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Received on: 09/11/2016
Accepted on: 23/11/2017
Published online: 25/8/2018

Developing of Reliability-Centered Maintenance Methodology in Second Power Plant of South Baghdad

Abstract- *Electric equipments of power station must be operated in the state of high reliability with its responsibility in the seamless power supply. Maintenance is one of the important and most costly phases in the lifecycle of any power generation systems, to improve maintenance management and system reliability and maintain the continuity of work of the system. Reliability-Centered Maintenance (RCM) is one of the most recent maintenance techniques. In this research, an enhanced RCM methodology based on quantitative relationships implemented at system component level and the overall system reliability was applied to identify the distribution components that are critical to system reliability. Only unit one of the Second Power Plant of South Baghdad were selected as a case study in this research application. The major contribution of the study is to create a maintenance plan through applying statistical, historical data to generate a failure probability distribution model by using the combined methods of Failure Mode of Effects and Criticality Analysis (FMECA) and Fault Tree Analysis (FTA). Evaluation criteria and matrixes of criticality are used to evaluate the criticality level of failure modes. The overall approach developed offers a cost-effective model, which can be applied prior to testing and inspection procedures during the RCM application. The results obtained from this case study show that the application of proposed RCM methodology based on preventive maintenance planning will decrease the total cost value of maintenance about 463469.85 \$. That Indicates saving about 59% of the total downtime cost compared with current maintenance. As well as Proposed maintenance program reduce the required time to repair the plant components annually at a rate ٦ day so that represent that the labor cost will minimized about ٦٤٢٤ \$.*

Keywords- *RCM, Reliability Engineering, Maintenance Planning, Failure Mode, FMECA, FTA, Cost Analysis.*

How to cite this article: A.B. Adulghafour, D.H. Dhayef, “Developing of Reliability-Centered Maintenance Methodology in Second Power Plant of South Baghdad,” *Engineering and Technology Journal,* Vol. 36, Part A, No. 8, pp. 842-852, 2018.

1. Introduction

Today, the majority of industry’s capital includes the production systems that use to produce goods and delivery of services. These systems are undergoing to deterioration with usage and age. Most of them are maintained or repairable systems. Therefore, maintenance on them may be necessary since it can improve reliability. The growing importance of maintenance has generated an increasing interest in the development and implementation of optimal maintenance strategies for improving system reliability, preventing the occurrence of system failures and reducing maintenance costs of deteriorating systems. The problem of research the maintenance cost are one of the important means to clarify the effectiveness of maintenance work and involves the economic effect, they reflect the success rate of maintenance work to achieve its goals through the realization of their programs, how much work completed match with what is planned already on track to plan. The goal of this research is to apply proposed improved Reliability Centered Maintenance to optimize reliability and availability by determining the need for maintenance activities based on equipment conditions. The research aims to realize maintenance technical support services, quantitative maintenance decision-making, and to ensure the Reliability, Availability, Maintainability and Safety, by developing a quantitative relationship between preventive maintenance of system components and overall system reliability. In this research, RCM method for electric power equipment's has been shown and applied in the Second Power Station in South Baghdad. The results of the application are presented through a maintenance strategy based

https://doi.org/10.30684/etj.36.8A.3
2412-0758/University of Technology-Iraq, Baghdad, Iraq

on RCM methodology to reduce maintenance cost and increase accurate maintenance action, which can sustain continuous and reliable operation of equipment. This paper organized as sections, include firstly review of update literature survey of interest related work. Second sections include of RCM definition and explain of maintenance structure. Third section shows framework of proposed methodology of RCM and main components. As well as implementation of developed RCM and tasted it through case study. Finally, discussion of obtained results, conclusions with recommendations for future work.

