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A Root Cause Failure Analysis (RCFA) on the Primary Air Fan (Pa Fan) Motor at Pangkalan Susu Power Plant

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Abstract: *PA Fan (Primary air fan) is equipment that functions to suck air from the atmosphere which aims to supply air to the coal pulveriser to dry the coal and transfer the coal ash to the boiler. PA Fan in operation has tripped with an indication on the protection panel OP_ROC. This ROC indication appears due to an indication of a short circuit to ground or an imbalance of currents between phases which causes a zero connection current. When the local inspection was carried out, it was found that there was a burnt insulator on the S side phase. This resulted in the motor losing one phase and causing ROC (Residual Over Current) protection on the 6 kV protection module to work.*
Keywords: *primary air fan; over current; short circuit; maintenance*

I. Introduction

Coal-fired power plants require air for the electricity production process. Air supply can be divided into two, namely primary air fan which produces primary air and secondary air fan which produces secondary air. These two fans are vital components in coal-fired power plants. At the Steam Power Plant (POWER PLANT) there are several fans used, such as primary air fans, secondary air fans, induced draft fans, and sealing air fans but this time the author will discuss about fans and primary air fans in particular.

Fans are used in increasing generator efficiency because they can maximize thrust at the fuel inlet line, save fuel and help the combustion process to be complete. Because without a fan, it will be difficult to get efficiencythermalin the kettle.

In addition, after the mixing process of coal powder and air carried out by a fan and assisted by a fixed dumper, namely the air stirrer regulator, it will be able to cause turbulence, which is a movement that can complete the mixing of coal powder and air.

Primary air fan (PAF) functions as a producer of primary air (primary air) which is used as air transporting coal powder from the pulverizer to the burner to be burned in the boiler furnace as well as a coal dryer. At first the PA Fan that works at low pressure takes air from the outside to be used as primary air, then the PA Fan will work at high pressure to distribute coal powder from the pulverizer to the boiler furnace which is assisted by a seal air fan (compressed air producer). Before entering the boiler, the primary air temperature is raised first by the primary air heater which functions as the primary air preheater produced by the PA Fan before being channeled to the Pulverizer.

Maintenance(maintenance) is an activity to maintain or maintain production facilities and machinery/equipment and carry out repairs or replacements needed in order to obtain satisfactory production operating conditions according to what has been planned.

The objectives and results of this RCFA study canFailure Defense Task(FDT) on abnormal equipment that results in unit trips, then the resulting recommendations can be made so that the possibility of the same problem can be minimized in the long term so that the reliability of the equipment can always be maintained.

II. Review of Literature

2.1 Primary Air Fan (PA Fan)

PA fan is a device that serves to suck air from the atmosphere to the pulverizer which passes through the air pre heater with the aim of taking heat from the exhaust gases. The heat from this flue gas serves to dry the crushed coal in the pulverizer. After this coal becomes ash, the coal ash is transferred to the boiler to meet the combustion air which aims to make combustion in the boiler. At the Pangkalan Susu Power Plant each unit has 2 PA fans with a capacity of 2 x 50%. The following is the construction of the PA Fan motor.

