Application of Preventive Maintenance Methods on Boilers at PT.XYZ

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Abstract. All over the world boilers are widely used in the food, chemical, oil and gas, textile, pharmaceutical, power generation industries as steam generators. As an important tool in the industry so its maintenance is also very important. Since there are two main maintenance approaches such as corrective maintenance and preventive maintenance, the typical implementation of definite maintenance is based on the type of application, safety concerns, and cost benefit ratio. In this thesis, studying indicators Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR) and Overall Equipment Effectiveness (OEE) as tools preventive and maintenance (PM) strategy to get a new concept towards cost efficiency for boilers at PT.XYZ.

Keywords: MTTF, MTBF, MTTR, OEE, Preventive Maintenance.

1. Introduction.

According to data from PT.XYZ, the boiler is a critical equipment because of its function as a producer of high pressure steam.This high pressure steam is used to move a steam turbine generator that produces electricity. This electricity is used to meet the needs of LNG production. If the boiler stops operating, LNG production will also stop and cause losses for the company. Inside the boiler there are several components that support the system so that it can run properly. If the system stops, the high-pressure steam production process will also stop. With this preventive maintenance system, it is expected that the level of machine effectiveness will increase and be able to provide effective solutions for handling production machines so that they continue to work optimally and do not experience malfunctions that cause production targets not to be achieved. Based on the above background, there are several methods to measure the effectiveness of the machine, namely MTBF, MTTR, MTTF and OEE. The author tries to analyze the method about how big the effect of preventive maintenance on the boiler machine production process at PT. new preventive maintenance as a solution towards cost efficiency.

2. Significance Of The Study

The Reliability Centered Maintenance (RCM) is a precise procedure to protected entire plant machinery through to full achieve in conformance along the arrangement and operation. Pertaining to effect so in 1990 motivation in raising RCM II that is the culminate of the system of improvement RCM formerly by additional safeness and good situation based on the result discussion [1]. RCM is a foundation of substantial and for the repair of ways that is practiced to establish PM, refer at official program. A technique of RCM is predicted to sustainment program and realize perceive for confident the action continuance work to be applied on all plant equipments [2].

In this decade, the concern on the strength tools constructed, whichever reliant on the machine dimension. Hence, the applicated method must be made in the same aspect of repair budget and system availability [3]. RCM is concentrate on plant operation maintenance system role, than maintenance physical assets. RCM evaluate the role, probable troubles of equipments and show seven demand analysis stride to decide system reliability include imperil cases.RCM is conceivably the election of competent care planning that will be desire "authenticity" of backup appliances [4].

1. The goal of RCM practice:

a) To resolve the best repair planning with minimize the effect and hazard due to deficiency.

b) To achieve the best repair by mean of center on the very importance tools in the plant and evade activities response are useless or not more efficient.

c) To boost the repair assignment that indicate at corrective record [5]

RCM is a mechanism generally practice to the trouble solve of a machine so as to be capable to prepare opinion on the most importance that can be expanded to increase a plant production gain to the aim grade of system authenticity, assurance, willingness and situation safeness with the lowest cost [6]. RCM is one of the option for systems, troubles, security and to minimize budget of the plant process. It is system that can show must be fixed to ensure all equipment achieving the plant production target [7]. For 30 years of application RCM, already certified and accepted become the most forceful preventive maintenance (PM) development program, a procedure that has got booming reputation at all of industries in the world [8].

We have commitment repair concept activeness for all process equipment to achieve which is expected goal. A concept of RCM II is system that adopted for certain the repair correlation in the program of operation and consequences its trouble to all plan system, as a result of all equipment demand a various of repair of diverse close to the background its plan process [9]. The target is to get good total of PM results achieved on all equipment, the excellent solution of equipment and the greatest chosen of equipments and minimize budget plan that efficiency the amount of plant expenditure [10]. Repair action need a lot of extra power that consuming in technical matters. A lot of power consuming of technical process has been violated in experiment before [11]. Excellent action and minimize overhaul are accepted in this combine type. A lot of equitable to reduce the amount finishing time and repair budget is catch to fulfill the criteria of completion date and budget [12].