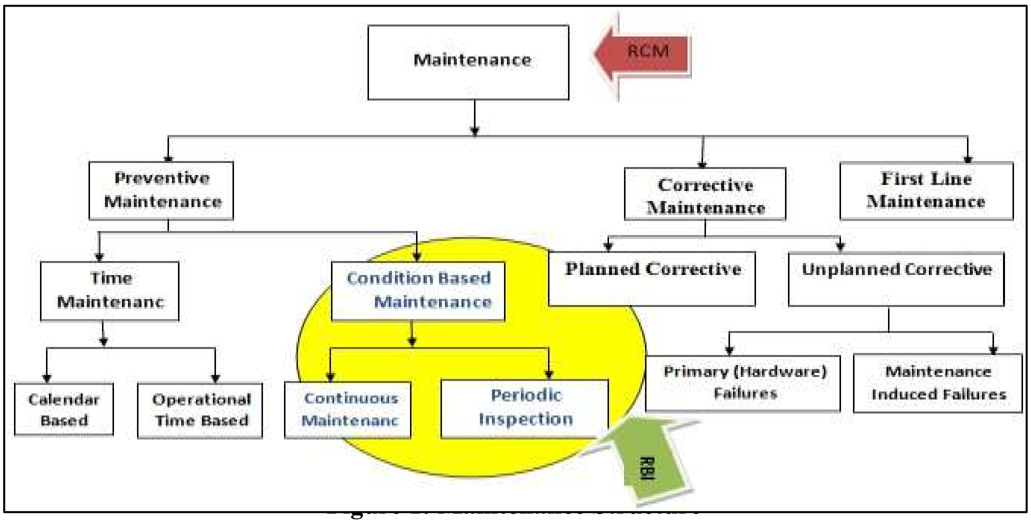
2. Reliability Centered Maintenance

The Reliability Centered Maintenance (RCM) is “the process used to determine the most effective maintenance which is defined as series of activities generated on the base of a systematic evaluation to develop or optimize a program of maintenance” [1,2]. *RCM* is a methodology, which can be used to ensure that the correct maintenance activities are carried out where and when they will give most benefit [3]. The researcher defined the *RCM* as a process used to determine the maintenance requirements of any physical system. Facilities and equipments of any system are combined and used for what the users want them to do. Maintenance is undertaken in a variety of forms, to ensure that the facilities and equipment continue to do successfully. RCM used to determines what maintenance strategy needs to be performed and what testing and inspection need to be performed to support the maintenance plan [4]. The RCM output result analysis change existing preventive maintenance tasks, the use of condition monitoring, inspections and functional testing, or the addition or elimination of such tasks. Figure 1 shows the structure of maintenance strategies. Using RCM effectively can make the result in the enhancement of safety and reliability of Facilities and equipment and the optimization of operations and maintenance activities [5].

3. Literatures Survey of Related Works

There are many research works in the field of planning and maintenance scheduling to deal with the principles and concepts of systems maintenance and scientific methods in planning to improve performance and increase production capacity. These studies and previous research works are addressed in the followings. Hong S. Kim (2008) introduces a RCM method for maintenance electric power equipment's. The RCM method was applied in the fields of aerospace, nuclear power plants and rail system, etc. This study designs to use the Failure Mode and Effect Analysis flow for power transformer to evaluate the importance level according to the fault information. This level was applied to the inspection period, fault detection approach and operator selection technique. The system results output provided as a workplan contains all maintenance information required [6].

Shows a new approach of maintenance strategy named Condition-Based Maintenance (CBM) that uses reliability-centered maintenance mechanism to optimize the maintenance parameters such as maintenance cost, employs data fusion strategy for improving condition monitoring, health assessment, and prognostics. This research show that optimized maintenance performance can be obtained with good generality through reducing of maintenance cost, increase enterprise profit. The accurate maintenance action can be more sustainable and reliable for operation of equipment [7], includes applying of RCM method to developing the maintenance workplan for a power plant. This research shows that decreasing of the Main Time between Failures (MTBF) and the probability of unexpected equipment failures for the plant equipments. The suggestion of labor program has been accomplished. As well as, the investigation of maintenance cost of the plant equipments done. The results of new maintenance plan indicates that reducing about 80% of the total maintenance cost as compared with that of present maintenance. Moreover, generation of the spare parts programs for the plant components [8], explains how to make the power system more stability through separating only the components that are under fault. Also presents RCM methodology as maintenance method, which can be applied to a digital protective relay installed in a primary distribution substation. In this work, RCM system can estimate failure before it occurs with predictive testing and inspection tools. Moreover, generate maintenance plans based on the effects of protective relay failure on system reliability and take the ideal decisions making to improve a protection system. In addition, the maintenance criteria according to the implication of power system dependability and security, through signaling from the protective relay “watchdog function” it is possible to identify 86% of all failures may be occurs in the power system. Therefore, the proposed tasks of corrective maintenance plan should be applied [9].



Introduces applying of RCM method and analysis of the performance of nuclear power energy field. The optimization parameters of RCM methodology was introduced with feasible experience and on the basis of adequacies analysis of the classical RCM. Using of RCM method in this field shown that the using improving in the safety, reliability and economy effectively of nuclear power plants. As well as, the regional nuclear energy is developed under a strong trend [10]. Shows the important of applying of maintenance strategies that satisfy in a accurate way the various needs of the production operations, independently of its technical complication or difficulty of incoming to the industrial plant equipments. The factories with a high automation level or wind farms are lying in remote sites with low accessibility. In addition, the studied situations have in common the low level of physical operation in its production process [11]. presents how a system a thinking way can be applied to identify the relevant side and possible interactions between the RCM method and wind turbine gearboxes. Also, describe how the gaps that exist within the system can be closed to add value to business. The results of this research represents as a framework for applying the proposal methodology to wind turbine gearbox process. Moreover, maintenance planning and optimization of the asset value adding contribution with minimum total cost to the operator [12]. presents a new approach of implementation steps of RCM in combined the power generation and transmission systems to recognize the critical components for the main purpose of a focused maintenance management. The actual market model has been carrying out to calculate the components outage results to the different system. The generation companies and distribution companies have been involved as participants. The introduced methodology is able to recognize the individual value and contribution of each facility in the cases of not only first order but also higher order emergencies. For the sake of confirmation, the proposed approach is applied to the IEEE reliability test system and IEEE 118-Bus test system [13].

