Analysis of Mak Diesel Engine Services at Merawang Power Plant Using FMEA Method

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Abstract

1st Tarumanagara International Conference on the Applications of Technology and Engineering 2018

Preface

On behalf of the organising committee of 1st Tarumanagara International Conference on the Applications of Technology and Engineering (TICATE) 2018, I would like to welcome all delegates to the Campus of Universitas Tarumanagara (UNTAR) in Jakarta, Indonesia with great pleasure. Being held from November 22 to 23, 2018 the international conference is organized by UNTAR and technically sponsored by IOP Conference Series: Materials Science and Engineering (MSE).

Universities play an important role in facing the rapid development of technology and engineering in recent digital era. The rapid developments of technology and engineering impact various aspects of people's life in welcoming the era of Industry 4.0. The biggest challenge faced by universities due to these rapid developments is how the results of research and technological innovation can contribute to the people's prosperity. As a form of contribution from universities in responding this challenge, Universitas Tarumanagara hold the 1st TICATE 2018 with the theme of: "The Implementation of Research Results and Innovation for People's Prosperity".

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Abstrak. Merawang Diesel Power Plant is one of the power plants that located on Bangka Belitung Islands. PLTD Merawang has many types of engine generators. One of them is the MAK type 8M453 engine generator which produced 2.544 Kilo Watt. The type of routine maintenance in MAK engine are daily, weekly, biweekly and monthly. Although maintenance has good control management, the MAK engine continues to have disruptions and repairs. The frequency of damage that often occured on the MAK engine were the cylinder head component (compression leakage when the engine is operating), valve (overwork), nozzle injector (fogging pressure), and others. In terms of analyzing the disturbances found on MAK engines using the FMEA method. The objective of this paper to identify and eliminate current defects, as well as searching, solving and drawing the best and potential problems from a manufacturing and to minimize the risk of product failures during production. Three major problems occurred at Merawang PLTD were: broken head cylinder; interference valve, broken nozzle injector. The suggestions for preventive maintenance of this major problems are: lubrication system should be changed and checked regularly, lubrication system should achieve valve system level, and nozzle injection should be replaced regularly. For all the old machines at Menerawan PLTD should be changed to new ones

1. Introduction

In this era of simplification technology, various policy has been made by the government programs towards national aspirations. This conflict improves the standard of living and prosperous material and spiritual people based on Pancasila and the 1945 Constitution. Occupational growth and increased economic activity will cause electricity consumption and continue to increase, for this reason then the activities of producing electricity should be increased too. Electricity is a basic human need, it can be shown by the increasing of electricity demand the growth of people and economic activities. All household or office equipment has been made sophisticated and have to run it by using electricity. In this case, PLN produces electricity from renewable energy such as hydropower or non-renewable energy such as PLTD and PLTU. For PLN effectiveness and efficiency rate, productivities are very important to fulfill large demands and global consumption. Because of this reason, so the production engine must be kept in good condition with routine and periodic maintenance. Maintenance activities can't be underestimated, because most of production activities are powering by engine. Well-

maintained factory facilities will support the company's activities effectively. Company whose doing production activities without noticing maintenance action, will cause difficulties for the company and will affect many complaints from the public [1]. If the company is pressing production by reducing maintenance cost, that will be profitable in the short term. However, in the long term, company will have losses because of spending money repairs the engine and also the factory facilities that are not well maintained [1]. In this paper, FMEA method would diminish the risk of failure and risk of making wrong decisions related to bus exploitation and maintenance, by modification from one of the key failure analysis methods.

1.1 Place and Time of Research

This research was done at PLTD Merawang as subsidiary of PT PLN (Persero) Bangka Belitung Region. This research was doing in August 2018.

1.2 Object Research

Type of research is descriptive. This research attempts to expose problem which exists and factually based on existing data. PLTD Merawang have 5 types of engine diesels. However, in this paper only show the problem of one type engine diesel at PLTD Merawang. MAK engine diesel is the oldest in the PLTD Merawang and the most needed replacement component.

