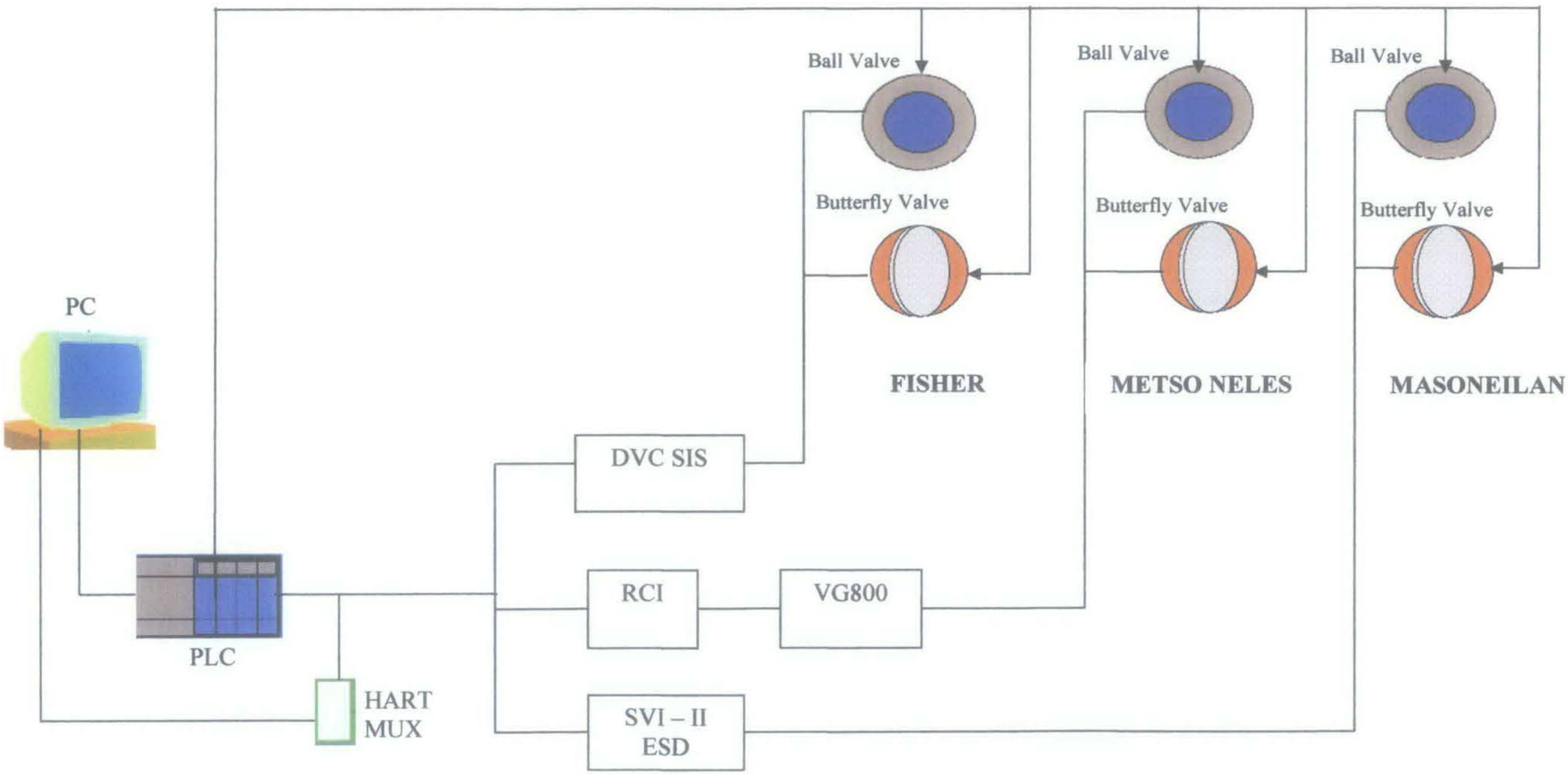
No	Activities / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic														
2	Data Gathering on Topic														
3	Submission of Preliminary Report														
4	Testing procedures and requirement identification														
5	Conduct testing (FST and PST)														
6	Submission of Progress Report														
7	Seminar														
8	Results 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	Planning for Semester 2 – any Improvement or additional testing														
2	Continue testing (FST and PST)														
6	Results Gathering & Discussion														
7	Submission of Progress Report 2														
8	Seminar														
9	Conclusion and Recommendation														
10	Poster Exhibition														
11	Submission of Dissertation (Draft)														
12	Oral Presentation														
13	Submission of Dissertation (softbound)														

APPENDIX II

Project Layout

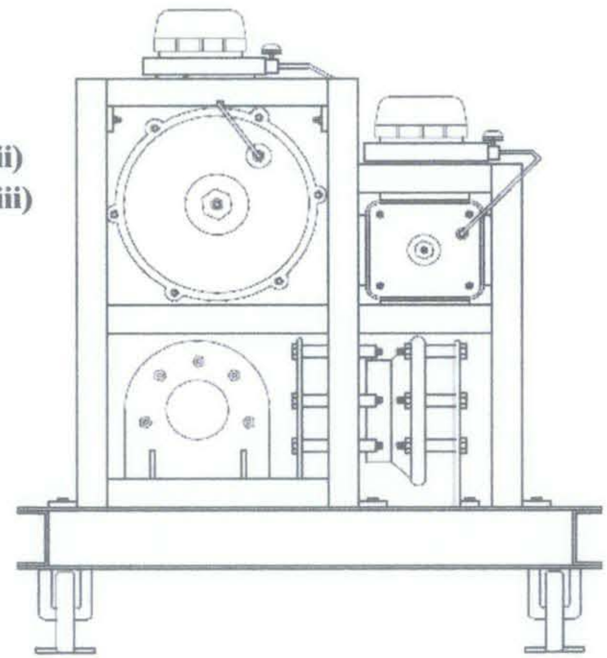


APPENDIX III

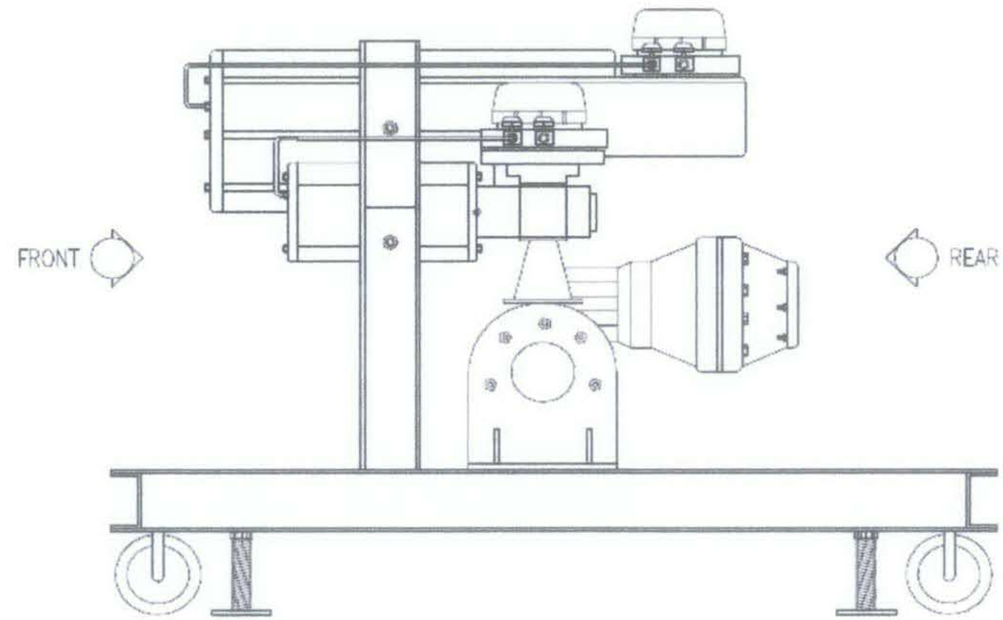
Loop Drawing

i) **External Skid Troley Layout – Metso Neles ESD Valve**

ii)
iii)

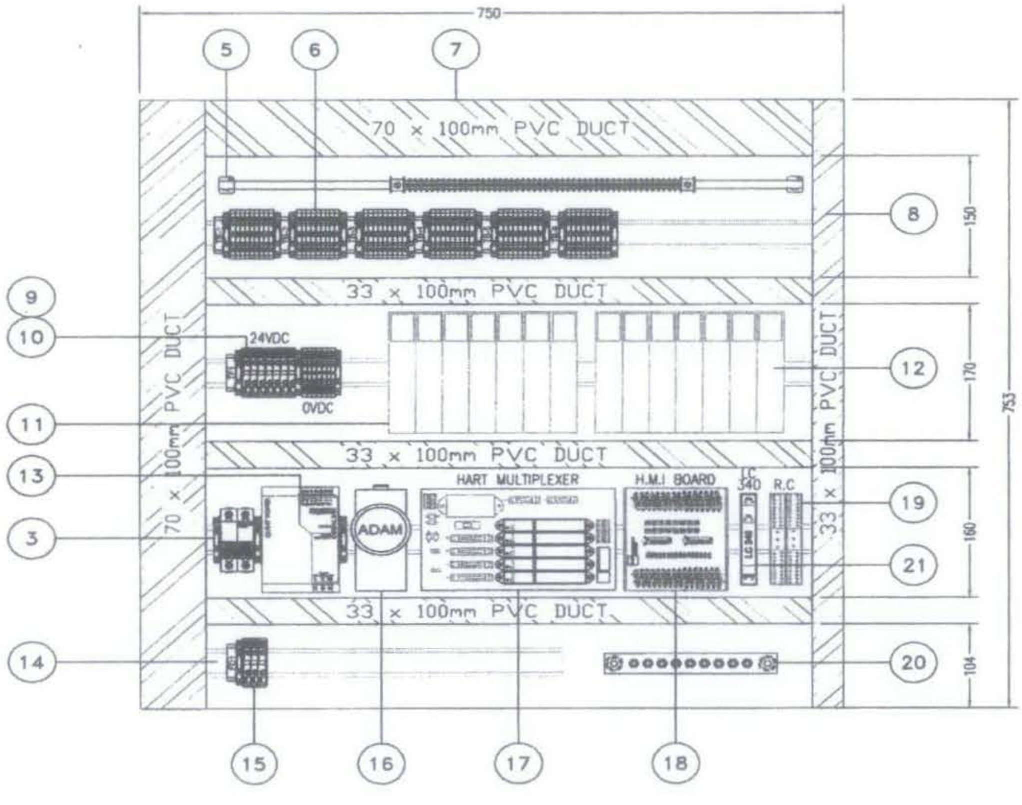


FRONT VIEW



SIDE VIEW

ii) Partial Stroke Valve Control Panel Layout



FRONT VIEW WITH OUT DOOR

BILL OF MATERIALS			
ITEM	DESCRIPTION	PART/MODEL NO.	QTY
1	METAL ENCLOSURE (800(H) x 800(W) x 260(D))	CVS	1
2	ISOLATOR	MERLIN GERIN	1
3	MCB - 2P,6A	MERLIN GERIN	4
4	FAN	LOCAL	2
5	INSTRUMENT EARTH BAR	LOCAL	1
6	TB-1 to TB-6 - WDU2.5	WEIDMULLER	54
7	70MM x 100MM - TRUNKING (GREY)	KSS	2
8	33MM x 100MM - TRUNKING (GREY)	KSS	4
9	TERMINAL BLOCK (24VDC) - WSI6	WEIDMULLER	7
10	TERMINAL BLOCK (0VDC) - WTR2.5	WEIDMULLER	7
11	PLC	-	1
12	PLC (SPARE)	-	1
13	110-240VAC/24VDC POWER SUPPLY (10A)	PHOENIX CONTACT	1
14	DIN RAIL	LOCAL	4
15	TERMINAL BLOCK (INCOMING) - WDU6	WEIDMULLER	3
16	CONVERTER	ADAM	1
17	HART MULTIPLEXER	-	1
18	HART MULTI INTERFACE BOARD	-	1
19	REMOTE COMMUNICATION	-	2
20	SAFETY EARTH BAR	LOCAL	1
21	LC 340	-	1

MANUFACTURER : ICPE Your Industrial Solutions — I. C. P. E SDN. BHD, 56, Jalan Harmoni 5, Taman Sungai Pinang, 42100 Klang, Selangor D. E.