4. Framework of Developed Methodology

In this research, the RCM maintenance approach application is proposed. This methodology is used to identify what it must be done to ensure that a equipments or systems should continue realizing his function. The Researcher aims to make the proposed methodology based on RCM technique more than just the failure analysis and optimizing of maintenance strategies through looking for holistically data more deep with applying of systems thinking tools & techniques at one of the selected power Plant. This research is an accomplished is relying on methodology of RCM to preserve the most important equipment (system) function with the required reliability and availability at the lowest cost of maintenance. The Figure 2 represents the general framework of proposed developed RCM methodology block diagram. The general steps for applying the RCM methodology can be summarized as follows

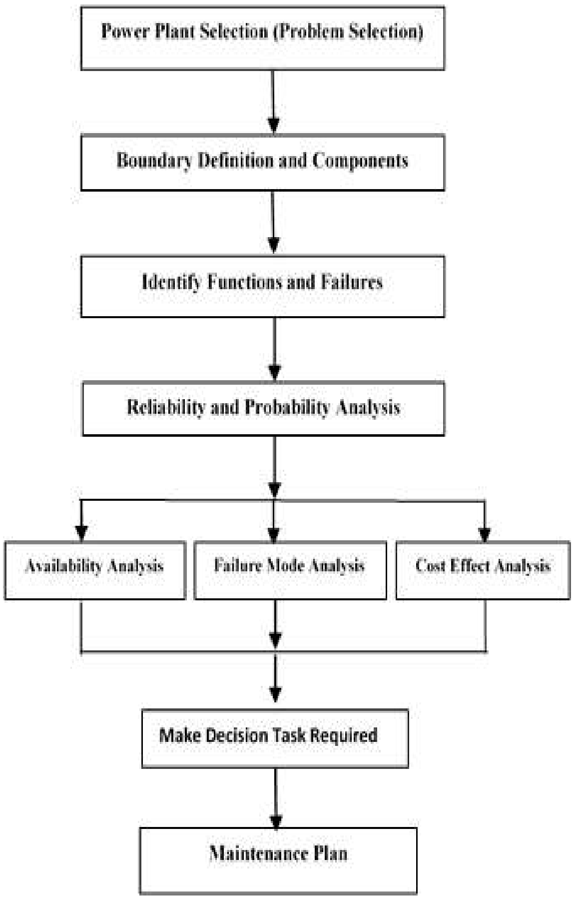


Figure 2: Block Diagram of Developed RCM Methodology.

I. Power plant selection (problem selection)

Second Power Plant of south Baghdad is identified as a site to the reality of the study for the application of research methodology. Five units are specified for suffering from frequent failure that lead to programmed and non-programming stoppages. They are of the same type, origin, similar failure, the period of installed convergent. The five units selected in the research represent the largest proportion of the failure and stoppages. The major station components consist of the parts Shows Figure 3.

II. Boundary definition and components description

The power plant (Second Power Plant of South Baghdad) consists of group of sections as in which stats the organizational structure of the power station including these technical sections (Operating sections, mechanical sections, electrical sections, auto–control sections, technical support sections, treatment section, planning and follow-up and safety and environment.

III. Identify functions and failures

For the purpose of study and evaluation of the reliability of the five units with their parts in the power plant one must monitor their work and times of stop when it is operating. Data is recorded for a year with the help of the central control section of the station that supervise and control all parts and equipment of unit one that has studied. A wide range of sensors and surveillance equipment deployed all parts of the unit. A first time stop is recorded for the parts for the functional performance and when to be rework after the testing and experiment. Table 1 forms a sheet to record the daily work failure model (log sheet) specific units with accessories and it represents all of the indicators which assess the status of each part and determine the performance of the part that works which it is not suitable.

IV. Reliability and probability analysis

This section will offer a simplified description of a preliminary analysis for explanation of the sequence of steps approved for parts of each unit, Steps can be summed up as follows

➢ **<u>First Step</u>**

Account of three basic criteria to assess reliability as following:

- Calculation of the number of iterations.
- Calculation of time between failures (TBF) Account for the difference between the time of the beginning of the operation of the unit after a certain failure and the following failure, the recording time in hours and minutes, then turn it into days and collect with the number of days in which there is not failure using this equation:

$$TBF_{total} = Sum\ of\ (B + C) \quad (1)$$

Where:

B= (Time of beginning the failure - time of the completion of the maintenance) /24.

