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Method of Valve Preventive Maintenance via Additional Overview on POS for Decreasing Failure Risk at Starting and Change Over Fuel Gas to Fuel Oil in Block 1 and 2 Gas Turbine GT13E2 PT. PJB UP Muara Tawar

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Abstract: *Block 1 and 2 Combined Cycle Power Plant (CCPP) Muara Tawar have 5 units gas turbine can be operated by using fuel gas. Due to limitation of fuel gas from gas company. Several gas turbine are operated using High Speed Diesel fuel (HSD) to fulfil load demand. The equipment that used for fuel gas system must have high realibility to serve in dual fuel system neither operated using fuel oil or gas without unit trip. In actual, there are several disturbances occur during change over from gas to oil, even when the plant operated using fuel oil. From the data of failure causes, one of the failure causes is valve failure. By considering the availbility of plant, in term of possibility to modify instrumentation and control system, gas turbine 1.3 was choosen as object of the study. Additional indicator in HMI can be described as follows additional pressure switch attribute at EDS-P3 using symbol K, upload program to EPROM at card 70BK06 as communication card, and the cycle time less than 1 second in both valve open or close. It indicate valve system under good condition or no maintenance action is required. Valve maintenance at gas turbine ALSTOM 13E2 in Block 1 and 2 CCPP Muara Tawar can be done by additional indicator of pressure switch and aux relay contact as feedback signal on POS 30. Therefore, no disturbances in valve system and gas turbine performance increases.*
Keywords: *failure risk, fuel gas, fuel oil, gas turbine, preventive maintenance*

I. Introduction

Fuel gas as source of energy that is mostly used in industrial power plant [1]. Block 1 and 2 of CCPP Muara Tawar have 5 unit gas turbine which is operated using fuel gas. Fuel gas is supplied from gas company through pipe line [2]. Due to limitation of fuel gas from gas company. Several gas turbine are operated using High Speed Diesel fuel (HSD) to fulfil load demand [3,4]. The equipment that used for fuel gas system must have high realibility to serve in dual fuel system neither operated using fuel oil or gas without unit trip. In actual, there are several disturbances occur during change over from gas to oil, even when the plant operated using fuel oil. From the data of failure causes, one of the failure causes is valve failure. The valve failures are caused by leakage in membrane or line system, selenoid valve stucked, contactor and relay broken and fail in air and electric power supply [5]. Therefore, the preventive maintanance is required to overcome hidden failure in the valve by perform optimization of preventive maintenance [6,7].

II. Theory

2.1 Sistem Sector Valve

Gas turbine in CCPP Muara Tawar are ALSTOM type 13E2 that consist 18 valves to regulate air combustion at 6 area i.e. area MBN41, MBN42, and MBN43.

2.2 P & I Diagram (Pipping and Instrumentation Diagram)

P&I Diagram represent all equipment, instrumentation and interconnection all of them. The standard of this diagram based on International Society of Automation (ISA) Standard S5.1. P&I Diagram is important document for operation, maintenance and process modification for operation and maintenance company, such as PT. PJB UP Muara Tawar. P&ID is developed from process flow diagram (PFD) that describe mass and energy balances. This diagram describes actual or as build existing plant that will used for all engineering discipline to realize design into plant. Process engineer use this document to calculate size of equipment, safety engineer for HAZOP study, piping engineer for design piping and support, instrument engineer for design instrumentation such as transmitter, controller and valve.

III. Method

3.1. Fuel Oil Distribution on Gas Turbine Alstom 13E2

As mentioned before, gas turbine CCPP Muara Tawar Blok 1 and 2 using Alstom type 13E2. Fuel oil distribution system in this turbine consist of 72 burner and 3 area control valve for fuel oil i.e. MBN41, MBN42, and MBN43. Distribution of 72 burners flow through six valves area. Each area serve some burner. For MBN41 serve to burner.MBN42 serve to for burner and MBN43 serve to six burner. P&ID of fuel oil distribution system is shown in Figure 1 and 2.

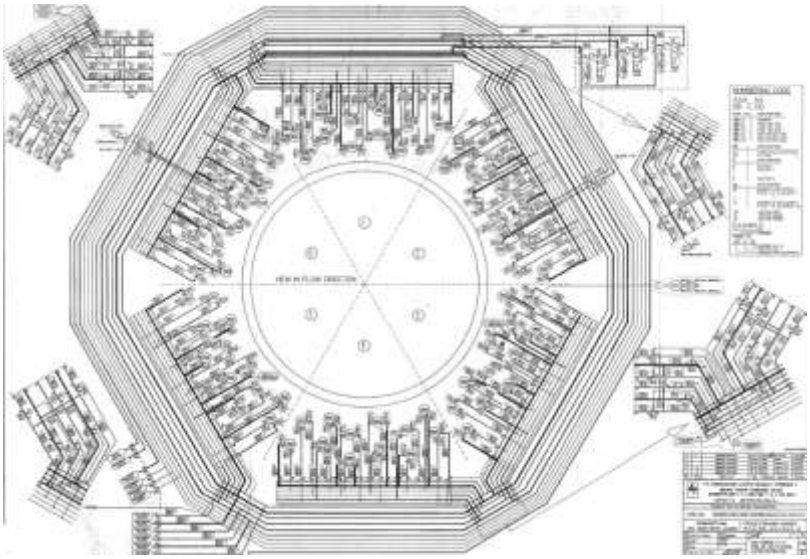


Figure 1. P&I Diagram of Fuel Oil Distribution

Flow rate of fuel oil from storage tank to burner are controlled by using 18 valve areas. All the valves are actuated by air supply through 7 solenoid valves.

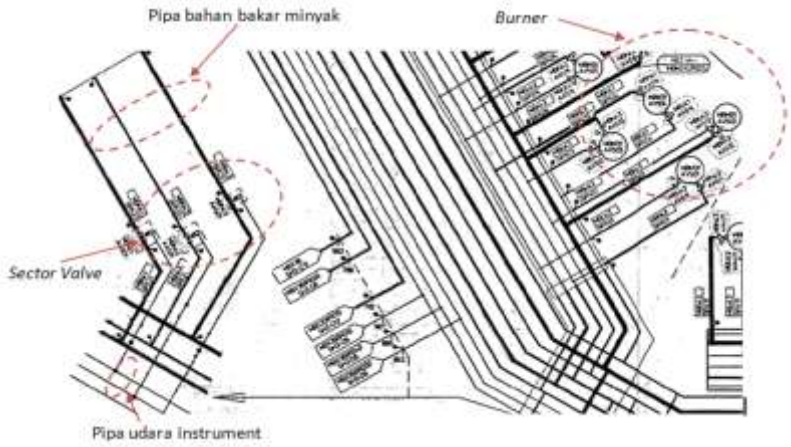


Figure 2. P&I Diagram of Valve Area 5

Each solenoid valve consist of pressure switch lay at outlet of solenoid valve and serve an area valve with configuration as follows:

- Solenoid valve MBX36AA041 serve valve MBN41 for sector 2, 3, 5 and 6.
- Solenoid valve MBX36AA042 serve valve MBN42 for sector 2, 3, 5 dan 6.
- Solenoid valve MBX36AA043 serve valve MBN43 for all sector.
- Solenoid valve MBX36AA026 serve valve MBN41 for sector 1 (MBN41/101).
- Solenoid valve MBX36AA027 serve valve MBN41 for sector 4 (MBN41/401).
- Solenoid valve MBX36AA028 serve valve MBN42 for sector 1 (MBN42/101).
- Solenoid valve MBX36AA029 serve valve MBN42 for sector 4 (MBN42/401).

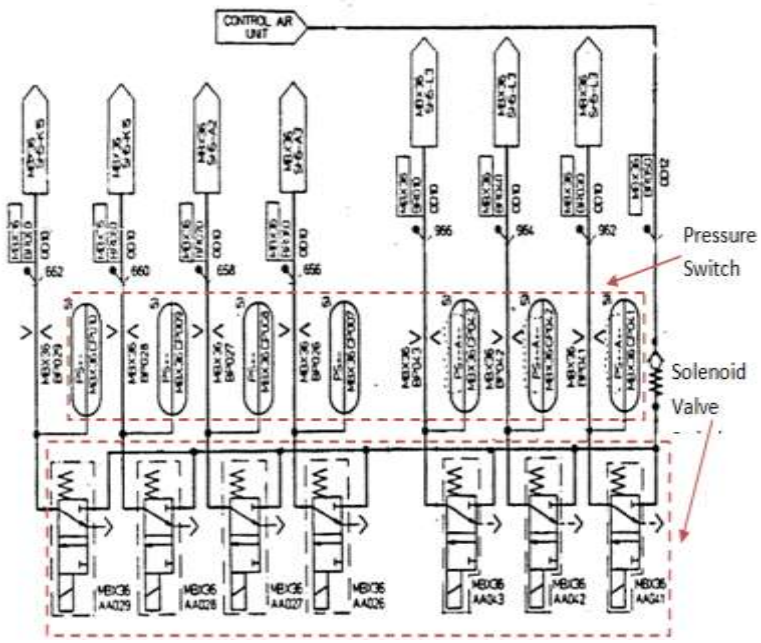


Figure 3. P&I Diagram Solenoid Valve and Pressure Switch in Sector Valve

3.2 Mapping System on Valve

Valve consist of valve body, actuator and sensor that operate normally open or air to close. In actuator, there are some part with function as follows:

- Card 70AB02 as an output modul that transmitt voltage signal 24 VDC to interposing relay, if output from PLC states = 1.
- Interposing relay convert 24 VDC to 220 VAC to activate contactor coil.
- Contactor is used to energize the solenoid coil with 220 VAC
- Solenoid valve is utilized to supply pneumatic valve with normally close or energize to open.

Sensor consist of:

- Pressure switch detect air pressurer that flow into the valve. pressure switch setting open at pressure system above 4 bar and vice versa.
- Aux relay detect the states of valve position
- Card 70EB02 as a converted modul that change switch position of pressure switch and aux relay become binary input signal to the PLC.

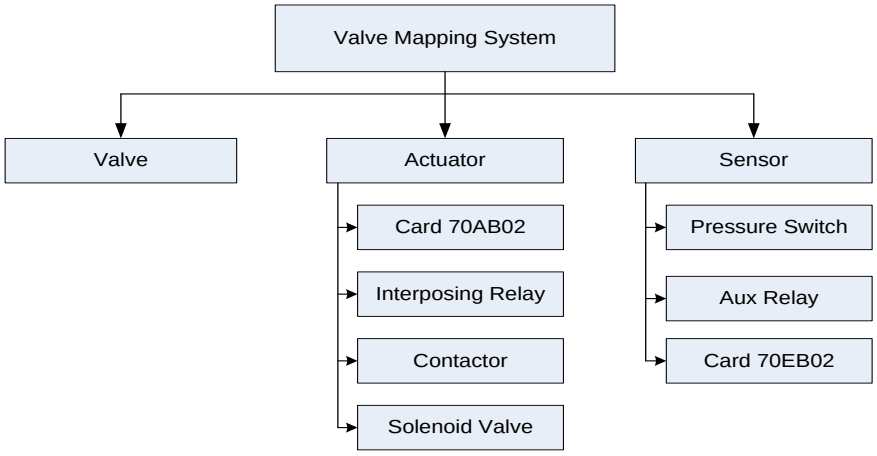
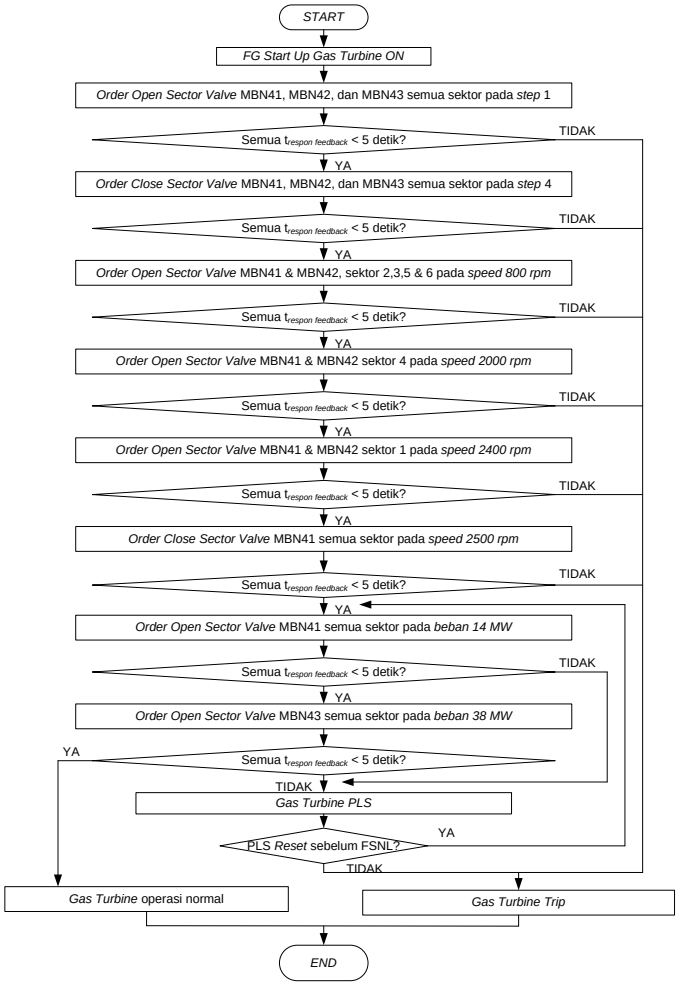


Figure 4. Mapping on Gas Turbine Valve



Note : $t_{respon\ feedback}$ adalah waktu yang dibutuhkan oleh pressure switch terhadap order yang diberikan

Figure 5. Process Maping Sector Valve When Start Up Turbine Gas

3.3. Gas Turbine Protection

Protection system in the gas turbin to avoid valve wrong position are shown in Figure 6 and 7.

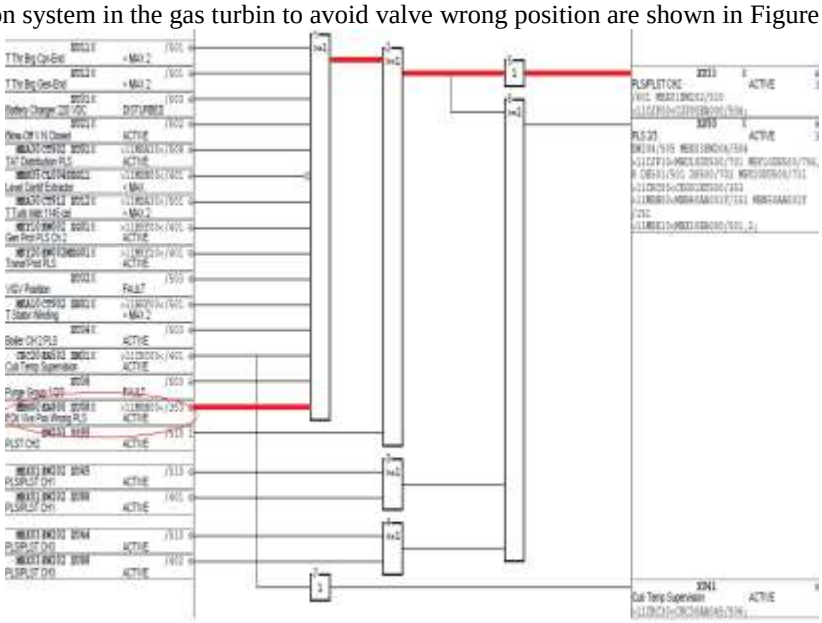


Figure 6. Logic Diagran Plst for Fuel Oil Wrong Position

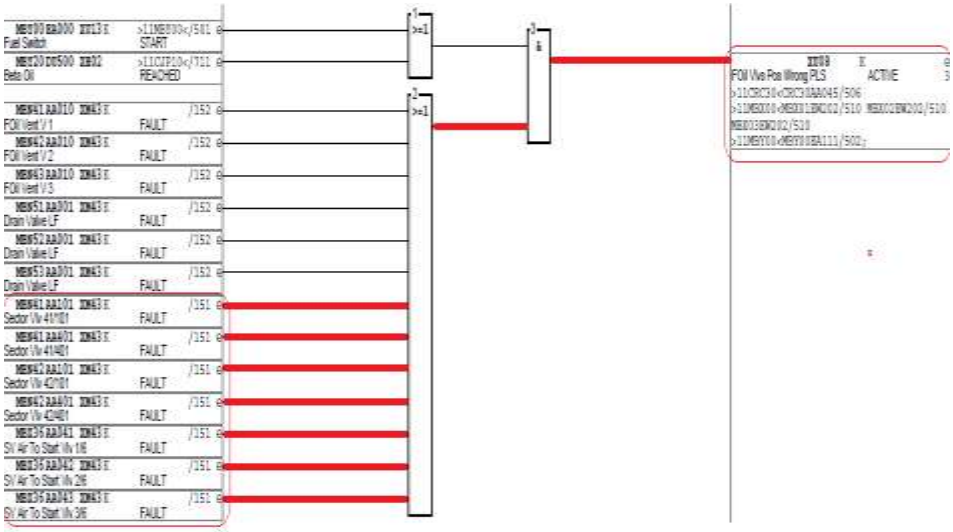


Figure 7. Logic Diagram Fuel Oil Wrong Position in Valve

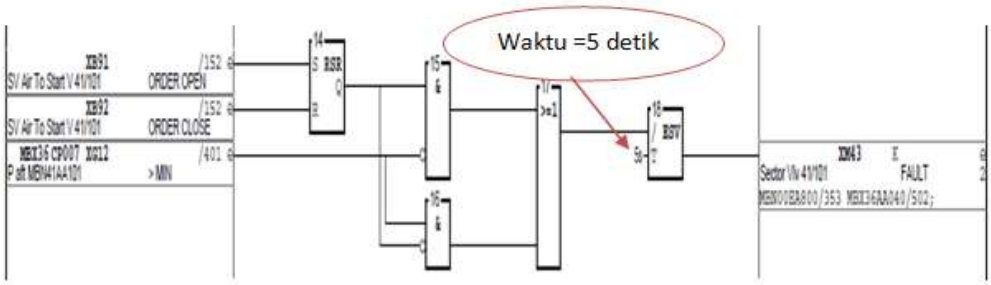


Figure 8. Logic Diagram Valve MBN41AA101

3.4. Valve Overview POS30

Human Machine Interface (HMI) CCPP Muara Tawar uses POS30 as an interface between operator and plant system. The status of valve both open or close can be viewed in HMI based on feedback signal from auxillary contactor, it is shown in Figure 9.

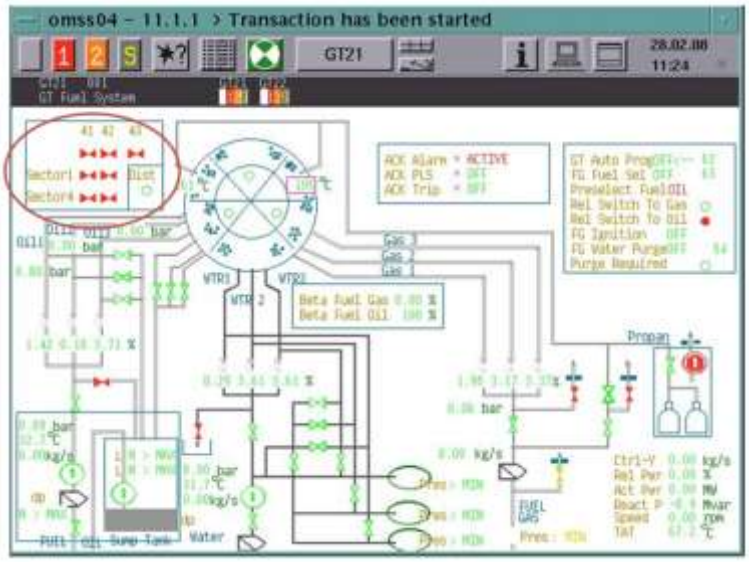


Figure 9. Overview Valve and Disturbed Indication

3.5. Problem Solving

Table 1 shows the causes, failures and actions in gas turbine during actual operation.

Table 1. Failure in Gas Turbine.

	Date	Disturbance	Cause	Improvement
1	13 August 2007	*Start Failure of SV MBN41 / 101 Failed*	*etting pressure switch not in 4 bars*	*Replace and calibrate pressure switch MBN41 / 101*
2	04 June 2008	*Start Failure of SV MBN42 / 101 Failed*	*Movement of solenoid valve more than 5 seconds*	*Cleaning SV MBN42 / 101*
3	07 January 2008	*Start Failure* from SV MBN41/401 *Failed*	*Movement of solenoid valve more than 5 seconds*	*Cleaning* all SV *Sector Valve*
4	08 January2008	*Start Failure* from SV MBN42/401 *Failed*	*Movement of solenoid valve more than 5 seconds*	Test open close all SV sector valve
5	15 March 2009	*Change Over Fuel Failure* from SV *Air To Start* MBN42 *Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning all SV *Sector Valve*
6	14 March 2009	*Change Over Fuel Failure* from SV *Air To Start* MBN41 Failed	*Movement of solenoid valve more than 5 seconds*	Cleaning all SV *Sector Valve*
7	14 March 2009	PLST from *SV MBN 41/101 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning all SV *Sector Valve*
8	21 November 2010	*Start Failure* from *SV Air To Start MBN41 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning SV Air To Start MBN41
9	13 January 2010	*Start Failure* from *SV Air To Start MBN43 Failed*	*Setting pressure switch not in 4 bars*	Replace and calibrate pressure switch Air To Start MBN43
10	08 August 2010	PLST from *SV MBN42/401 Failed*	Failed Contactor	Replace SV MBN41/101 contactor
11	24 December 2010	*Start Failure* from *SV Air Tor Start MBN41 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning all SV *Sector Valve*
12	25 December 2010	*Start Failure* from *SV Air Tor Start MBN41 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning SV Air To Start MBN41
13	13 January 2010	*Start Failure* from *SV Air To Start MBN42 Failed*	*Setting pressure switch not in 4 bars*	Replace and calibrate pressure switch Air To Start MBN42
14	14 January 2010	*Start Failure* from *SV MBN42/401 Failed*	*Movement of solenoid valve more than 5 seconds*	Test open close all SV *sector valve*
15	24 April 2010	*Start Failure* from *SV MBN42/401 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning SV MBN42/401
16	16 May 2011	*Start Failure* from *SV MBN41/401 Failed*	Movement of solenoid valve more than 5 seconds	Cleaning all SV *Sector Valve*
17	20 May 2011	*Start Failure from SV Air To Start MBN41 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning all SV *Sector Valve*
18	05 January 2012	*Start Failure* from *SV MBN42/401 Failed*	*Movement of solenoid valve more than 5 seconds*	Cleaning all SV *Sector Valve*
19	17 February 2012	*Start Failure* from *SV MBN42/401 Failed*	Failed Contactor	replace SV MBN42/101 contactor

Data in Table 1 can be presented as pareto chart as shown in Fig.10.

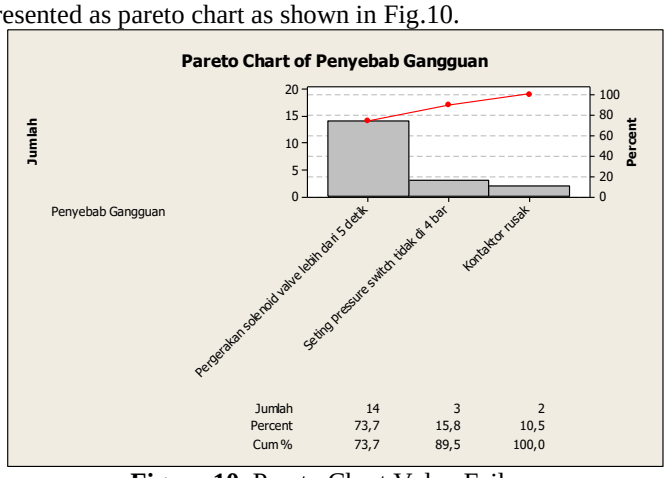


Figure 10. Pareto Chart Valve Failure

Based on pareto chart, the biggest percented of gas turbine valve failure about 73,7% due to slow respon at solenoid valve more than 5 second. The solution of this problem to avoid slow respon more than 5 second are tabuleted in Table 2

Table 2. Solution of Problem

Problem Cause	Solution	Note
There are some impurities in solenoid valve	Cleaning pilot solenoid	Preventive maintenance done
There are no method to monitor solenoid valve	additional overview POS 30 for pressure switch as feedback in aux relay contactor	
Air instrument contain water	Installation of drain instrument	
Feedback pressure switch condition not yet shown in POS30	Showing pressure switch di POS30	

Refer to Table 2, the required action to overcome the problem can be describe as follows:

- Additional indicator in HMI using POS 30 and pressure switch and aux relay contact as feedback signal.
- Update maintenance task refer to existing instrumentation system especially valve in gas turbine system

IV. Results And Discussions

By considering the availbility of plant, in term of possibility to modify instrumentation control system, gas turbine 1.3 was choosen as object of the study. Additional indicator in HMI can be described as follows:

1. Additional pressure switch attribute at EDS-P3 using symbol K

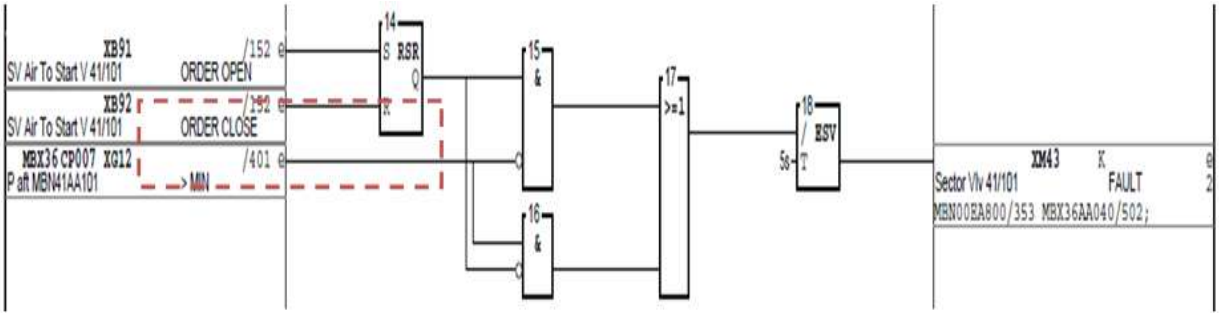


Figure 11. Pressure Switch Signal Before K Symbol Addition

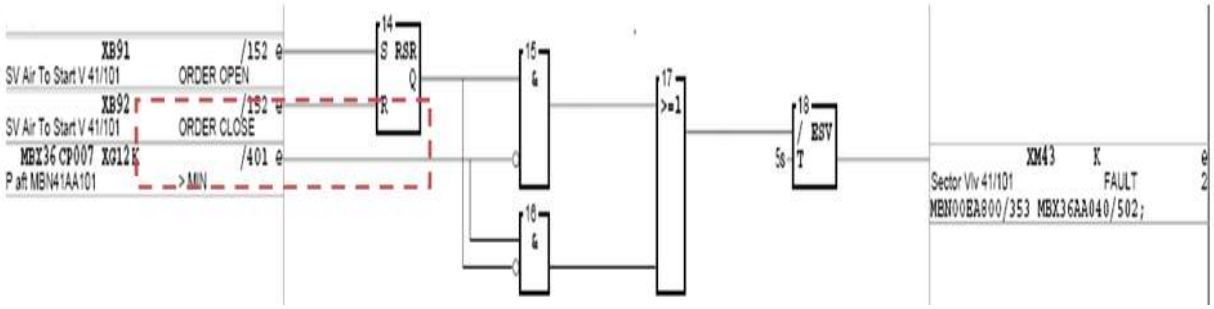


Figure 12. Pressure Switch Signal After K Symbol Addition

2. Upload program to EPROM at card 70BK06 as communication card

Figure 13. EPROM from EDS-P3

3. Address configuration on OPC server and OPC client
4. Build logic diagram on POS 30 Server

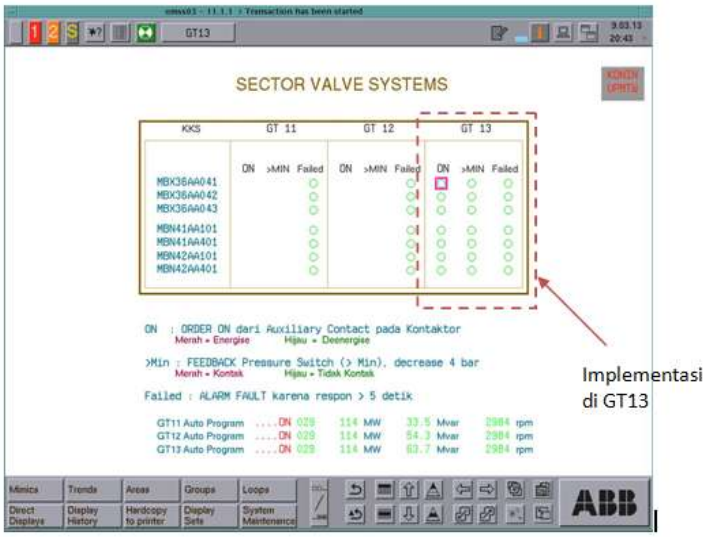


Figure 14. Overview System Valve Block 1

Testing of proposed design should be perform to evaluated the performance or cycle time of the system. Detail results of testing as shown in Fig. 15 and Table 3.

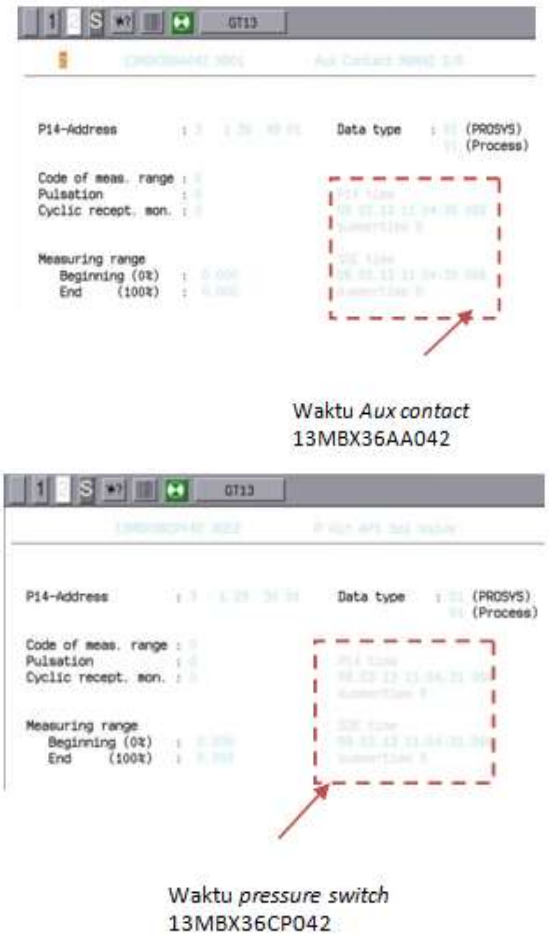


Figure 15. Aux Contact Time and Pressure Switch in 13MBX36AA042

Table 3. Response Time Pressure Switch by Aux Contact

KKS	Solenoid Valve (ORDER CLOSE)		
	Aux Contact (Energize Time)	**Pressure Switch** (Contact Time)	**Respond Time** (second)
13MBX36AA041	11:11:02	11:11:02	0
13MBX36AA042	11:11:02	11:11:02	0
13MBX36AA043	11:11:02	11:11:02	0
13MBX41AA101	11:11:02	11:11:02	0
13MBX41AA401	11:11:02	11:11:02	0
13MBX42AA101	11:11:02	11:11:02	0
13MBX42AA401	11:11:02	11:11:02	0

Table 3. Response Time Pressure Switch by Aux Contact (Cont)

KKS	Solenoid Valve (ORDER OPEN)		
	Aux Contact (De – energize Time)	**Pressure Switch** (Open Time)	**Respond Time** (second)
13MBX36AA041	11:04:29	11:04:29	0
13MBX36AA042	11:04:30	11:04:31	1
13MBX36AA043	11:04:31	11:04:31	0
13MBX41AA101	11:04:35	11:04:36	1
13MBX41AA401	11:04:36	11:04:37	1
13MBX42AA101	11:04:38	11:04:39	1
13MBX42AA401	11:04:39	11:04:40	1

Table 3 shows the cycle time less than 1 second in both valve open or close. It indicate valve system under good condition or no maintenance action is required

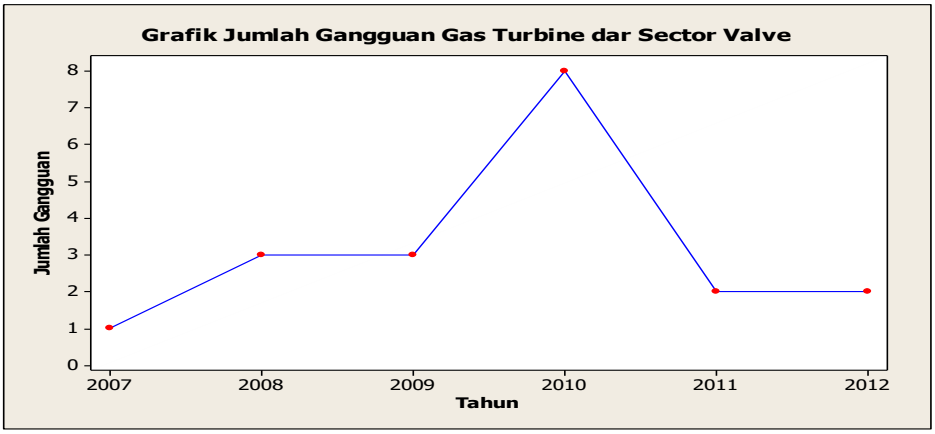


Figure 16. Valve Problem in 2007 – 2012 Period

Table 4. Problem in Valve

	Tanggal	Loss (Hour)	Loss Product (MW)	Unit	Problem
1	13 August 2007	2,27	306,0	GT12	Start Failure SV MBN41/101 Failed
2	04 Juny 2008	1,90	256,5	GT12	Start Failure from SV MBN42/101 Failed
3	07 January 2008	1,47	198,0	GT21	Start Failure from SV MBN41/401 Failed
4	08 January 2008	1,20	162,0	GT22	Start Failure from SV MBN42/401 Failed
5	15 March 2009	0,00	0,0	GT11	Change Over Fuel Failure from SV Air To Start MBN42 Failed
6	14 March 2009	0,00	0,0	GT13	Change Over Fuel Failure from SV Air To Start MBN41 Failed
7	14 March 2009	0,00	0,0	GT13	PLST from SV MBN 41/101 Failed
8	21 November 2010	2,78	389,7	GT12	Start Failure from SV Air To Start MBN41 Failed
9	13 January 2010	1,20	162,0	GT21	Start Failure from SV Air To Start MBN43 Failed
10	08 August 2010	3,73	541,3	GT21	PLST from SV MBN42/401 Failed
11	24 December 2010	0,37	51,3	GT21	Start Failure from SV Air Tor Start MBN41 Failed
12	25 December 2010	5,72	600,3	GT21	Start Failure from SV Air Tor Start MBN41 Failed
13	13 January 2010	4,52	609,8	GT22	Start Failure from SV Air To Start MBN42 Failed
14	14 January 2010	1,88	254,3	GT22	Start Failure from SV MBN42/401 Failed
15	24 April 2010	0,93	130,7	GT22	Start Failure from SV MBN42/401 Failed
16	16 May 2011	1,43	137,0	GT21	Start Failure from SV MBN41/401 Failed
17	20 May 2011	4,12	137,0	GT21	Start Failure from SV Air To Start MBN41 Failed
18	05 January 2012	1,02	137,7	GT22	Start Failure from SV MBN42/401 Failed
19	17 Februari 2012	1,73	233,6	GT22	Start Failure from SV MBN42/401 Failed

V. Conclusion

Valve maintenance at gas turbine ALSTOM 13E2 in Block 1 and 2 CCPP Muara Tawar can be done by additional indicator of pressure switch and aux relay contact as feedback signal on POS 30. Therefore, no disturbances in valve system and gas turbine performance increases. .

Acknowledgement

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