REV	DATE	DESCRIPTION
1	04-08-09	PRELIMINARY PROPOSAL DRAWING
2	13-08-09	AS BUILT

CLIENT : UNIVERSITI TEKNOLOGI PETRONAS

DRAWN	: ANIE
DESIGNED	: MR
APPROVED	: KHAIRUL
SCALE	: N.T.S
PAPER SIZE	: A4

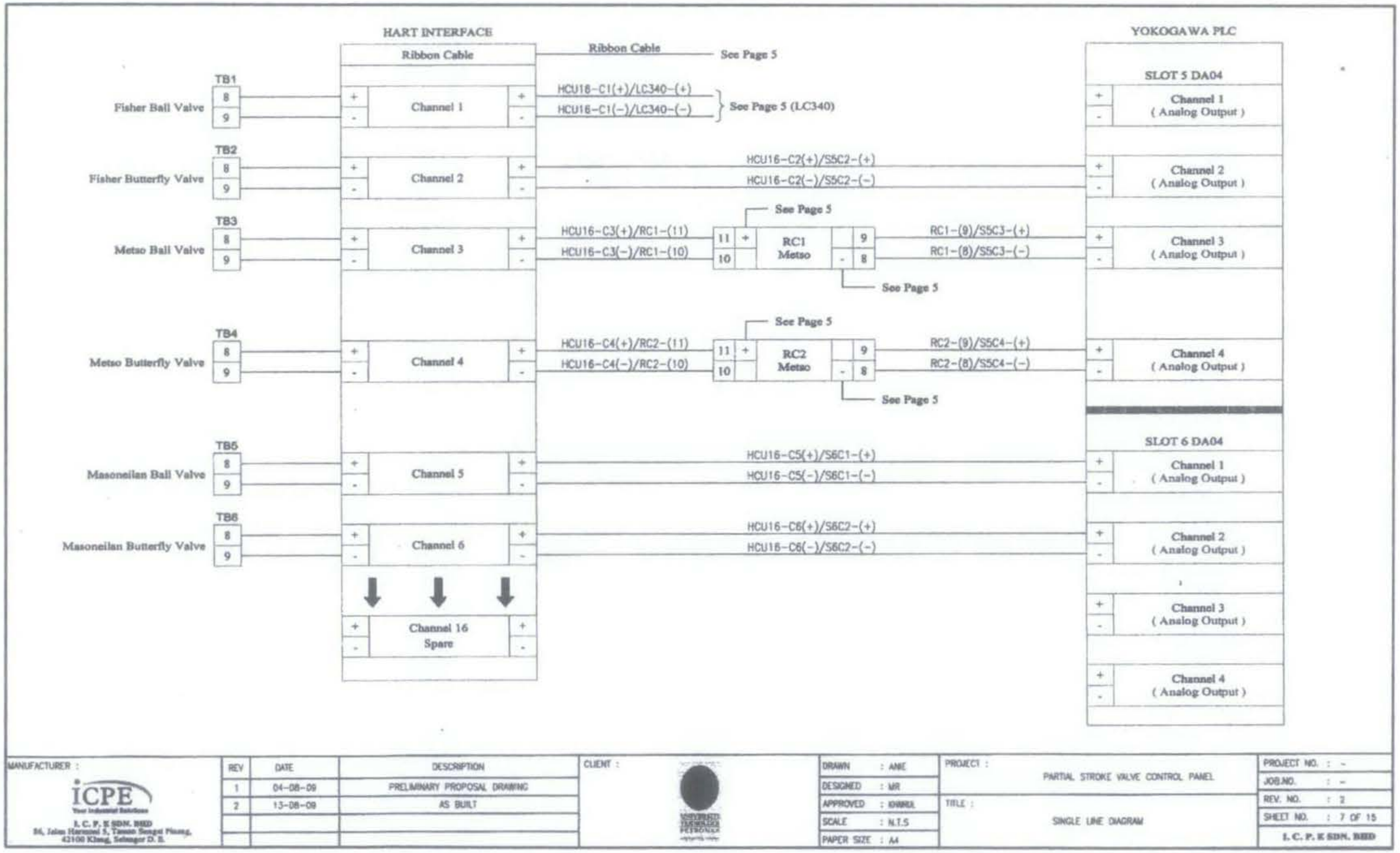
PROJECT : PARTIAL STROKE VALVE CONTROL PANEL

TITLE : CONTROL PANEL DETAILS LAYOUT

PROJECT NO.	: -
JOB.NO.	: -
REV. NO.	: 2
SHEET NO.	: 10 OF 15

I. C. P. E SDN. BHD

iii) Single Line Diagram

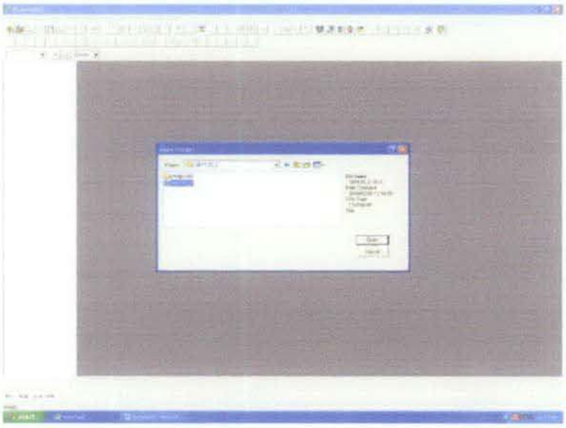


APPENDIX IV

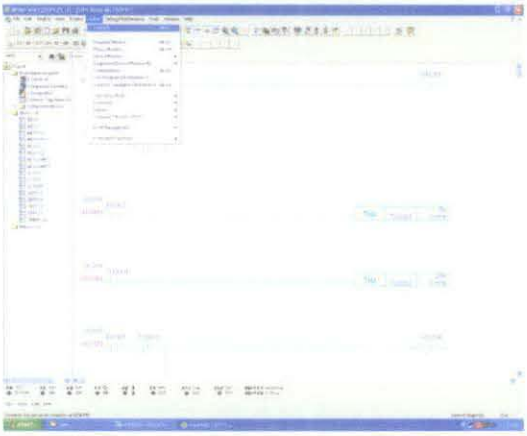
Testing Procedures for Full Stroke Testing (Widefield2 Software)

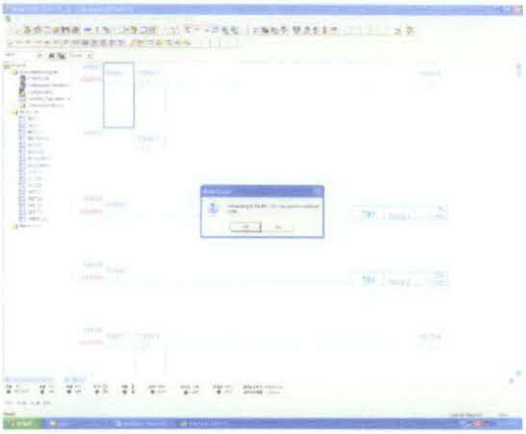
Widefield2 software is used for Full Stroke Testing. PLC is used to force the valve to fully open or close.

1) Open widefield2 software. Open project > SEPT25_2

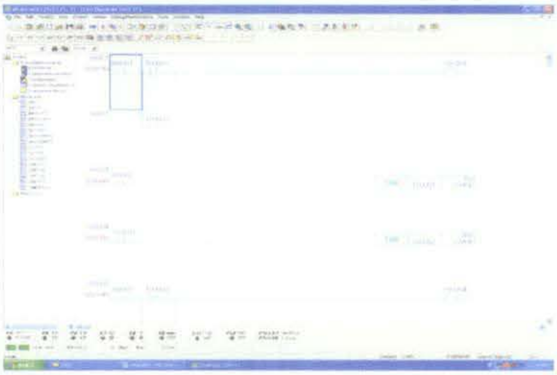


2) METSOFT > online > connect

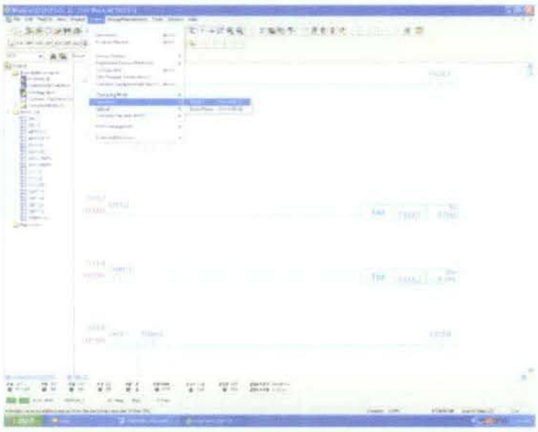


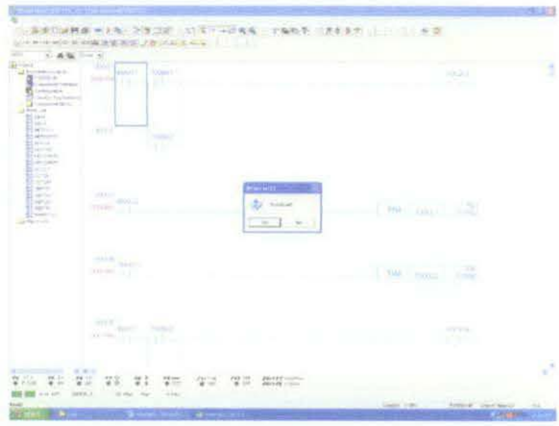


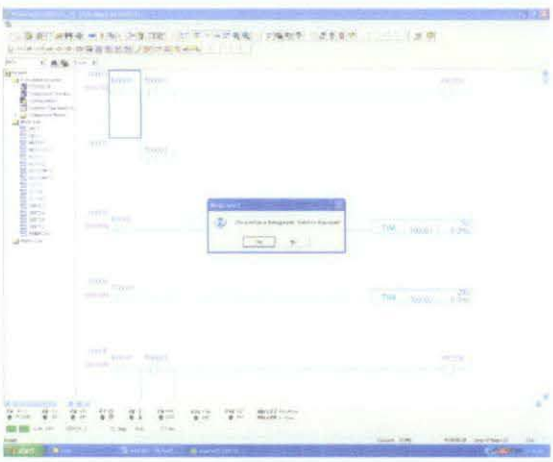
The PLC is on ready and run

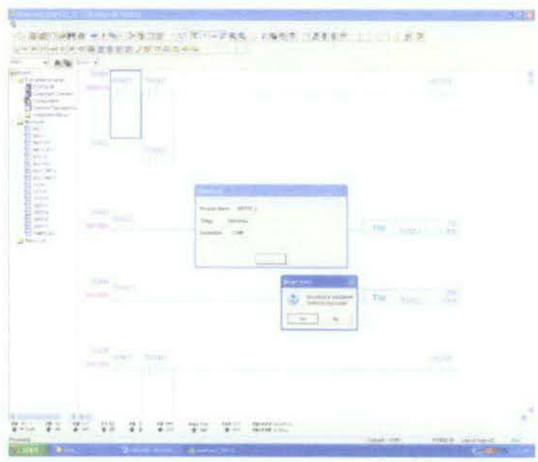


3) Download project



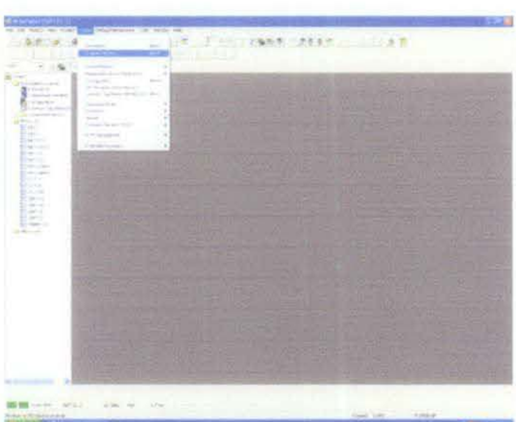


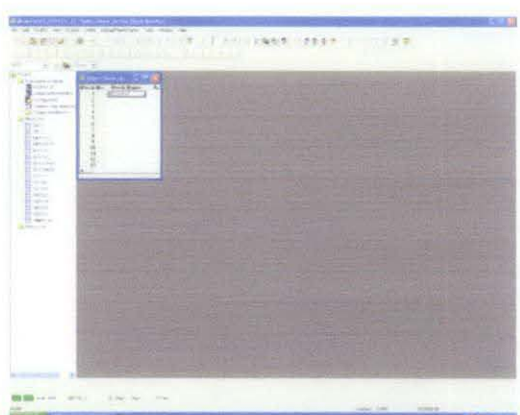




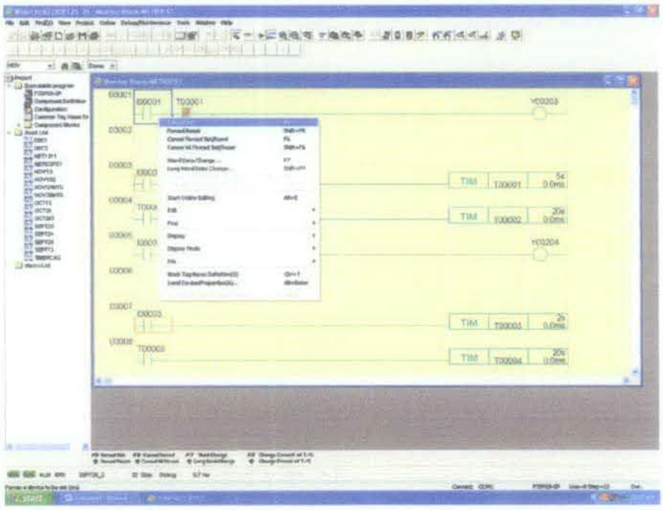
Download is completed and switch to run mode back