C= Calculating the number of days where there is no failure.

- Calculation of repairs time (TTR): calculate the difference between the beginning the time of the failure and the time of completion of the maintenance, inspection and operation, hour and minute a converted to the days. using the follow equation

$$\text{TTR} = (\text{Time of the completation maintenance} - \text{Time of beginning the failure}) \quad (2)$$

$$\text{Total of TTR (day)} = \text{TTR}/24 \quad (3)$$

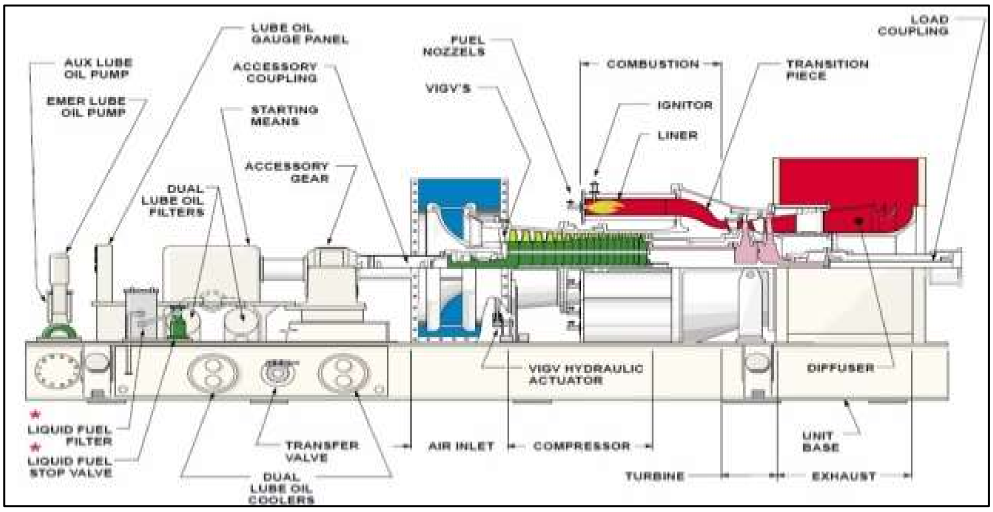


Figure 3: Section and Components of Unit

Table 1: Represents the Data Log Sheet of the Power Station.

Unit No.	Stopping Time	Stopping Date	Starting Time	Starting Date	Type of Stop	REASON
1	22:45	2/1/2014	12:00	2/2/2014	P	Washing
	21:10	2/11/2014	15:10	2/12/2014	p	Washing
	20:00	2/21/2014	13:37	2/22/2014	p	Washing
	1:08	2/27/2014	3:12	2/27/2014	F	Trip lack of 14HS
2	0:30	2/1/2014	14:25	2/1/2014	P	Washing
	0:30	2/9/2014	18:20	2/9/2014	p	Washing
	21:00	2/17/2014	13:19	2/18/2014	p	Washing
	21:10	2/27/2014	14:20	2/28/2014	P	Washing
3	23:05	2/10/2014	18:40	2/11/2014	p	Washing
	18:00	2/16/2014	20:35	2/16/2014	F	trip Mcc loss of power
	22:00	2/20/2014	12:35	2/21/2014	p	Washing
4	7:30	2/4/2014	17:07	2/5/2014	P	Washing
	18:05	2/5/2014	20:50	2/5/2014	F	Trip / IGV control trouble trip
	20:40	2/13/2014	14:40	2/14/2014	p	washing
	18:00	2/16/2014	19:25	2/16/2014	F	trip Mcc loss of power
	22:45	2/22/2014	20:52	2/23/2014	p	Washing
5	22:35	2/6/2014	14:50	2/7/2014	P	Washing
	21:50	2/15/2014	14:16	2/17/2014	p	washing

Table 2: the Initial Data of Unit

No.	Cum	Reason	Stopping Date 2014	Stopping Time H:M	Starting Date 2014	Starting Time H:m	Outage Time	TBF (Day)	TTR (Day)
1-	8	washing	8/1	07:57	8/1	16:30	08:33	0.0083	0.34708
2-	8	Trip\lack of 14HS	8/1	16:50	8/1	18:30	01:40	0.0083	0.05833
3-	9	gear box radial vibration high trip	9/1	18:50	9/1	23:55	05:05	6.8521	0.21042
4-	16	washing	16/1	20:00	17/1	13:26	17:26	3.5787	0.71916
5-	20	Gear box LS shift seismic vibration	20/1	03:15	20/1	11:16	08:01	0.0854	0.33375
6-	20	gear box radial vibration high trip	20/1	13:21	20/1	15:43	02:22	1.3592	0.0925
7-	22	gear box radial vibration high trip	22/1	00:05	22/1	00:45	00:40	0.47292	0.01667
8-	22	gear box radial vibration high trip	22/1	12:20	22/1	15:05	02:45	3.7	0.10208
9-	26	washing	26/1	07:45	26/1	15:45	08:00	0.00625	0.33333

.	.	.	.	.		.	.	.	.
.	.	.	.	.		.	.	.	.
64-	361	washing	27/12	06:40	27/12	21:43	15:03		0.62625

Data were collected and the results are arranged as shown in Table (٢) which represents the initial data failure to unit one and its section in the year (2014).