The numerous equipment of boilers inclusive of the tools needed for its development, the possibility effect of equipment decline, the matching of tools referring to criteria of configuration such as pressure, temperature and variant system situations. The emphasis of boiler old age matter along with similar matters such as economic matter, repair history has been advised to get determination relevant to service and reinstatement of the boiler [13]. Corrective maintenance (CM) is work on to repair the trouble while preventive maintenance(PM) is prevent the trouble. Both factors a crucial aspect in company role. Precisely prediction the successful of PM is required will effect on the fitness company operation [14].The PM rule is program to increase the availability system which is impacted by the actual trouble. The impact of troubles are depend on the quality based on service is determined via PM lowest limit of which is original value has been established by the consecutive appeared disturbance later [15]. The recommended priority allotment take towards report diverse service activities cover incomplete service and not right correction , associate the benefit of time-reliant and time self-reliant use allotment on calculate equipment emphasis and convenient to relief PM arrangement on equipment choice at any time [16].

Repair activities as a priority task in operation system that control component in the great situation. A lot of repair activities rules advice to minimize the unanticipated troubles and minimize huge process budget for example traditional PM [17]. PM is one of the analysis method has invited a lot of consideration as long as the last era. The most importance of PM is maximize the operation availability and minimize the repair budget of the all company equipment [18]. Anticipating repair already selected by diverse categories in fabricate and maintenance companies to increase performance, safety, availability, economical factor and quality also to cover the surrounding area [19]. Refer to activity, repair and trouble data record, we show the availability deterioration of the main machine and its component beneath the new repair rule by Weibull distribution [20]. Although its main policy, but the idea and control of an forceful PM planning is not an easy to understand problem. The main matter appear with regards to decide goal PM rule and repetition refer to actual estimation and data on trouble type, relative impact, successful of accurate PM task and variation of plant equipment. Determination and progression of the PM concept as well as new matter along the target of maximize and minimize budget also increasing internal and external efficiency [21].

The main idea of RCM is that all machines used have a life limit, and the number of failures that generally occur follows a "bath-up curve" as shown in the following Figure:

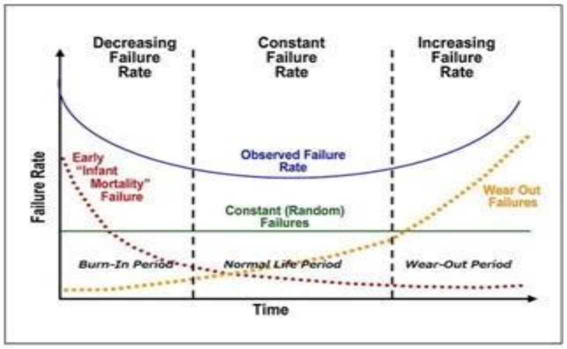

Figure 1. Bathtub curve (FLUKE, 2018) (Daley, 2008)

Improving reliability or reliability can be done with prevention through maintenance. This preventive maintenance reduces the effects of wear-out and shows significant results in component/machine life. This reliability model assumes the system returns to a new state after preventive maintenance [28].

R(m) – R(T) for $0 \leq t < T$

Rm(t).R(tT) for $T \leq 1 < 2T$

Where:

T = breakage prevention replacement time interval

rm(t) = reliability of the preventive maintenance system

R(t) = system reliability without preventive maintenance

R(T) = probability from reliability to first preventive maintenance

R(tT) = probability of reliability between tT after the system is restored to its initial state at time T.

In general, the formula is:

$R(m) = T(t)^{n}.R(t\text{-}T)$

For $nT \leq t < (n + 1)$ and n = 0.1,2….

Where:

N = number of preventive maintenance that has been performed to date.

T = maintenance time interval

R(t)n = probability of reliability up to n maintenance intervals

R(t-nT) = reliability probability for time t-nT from last preventive maintenance

The formula for each distribution before preventive maintenance is carried out is:

a. Normal Distribution:

$$R(t) = 1 - \Phi(\frac{t-\mu}{\sigma}) \quad \text{.....................(1)}$$

b. Lognormal Distribution

$$R(t) = 1 - \Phi(\frac{1}{s}\ln\frac{t}{tmed}) \quad \text{..................(2)}$$

c. Weibull Distribution

$$R(t) = \exp[(\frac{t}{\theta})^{\beta}] \quad \text{.....................(3)}$$