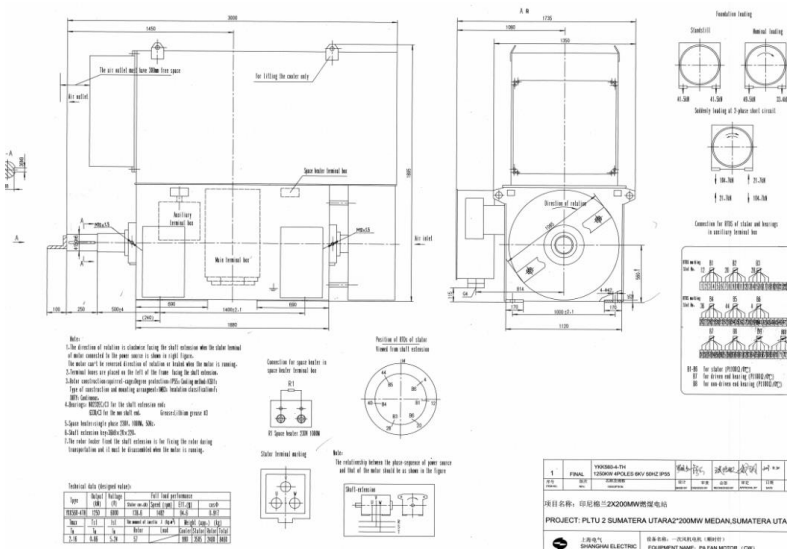

Figure 1. *Construction of PA Fan Motor*

Fans are used in increasing generator efficiency because they can maximize thrust at the fuel inlet line, save fuel and help the combustion process to be complete. Because without a fan, it will be difficult to obtain thermal efficiency in the boiler. In addition, after the mixing process of coal powder and air carried out by a fan and assisted by a fixed dumper, namely the air stirrer regulator, it will be able to cause turbulence, which is a movement that can complete the mixing of coal powder and air.

Table 1. Specifications of Primary Air Fan

PAF		Motorcycle	
Model	SFG20.5F-C5A	*Model*	YKK 630-4TH
Air Flow	76.8 m3/s	*Power*	1250 Kw
Air Pressure	16576 Pa	*Voltage*	6000 V
Speed	1482 rpm	*speed*	1482 rpm

2.2 Working Principle Primary Air Fan

Primary air fan(PAF) functions as a producer of primary air (primary air) which is used as air transporting coal powder from the pulverizer to the burner to be burned in the boiler furnace as well as a coal dryer.

At first the PA Fan which works at low pressure takes air from the outside to be used as primary air, then the PA Fan will work at high pressure to distribute coal powder from the

pulverizer to the boiler furnace which is assisted by Seal Air Fan (compressed air producer). Before entering the boiler, the primary air temperature is raised first by the primary air heater which functions as the primary air preheater produced by the PA Fan before being channeled to the Pulverizer. Primary water is divided into two based on its location, namely the cold primary air system and the hot primary air system. The cold primary air system is located in the channel before the water heater, while the hot primary air system is located after passing the air heater, the two will mix on the mixbed.

If *primary air fan* operated for a certain time, there will be a decrease in the performance of the tool. Decrease in performance can occur due to poor motor performance, leaks or imperfect cooling. In addition to these factors, changes in the performance of the primary air fan are also influenced by the water content in the air, air flow, electric current in the motor, and the fan press head. Indirectly, the water content in the air will affect changes in air flow, pressure head, and electric current in the motor. The more water content in the air, the weight of the air will increase, the additional weight of the air will reduce the flow of air flowing in the fan. In addition, the weight of the air will make the fan work harder, the fan rotation will slow down because the air is getting heavier. Changes in the rotation of the fan will affect the motor that drives it. The motor must respond to these changes by increasing the electric current in the motor. While the weight on the air will increase the head press on the fan. . Because of these factors, an effort is needed to evaluate the performance of the primary air fan. Evaluation is carried out to find out how much the primary air fan performance has decreased.