➢ Second Step

This step includes calculating and drawing of Pareto chart, after the completion of the following accounts: -

- Counting of failure part.
- Arrange the number of iterations in descending order.
- Calculate percentage of repeat failure and the adoption of the equation below:

$$Fr\% = \frac{Number\ of\ Iterative\ Failure}{Sum\ of\ Total\ Failure} \quad (4)$$

Cumulative percentage of frequency to drawing Pareto chart using a ready program Minitab16 as shown in table (3). The output of the program represents a summary of the accounts. The Figure 4 shows Pareto chart for the unit one.

➢ Third Step

Calculate of reliability for selected parts and units as a complete system, which is considered the traditional method. To simplify the calculation for the data collected from the power station, the researcher builds an algorithm to calculate the Time to Repair, Time between Failure and Reliability for each unit by using the Minitab16 program, which is designed, based on the algorithm equations. The result TBF and TTR listed in Table 4 and Figure 5 Shows the algorithm sequence of the work steps.

➢ Fourth Step

This step covers testing comparison for the nomination of one of the four distributions (log-normal distribution, exponential, Weibull and Rayleigh distribution) and thus calculates the following grounds:

Distribution parameters using the least square method to estimate the parameters by equation as following:

$$Y = ax + b \quad (5)$$

Through the application of Minitab16 program on obtained data another data has been extracted as in the table (5).

Comparison between the distributions: using the Chi-square test for Goodness of fit to choose best distribution they describe data by equation as following:

$$X^2 = \sum \frac{(O-E)^2}{F} \quad (6)$$

Weibull distribution is the best for representation of data of the four elected distributions as shown in Table 6 because the value of likely acceptance, of assumption of the null hypothesis was bigger than all the other distribution values.

To determine the reliability of such system, by using the following equation:

$$R\,sy = R_1 * R_2 * R_n \quad (7)$$

The unit with their parts is an integrated system connected with each other so that any failure of a part means stops for the units, this is called series configuration and by the application of the equation of Weibull we get the reliability of every part of unit as shown in Table 7.

V. Availability, failure mode and cost effect analysis

This step is divided into:

- Availability Analysis

The main steps to calculate the availability of units are as follows:

A- Calculation Availability A (T) based on the values of (TTR and TBF). Availability calculation can clarify each unit as follows:

$$A(T) = \frac{MTBF}{MTBF + MTTR} \quad (8)$$

B- Calculation useful time U (t) according to the following equation:

$$U(t) = Time\ Period(days) * 24(hr) * A(t) \quad (9)$$

The Availability for Unit$A(t) = 0.8781$,

Useful time$U(t) = 7692\ hr$.

- Failure Mode Analysis

Failure Mode and Effect Analysis (FMEA) defined as a tool used to examine the potential product or process failures. As well as FMEA used to evaluate risk priorities, and helps to find remedial actions to avoid distinguished problems. The spreadsheet format almost is easy to review of the effect analysis. FMEA help on identifying and the creation of functional failure by using the equations as follows:

RPN = (Severity) x (Probability) x (Detection).. (10)

Through the above equation It can be noticed the RPN for unit [Gear A. System (252), Turbine (162), Electrical A. System (120), Control A. System (108), Fuel A. System (72), Comb. A. System (64)].

Table 3: The failures of Unit One Components.

NO.	Component	Frequency	Percentage of Frequency	Cumulative Percentage of Frequency
1.	Turbine system	32	0.5	0.5
2.	Gear Box System	10	0.15625	0.65625
3.	Control Auxiliary System	٩	0.140625	0.796875
4.	Electrical Auxiliary System	٨	0.125	0.921875
5.	Fuel Auxiliary System	٣	0.046875	0.96875
6.	Combustion System	٢	0.03125	١
SUM		٦٤		

Table 4: Values of TBF **Represents the and TTR**

NO.	TBF(DAY)	TTR(DAY)	NO.	TBF(DAY)	TTR(DAY)
1-	0.0083	0.34708	28-	8.8625	3.13125
2-	0.0083	0.05833	29-	2.3708	0.70833
3-	6.8521	0.21042	30-	0.1321	0.31458
4-	3.5787	0.71916	31-	0.875	0.14917
5-	0.0854	0.33375	32-	2.9479	0.08333
6-	1.3592	0.0925	33-	7.4	0.63542
7-	0.47292	0.01667	34-	7.5671	0.46458
8-	3.7	0.10208	35-	4.0125	0.51417
9-	0.00625	0.33333	36-	2.9375	0.00625
10-	0.5354	0.17292	37-	0.4062	0.05
11-	0.7283	0.3375	38-	2.5062	1.39583
12-	6.6946	0.16875	39-	2.225	0.52292
13-	1.0242	1.39042	40-	4.5771	0.0125
14-	7.9958	0.10208	41-	27.0583	0.46875
15-	3.1333	0.75	42-	6.0875	0.68333
16-	6.1333	0.05208	43-	2.9546	0.04542
17-	9.045	0.91958	44-	7.2321	0.84708
18-	5.4229	7.08958	45-	1.9812	0.16667
19-	11.385	0.05917	46-	3.7062	0.72917
20-	2.2917	0.60583	47-	1.5279	0.13458
21-	14.0196	0.04375	48-	4.1887	0.10083
22-	8.2529	0.595	49-	7.9583	0.58958
23-	2.1454	0.4725	50-	6.2625	0.80417
24-	0.7271	0.14583	.	.	.
25-	9.4479	0.29792	.	.	.
26-	8.4792	0.46875	.	.	.
27-	9.7437	0.55833	64		0.62625
TOTAL MTBF & MTTR				5.345044	0.741818

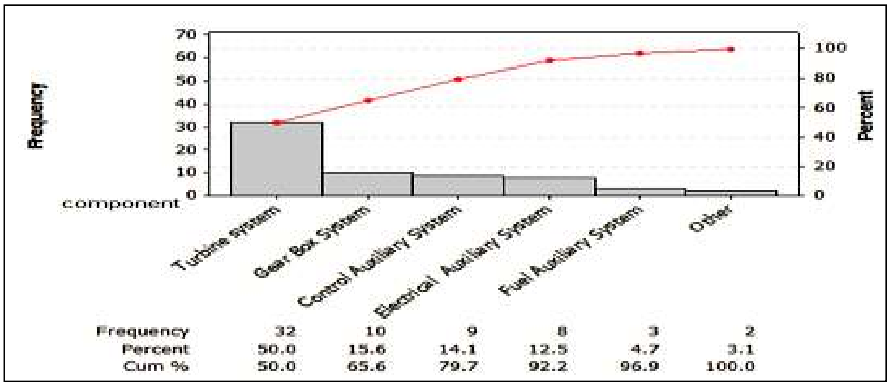


Figure 4: Pareto Chart for the Unit

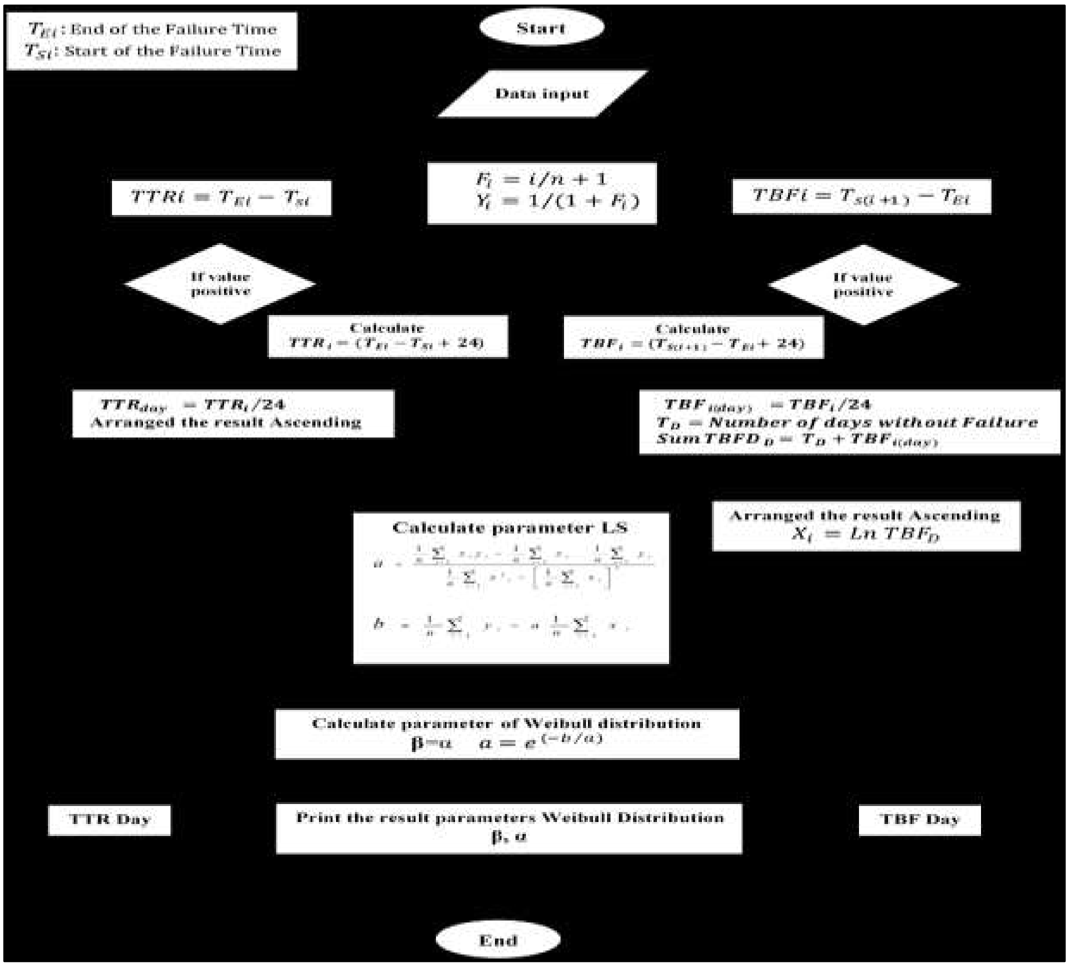


Figure 5: Flow Chart of Proposed Algorithm for Work Sequence Steps

Table 5: Nominated Distribution for Unit

(P-value) H_0	Shape Parameter	Figure Parameter	Parameter Measurement	Measurement Parameter	Distribution Name
0.006	1.0113	μ	1.7081	α	Lognormal Distribution
0.0215	-	-	0.18709	α	Exponential Distribution
0.0773	0.2244	β	1.8617	α	Weibull Distribution
None	-	-	4.2647	α	Rayleigh distribution

Table 6: Goodness Fit for Distribution

Test result	(P-value) H_0	Distribution Name
Rejected the hypothesis	0.0104	Lognormal Distribution
Rejected the hypothesis	0.0217	Exponential Distribution
Acceptance of the hypothesis	0.0310	Weibull Distribution
Rejected of the hypothesis	NONE	Rayleigh Distribution

Table 7: the Parameters Values and Unit Reliability

Component / Parameters	Turb.	Fuel	Cont.	Elect.	Com.	Gear.	Sum (R)
β	1.2530	0.5538	0.5204	0.5436	0.3025	0.4160	-
α	13.6504	94.9916	29.0302	44.3428	140.6417	15.9178	-
R	0.7343	0.8161	0.6606	0.7286	0.6894	0.5299	0.1054

- **Cost Effect Analysis**

The maintenance cost is divided into

A- Estimation Corrective maintenance cost

The total cost of the corrective maintenance (C_f) is

$C_f = Unit\ Power * Unit\ Price * TTR\ Planned + Cost\ Spare\ Part + (Work\ Cost * TTR\ Planned) \ldots (10)$

According to decision taken by the specialized maintenance engineer, the maintenance labors cost is taken from the power station account table and the unit price from the distribution department tables. The calculation procedure repeated for all parts of units to find out the cost of maintenance as show in Table 8.

Table 8: Shows the Calculation Summary of the Maintenance Cost.

NO.	Component	Corrective maintenance cost C_f	Preventive maintenance cost C_p	Total Corrective maintenance cost C_{ft}	Total Preventive maintenance cost C_{pt}
1	Turbine	51944.86	36682.6	69723.98	48199.8
		17779.12	11517.2		
2	Gear	33941.26	30318.1	80431	74129.1
		46489.74	43811		
3	Control	25108.2	20724.1	57881.47	41413.7
		32773.27	20689.6		
4	Electric	24971.63	15103.4	24971.63	15103.4
5	Fuel	141479.62	77654.9	168329.87	94399.5
		26850.25	16744.6		
6	Comb	712816.67	377439.27	712816.67	377439.27

VI. Logic Tree Analysis (LTA) In this research, the decision making of RCM by Logic Tree Analysis (LTA) that used to help data center managers to identify the appropriate type of maintenance strategies for any given system or facility. The result of LTA indicates which particular item of facility should be minted reactively, through a preventive maintenance approach or monitoring to take maintenance task based on predictions of imminent failure. Therefore, the research uses the decision tree structure to do those actions as shown in Figure 6.