While the formula for each distribution after preventive maintenance actions are carried out is:

a. Normal Distribution

$$R(t-nT) = 1 - \Phi[\frac{(t-nT)-\mu}{\sigma}] \quad \text{...............(4)}$$

b. Lognormal distribution

$$R(t-nT) = 1 - \Phi(\frac{1}{s}\ln\frac{t-nT}{tmed}) \quad \text{.................(5)}$$

c. Weibull Distribution

$$R(t-nT) = \exp[-\left(\frac{t-nT}{\theta}\right)^{\beta}] \quad \text{................(6)}$$

Optimal boiler running will be derived if good PM method is applicated. A lot of benefit to apply a method PM, that implement to all model and various of industries. The policy goal of PM is which the bigger the value of factory and tools assets, the highest recovery if PM program implemented [22]. PM is one of an amount activities of preserving strategy, this case include to repair schedule planning which needed a long period program, for preserving activities at has been determined step. This protect which the operation running smoothly and achieve its expected intention [23]. To reach the best preserving achievement, peril and budget mandatory to calculated to reach the highest quality result. This involve enhancement technique for improvement the advantages of repair program, which are commonly allocated in two major classification:CM and PM [24].

PM can be said to examine the situation of low performance tools definitely and evade changing tools previous big trouble happens. PM minimize the time for repair action at the peril of changing spare parts with proper remain life and impacting to the system reliability [25]. The purpose of PM is to minimize repair budget and impairment to tools with attention past repair history record and new technique when prepare for the best reliability, maintenance, operability, flexibility, safety, and more specifications [26].

3. Research Methodology

3.1 Field Observation.

Field studies in the form of direct observation of the Production Department and identification of problems that exist in the related Production Department. In the field study there are also discussions with the company, especially with the Maintenance Division regarding production lines and maintenance actions that have been carried out by PT. XYZ so that the problem formulation is obtained.

3.2 Literature Study

This library study includes library research and searching for references related to research. In this study, the related references include the concept of reliability, failure distribution, maintenance, replacement of critical components based on age and Pareto diagrams.

3.3 Determination of Research Objectives.

Determining the purpose of the research objective is to guide the steps that must be taken. It also serves so that the research carried out remains focused and does not deviate from the target. The research objectives must be answered at the end of the study on the conclusions or recommendations of the results of the research conducted.

3.4 Data Collection

The main variables that are related include the time between breakdowns and the breakdown time of the boiler engine, especially the frequency of damage that occurs. Sources of data obtained include:

- Primary data obtained from SAP recorder Department Maintenance
- Secondary data obtained from the library of PT.XYZ
- Statistical test using the Kolmogorov Smirnov method.

3.5 Data Processing

OEE data processing was done manually while testing the distribution of MTTF, MTTR and MTBF data using Goodness of Fit Kolmogorov Smirnov from easy fit 5.5 professional software. Determination of distribution in terms of the statistical value of the smallest significant Kolmogorov Smirnov test. The types of distribution used in the calculation are normal, lognormal and Weibull distributions.

4. Results and Discussion

Overall Equipment Effectiveness value.

Table 1. OEE (Overall Equipment Effectiveness) value

Period	Boiler-1 (%)	Boiler-2 (%)	Boiler-3 (%)	Boiler-4 (%)	Boiler-5 (%)	Boiler-6 (%)
2010	85	85	85	85	85	85
2011	78	78	78	78	78	85
2012	85	85	85	85	85	78
2013	85	85	85	85	85	85
2014	78	78	78	78	78	85
2015	83	83	83	83	83	76
2016	85	85	85	85	85	85
2017	78	78	78	78	78	85
2018	85	85	85	85	85	78
2019	85	85	85	85	85	85
2020	78	78	78	78	78	85

Table 1. describes the OEE data for each boiler for the period 2010 to 2020 in % units

Table 2. Presentation of boiler component damage from highest to lowest

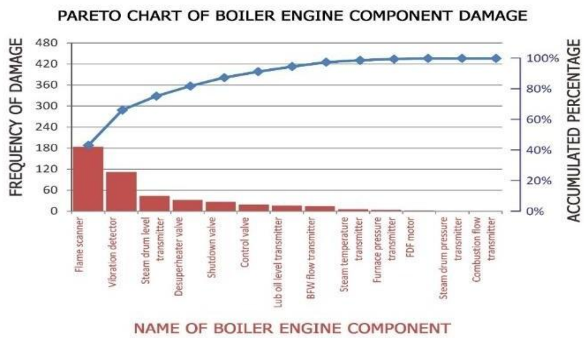

Figure 2 Pareto diagram of the frequency of boiler engine component damage

Based on Figure 2, it is known that there are 3 components that are priority improvements with the 80:20 Pareto Diagram concept. The components included in 80% are *Flame scanner*, Vibration detector and Steam drum level transmitter. Where the component is included in category A (critical) which has the largest cumulative percentage of damage frequency during the observation period starting from January 1, 2010 to December 31, 2020.There are three kinds of distribution used for the time of breakdown data. The three types of distribution are Weibull distribution, lognormal and normal. Distribution testing and parameter determination for each critical component using Easyfit 5.5 Software. Professional.