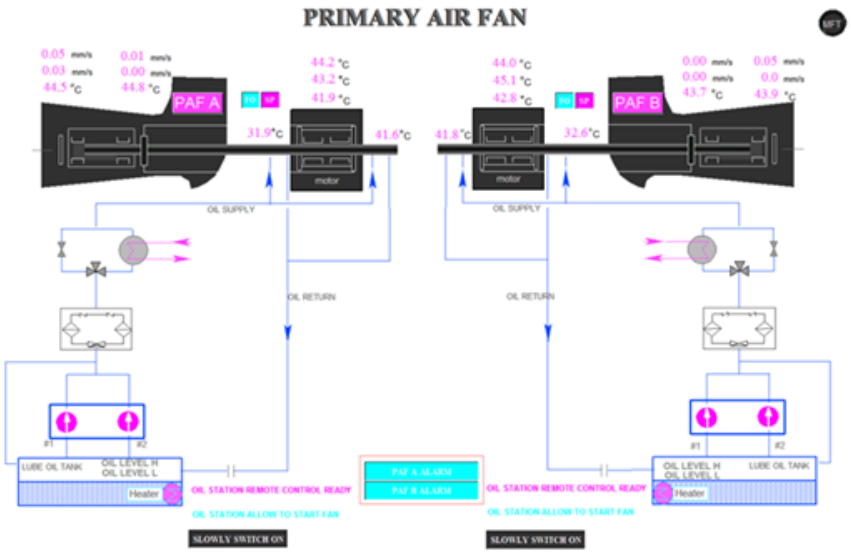

Figure 2. *Block Diagram of Primary Air Fan*

The PA Fan as shown in Figure 2. is located not far from the pulverizer and functions as a producer of primary air (primary air) which is used as air transporting coal powder from the pulverizer to the burner to be burned in the boiler furnace (the room containing the boiler pipes used for storage). burning). As the primary air passes through the mill at high speed, small pulverized coal particles enter the air stream and flow upward through the classifier and coal pipe to the burner.

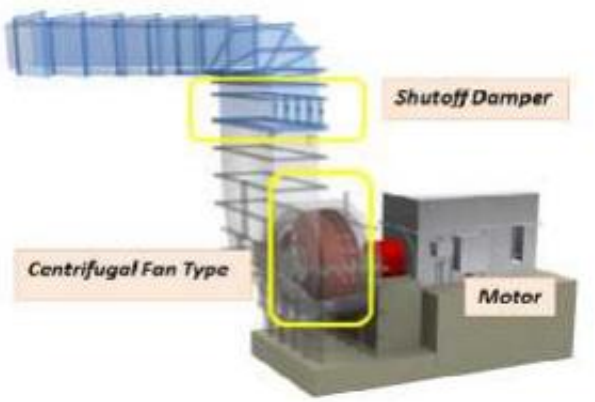

Figure 3. *Primary Air Fan*

2.3 Primary Air System

At first the PA Fan which works at low pressure takes air from the outside to be used as primary air, then the PA Fan will work at high pressure to distribute coal powder from the pulverizer to the boiler furnace which is assisted by a sealing air fan (air sealing system). Before entering the boiler, the primary air temperature is raised first by the primary air heater which functions as the primary air heater produced by the PA Fan before being channeled to the pulverizer.

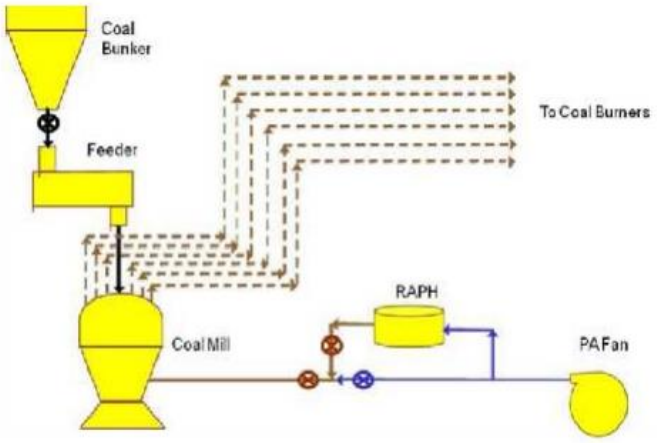

Figure 4. *Primary Air Cycle*

Primary air fan It is divided into two based on its location, namely cold *primary air system*and hot primary air system. The cold primary air system is located in the channel before the water heater, while the hot primary air system is located after passing through the air heater. The cold primary air system has the advantage that it has a small volumetric efficiency when pressed but has a greater loss in the air heater than the hot primary air heater which has a small loss in the air heater but requires cooling for the fan components and the construction is more complicated.

2.4 PA Fan Protection Equipment

Protection system is a security system for electrical equipment, which is caused by technical disturbances, natural disturbances, operating errors, and other causes. The protection system is a way to prevent or limit equipment damage to interference, so that the continuity of electricity distribution can be maintained and engine reliability is maintained.

The primary air fan motor uses a voltage of 6 kV. On 6 kV protection equipment needs to be made reliable in order to secure the equipment when there is an electrical problem on the equipment.

