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

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Abstract—In electric power generation, reliability of each equipment 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 Output 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

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 $RPN = Severity \times Occurrence \times Detection$, 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:

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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:

| 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 electrode covered ash | 1 |
| 8  | Ash transporter abnormal   | 20        |
| 9  | Unproper Manhole packing   | 1         |
| 10 | Heater fluidizing blower abnormal | 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:

| No | Item                          | Failure Mode                  | S  | O  | D  | RPN |
|----|-------------------------------|-------------------------------|----|----|----|-----|
| 1  | ESP Module                     | Abnormal module               | 8  | 2  | 1  | 16  |
| 2  | Busbar disconnected            |                               | 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  | Ash Transporter problem        |                               | 9  | 9  | 9  | 729 |
| 8  | Collecting Plate abnormal      |                               | 7  | 5  | 1  | 35  |
| 9  | Electroda wire/discharge electrode covered ash | 6 | 5 | 1 | 30 |
| 10 | Heater fluidizing blower operation abnormal | 6 | 2 | 1 | 12 |
| 11 | Manhole packing improper       |                               | 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:

| No | Item                               | Frequency | Severity | Occurrence | Detection | RPN |
|----|-----------------------------------|-----------|----------|------------|-----------|-----|
|    | No Item                           | Fail rate | X1       | X2         | X3        |     |
| 1  | Fluidizing/blower malfunction     | 10        | 10       | 10         | 10        | 10  |
| 2  | Inoporator                       | 10        | 10       | 10         | 10        | 10  |
| 3  | Manhole                          | 10        | 10       | 10         | 10        | 10  |
| 4  | Electroda wire/discharge electrode covered ash | 6 | 5 | 1 | 30 |
| 5  | Ash Transporter                   | 10        | 10       | 10         | 10        | 10  |
| 6  | Employee not qualify              | 10        | 10       | 10         | 10        | 10  |
| 7  | Poor work                        | 10        | 10       | 10         | 10        | 10  |
| 8  | Poor supervising                  | 10        | 10       | 10         | 10        | 10  |
| 9  | Poor maintenance                  | 10        | 10       | 10         | 10        | 10  |
| 10 | No proper cleaning area           | 10        | 10       | 10         | 10        | 10  |
| 11 | Processivity                      | 10        | 10       | 10         | 10        | 10  |
| 12 | Quality                          | 10        | 10       | 10         | 10        | 10  |
| 13 | Equipment operation not good      | 10        | 10       | 10         | 10        | 10  |
| 14 | Poor supervising                  | 10        | 10       | 10         | 10        | 10  |
| 15 | There are fly ash                 | 10        | 10       | 10         | 10        | 10  |

CONCLUSION From above table, only NGT with a value of 38, 5 or higher will be analyzed and improved, where:
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 | Whut | Why | Where | When | Who | How |
|----|-------------|------|-----|-------|------|-----|-----|
| 1  | Fluidizing blower malfunction | a. Motor problem | a. Insulator motor bad condition, no maintenance | a. Motor fluidizing blower | Juli 2018 | a. Technician Team | a. Revise PM Schedule |
|    |             | b. life time | b. No any replacement before | b. Machine of fluidizing blower |       | b. Mechanical Team | b. Do the replacement |
| 2  | Employee did not understand | Skill and competences are not enough | Not enough training events | Production Department | Mar 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 |       |       |       |
| 6  | Ash mixed with solar and oil | Ash stuck on hopper and jammed | No SOP operating 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. ILC. 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 UB3 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.

[5] Muzakkir, S. M, dkk. 2015. Failure Mode And Effect Analysis Of Journal Bearing, International Journal Of Applied Engineering Research, Vol.10. No. 16.

[6] Modul Ash Handling. Modal Operator PLTU Suralaya, Banten. 2009

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

[8] Sayuti, M., dkk. 2013. Evaluasi Manajemen Perawatan Design Dengan Menggunakan Metode Reliability Centered Maintenance Pada PT. Z. Malikussuleh Industrial Engineering Journal. Vol.2