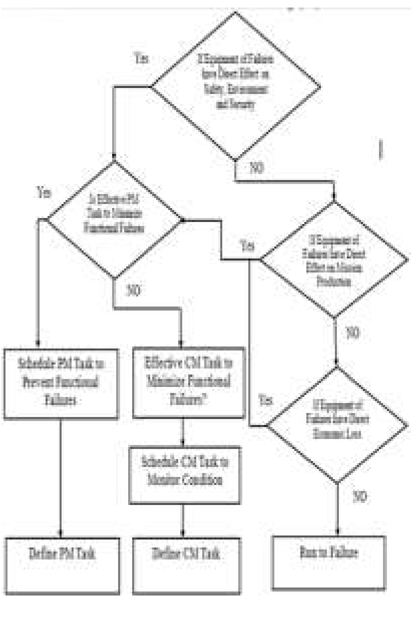


Figure 6: Represent Structure of Tree Analysis

VII. Criticality Analysis (CA)

In this work, Criticality Analysis (CA) used as tool to evaluate the effects of equipment failures on total performance according to functionally rank plant assets for the objective of work prioritization, material classification, PM/CM development and reliability improvement. The criticality is assessed based on the effect of defect on the time from the

$$EC = (30 * \beta + 30 * RPN + 25 * A + 15 * C_f)/3 \qquad (11)$$

Where:

EC: is the equipment criticality, %.

Table 9 represent the result of Criticality analysis, the group consists of four ranges (A, B, C and D). Where: (A > 3000), B (2000 - 3000), C (1000 - 2000) and (D < 1000).

5. Results and Discussion

The proposed RCM methodology is carried out to determine the preventive maintenance needs and can be applied to improve the equipment reliability & availability and reduce operating & maintenance costs. The results of applying RCM program on the parts of selected units are provided as tables previously containing all the information that needs to be maintained. Table 10 shows the results of optimum time required to apply the preventive maintenance for each part of the unit depending on the classification groups to

identify priority. The results obtained from this study show
that the application of proposed RCM methodology based on preventive maintenance planning will decrease the total cost value of maintenance about $ 463469.85 this result indicate a saving of about 59% of the total downtime cost compared with current maintenance. Proposed maintenance programs reduce the required time to repair the plant components annually at a rate 6 day so that represent that the labor cost will minimize about $ 6424. Applying of the RCM methodology showed that the main time between failures for the plant equipment's and the probability of sudden equipment failures are decreased. The results show that total costs are saved when applying proposed preventive maintenance planning compared with that of current maintenance. Based on these results, the application of the preventive maintenance should be applied.

Table 9: Represent the Result of Criticality Analysis

NO.	Component	Criteria				Weight				EC	Group
		A(t)	Impact on Production (β)	Impact on Safety (RPN)	Equipment Value (C_f)	A(t) 25%	β 30%	RPN 30%	C 15%		
1	Turbine	0.9441	1.2530	162	48199.8	0.2360	0.3759	48.6	7229.97	2426.39	B
2	Gear Box	0.9921	0.4160	336	74129.1	0.2480	0.1248	100.8	11119.36	3740.18	A
3	Control	0.9915	0.5204	108	41413.7	0.24780	0.1561	32.4	6212.055	208162	B
4	Electric	0.9944	0.5436	120	15103.4	0.2486	0.16308	36	2265.51	767.31	D
5	Fuel	0.9824	0.5538	72	94399.5	0.2456	0.16614	21.6	14159.92	4727.31	A
6	Comb	0.9583	0.3025	64	377439.27	0.2396	0.0907	19.2	56615.89	18878.47	A

Table 10 : Represent the Result Group and Perfect Time for Preventive Maintenance

NO.	Component	Group	Perfect Time of PM (Day)	Reduced Cost
1	Turbine system	A	190	21524.18
2	Gear Box System	A	64	6301.9
3	Control Auxiliary System	A	23	16467.77
4	Electrical Auxiliary System	B	10	9868.23
5	Fuel Auxiliary System	B	23	73930.37
6	Combustion System	D	45	335377.4
Total Cost Reduced				463469.85 $

6. Conclusions

This research describes the state of the art in RCM, which consider a very useful tool in electrical power plant with constraints that can be adapted where it is applied. In addition, is suggested to developing Proposed RCM methodology for applied successfully in Second Power Plant of south Baghdad that shows that preventive maintenance must be adopted which saved of about 59% of the total downtime cost compared with current maintenance plan. From the result, data of failure for the unit and according to its parts show, that Weibull Distribution is the best distribution used to calculate the value of the parameter beta analysis to overcome the difficulties in the application of traditional statistical theories to estimate reliability. Also, The recommendations of research to Second Power Plant of south Baghdad Improvement or replacement of fuel inside the units. The fuel is a heavy gas was poor quality, which increases the burden of washing turbine and leads to stop functioning and this is loss in production and thus increases maintenance cost. Future studies include Construct Software program that includes database on component failure. This will consider feedback to managers in the condition of similar issues and help them to determine the proper maintenance strategies.

Acknowledgement

This Work is supported by the Industrial Department of Production and Metallurgy Engineering, University of Technology; the authors also gratefully acknowledge the support of the technology University Especially Engineering Department to contribute to the provision of scientific research.

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