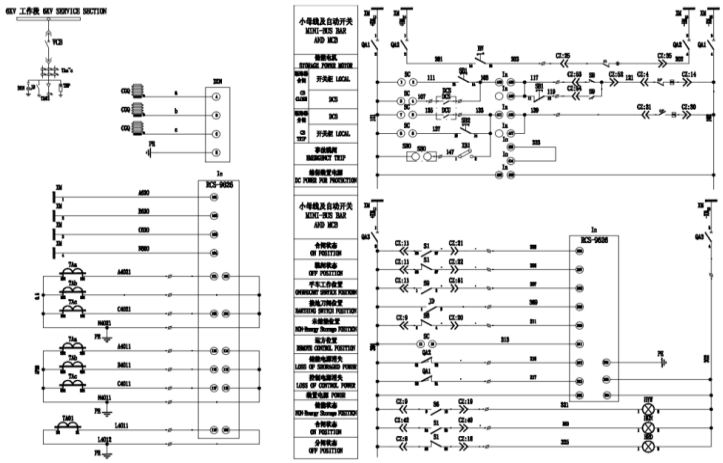

Figure 5. *Specifications and Drawing of Electrical Equipment on PA Fan*

Hot Dumper Shut Off Function Failure Shut Off Damper is equipment that supports the primary air distribution process to the Mill/Pulvarizer on line hot, shut off damper using the Guilotine/Slide Damper type. Shut off damper works linearly that is open and close horizontally. The damper is made of iron plate which is designed so that it can continue or stop the flow of air from the Primary Air Fan (PAF) and prevent backflow of air from Mill/Pulvarizer.

Backflow from the Mill/Pulvarizer can lead to accumulation of residual coal from Mill/Pulvarizer to PAF line, PAF line consists of many important equipments such as air blade preheater and PAF blades. If the remaining coal enters the fan blade, it will damage the blade so that cause the equipment to trip. The air preheater has a high temperature because it occurs heat extraction between PAF air and flue gas from boiler, exhaust gas capable of meeting the force requirements to move the damper quickly and reliably in any condition.

The temperature and temperature on the PAF line can vary according to the needs of the resulting load. When the load is full, the temperature the air in the hot PA will be high and vice versa. The working mechanism of the shut off damper is divided into 2 modes, namely:

1. Remote mode is a mode that is run from the Control Room and is set by the operator.
   The working mechanism of the shut off damper based on the remote mode is as follows:
   - The Human Machine Interface sends a signal to the function block that will define the command/command input that has been given.
   - The signal sent via the command input is passed to the command output which will be sent to the control cabin. The signal sent to the control cabin will enter the digital output which will send commands to the relay. The relay will define the command so that sends electricity to the solenoid coil.
   - The flow of electricity in the solenoid coil will produce a magnetic field so that the piston is the solenoid valve will shift towards the magnetic coil.
   - The solenoid valve that moves towards the magnetic coil will touch the Open Limit Switch so that the limith switch will send electricity to the control panel indicator light and forwarded to the feedback relay.

2. Total Productive Maintenance

Total Productive Maintenance (TPM) is a holistic approach to maintenance of equipment that seeks to achieve a production process which is near perfect. TPM process

ensures less damage, downtime, and breakdowns while lowering costs and involvement employees, where TPM improves equipment operating conditions, enabling achieving high productivity and effectiveness on a machine, and maintain equipment at optimal performance levels (Agustiady & Cudney, 2018).

2.5 Benefits of Total Productive Maintenance (TPM)

There are many advantages of TPM including sharpening equipment employees related knowledge and skills, improve communication internal, provides the basis for building cooperation, establishes specifications basic equipment, promote equipment audit and diagnosis, control equipment variation and reduce defects, eliminating unnecessary downtime planned, ensure quality control, improve Overall Equipment Effectiveness (ORE), and eliminating crisis management (Agustiady & Cudney, 2018).

Total Productive Maintenance (TPM) is a maintenance concept productive systems designed to achieve the comprehensive effectiveness of the system production by involving everyone in an organization/company (Adesta, Prabowo, & Agusman, 2018). In more detail, TPM is divided into three important concepts:

1. Total, which means the involvement of all company personnel/employees.
2. Productive which means activities, TPM activities are carried out as much as possible so as not to interfere with the company's productivity.
3. Maintenance, meaning the selection of the most appropriate/effective method maintenance.