4) Program Monitor > to monitor the PLC

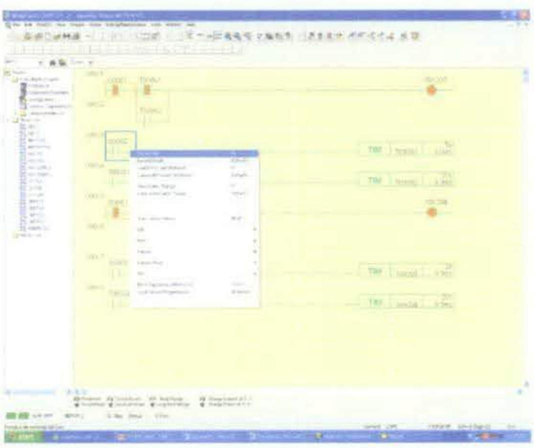


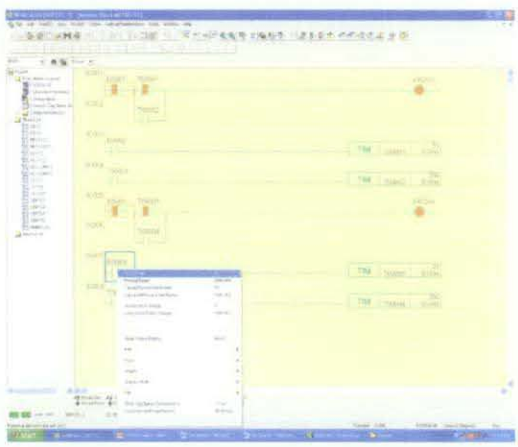


5) Forced set the I0001 to fully open the valve. Valve initially in closed position, have to fully open it in order to do the Partial Stroke Testing.

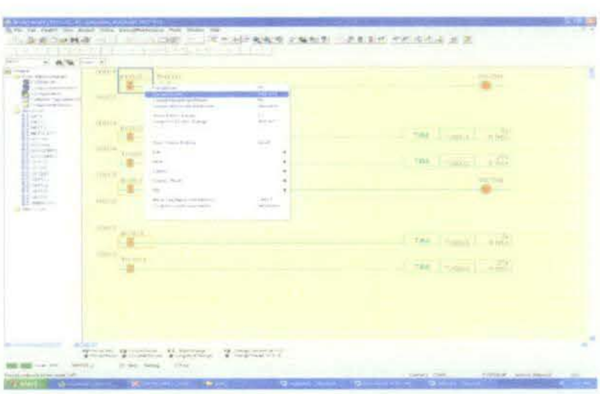


6) On the third stroke, PST is conducted at the same time with FST Ball Valve (I0002), Butterfly Valve (I0003)





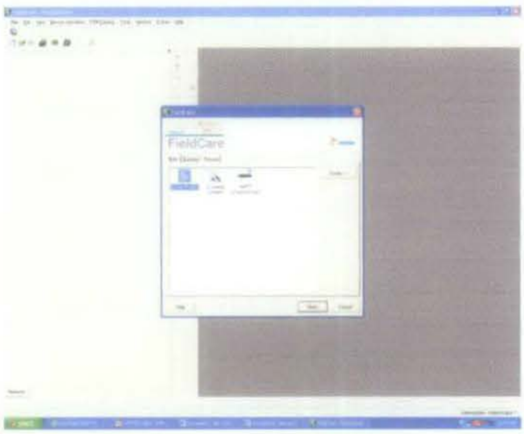
7) After testing is done, 'Force Reset' both valves to move the valves to close position.

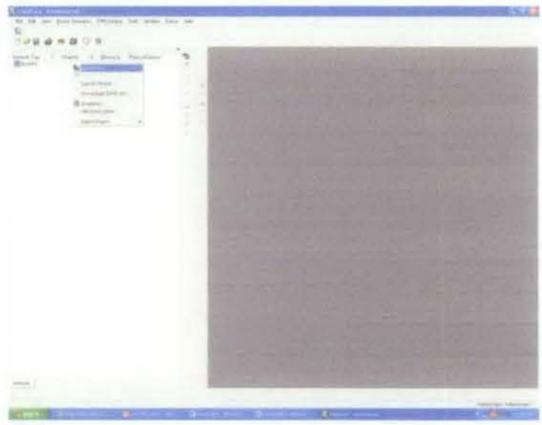


APPENDIX V

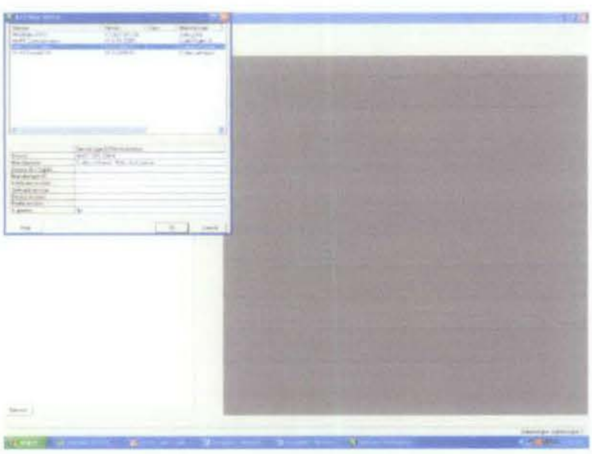
Testing Procedures for Partial Stroke Testing (FieldCare Software)

1) Open FieldCare Software > create project

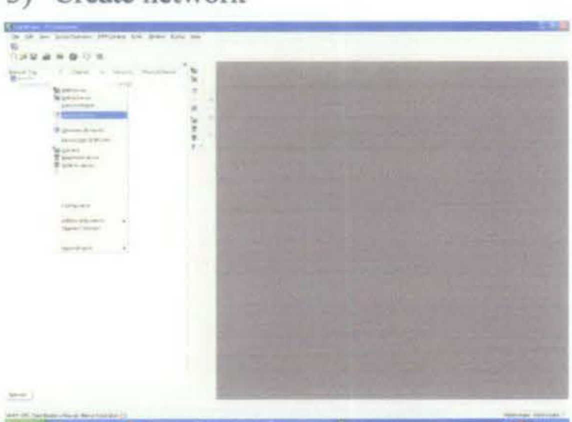


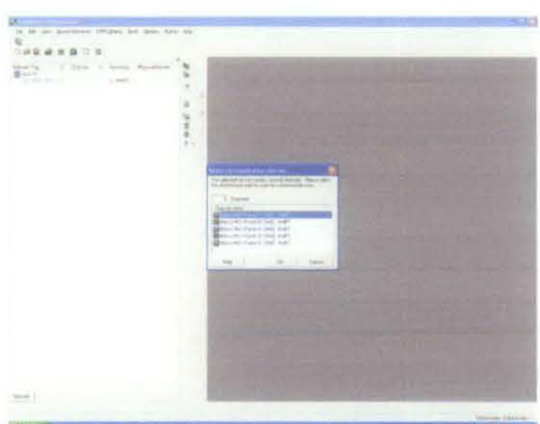


2) Add new device > HART OPC Client

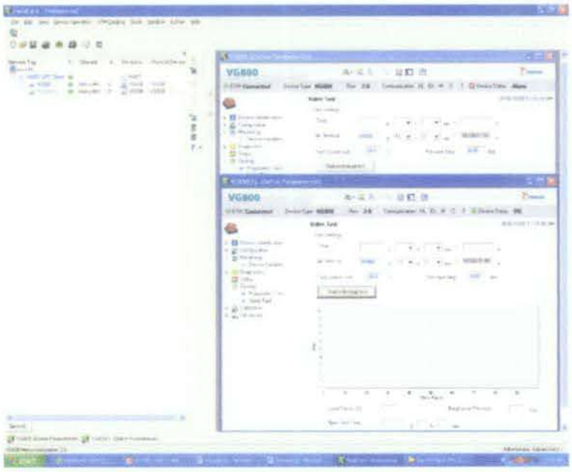


3) Create network

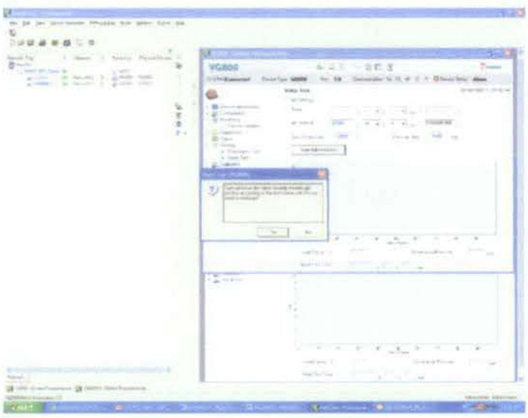


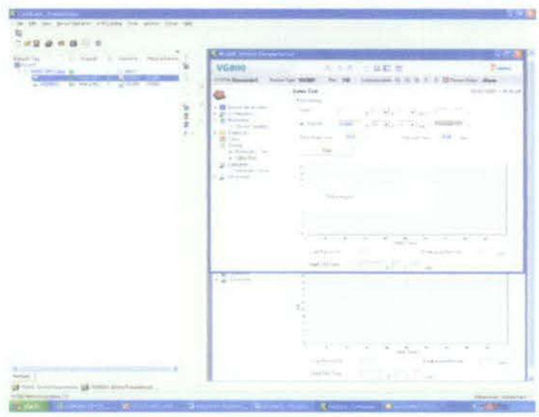


4) Connect both valves: VG800 – Ball Valve, VG800(1) – Butterfly Valve



5) Start individual test to start the Pneumatic Tests followed by PST



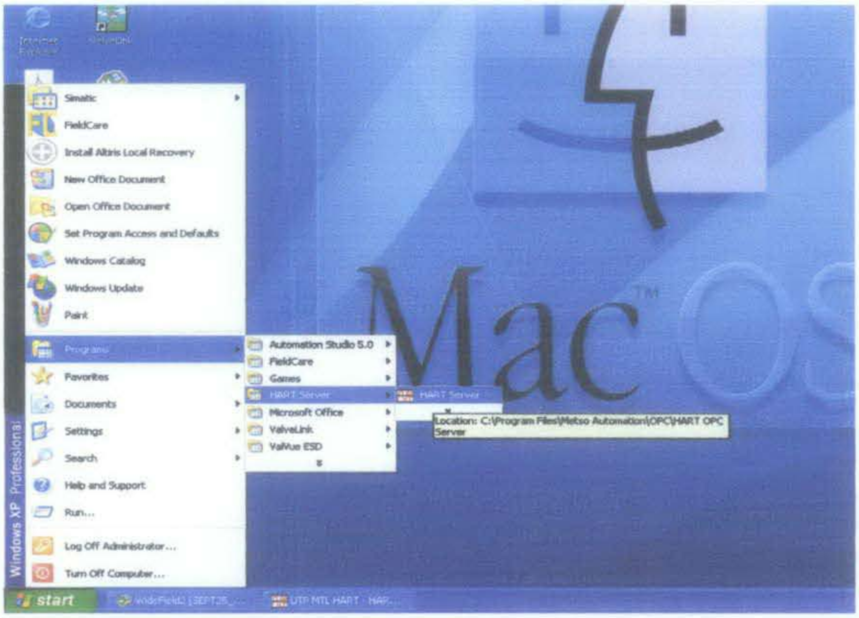


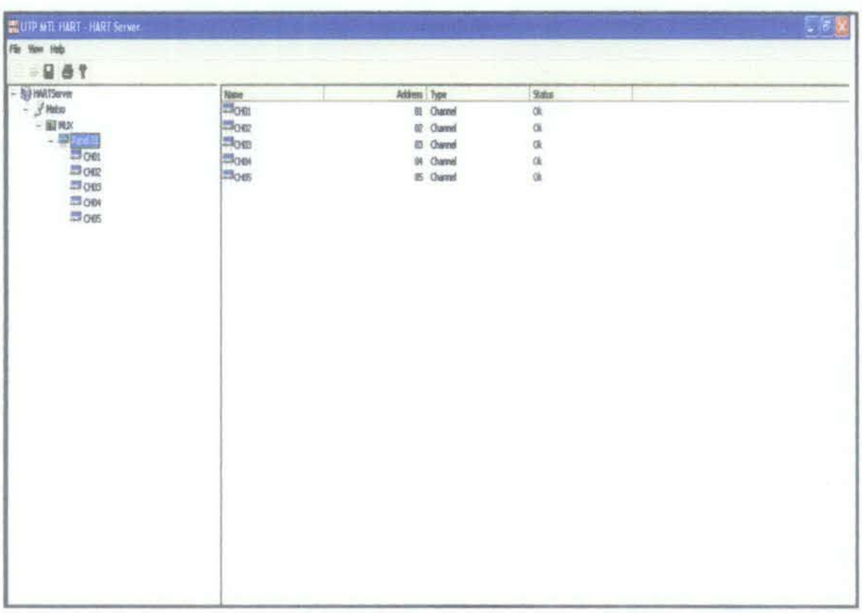
6) After sixth stroke is done, disconect both valves at the FieldCare Software