1.3 Research Purposes

The purpose of this research is to acknowledge maintenance problem, and solution from the maintenance problem that have been handled. The main objective of this step is to minimize the risk of product failures during production and during its all activities. For this purpose, the FMEA method is applied.

1.4 Research Design

At the beginning of the research, observations on the MAK engine was done to find out the broken components and the caused problems.

1.5 Data Collection Type

The data used is maintenance data of component parts of the MAK engine.

1.6 Instruments and Techniques

Data collecting methods includes observation, documentation and interviews. Method used regarding data processing is worksheet which are used to record company’s data related to repair of MAK engine components. Data acquired are later processed to portrait a picture regarding the faults in those engines.

2. Literature Study

FMEA is a method which enterprises use at preventing and eliminating defects which can appear in the manufacturing process. The procedure of FMEA application includes analysis of potential failure modes, identification of their possible effects, causes and analysis of preventive actions used for failures detection [2]. However, in 1970 this method found application in Europe in the electronics industry but then in the mechanical engineering. The fast growth of the competition in Europe as well as in the world and civil liability behind the produced product (CEE directive of No. 85/374) forced companies into increasing efforts in area of the quality preventions. It’s a result was wide spreading FMEA methods in the eighties, above all in the

motorization industry [2]. One of the best tools for sorting out the above-mentioned problems, is FMEA method. FMEA is especially efficient if applied in the analysis of elements which cause the whole system failure. However, it can be very complicated in the case of complex systems (such as vehicles), which have multiple functions and are comprised of a number of components, since a variety of information on the system has to be considered [3]. The analysis of these effects requires a thorough understanding of characteristics and work capabilities of different system components [4].

The FMEA goals are: reduction of warranty costs, trouble-poor start of series production, economical and optimized manufacturing, increase of the function accuracy and reliability of products, shorter processes of development, better adherence to schedules, creation of an in-house knowledge base and reduction of the number of technical changes after SOP (Severity-Occurrence- Detection) [5].

3 Research Methodology

FMEA relies on a team-based analysis of risks of potential failures. The procedure of FMEA application includes [6] analysis of potential failure modes (function and failure analysis), identification of their possible effects (risk analysis) and causes and analysis of preventive actions used and actions for failures detection (optimation) as seen in figure 1.

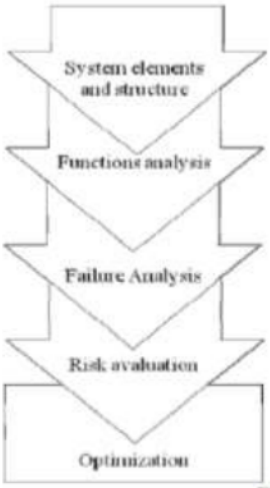

Figure 1. FMEA Research Methodology [6]

4. Data Collection and Analysis

4.1 The Engine

In PLTD Merawang, the quantity of MAK engines on site is one unit. Picture of the engine can be seen along with its specification in figure 2 and table 1.

Figure 2. MAK Diesel Engine

Table 1. Specification of MAK diesel engine

Engine Brand	MAK # 2
Engine Type	8M453
Number Series Engine	26892
Capacity Power (kW)	2.544

4.2 Maintenance MAK Engine

Preventive maintenance has been done in many ways. There were daily, weekly, biweekly, and monthly routine checks.

4.2.1 Daily Check Routine

Daily check has been done every day on each shift. Daily check routine for generator engines in table 2.

