Advances in Social Science, Education and Humanities Research, volume 410
1st International Multidisciplinary Conference on Education, Technology, and Engineering (IMCETE 2019)

Electrostatic Precipitator Failure Analysis Using FMEA Method on Steam Turbine Electricity Generation (PLTU Banten 2 - Indonesia)

1st Tatan Zakaria
Industrial Engineering
Universitas Banten Jaya
Serang, Indonesia
tizet.tasmal@gmail.com

2nd Wawan Gunawan
Industrial Engineering
Universitas Banten Jaya
Serang, Indonesia

3rd Ahmad Faisal
Industrial Engineering
Universitas Banten Jaya
Serang, Indonesia

***Abstract*—In electric power generation, reliability of each equipments is important in order produce optimal electrical energy. Unreliable units will influence to other cost due to an expensive production losses. So, it is very important to know the reliability on each system. In this case study, an Electro Static Precipitator (ESP) failure analysis was performed using the Failure Mode and Effect Analysis (FMEA) method and found the potential causes issue was came from the Outpu Voltage Lack ESP # 1 alarm. The Risk Priority Number (RPN) is obtained from identifying the potential causes of failures that occur on the machine / equipment and then for corrective action, we use the 5W + 1H analysis method. Based on FMEA analysis and cause and effect diagrams, the potential failure factor for alarm Output Voltage Lack ESP # 1 is an abnormal ash transporting factor with the value up to 57% or an RPN value is 648. After improvement to be implemented, the results of corrective action can be described as follow as: Before improvement the ESP # 1 damage caused by abnormal ash transporting 20 times / year (July 2017 - June 2018) and After Improvement the failure or abnormal ash transporting was not occurred any more (July 2018 – June 2019).**

Keywords: FMEA, ESP, PLTU, Banten 2

I. INTRODUCTION

PLTU Banten # 2 Labuan is one of the many Indonesian government owned steam turbine electric power plants, located in Labuan Banten Indonesia. Generally, steam turbine power plant, consists of 4 main parts: Boilers, Steam Turbines, Generators and Power transmission Distribution. A boiler is an energy conversion machine that converts the chemical energy of coal fuel into the kinetic potential energy of pressurized steam, which will be used to rotate the steam turbine shaft through the turbine blade, and then the shaft rotation is forwarded to the generator which converts the mechanical energy of the shaft rotation to electrical energy.

All parts of the machine are required to operate continuously in order supply of electrical energy is not interrupted. Boilers consist of various systems function as like as: fuel supply systems, water supply systems, combustion air systems and exhaust gas systems. Included in the flue gas control system, the Electrostatic Precipitator (ESP) is a boiler exhaust air filter that is mostly used, and part is also required to be operated properly for 24 hours per day without interruption. Please find the ESP on Pigure-1 below :

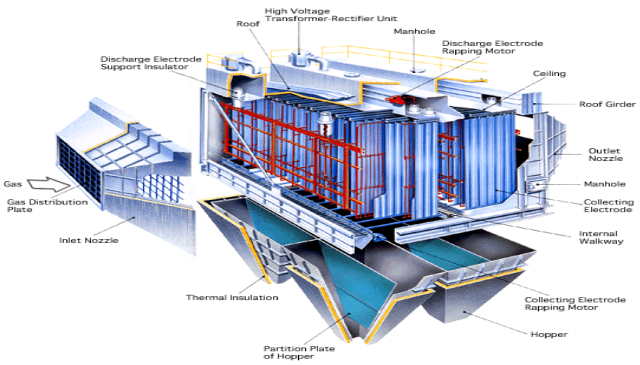

Fig.1.The Electrostatic Precipitator (ESP)

II. METHOD

This analytic description research uses the Failure Method Effect Analysis (FMEA) method, which is a method of failure analysis of machine work functions. From the failures data obtained, it is calculated the value of ***RPN = Severity x Occurrence x Detection***, where *Severity* is a warning of the seriousness of the risk of failure to function the machine, *Occurrence* is the frequency of malfunctioning events and *Detection* is the extent to which the failure is initiated or equipped with a detection or warning function before the event. In addition to the RPN number, another analysis tool used is the NGT which is an analysis based on judgmental the ESP from experts involved and then for the proposed improvement using 5W + 1H method. The research flowchart can be described as shown below:

The research flowchart can be described as shown below:

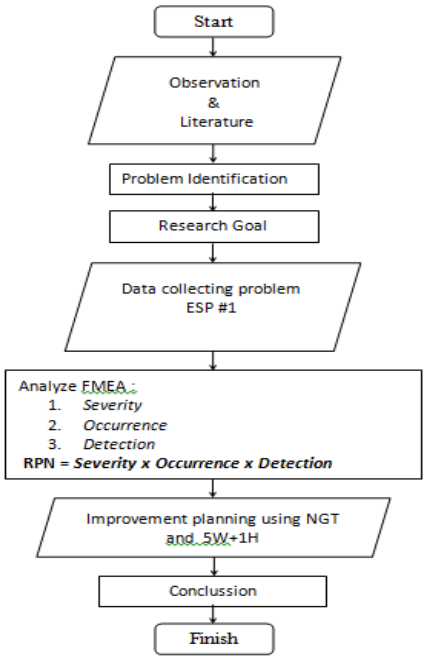

Fig.1. The research flowchart

III. Results and Discussion

A. Baseline Data

Based on ESP abnormal and failure data reports for 2017, the data obtained are as in Table-1 below:

TABEL I. BASELINE ESP FAILURE 2017

No	Failure Mode	Frequency
1	Busbar moist	1
2	Disconnecting switch problem	1
3	Transformer input cable problem	1
4	Disconnecting busbar	1
5	Oil transformer problem	1
6	Collecting plate abnormal	1
7	Electroda wire/ discharge electroda covered ash	1
8	Ash transporter abnormal	20
9	Unproper Manhole packing	1
10	Heater fluidzing blowerabnormal	1
11	Card Module abnormal	1
Total 2017 Problem		30

B. Data Analysis

The abnormal and failure data were analyzed by the FMEA method to calculate and find the RPN number, and obtained as Table-2 below:

TABEL 2. RPN NUMBER OF ESP FAILURE 2017

No	Item	Failure Mode	S	O	D	RPN
1	ESP Module	Abnormal module	8	2	1	16
2	ESP Transformer	Busbuar disconected	7	2	1	14
3		Oil Leakage	6	2	1	12
4		*Disconnecting switch*	6	2	1	12
5		Busbar moist	6	2	1	12
6		Input cable damage	6	2	1	12
7	ESP *Hopper*	Ash Transporter problem	9	9	9	729
8		Collecting Plate abnormal	7	5	1	35
9		*Electroda wire/discharge electroda* covered by ash	6	5	1	30
10		*Heater fluidzing blower* operation abnormal	6	2	1	12
11		*Mainhole* packing unproper	6	2	1	12

And then from above 11 abnormality and malfunction of the ESP, we found that the dominant problem of ESP is the jammed transporter ash which has biggest RPN number 729. Therefore, the cause is searched and analyzed by NGT to focus more on what is the most dominant improvement in the failure of the ash transporter to be required. The NGT is the quantification of expert opinion on the problem to find what dominant root cause analysis. Table-3 is an analysis of NGT describe on the problem that causes Abnormal of Ash Transporter:

TABEL III. ASH TRANSPORTER ABNORMAL – NGT

Root Cause : ASH TRANSPORTER ABNORMAL

No	Penyebab Masalah	Expertise judges						Remark
		Section head	Supervisor	X1	X2	X3	Total	
1	***Fluidzing blower* malfunction**	10	11	11	7	9	48	*5W-1Hanalyze*
2	Wrong schedule	4	6	7	1	3	21	
3	Mis Measurement	5	6	3	7	2	23	
4	*Air dryer* offerly trip	7	8	7	6	7	35	
5	*Air compressor* offerly trip	6	8	9	7	7	37	
6	wrong connecting cable	3	7	3	4	5	22	
7	Employee not care	4	3	6	7	2	22	
8	**Employee did not understand**	8	12	15	13	11	59	*5W-1Hanalyze*
9	Poor teamwork	8	6	9	7	6	36	
10	**No Maintain cleaning area**	15	14	11	13	11	64	*5W-1Hanalyze*
11	Rairing rate high	3	5	2	7	3	20	
12	Bad coal quality	2	4	5	6	9	26	
13	**PM Planning not good**	15	13	13	14	11	66	*5W-1Hanalyze*
14	**Poor supervising**	12	14	15	10	10	61	*5W-1Hanalyze*
15	**There are wet fly ash**	13	11	10	10	12	56	*5W-1Hanalyze*

CONCLUSION From above table, only NGT with a value of 38, 5 or higher will be analyzed and improved, where:

Root Cause = 15

Respondent = n = 5 persons

$$NGT = \frac{(\text{Respondent} \times \text{Root Cause}) + 1}{2} = \frac{(5 \times 15) + 1}{2}$$

NGT = 38.5 (only score 38.5 and Up to be analyzed by 5W + 1H)

C. *Improvement Planning*

The repair action plan of the ash transporter problem used the 5W + 1H method, as described as in Table 4 below:

TABLE 4. IMPROVEMENT PLANNING & IMPLEMENTATION USING 5W+1H METHOD

No	Root Cause	What	Why	Where	When	Who	How
1	*Fluidzing blower* malfunction	a. Motor problem	a. *Insulator motor bad condition , no maintenance*	a. Motor *fluidzing blower*	Juli 2018	a. Technician Team	a. Revice PM Schedule
		b. *life time*	b. No any replacement before	b. Machine of *fluidzing blower*		b. Mechanical Team	b. Do the replacement
2	Employee did not understand	*Skill and competences are not enaugh*	Not enaugh training events	Production Department	Maret 2018	Operation Supervisor	Training and give the Certifications of competences
3	No Maintain cleaning Area	Machine and equipment cleaning	Employee not care about cleaning area	Machine area ESP #1	Apr-18	Operation & Maintenance	Do the briefing and coaching
4	Breakdown machine	Operation and maintenance out of SOP	Employee not understand SOP	Machine area ESP #1	Mei 2018	Operation & Maintenance	Giving a training of SOP
5	Wet Fly ash	a.FA mixing with water	a. No Drain schedule	a. *Air receiver tank*	Juni 2018	Mechanical	a. Make auto drain
		b. *Aramid /membran leakage*	b. part *life time*	b. Peralatan ESP #1			b. Replace *aramid/membran*
6	Ash mixed with solar and oil	Ash sticked on hopper and jammed	No SOP operting ESP during start *fairing boiler unit*	Machine area ESP #1	Juni 2018	Operator	Make new SOP and give training

IV. CONCLUSION

Based on FMEA analysis and action plan repairs using the 5W + 1H method, the failure of the ESP function can be corrected and be improved. Baseline data in 2017 malfunctions in ESP were 20 events and major problems in the ash transporter, after carrying out repairing 8 action items at 5W + 1H at column " HOW ", the abnormality and failure from July 2018 to June 2019 the problem does not occur again. And it can be summarized, the succeed Improvements can be categorized: Revised SOP & PM Schedule, Training & Coaching, Modification of manual drain by Auto Drain.

REFERENCES

[1] Hasbullah, H., dkk. 2017. Analisis Kegagalan Proses Insulasi Pada Produksi *Automotive Wires* (AW) Dengan *Metode Failure Mode And Effect Analysis* (FMEA) Pada PT. JLC. *SINERGI*. Vol. 21, No.3.

[2] Hidayatullah, R., dan Muliatna, I. M., 2017. Study *Failure Mode And Effect Analysis* (FMEA) Sebagai Identifikasi Bahaya Dan Upaya Pencegahan Kecelakaan Kerja Di PT. PJB UBJ O & M Tanjung Awar – Awar, JPTM, Vol. 06. No. 02.

[3] Ishikawa, Kaoru. 1998. Teknik Penuntun Pengendalian Mutu. Penerbit Mediyatama Sarana Perkasa.

[4] McDermott, R. E, dkk. 2009. *The Basic Of FMEA 2nd Edition*, Taylor And Francis Group, LLC. New York.
Muzakkir, S. M, dkk. 2015. Failure Mode And Effect Analysis Of Journal Bearing, *International Journal Of Applied Engineering Research*, Vol.10. No. 16.

[5] Modul Ash Handling. *Modul Operator PLTU Suralaya*, Banten. 2009

[6] Pontororing, P. P., dan Andika, A., 2019. Analisis Risiko Aktivitas Pekerjaan Karyawan Perusahaan Ritel Dengan Metode FMEA Dan Diagram Fishbone, *Jurnal Kajian Ilmiah*, Vol. 19. No. 1.

[7] Sayuti, M., dkk. 2013. Evaluasi Manajemen Perawatan Design Dengan Menggunakan *Metode Reliability Centered Maintenance* Pada PT. Z. *Malikussaleh Industrial Engineering Journal*. Vol.2 No.1.

[8] Yuhelson, dkk. 2019. Analisis *Realiability* dan *Availability* Mesin Pabrik Kelapa Sawit PT. Perkebunan Nusantara 3. *Jurnal Dinamis*. Vol II. No. 6.