III. Research Methods

Data collection for making this RCFA uses several methods to obtain data and analyze matters relating to abnormal equipment that results in unit trips, including the following:

a. Observation in the field, to find out the actual conditions that existed at the time of the incident.
b. Conduct interviews with SPS/SP Operations, Operators in the Central Control Room, local operators and maintenance teams.
c. Process and analyze data.
d. Analyzing with the Why-Tree Diagram method, to find the exact root of the problem in a predetermined failure mode.
e. Conduct literature studies from manual books and the internet.

The following is a research flow chart that requires the stages in the research process carried out in the field.

Figure 6. *Condition of S-Phase Motor Terminal Burns During Unit Trip*

IV. Discussion

Root Cause Failure Analysis (RCFA)

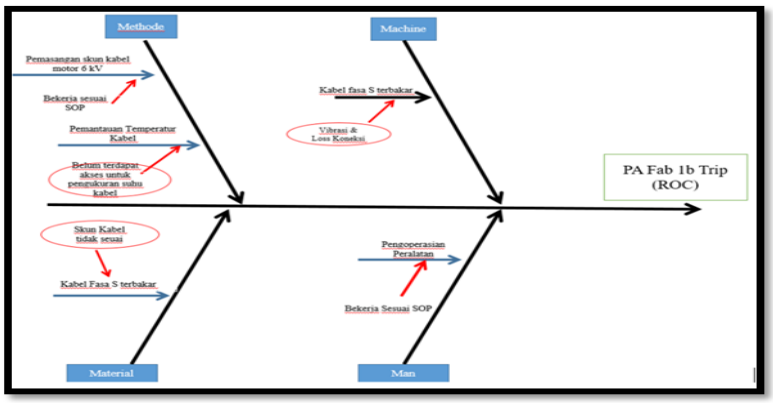

Figure 7. *Failure Mode Effect Analysis*

After checking the condition of the equipment locally, a burnt condition S phase insulator was found and a motor inspection was carried out to ensure that the PA FAN motor was in good condition.

Table 2. Insulation Measurement Results on Motors and Power Cables

Insulation Tester Measurement (1 minute)			
No.	Description	Score	Information
1	Motor Winding - Ground	2.44 Gohm	Well
2	R-Ground Phase	17.67 Gohm	Well
3	S-Ground Phase	13.80 Gohm	Well
4	T-Ground Phase	17.67 Gohm	Well

Table 3. Results of DC Resistance Measurements in the Pa fan motor winding

Motor Winding DC Resistance Measurement			
No.	Description	Score	Information
1	U -V . winding	0.37 Ohm	Well
2	U-W . winding	0.569 Ohm	Well
3	V-W . winding	0.549 Ohm	Well

After making sure the condition of the motor is good, it is continued to repair the terminal cable on the PA Fan motor.

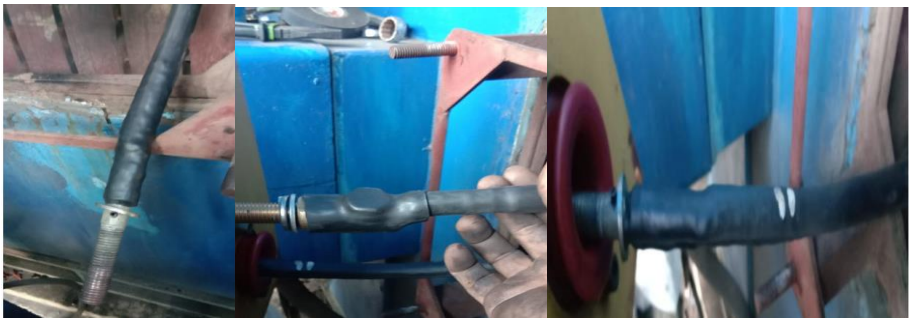

Figure 8. *Motor Terminal Cable Repair*

Re-measure the resistance value after repairing the motor:

Table 4. Measurement Results of DC PA Fan Motor Winding Resistance After Repair

Motor Winding DC Resistance Measurement			
No.	Description	Score	Information
1	U -V . winding	0.434 Ohm	Well
2	U-W . winding	0.4077 Ohm	Well
3	V-W . winding	0.470 Ohm	Well

Some findings related to problems in PA Fan see*root cause*from the fishbone diagram above are:

1. Inappropriate Use of Skun on S Phase Motor Terminals

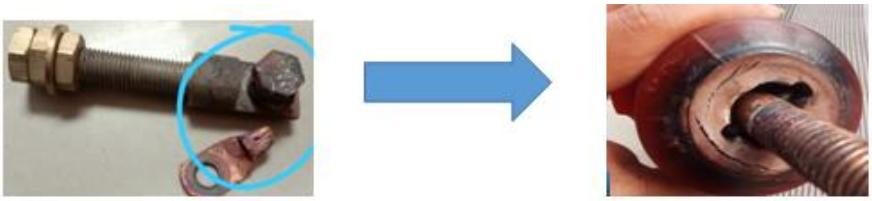

Figure 9. *The Skun Used in the S Phase is not Appropriate*

2. Overal Vibration on PA Fan Unit

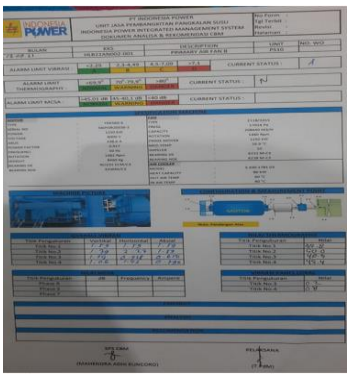

Figure 10. *Measurement Form for PA Fan Vibrator Unit*

Table 5. Overall Vibration Measurement Results Indicate Damage to DE . Side Bearings

Overall Vibration			
Measuring Point	Vertical	Horizontal	Axial
Point No. 1	1.59	1.59	1.59
Point No 2	1.79	2.27	1.59
Point No 3	1.59	0.938	0.650
Point NO 4	1.06	1.42	0.796

Due to the unavailability of the existing 6 kV skun and still in the purchase stage, currently the S phase terminal skun on PA fan 1B still uses the available motor skun with a spring ring holder on the inside to avoid potential looseness in the S phase skun and will scheduled to be replaced during unit 1 overhaul along with replacement of DE Motor side bearings.

V. Conclusion

1. Unit 1 trips are caused by effects and impacts when PA Fan 1B trips which results in PA flowto a drop of 50 t/h.
2. Interference with the PA fan is indicated by the ROC (Residual Over Current).
3. There is no method of detecting a 6 kV motor cable from the Hot Spot due to connection loss.
4. The use of inappropriate cable skun causes lossnes

References

Chunju Fan. 2015. Short-circuit current calculation method for partial coupling transmission lines under different voltage levels. Journal of Electrical Power and Energy Systems 647-654.

Daryus, Asyria. 2007, Directorate of Machinery Maintenance Management, Darma Persada University, Jakarta.

Fadhi, 2020. Analysis of Overcurrent Relay Coordination for Addition of Motor Circulating Pump (BCP) 520 kW/3kV for Continuity of Water Circulation Supply in Boilers Using ETAP 12.6.0. Proceedings of the Engineering Cluster Unissula Student Scientific Conference (KIMU).

Hamid, Abdul., Dr. B. Eng. 2012. "Practical Mechanical Vibration Tori and Practice". Yogyakarta. Graha Ilmu

Huda, Nazaruddin, Dovani Mario. 2015. Analysis of Rotordinamic Sound Due to Unbalance, Misalignmet, and Looseness. National Journal. Riau University, October 2015.

Nursalim. 2019. Analysis of Coordination and Setting Over Current Relay (OCR) on Own Power Consumption of POWER PLANT SMS Energy using ETAP 12.6.0 Software. electronic media journal (2019): 100-109.

Siti Sholihatul. 2021. Evaluation of the Primary Air Fan Motor Protection System at POWER PLANT Tanjung Jati B Unit 3. Universitas Muhammadiyah Surakarta.

Tampubolon P, Manahan. 2004. Operations management. First Edition. Ghalia Indonesia, Jakarta

Taufik, Selly Septyani. 2015 . Determination of Critical Component Maintenance Intervals on Turbine Engines at PT PLN (Persero) Ombilin Generation Sector. Journal of Industrial System Optimization, Vol. 14 No. 2, October 2015:238- 258

The son of Kadek Dwi Permana, Taufik Ahmad, Saefudin Encu. 2016. Analysis of Shaft Vibration on Motors and Pumps Experiencing Misalignment. National Journal. Bandung National Institute of Technology, January 2016.