a. Flame Scanner

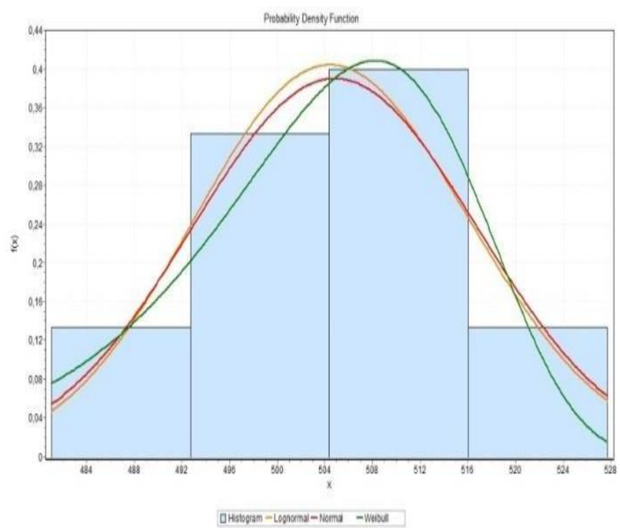

Figure 3. Probability Density Function TTF flame scanner component
(Source: from EasyFit 5.5 professional software).

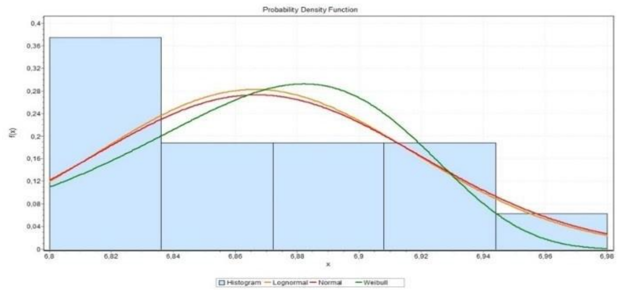

Figure 4. Probability Density Function TTR flame scanner component
(Source: from EasyFit 5.5 professional software)

Table 3. Test Output for the TTF distribution of flame scanner components

No.	Distribution	Kolmonogorov Smirnov		Parameter
		Statistic	Rank	
1.	*Weibull*	0,16513	3	α = 48,341 β = 508,41
2.	*Normal*	0,15469	2	σ = 11,942 μ = 504,81
3.	*Lognormal*	0,14536	1	σ = 0,02284 μ = 6,2239

(Source: from EasyFit 5.5 professional software)

Table 4. Test Output for the TTR distribution of flame scanner components

No.	Distribution	Kolmonogorov Smirnov		Parameter
		Statistic	Rank	
1.	*Weibull*	0,17625	1	α = 151,89 β = 6,8824
2.	*Normal*	0,19521	2	σ = 0,05263 μ = 6,8669
3.	*Lognormal*	0,2005	3	σ = 0,00741 μ = 1,9267

(Source: from easyfit 5.5 professional software)

Based on statistical value *Kolmogorov Smirnov* the smallest in table 3, it is known the type of Time to Failure (TTF) distribution of damage flame scanner component is a Lognormal distribution of 0.14536 and in table 4 it is known the type of Time to Repair (TTR) distribution of damage the component of the flame scanner is the Weibull distribution of 0.17625.

b. Vibration Detector

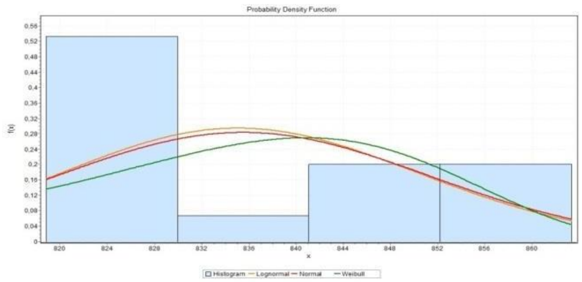

Figure 5. Probability Density Function TTF vibration detector component (Source: from EasyFit 5.5 professional software).

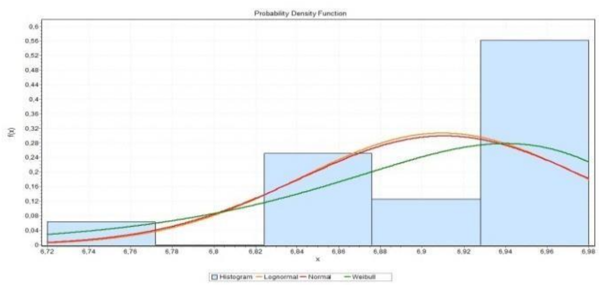

Figure 6. Probability Density Function TTR component vibration detector (From EasyFit 5.5 professional software)

Table 5. TTF Distribution Test Output for vibration detector components

No.	Distribution	Kolmonogorov Smirnov		Parameter
		Statistic	Rank	
1.	*Weibull*	0,22157	1	α = 55,317 β = 841,1
2.	*Normal*	0,25511	2	σ = 15,675 μ = 835,48
3.	*Lognormal*	0,26088	3	σ = 0,01806 μ = 6,7278

(Source: from easyfit 5.5 professional software)

Table 6. TTR Distribution Test Output for vibration detector component

No.	Distribution	Kolmonogorov Smirnov		Parameter
		Statistic	Rank	
1.	*Weibull*	0,17129	1	α = 100,94 β = 6,9408
2.	*Normal*	0,17256	2	σ = 0,06933 μ = 6,9106
3.	*Lognormal*	0,17704	3	σ = 0,00978 μ = 1,933

(Source: from easyfit 5.5 professional software)

Based on statistical value *Kolmogorov Smirnov* the smallest in table 5, it is known the type of Time to Failure (TTF) distribution of damage component *vibration detector* is the Weibull distribution of 0.22157 and in table 6 it is known the type of Time to Repair (TTR) distribution of damage component *vibration detector* is the Weibull distribution of 0.17129.

c. Steam drum level transmitter

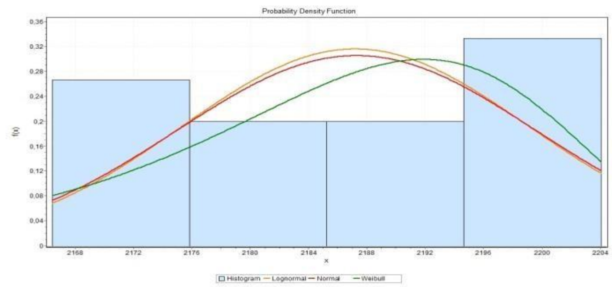

Figure 7. Probability Density Function TTF component steam drum level transmitter (Source: from EasyFit 5.5 professional software).

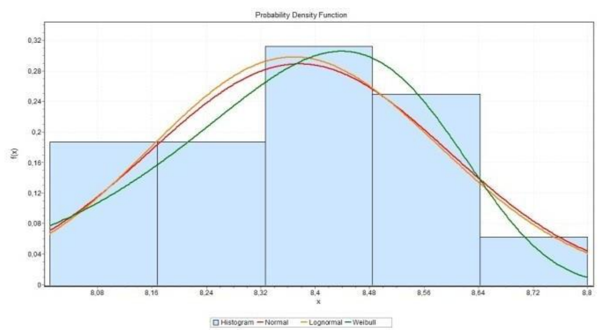

Figure 8. Probability Density Function TTR component steam drum level transmitter (Source: from EasyFit 5.5 professional software).

Table 7. Test Output TTF distribution of steam drum level transmitter components

No.	*Distribution*	*Kolmonogorov Smirnov*		*Parameter*
		Statistic	*Rank*	
1.	*Weibull*	0,14128	3	**α = 189,4** **β = 2191,9**
2.	*Normal*	0,12392	1	**σ = 12,301** **μ = 2187,3**
3.	*Lognormal*	0,13201	2	**σ = 0,00543** **μ = 7,6904**

(Source: from easyfit 5.5 professional software)

Table 8. TTR Distribution Test Output for steam drum level transmitter components

No.	*Distribution*	*Kolmonogorov Smirnov*		*Parameter*
		Statistic	*Rank*	
1.	*Weibull*	0,21281	3	**α = 44,359** **β = 8,4429**
2.	*Normal*	0,20448	1	**σ = 0,21814** **μ = 8,3763**
3.	*Lognormal*	0,21161	2	**σ = 0,02526** **μ = 2,1251**

(Source: from EasyFit 5.5 professional software).

Based on statistical value *Kolmogorov Smirnov* the smallest in table 7, it is known the type of Time to Failure (TTF) distribution of damage component s*team drum level transmitter* is the Normal distribution of 0.12392 and in table 8 it is known the type of Time to Repair (TTR) distribution of damage component s*team drum level transmitter* is the Normal distribution of 0.20448.

4.1 MTTF parameter analysis

Table 9. MTTF recapitulation value and preventive t for each critical component

No.	Komponen	Distribusi	MTTF	t (*preventive*)
1.	*flame scanner*	*Lognormal* **σ = 0,02284** **μ = 6,2239**	504,80 jam	489 jam
2.	*vibration detector*	*Weibull* **α = 55,317** **β = 841,1**	832,59 jam	822 jam
3.	*steam drum level transmitter*	*Normal* **σ = 12,301** **μ = 2187,3**	2187,30 jam	2159 jam

(Source: from EasyFit 5.5 professional software).

Critical components will be damaged after operating for a certain time, which will reduce the performance and productivity of the main machine. From the table we can see that the MTTF value is always bigger than the preventive t value (MTTF > tp).). The preventive t value is the lead time with a minimum downtime value which can be a recommendation for the replacement time of a machine component. Based on table 9, the replacement of old critical components with new components can be done after 489 hours for the flame scanner component, 822 hours for the vibration detector component and2159 hours for components *steam drum level transmitter*.

4.2 MTTR parameter analysis

Table 10. MTTR recapitulation value and recommendation tf for each critical component

No.	Komponen	Distribusi	MTTR	tf (*rekomendasi*)
1.	*flame scanner*	*Weibull* **α = 151,89** **β = 6,8824**	6,8565 jam	7 jam
2.	*vibration detector*	*Weibull* **α = 100,94** **β = 6,9408**	6,9018 jam	7 jam
3.	*steam drum level transmitter*	*Normal* **σ = 0,21814** **μ = 8,3763**	8,3763 jam	8 jam

(Source: from EasyFit 5.5 professional software).

Based on table 10 the average repair time for each component has the same repair duration with the recommended time, namely 6.8565 hours for the flame scanner component, 6.9018 hours for the vibration detector component and 8.3763 hours for the component *steam drum level transmitter*.

4.3 MTBF Analysis

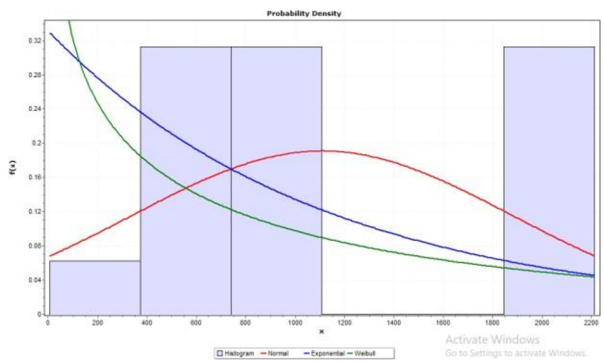

Figure 9. Probability Density Function MTBF boiler
(Source: from EasyFit 5.5 professional software)

Figure 9 Probability Density Function MTBF of six boilers (from easyfit 5.5 professional software). The distributions used are Weibull, Normal and Lognormal. Shown in the picture the best is the result of the Weibull distribution data processing.

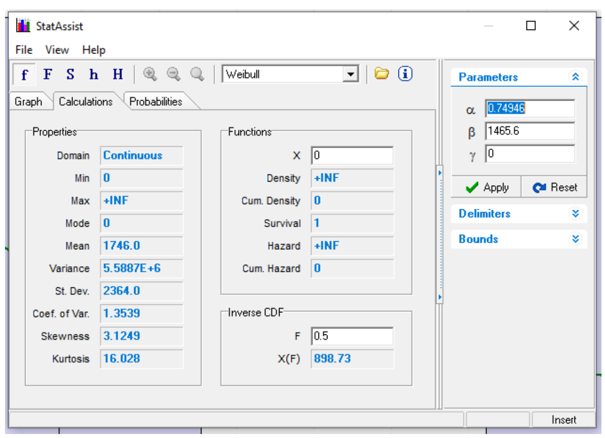

Figure 10. Boiler MTBF value from normal distribution
(Source: from easyfit 5.5 professional software).

Based on Figure 10, the boiler MTBF value is in the Weibull distribution. This gives a conclusion from the three distributions used, the best is the result of data processing using the Weibull distribution with the results of 1746.0 hours.

4.4 Comparison of reliability before and after replacement of flame scanner

Increasing the value of reliability or reliability and knowing the optimal age of a component, preventive maintenance is carried out.

a. Flame Scanner

Table 11. Comparison of reliability before and after replacement of flame scanner

n	t	Rt	R(t-nT)	R(T)^n	Rm (t)
0	1	1	1	1	1
0	481	0.982268	0.982268	1	0.982268
0	485	0.959107	0.959107	1	0.959107
1	489	0.916330	1	489	489
1	493	0.847110	1	489	489
1	500	0.657932	1	489	489
1	980	0.000000	0.972655	489	475.628494
1	981	0.000000	0.966434	489	472.586012
1	982	0.000000	0.959107	489	469.003338
1	983	0.000000	0.950553	489	464.820221
1	984	0.000000	0.940648	489	459.977062
1	985	0.000000	0.929277	489	454.416538
2	986	0.000000	1	239121	239121

From table 11 the results of the calculation of the level of reliability before and after the replacement of the flame scanner, it can be seen that before the replacement was carried out at 489 hours the level of reliability was 0.916330, and after the replacement the level of reliability increased to 1.

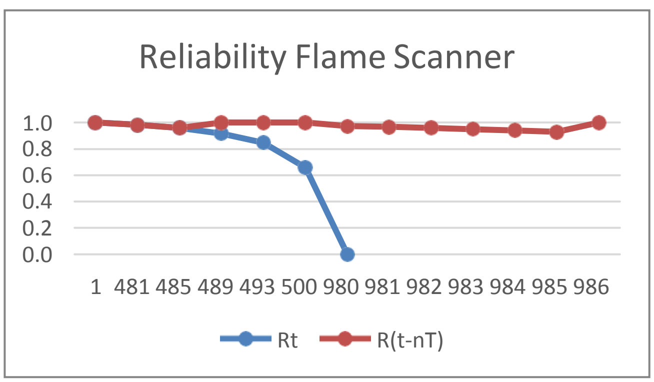

Figure 11. Comparative graph of reliability before and after replacement of the flame scanner.

Figure 11 is a graph that describes the comparison of reliability before and after the replacement of the flame scanner. The blue line shows before the replacement is done and the red one shows after the flame scanner replacement is done.

b. Vibration Detector

Table 12. Comparison of reliability before and after vibration detector replacement

n	t	Rt	R(t-nT)	R(T)^n	Rm (t)
0	1	1	1	1	1
0	100	1.000000	1.000000	1	1.000000
0	700	0.999961	0.999961	1	0.999961
0	800	0.939338	0.939338	1	0.939338
0	821	0.769222	0.769222	1	0.769222
1	822	0.755291	1.000000	822	822.000000
1	850	0.166948	1.000000	822	822.000000
1	1500	0.000000	0.999993	822	821.994090
1	1600	0.000000	0.985735	822	810.274355
1	1641	0.000000	0.782493	822	643.209467
2	1642	0.000000	1.000000	675684	675684

From table 12 the results of the calculation of the level of reliability before and after replacing the vibration detector, it can be seen that before the replacement was carried out at 822 hours the reliability level was 0.755291, and after the replacement the level of reliability increased to 1.

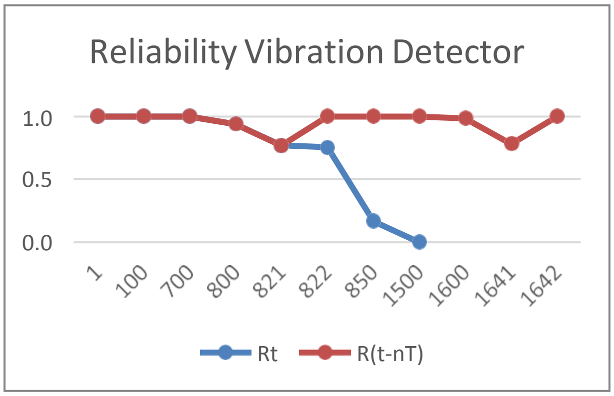

Figure 12. Comparative graph of reliability before and after vibration detector replacement

Figure 12 is a graph that describes the comparison of reliability before and after the replacement of the vibration detector. The blue line shows before the replacement is done and the red one shows after the vibration detector has been replaced.

c. Steam Drum Level Transmitter

Table 13. Comparison of reliability before and after replacing the steam drum level transmitter.

n	t	Rt	R(t-nT)	R(T)^n	Rm (t)
0	1	1	1	1	1
0	1000	1.000000	1.000000	1	1.000000
0	2000	1.000000	1.000000	1	1.000000
0	2157	0.993115	0.993115	1	0.993115
0	2158	0.991389	0.991389	1	0.991389
1	2159	0.989294	1.000000	2159	2159.000000
1	2173	0.877485	1.000000	2159	2159.000000
1	4300	0.000000	0.999885	2159	2158.750806
1	4308	0.000000	0.998786	2159	2156.379849
1	4315	0.000000	0.993115	2159	2144.135549
2	4316	0.000000	0.991389	4661281	4661281

From table 13 the results of the calculation of the level of reliability before and after replacing the steam drum level transmitter, before the replacement at 2159 hours the reliability level was 0.989294, and after replacing the level of reliability increased to 1.

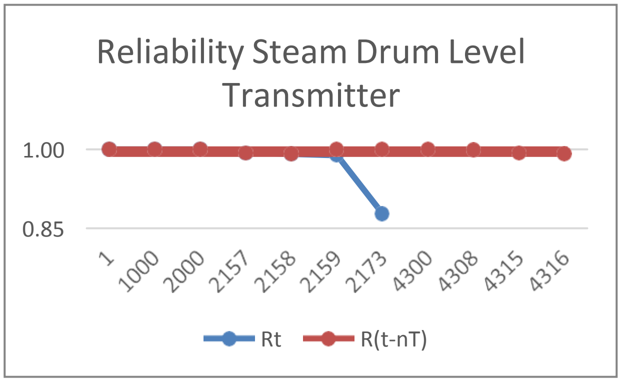

Figure 13. Reliability comparison graph before and after replacing the steam drum level transmitter.

Figure 13 is a graph that describes the comparison of reliability before and after replacing the steam drum level transmitter. The blue line shows before the replacement is done and the red one shows after the steam drum level transmitter has been replaced. Based on the data from the comparison of reliability before and after the replacement of critical components, the analysis obtained is that the flame scanner must be replaced at 489 hours (t preventive), vibration detector at 822 hours (t preventive) and steam drum level transmitter at 2159 hours (t preventive). . After using this concept, it is expected to minimizethe damage that occurs which has an effect on cost efficiency and time.

5. Conclusion and Recommendations

Conclusion

1- Refer on analysis and damage identification data and frequency of damage to six boilers, three critical components were obtained, namely flame scanner, vibration detector and steam drum level transmitter.. The highest MTBF value of the boiler from data processing using EasyFit 5.5 professional software is the weibull distribution of 1746.0 hours. Increasing the MTBF is proportional to the success of the maintenance carried out. The increased MTBF after the implementation of preventive maintenance is an indication of an increase in the quality of production.
2- The probability value of each critical component, the flame scanner is 0.916 %, the vibration detector is 0.75% and the steam drum level transmitter is 0.987 %. PM's probability is very large in saving cost and time compared to repair policy. The greater the probability value, the greater the reliability value of the equipment. The reliability of a component is an opportunity to achieve the highest value, namely 1.
3- From the results of data processing on all boilers from January 2010 to December 2020, the average Overall Equipment Effectiveness (OEE) value is 82.27%. This value is in the range75% OEE 85% means that it is acceptable and gives the conclusion that there is little economic loss and slightly low competitiveness. Of the six big losses from data processing, the most influential thing on the OEE value is because the reduce speed loss factor is 13.87%, this is for one reason because all boilers during normal operation are set at 85% of the maximum flow capacity that has been set by the vendor. as a safety purpose.

Recommendations.

1- Conducting PM activities periodically to minimize downtime so that the level of machine reliability increases, reducing breakdowns on machines can also save the cost of maintenance activities for the company.
2- Procurement of training for maintenance technicians so that they can operate production facilities correctly and directed to carry out PM properly.

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