APPENDIX VI

HART Server

1) Open the Hart Server: Window >Programs>Hart Server





APPENDIX VII

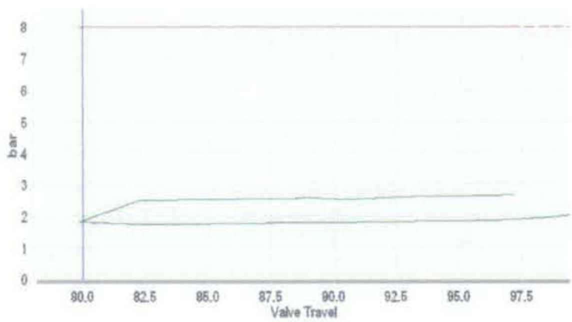
Test Result for Ball Valve

Sample 1 : Day 1

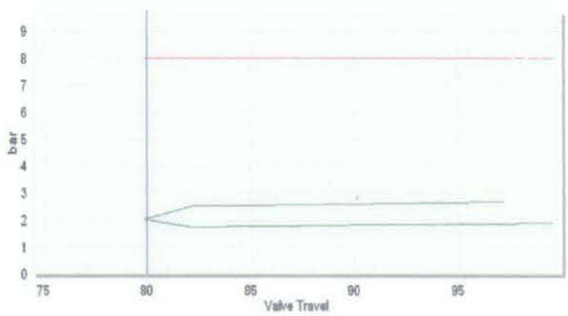
Test Date : December 22nd , 2008

Time : 10.20am – 11.35 am

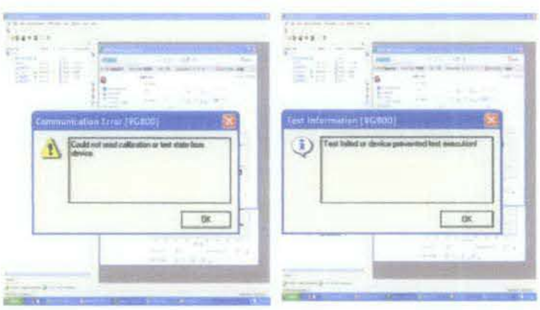
First Stroke:



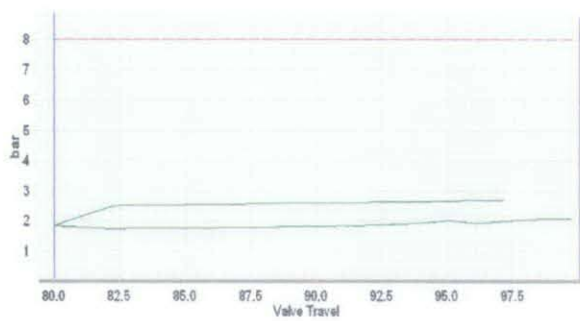
Second Stroke:



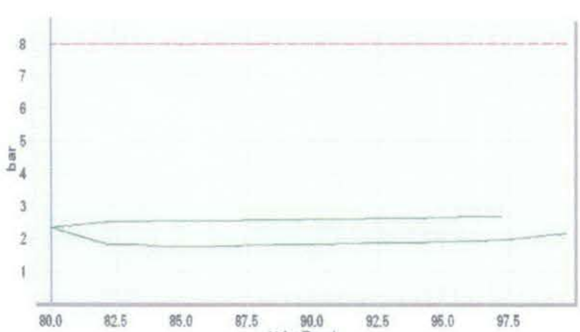
Third Stroke – PST + FST:



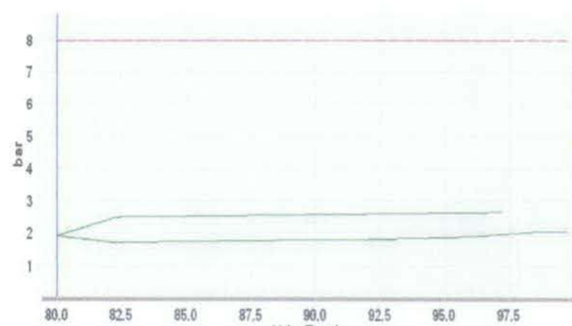
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

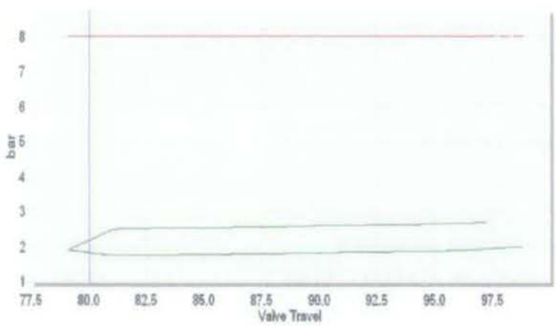


Sample 2 : Day 10

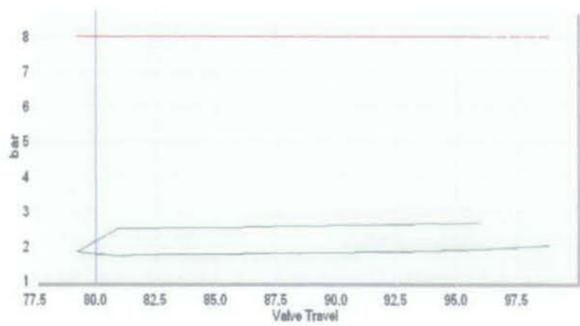
Test Date : January 14th , 2009

Time : 8:50 am – 10:05 am

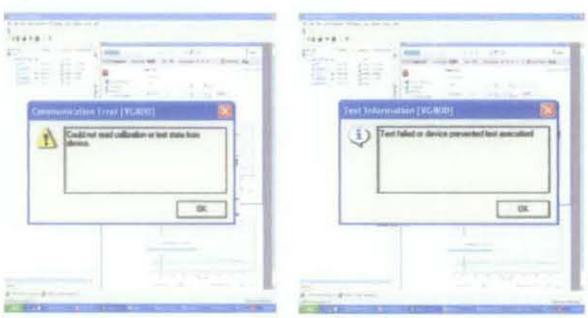
First Stroke:



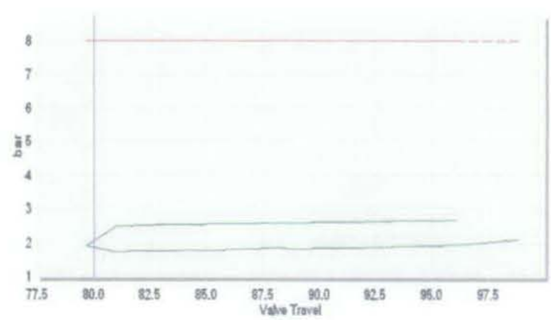
Second Stroke:



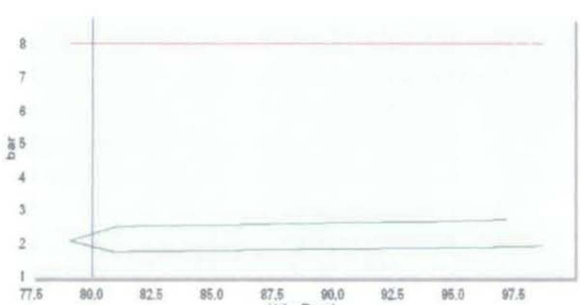
Third Stroke – PST + FST:



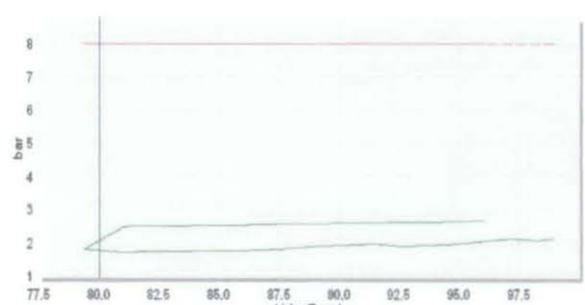
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

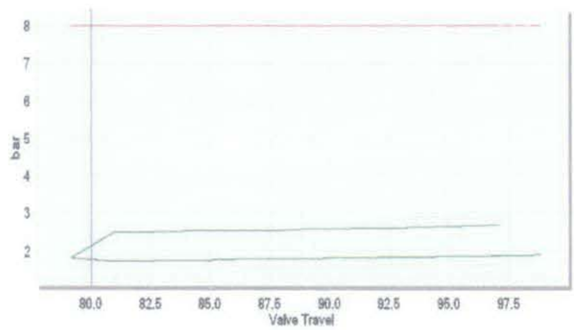


Sample 3 : Day 20

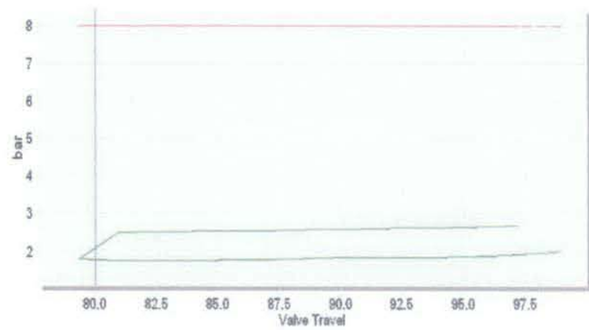
Test Date : January 24th , 2009

Time : 9:00 am – 10:15 am

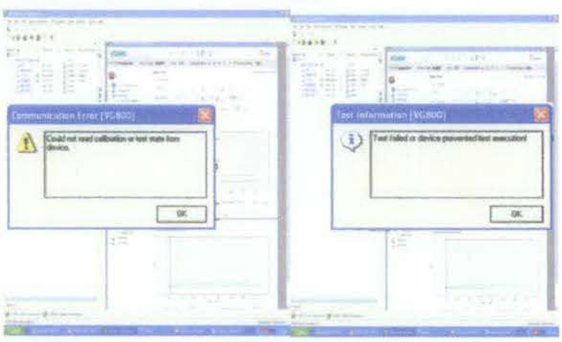
First Stroke:



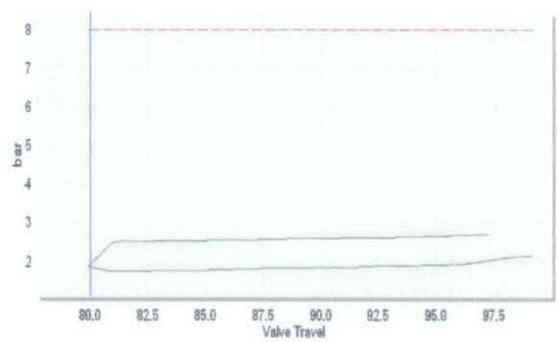
Second Stroke:



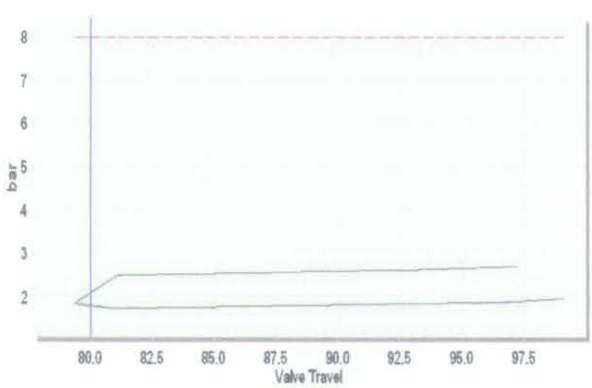
Third Stroke – PST + FST:



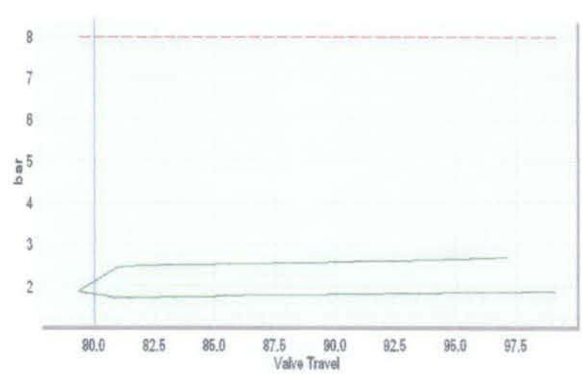
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

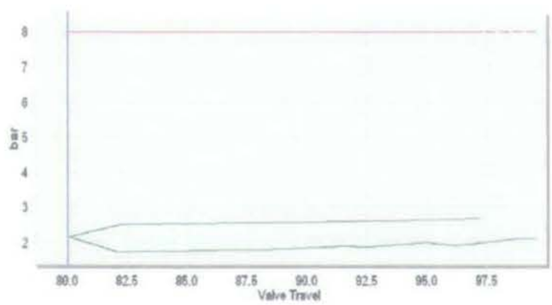


Sample 4 : Day 30

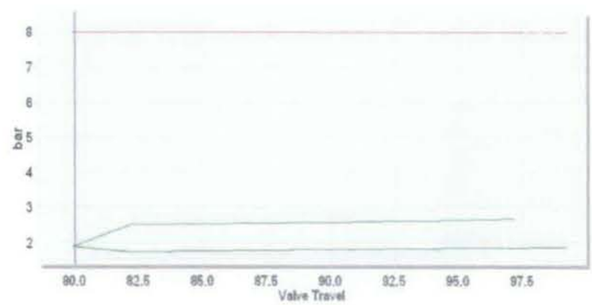
Test Date : February 12th , 2009

Time : 11:20 am – 12:35 pm

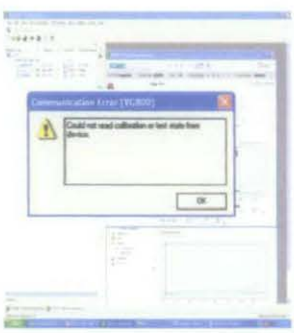
First Stroke:

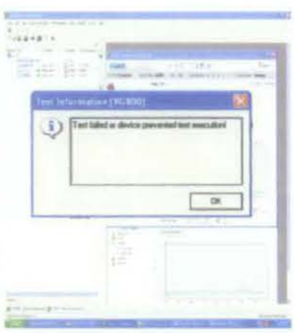


Second Stroke:

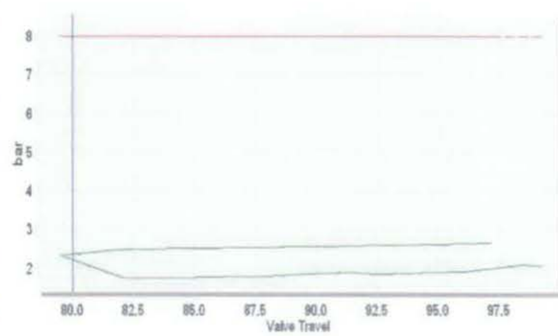


Third Stroke – PST + FST:

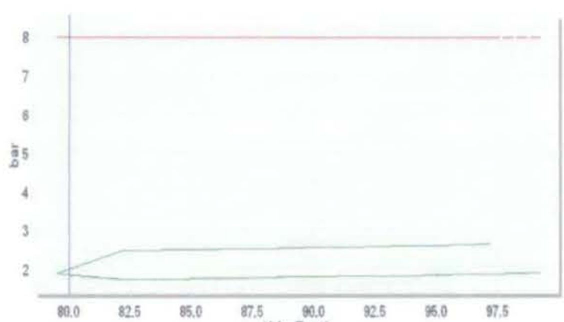




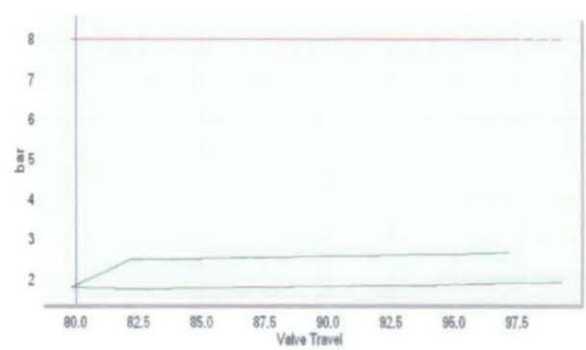
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

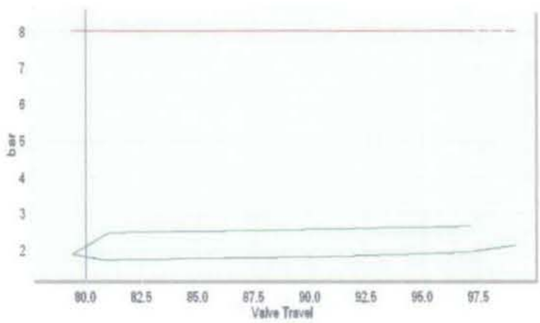


Sample 5 : Day 40

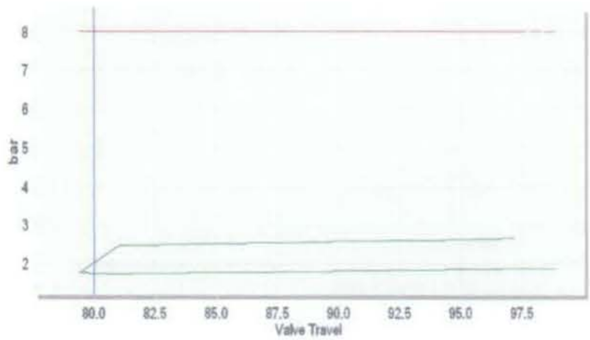
Test Date : February 28th , 2009

Time : 2:40 pm – 3:55 pm

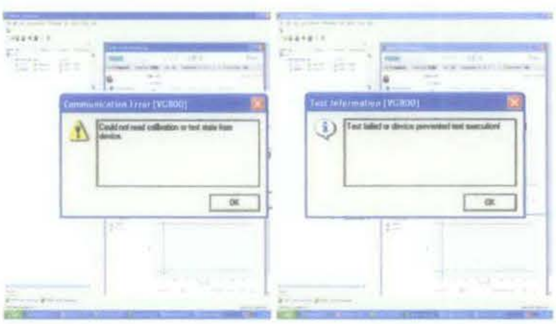
First Stroke:



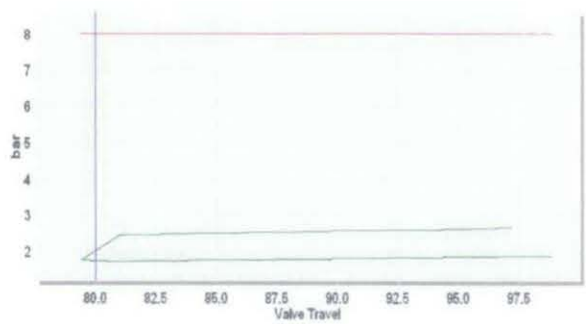
Second Stroke:



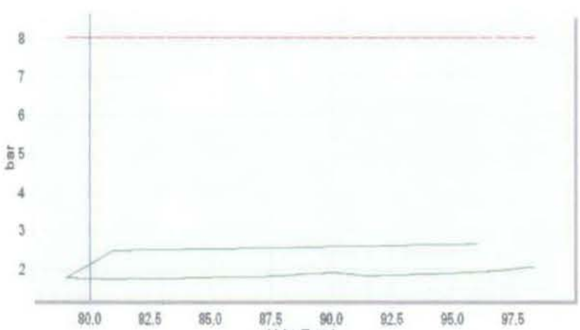
Third Stroke – PST + FST:



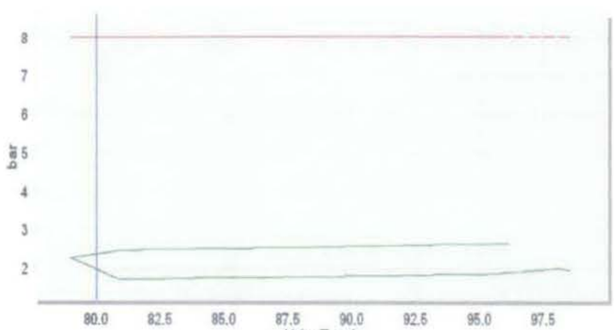
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

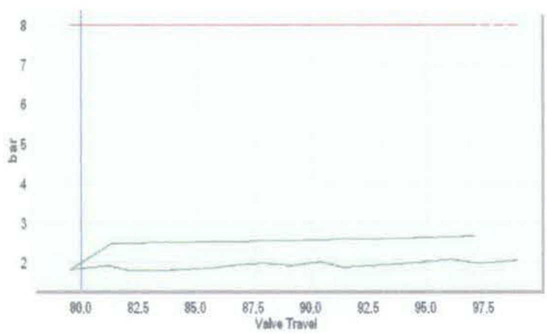


Sample 6 : Day 50

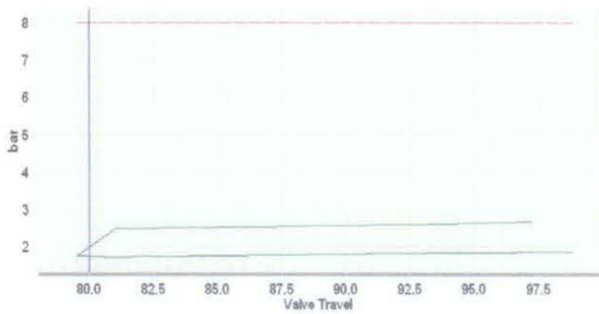
Test Date : March 16th , 2009

Time : 9:00 am – 10:15 am

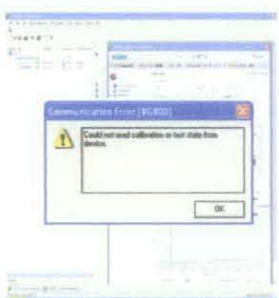
First Stroke:



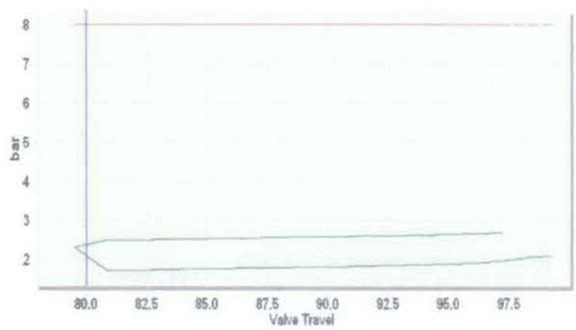
Second Stroke:



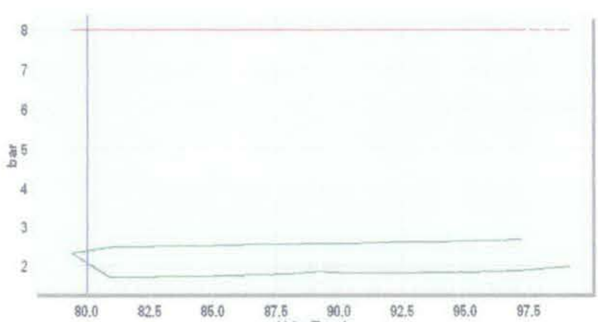
Third Stroke – PST + FST:



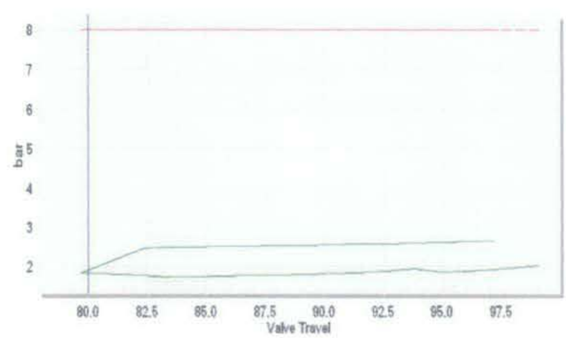
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