Table 2. Sample of daily check routine

NO	JOB DESCRIPTION	
1	**Check** joint ring between liner and the cylinder head for gas leakage	**24 H**
2	**Check** oil lubricant level on the turbocharger glass	
3	**Check** panel instrument	
4	**Pour out** from air condesat	
5	**Check** temperature on exhaust gas	
6	**Check** oil lubricant governor level	
7	**Check** temperature and pressure of the water jacket	
8	**Check** temperature and pressure of secondary water	
9	**Check** temperature and pressure lubricant system	
10	**Check** oil lubricant level	
11	**Check** daily fuel tank level	

4.2.2 Weekly Check Routine

Weekly check routine has been done in a total 125 working hours. Weekly check routine for generator engines shows in table 3:

Table 3. Sample of weekly check routine

NO	JOB DESCRIPTION	
1	**Clean** BBM strainer	**125 H**
2	**Clean** automatic BBM filter	
3	**Check / addition** of oil lubricant to engineer	

4	**Check** turbocharger condition (oil, sound, vibration & level)	
5	**Clean** oil strainer	
6	**Clean** oil separator	
7	**Check** oil & lubricant piping	

4.2.3 Biweekly Check Routine

Routine biweekly check routine has been done in a total 250 working hours. Regular bi-weekly check routine for generator engines shows in table 4.

Table 4. Sample of Biweekly Check Routine

NO	JOB DESCRIPTION	
1	**Check** clearance valve	**250 H**
2	**Check** injector pressure	
3	**Check** timing injection pump	
4	**Check** tightness of rocket arm screw	
5	**Check** condition of cover crankcase	
6	**Check** sensor temperature cylinder condition	

4.2.4 Monthly Check Routine

Monthly check routine has been done in a total 500 working hours. Monthly check routine for generator engines shows in table 5:

Table 5. Sample of monthly check routine

NO	JOB DESCRIPTION	
1	**Check** governor performance	**500 H**
2	**Add / change** oil lubricant turbocharger	
3	**Check** machine performance	
4	**Check / set** BBM rack	

5. Data Calculation

The table 6 shows a table of minor damage data on the MAK engine at Merawan PLTD happened from 2015-2018.

Table 6. Data of minor damage of MAK engine from year 2015 – 2018

No	Item	2015		2016		2017		2018	TOTAL
		Semester 1	Semester 2	Semester 1	Semester 2	Semester 1	Semester 2	Semester 1	
		Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	Quantity	
1	Turbocharger	-	1	1	-	1	-	1	4
2	Expansion Joint	-	-	-	-	-	-	1	1
3	Charge Air Cooler	-	-	-	-	-	-	1	1
4	Cylinder Liner	-	-	-	-	1	-	2	3
5	Nozzle Injector	-	3	1	1	3	4	1	13
6	Thermometer	-	1	1	-	-	-	1	3
7	Pump	-	-	-	-	-	-	1	1
8	Oil Separator	-	-	-	-	2	-	1	3
9	Silencer	-	-	-	-	-	-	1	1
10	Valve	3	2	1	-	5	3	1	15
11	Cylinder Head	4	3	4	-	4	-	1	16
12	Governor	-	1	2	-	-	-	1	4
13	Injection Pump	1	1	-	-	2	-	1	5
14	Fuel Injection Pipe	-	1	1	-	-	-	-	2
15	Cylinder Block	-	1	1	-	-	-	-	2
16	Radiator	-	1	-	-	-	-	-	1
TOTAL		8	15	12	1	18	7	14	75
		23		13		25		14	

The figure 3 shows a graph of the number of minor stop MAK engines.

6. Data Analysis

From the figure 3, we know that MAK engine damage occurred with fluctuating movement. The disturbances in term 1 in year 2018 occurred 14 times, in year 2017 occurred 18 times for term 1 and occurred 7 times for term 2, in year 2016 occurred 12 times for term 1 and occurred 1 times for term 2, and in year 2015 occurred 8 times for term 1 and occurred 15 times for term 2. Disturbance based on the FMEA at table 7 for the Merawang PLTD, maintenance will be prioritized on the 9 main causes with the most frequency. It concluded the 3 main causes of minor stops on the Merawang PLTD. There were 16 frequency head cylinder interference, 15 frequency interference valves, and 13 frequency nozzles. The most important damage that regularly occurred is the cylinder head leakage.

Figure 3. The number of damage of MAK engine from year 2015-2017

Table 7. FMEA (failure mode and effect analysis) method used to determine the failure mode, failure cause, and failure effect.

No	Item	function failure	Failure mode	Failure cause	Failure effect
1	*Turbocharger*	*defect of turbocharger*	machine can't cope up with maximum load	defect in turbocharger blade	machine can't be operated with max load
2	*Cylinder liner*	water leakage	water leakage at carter room	drop in temperature	machine ejection from system
			water leakage when blow up		
3	*Nozzle injector*	broken nozzle	can't reach pressure revocation level when operated	exhaust temperature decrease	machine ejection from system
4	*Termometer*	broken termometer	foggy glass	vibration on thermometer exhaust	machine ejection from system
			loose on locking system	leakage on thermometer	
5	Oil lubricanr separator	foggy glass, difficulty in checking condition of machine	wasted oil	faulty in innerpart separator	decrease in machine performance
			leakage of oil in separator	wear on several part of the separator	
6	*Valve*	overwork	big load in hunting	jammed valve	machine ejection from system
			smoke spewing out of the cylinder head	*logged nozzle injector*	
7	*Cylinder head*	*broken stud*	leakage in compression when machine is operated	vibration on *cylinder head*	machine ejection from system
				fracture *stud cylinder head*	
8	*Governor*	broken, needed reconditioning	respon of machine slowing down due to load	governor perlu rekondisi dan kalibrasi ualng	decrease in machine performance
					mesin tidak dapat diberi beban maksimal
9	*Injection pump*	leakage in seal and rack of fue	uneven opening of fuel rack of every cylinder	few broken adjusting screw on injection pump	decrease in machine performance
			leakage of fuel in sela flange injection pump	faulty seal flange injection pump	

This is fishbone diagram from the FMEA MAK engine in the Merawang PLTD could be shown at Figure 4.

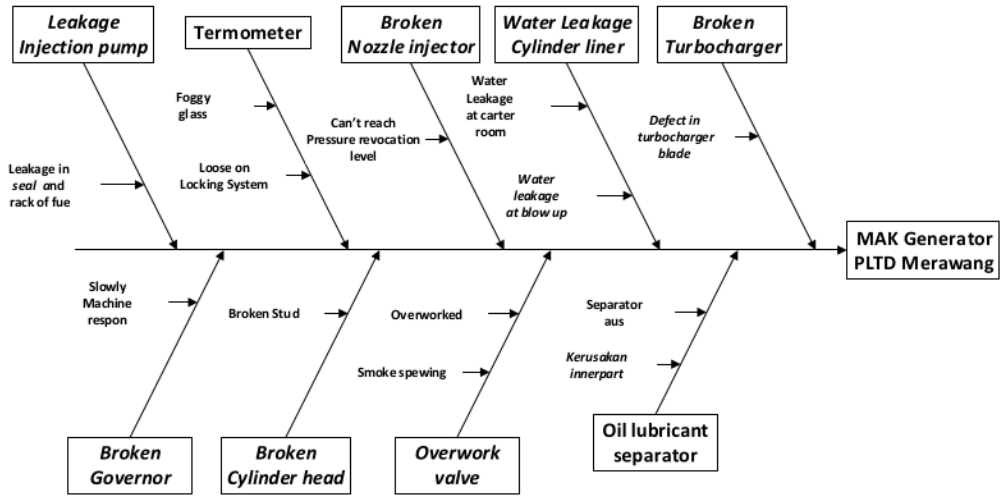

Figure 4. Fishbone Diagram of FMEA MAK Engine at Merawan PLTD

7. Discussion and Suggestion

Three major problems occurred at Merawang PLTD were: broken head cylinder; interference valve, broken nozzle injector. The suggestions for preventive maintenance of this major problems are: lubrication system should be changed and checked regularly, lubrication system should achieve valve system level, and nozzle injection should be replaced regularly. For all the old machines at Menerawan PLTD should be changed to new ones.

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