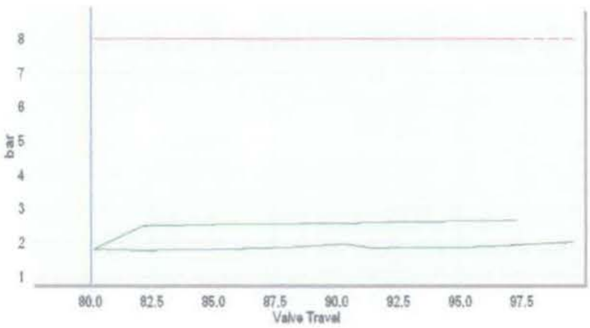


Sample 7 : Day 60

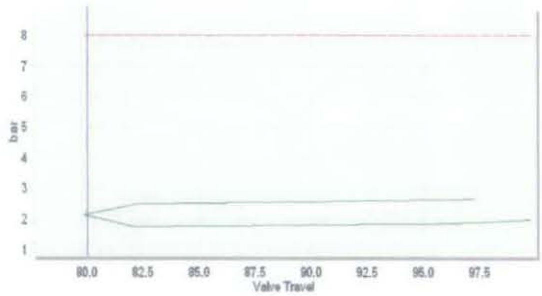
Test Date: July 26th, 2009

Time : 12:45 pm – 2:00 pm

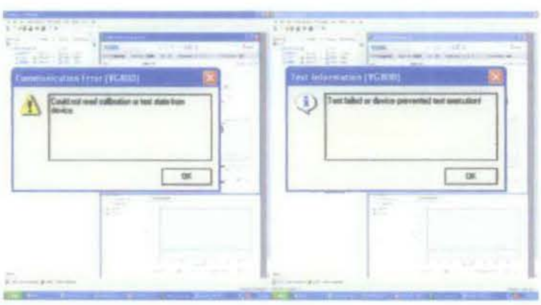
First Stroke:



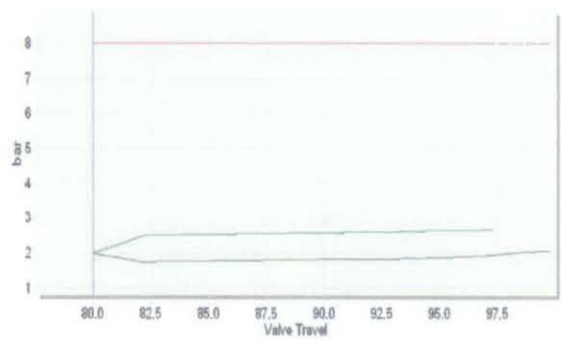
Second Stroke:



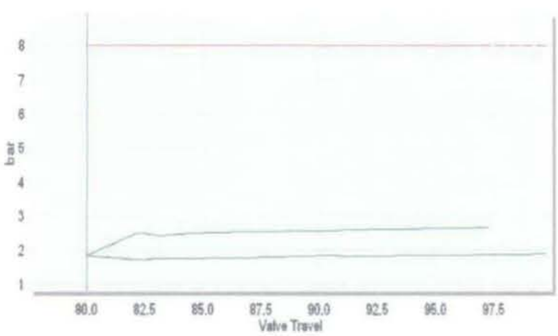
Third Stroke – PST + FST:



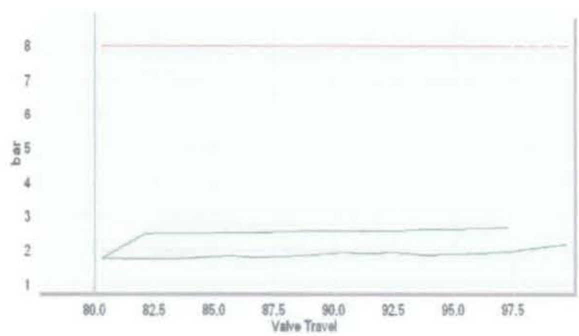
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

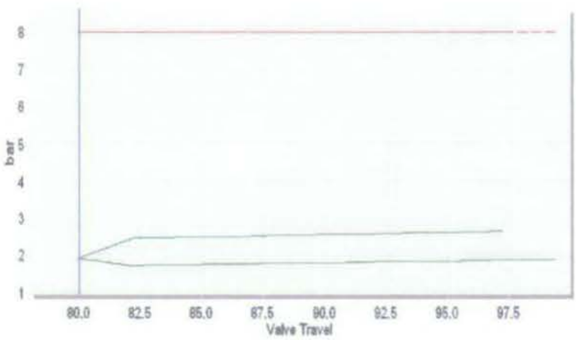


Sample 8 : Day 70

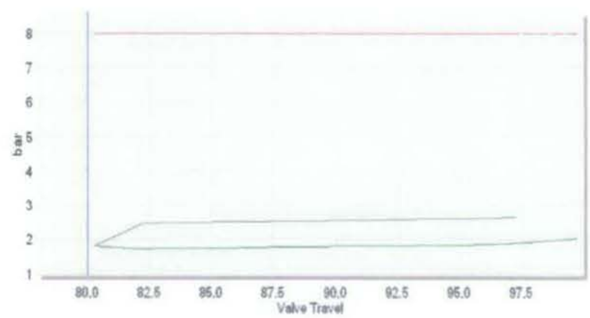
Test Date : August, 21st 2009

Time : 11.50 am – 1:15 pm

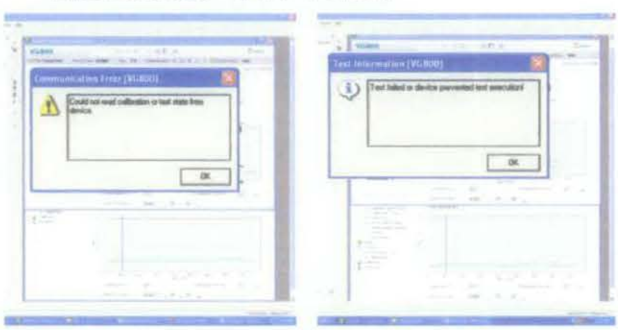
First Stroke:



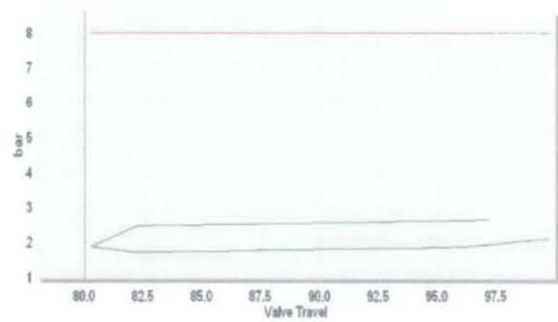
Second Stroke:



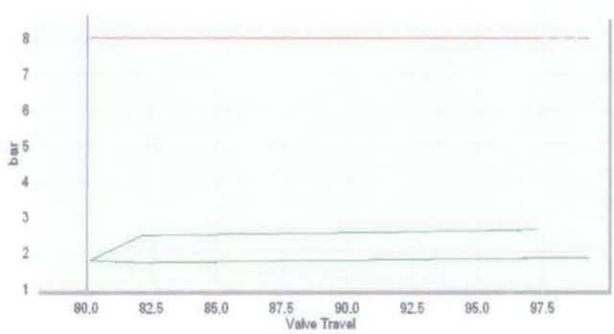
Third Stroke – PST + FST:



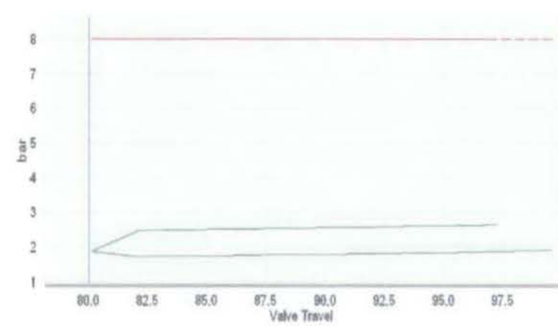
Forth Stroke:



Fifth Stroke:



Sixth Stroke:



APPENDIX VIII

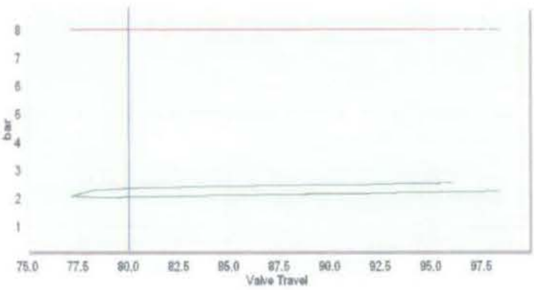
Test Result for Butterfly Valve

Sample 1 : Day 1

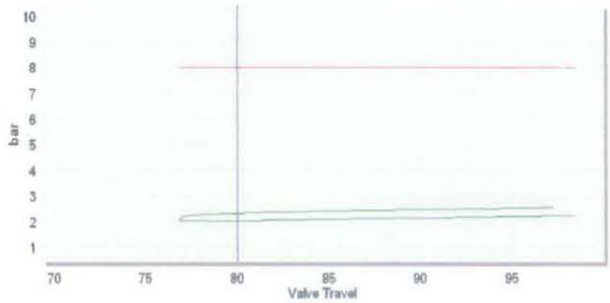
Test Date : December 22nd , 2008

Time : 10.20am – 11.35 am

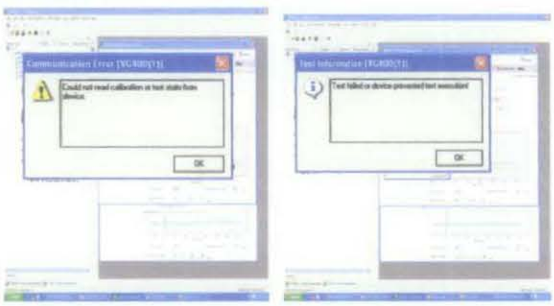
First Stroke:



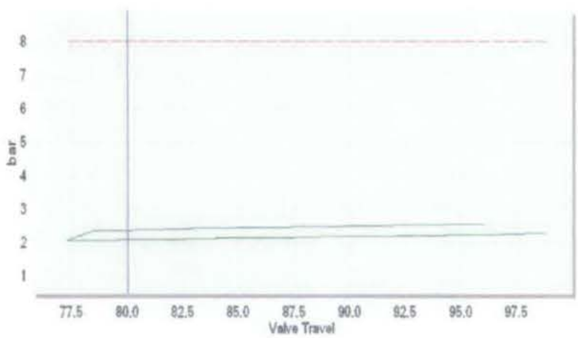
Second Stroke:



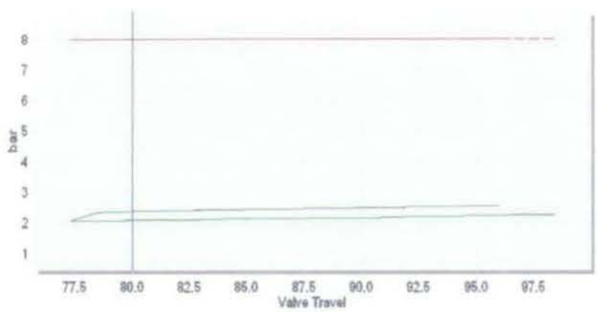
Third Stroke – PST + FST:



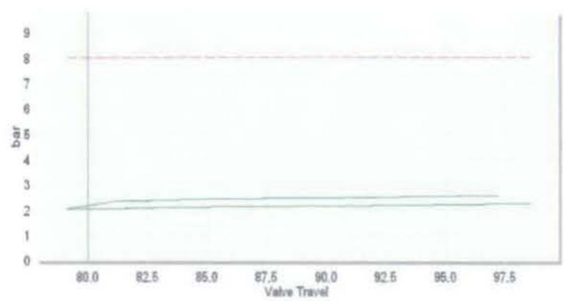
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

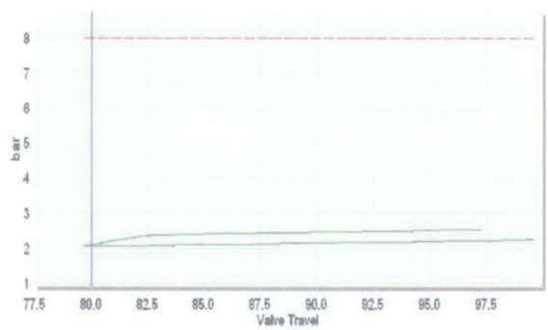


Sample 2 : Day 10

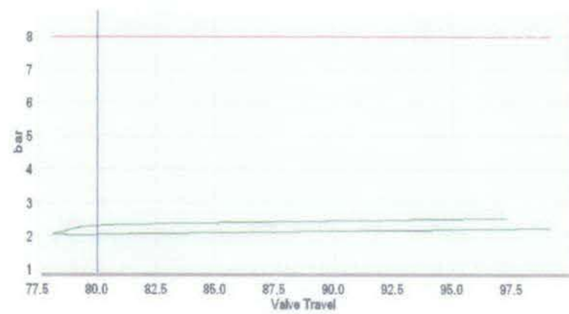
Test Date : January 14th , 2009

Time : 8:50 am – 10:05 am

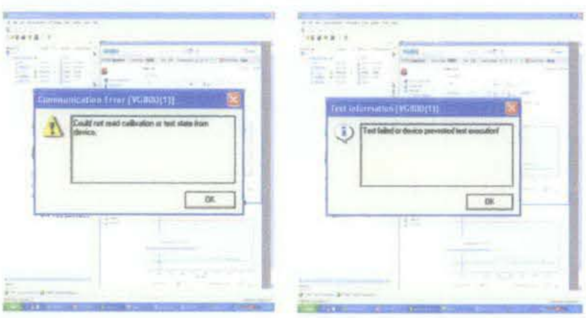
First Stroke:



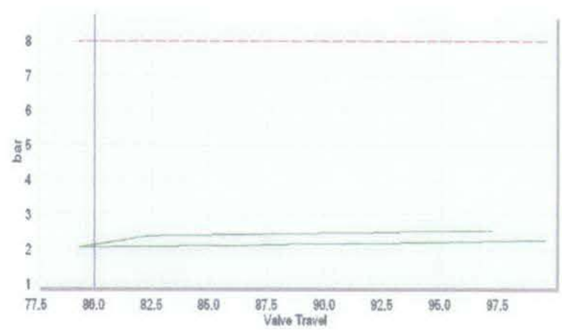
Second Stroke:



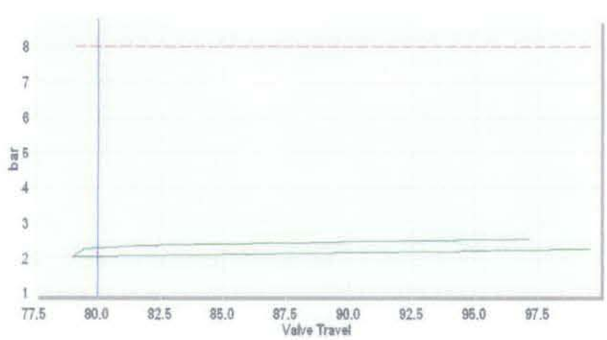
Third Stroke – PST + FST:



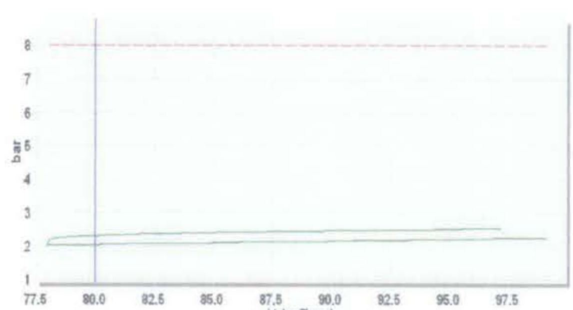
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

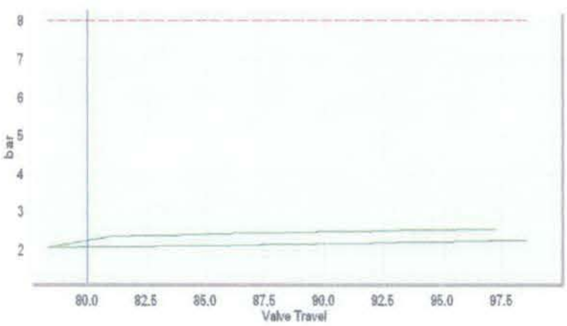


Sample 3 : Day 20

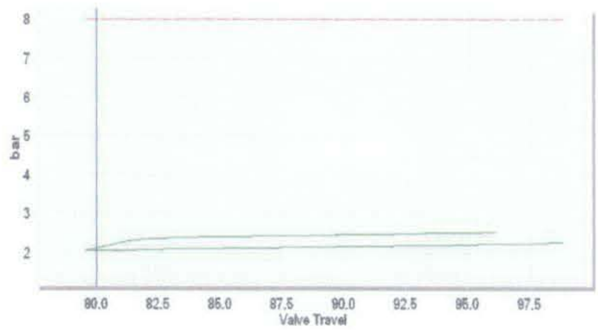
Test Date : January 24th , 2009

Time : 9:00 am – 10:15 am

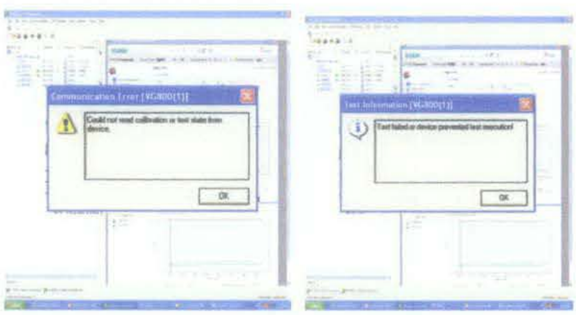
First Stroke:



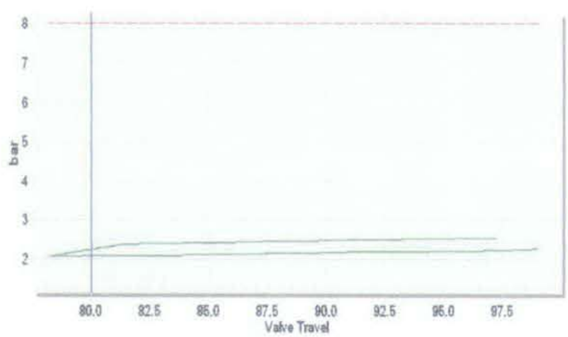
Second Stroke:



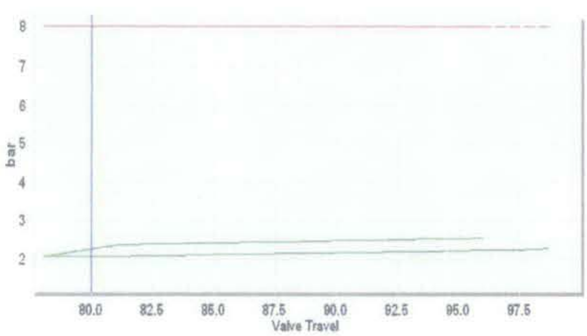
Third Stroke – PST + FST:



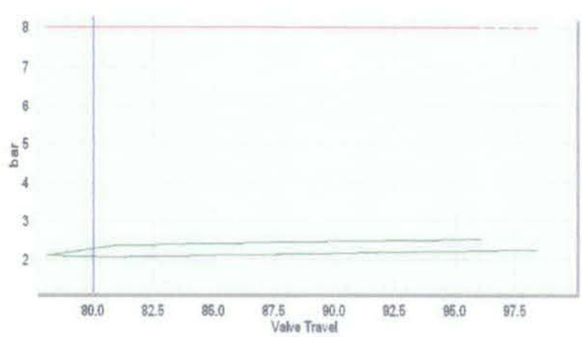
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

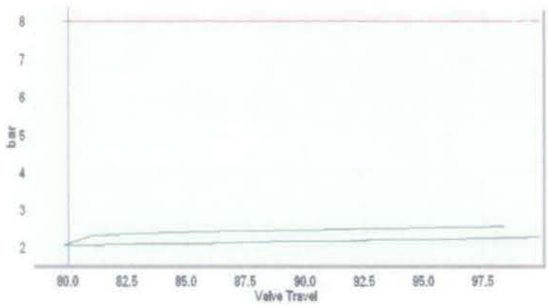


Sample 4 : Day 30

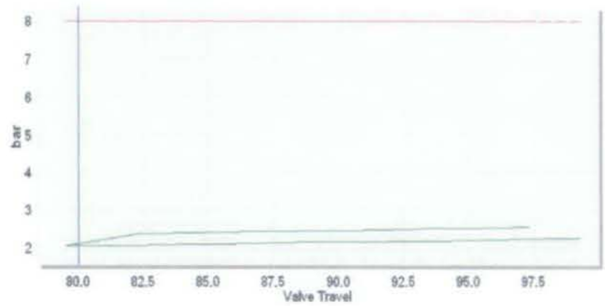
Test Date : February 12th , 2009

Time : 11:20 am – 12:35 pm

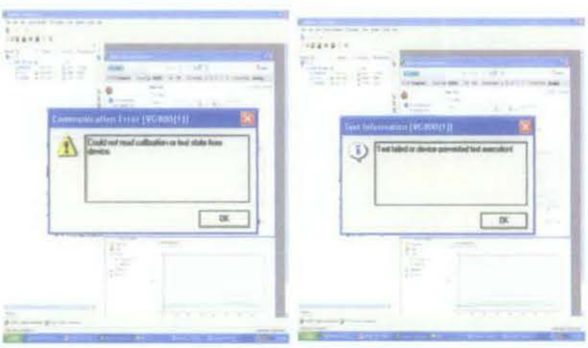
First Stroke:



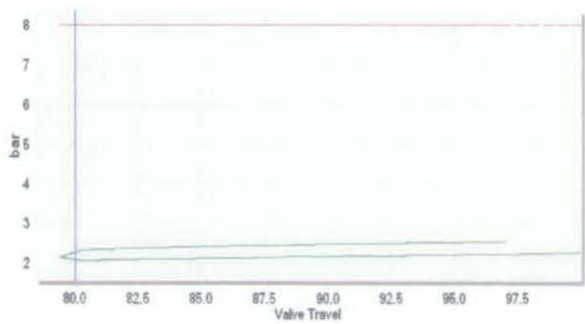
Second Stroke:



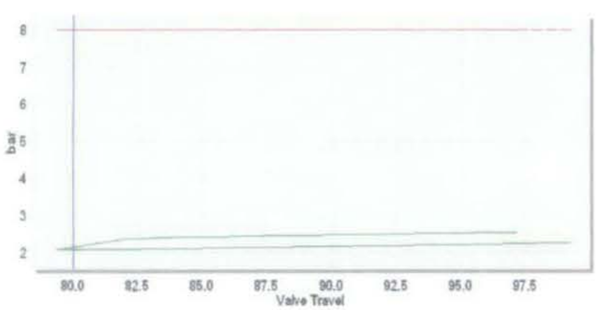
Third Stroke – PST + FST:



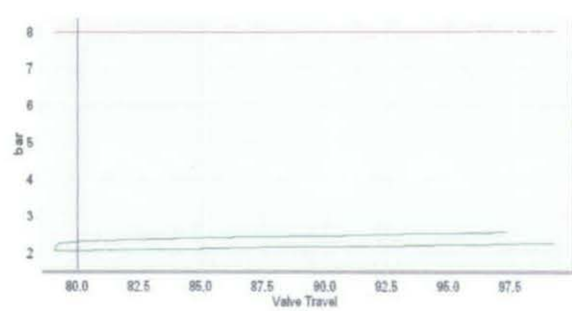
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

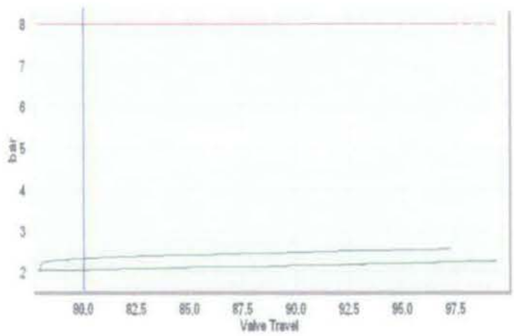


Sample 5 : Day 40

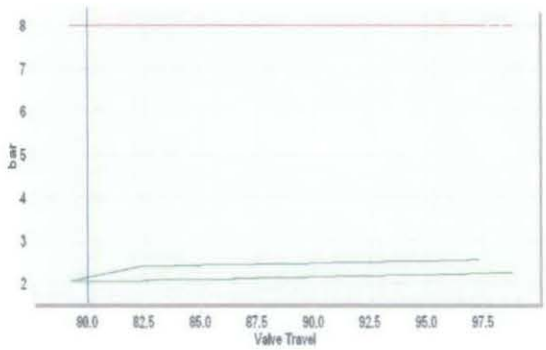
Test Date : February 28th , 2009

Time : 2:40 pm – 3:55 pm

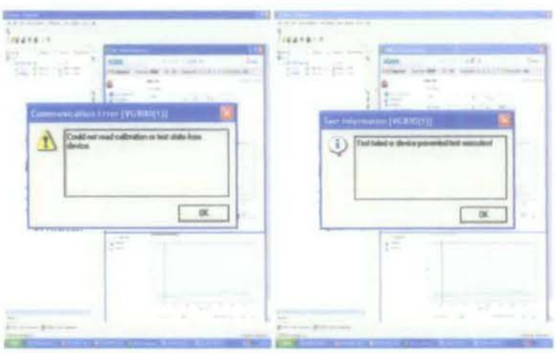
First Stroke:



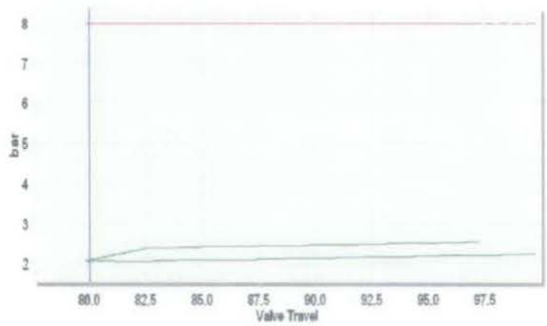
Second Stroke:



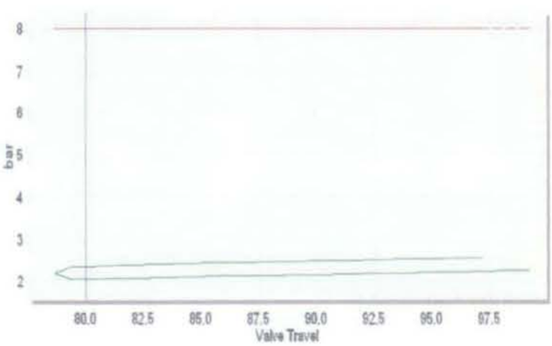
Third Stroke – PST + FST:



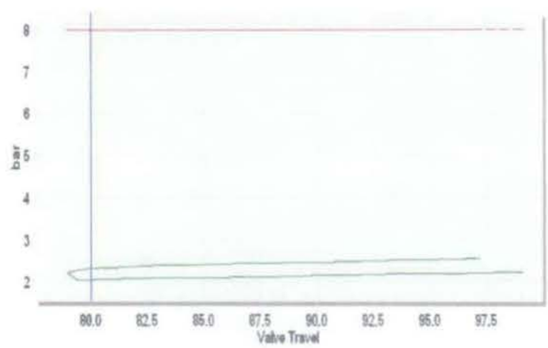
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

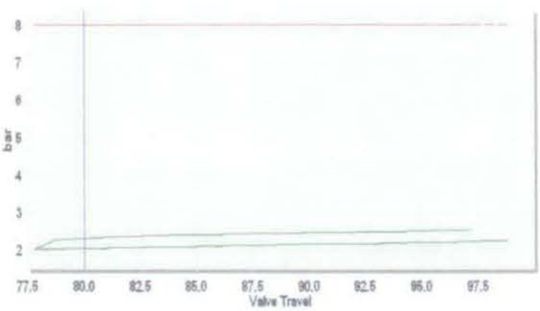


Sample 6 : Day 50

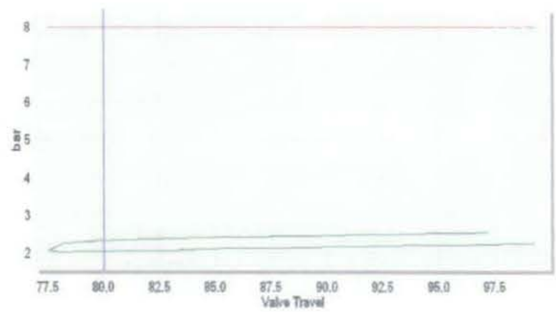
Test Date : March 16th , 2009

Time : 9:00 am – 10:15 am

First Stroke:

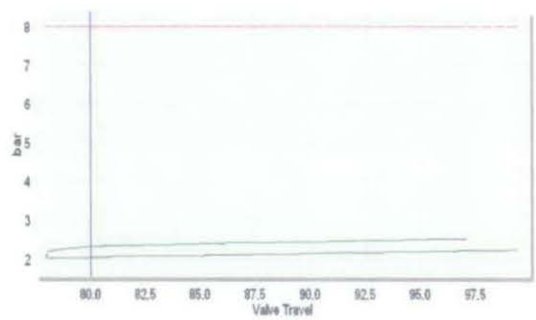


Second Stroke:

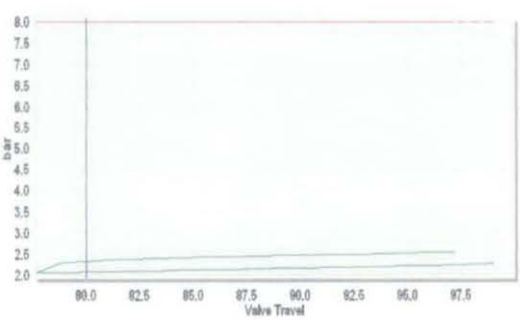


Third Stroke – PST + FST:

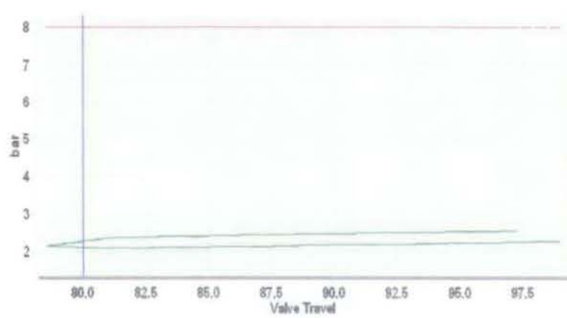
Forth Stroke:



Fifth Stroke:



Sixth Stroke:



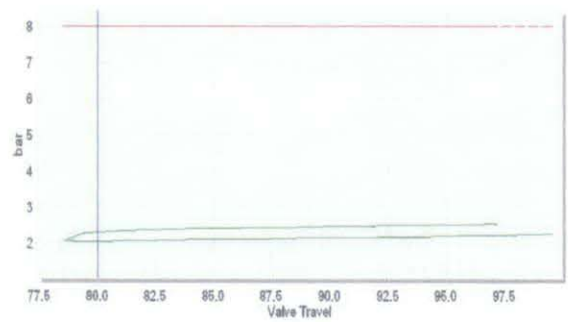
Sample 7 : Day 60

Test Date: July 26th, 2009

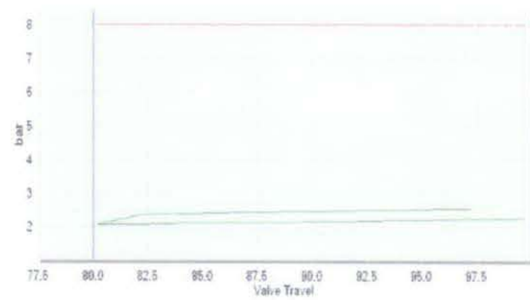
Valve : Metso Neles (Ball Valve)

Time : 12:45 pm – 1:05 pm

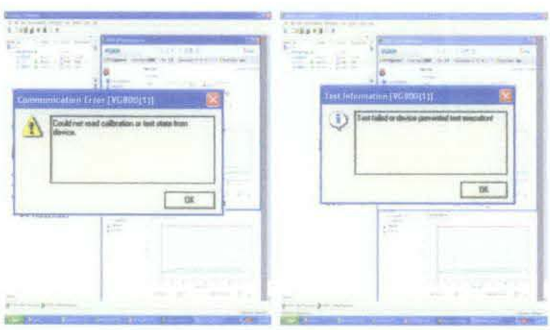
First Stroke:



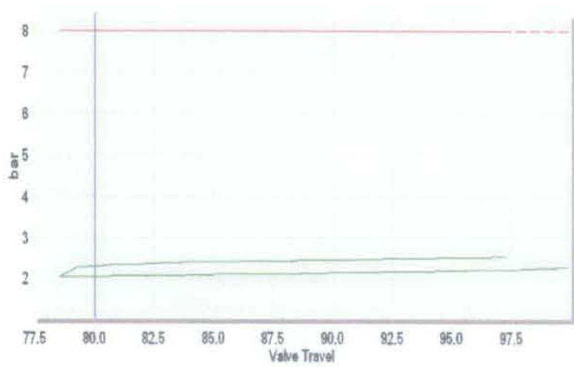
Second Stroke:



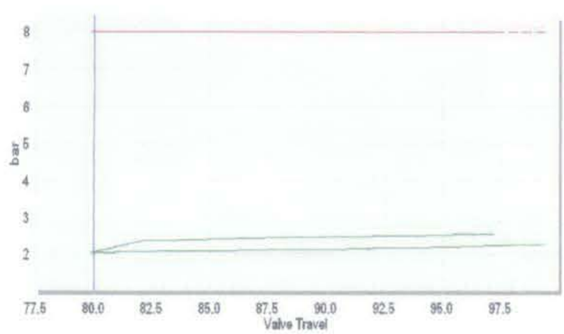
Third Stroke – PST + FST:



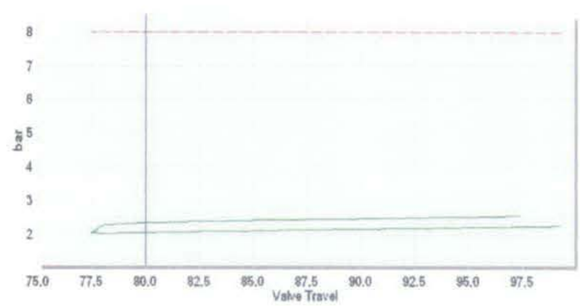
Forth Stroke:



Fifth Stroke:



Sixth Stroke:

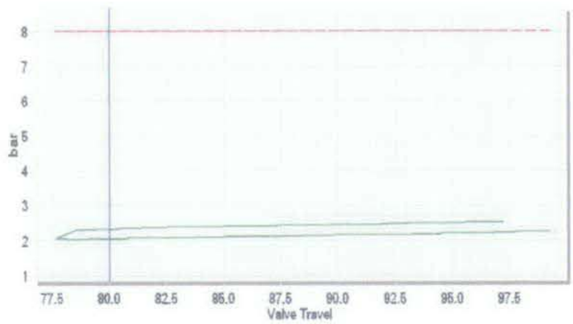


Sample 8 : Day 70

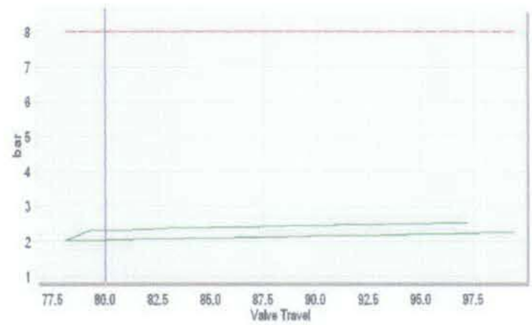
Test Date : August, 21st 2009

Time : 11.50 am – 1:15 pm

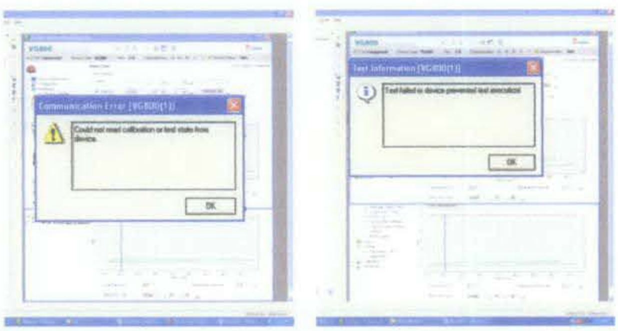
First Stroke:



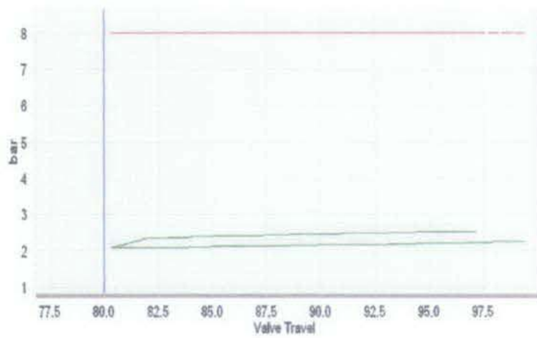
Second Stroke:



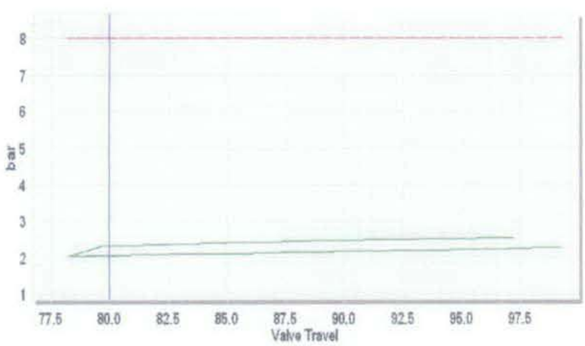
Third Stroke – PST + FST:



Forth Stroke:



Fifth Stroke:



Sixth Stroke: