A STUDY OF BEST PRACTICE OF SCHEDULED OUTAGE PROGRAM IN INCREASING PLANT PERFORMANCE

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DEDICATION

This project report is dedicated to my beloved husband, Mohamad Khairulazizi Bin Abdul Kadir together with both of my parents and parents in law who constantly gave me strong support and courage over the years. It also dedicated specially to my late son, Muhammad Faiz Zhariff who always put his prayer for my accomplishment in doing the postgraduate. He knew my love to him will last forever until Jannah. Finally, the project report also is a special gift to both of my beloved sons, Muhammad Faiz Zayyan and Muhamad Faiz Zhafran who gave me strength to complete my study over many challenges and difficulties through the tough period. They knew my love to them is unconditionally.

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ABSTRACT

The purpose of this study is to determine solution in meeting high expectation from plant owner to the one and only asset in Malaysia of thermal type coal-fired power plant, Chinese Group of Nuclear (CGN) through Malaysian local company EDRA Power Holdings Sdn Bhd has challenged Jimah power plant to increase its plant performance and reliability with significant reduction toward Unplanned Outage Rate (UOR) which currently has exceeded the target limit of 4%, two percent (2%) is higher than the limit as stipulated in Power Purchase Agreement (PPA). It is believed that key success factor in achieving this target is through the implementation a comprehensive scheduled maintenance program that can be realized with collaboration of functional organization lead by dedicated outage team known as Outage and Project Management (OPM). Originally, the plant backlog is managed by each functional area without any collaboration from other multidisciplinary which also could lead to the unresolved issue at plant. The main challenge in this research mainly in determining the best approach in managing plant backlog from multidisciplinary section with minimum intervention from outage team using a systematic system approach. The outcome should be a total clearance of outstanding defects and completing all planned job including preventive, predictive and condition based maintenance under Jimah maintenance strategy mainly to prolong the lifespan of asset for profitability until the end of PPA with Tenaga National Berhad (TNB) in year 2033. The development of scheduled outage management program is tailored through combination of world standard of quality management such as Total Quality Management (TQM), Reliability Centered Management (RCM), Total Production Maintenance (TPM) and many more. This research helps reveal the current plant condition and performance statistically through number of outstanding backlog and abnormalities registered in asset management system (MAXIMO), Operation's logsheet, key performance indicator for every outages and etc. A complete work scheduling comprises all planned job for each type of outage shall be developed as the major outcome from this research.

ABSTRAK

Tujuan kajian ini adalah untuk menentukan penyelesaian dalam memenuhi jangkaan yang tinggi dari pemilik loji kepada satu dan satu-satunya aset di Malaysia loji janakuasa bertenaga arang termal, Kumpulan China Nuklear (CGN) melalui syarikat tempatan Malaysia EDRA Power Holdings Sdn Bhd mencabar loji kuasa Jimah untuk meningkatkan prestasi loji dan kebolehpercayaannya dengan pengurangan yang ketara ke atas Kadar Outage yang tidak dirancang (UOR) yang kini telah melebihi had sasaran sebanyak 4%, dua peratus (2%) lebih tinggi daripada had seperti yang termaktub dalam Perjanjian Beli Kuasa (PPA). Adalah dipercayai bahawa faktor kejayaan utama dalam mencapai sasaran ini adalah melalui pelaksanaan program penyelenggaraan berjadual yang komprehensif yang dapat direalisasikan dengan kerjasama organisasi fungsional yang diketuai oleh pasukan pemadam kebajikan yang dikenali sebagai Outage dan Pengurusan Projek (OPM). Pada asalnya, backlog loji diuruskan oleh setiap bahagian tanpa kerjasama dari pelbagai disiplin lain yang juga boleh membawa kepada isu yang belum diselesaikan di loji. Cabaran utama dalam penyelidikan ini terutamanya dalam menentukan pendekatan terbaik dalam pengurusan backlog loji dari seksyen multidisiplin dengan campur tangan minimum daripada pasukan pemadaman menggunakan pendekatan yang sistematik. Hasilnya merupakan jumlah pelepasan cacat yang belum dijelaskan dan melengkapkan semua pekerjaan yang dirancang termasuk pencegahan dan ramalan berdasarkan Jimah strategi penyelenggaraan terutamanya untuk memanjangkan jangka hayat aset untuk keuntungan sehingga akhir PPA dengan Tenaga Nasional Berhad (TNB) pada tahun 2033. Pengembangan program pengurusan gangguan yang dijadualkan disesuaikan dengan kombinasi standard pengurusan kualiti dunia seperti Pengurusan Kualiti Keseluruhan (TQM), Pengurusan Berwawasan Keandalan (RCM), Total Maintenance Maintenance (TPM) dan banyak lagi. Penyelidikan ini membantu mendedahkan keadaan loji dan prestasi semasa secara statistik melalui jumlah tertunggak dan keabnormalan yang tercatat dalam sistem pengurusan aset (MAXIMO), Lembaran log operasi, petunjuk prestasi utama bagi setiap gangguan dan sebagainya. Penjadualan kerja lengkap terdiri daripada semua kerja yang dirancang untuk setiap jenis daripada gangguan akan dibangunkan sebagai hasil utama dari kajian ini.

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LIST OF ABBREVIATIONS

EDRA	-	EDRA Power Holdings Sdn Bhd
IPP	-	Independent Power Producer
MW	-	Mega Watt
JEV	-	Jimah Energy Ventures
OEM	-	Original Equipment Manufacturer
HP	-	High Pressure
IP	-	Intermediate Pressure
LP	-	Low Pressure
TKF	-	Thyssenkrupp Germany
UOR	-	Unplanned Outage Rate
BTF	-	Boiler Tube Failure
UTM	-	Universiti Teknologi Malaysia
OPM	-	Outage and Project Management
PPA	-	Power Purchase Agreement
TPM	-	Total Production Maintenance
O&M	-	Operation and Maintenance
WIRP	-	Work Identification and Resource Planning
PIC	-	Person In Charge
CF	-	Certificate of Fitness
PTW	-	Permit To Work
NLDC	-	National Load Dispatch Centre
BMS	-	Boiler Maintenance Section
TMS	-	Turbine Maintenance Section
CES	-	Chemical and Environment Services
C&I	-	Control and Instrumentation Section

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

EDRA Power Holdings Sdn Bhd (EDRA) was originally formed in 2014 from the consolidation of three major IPPs in Malaysia, Powertek Energy Group, KLPP Group and Jimah Energy Group, each with an impressive history of over 20 years in the development, operation and maintenance of power plants as projected in Figure 1.1. EDRA is led by experienced management teams with deep industry knowledge, expertise and established track records, which are further supported by strategic partnerships with reputable global players. Currently, EDRA has a portfolio of 13 power and desalination plants in five countries, with a gross installed capacity under management of 6,532.5 MW and an effective capacity of 5,529 MW.

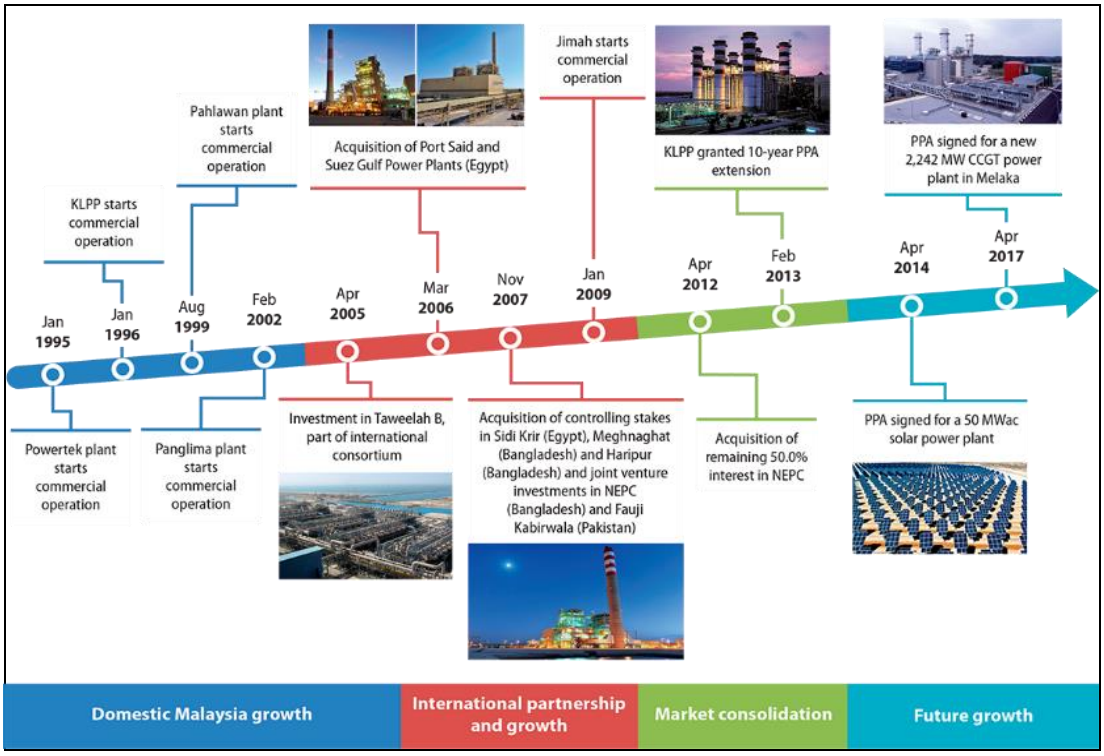


Figure 1.1 Power plants of EDRA

Jimah Energy Ventures (JEV) as one of the subsidiaries of Edra Power Holding Sdn Bhd, has set-up 2 units of 700MW Coal Fired Power Plant at Mukim Jimah, Districh of Port Dickson, Negeri Sembilan Darul Khusus with Jimah O&M Sdn Bhd (JOM) is the project Manager as well the Operation and Maintenance (O&M) contractor for the Jimah Power Plant. In year 2006, this project among mega project with project cost approximately six billion was accepted by government for a knowledge transfer of the higher technology. The technology was brought over from Japan through giant company like Toshiba International Corporation and Ishikawajima-Harima Heavy Industries (IHI Corporation) for major equipment of turbine and boiler. The technology.

1.1.1 Jimah Power Plant Overview

The two units of sub-critical boilers with total capacity of 1400 MW were commenced in year 2009 on January and July respectively without any delay. It was known that Japanese has highly discipline culture and practicing good project management body of knowledge (PMBOK). It has become the main factor of their success in every project. Overall design and capacity of Jimah power plant are described in Figure 1.2 followed by overall process flow as illustrated in Figure 1.3.

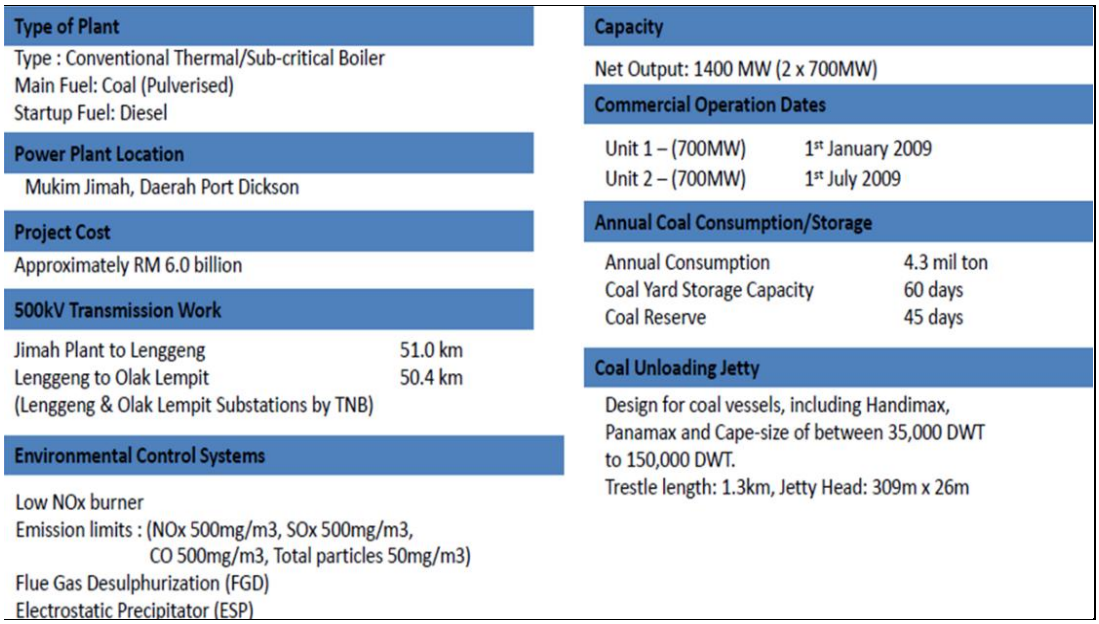


Figure 1.2 Overall Design and Capacity

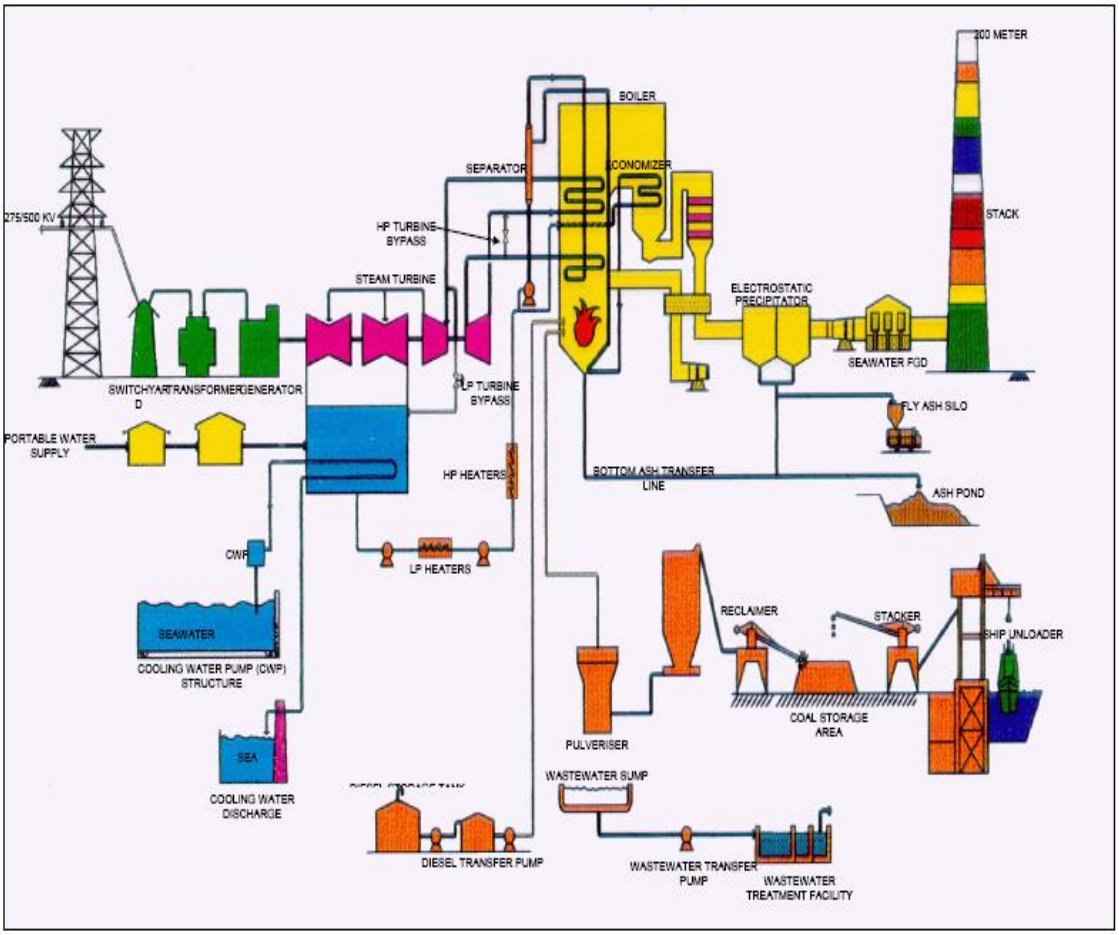


Figure 1.3 Overall Process Flow

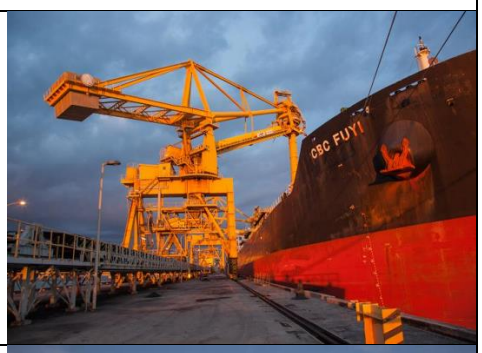
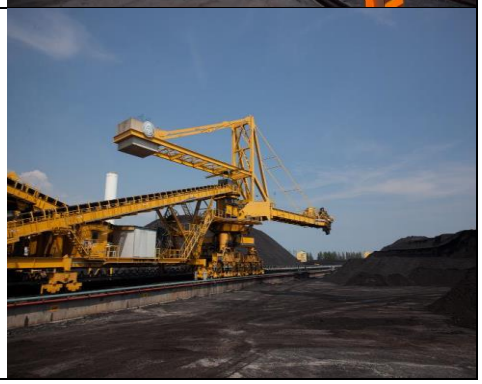
1.1.2 Major Equipment

There are five major equipment that required to be well-maintained in order to avoid any commercial loss mainly capacity payment due to loss of production and demurrages is the penalty incurred due to delay in unloading coal at jetty within certain period of time. Thus it is crucial for Jimah in ensuring reliability of these equipment through efficient maintenance program as well as operating within the design limit as recommended from OEM to prevent overstress to the machineries. The major equipment was grouped into Main Plant and Coal Handling Plant as tabulated in Table 1.1. However, this study will focus on how maintenance team manage and maintain systems that available in the main plant only.

Table 1.1 Five Major Equipment of Jimah Power Plant

No.	Equipment	Component	Photo
A. Main Plant			
1	Turbine	• One (1) HP Turbine • One (1) Double Flow IP Turbine and • Two(2) Double Flow LP Turbines • Maker: Toshiba Corporation	
2	Boiler	• Pulverized Coal Fired • Natural Circulation • Subcritical Single Drum • Reheat Type • Balanced Draught System • Three (3) stages of Superheaters • Five (5) sets of Coal Feeder & Pulverizer • Two (2) sets of Air Preheater per Boiler • Maker: IHI Corporation	
3	Generator	• Generator Rotor is hydrogen cooled • Generator Stator is water cooled • Maker: Toshiba Corporation	

Table 1.1 Five Major Equipment of Jimah Power Plant (Cont')

No.	Equipment	Component	Photo
4	Coal Unloader	• No. of machine: 2 sets • Design capacity: • Stacking: 3,600 t/h • Reclaiming: 1,800 t/h • Maker: TKF Germany	
5	Stacker and Reclaimer	• No. of machine: 3 sets • Design capacity: • Stacking: 3,600 t/h • Reclaiming: 1,800 t/h • Maker: TKF Germany	

1.2 Problem Background

Jimah Energy Group is the only subsidiary in EDRA that generate electricity using thermal power where the plant known as Jimah Coal Fired Power Plant that consists of 2 units of sub-critical boilers with total capacity of 1400 MW as shown in the top view of schematic diagram Jimah Power Plant, Figure 1.4. These boilers have been operated since commissioning for almost ten years where the Commissioning of Date (COD) happened in year 2009. The plant performance has shown deterioration through series of forced outages starting from year 2011 until present.

The major culprit that cause high Unplanned Outage Rate (UOR) at Jimah is boiler tube failure (BTF) which up to date, the total accumulated losses is approximately more than RM150 millions comprising of loss of Availability Capacity Payment (ACP) and Daily Utilization Payment (DUP) as well as repair cost incurred from 24 incidents at both Unit 1 and Unit 2. Other contribution of UOR to Jimah power

plant are including condenser tube leak, submerged chain conveyor (SCC) tripped, primary air fan (PAF) vibration high and etc.

It is believed that these defects can be cleared through a proper maintenance planning with an application of quality management toward the problem prior to equipment failure. L. Wang (1977) has done an analysis of how the loss of load probability is affected by uncertainties in the estimated forced outage rates of generating units and the forecast peak loads. Equations were derived for calculating the mean and the variance of the LOLP distribution under these uncertainties. He has believed that by transforming uncertainties to be certain may reduce the loss of load and increase the production of the generating plant.

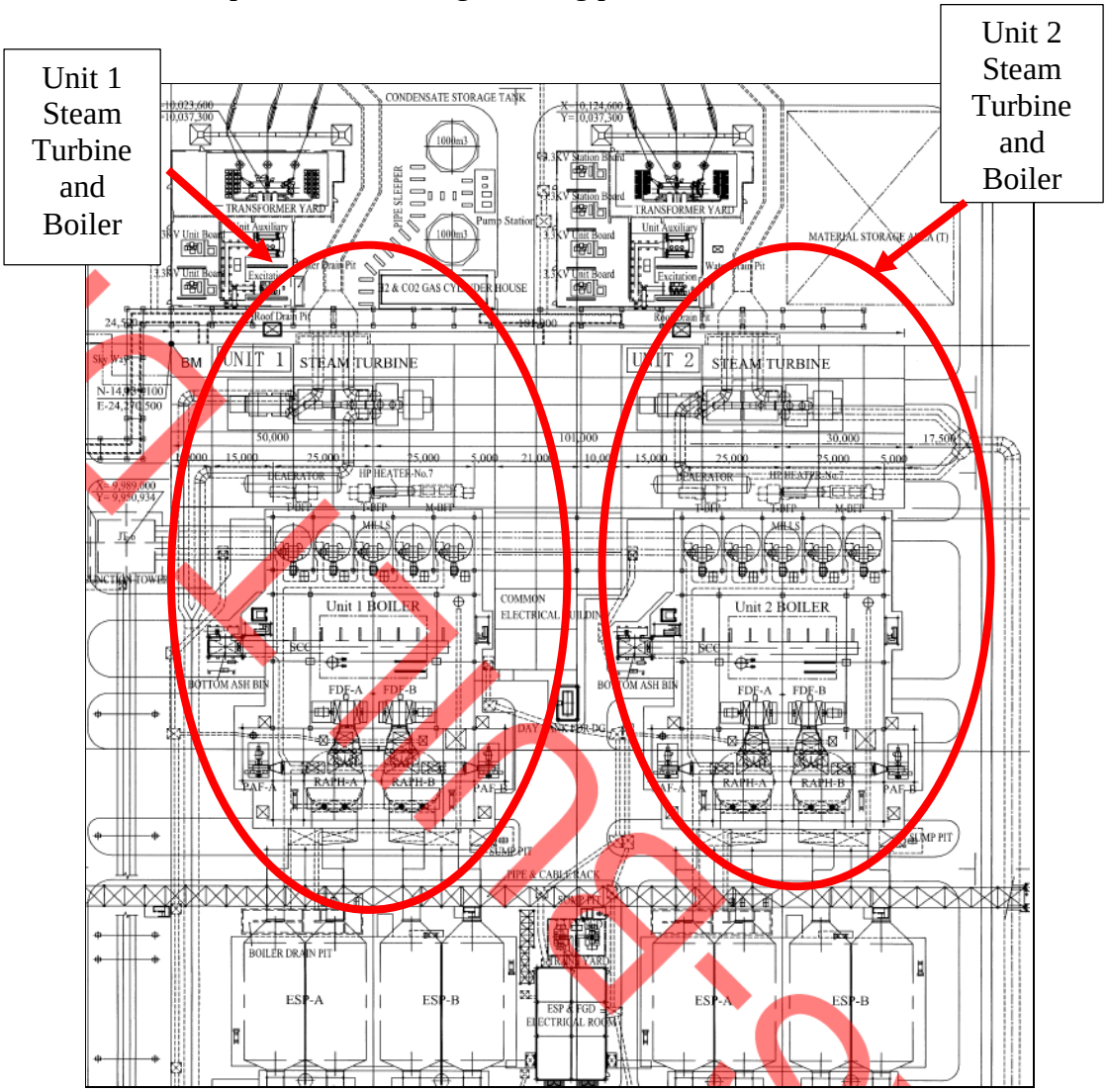


Figure 1.4 Top View of Steam Turbine and Boiler of Unit 1 and Unit 2

In Jimah, there are four main functional groups comprises of Maintenance, Business Support Services, Operation and Quality, Health Safety and Environment (QHSE) as shown in Figure 1.5. Under maintenance itself, there are four workgroups who responsible to manage and maintain mechanical, electrical and control system in Jimah power plant known as boiler, turbine, electrical and control and instrumentation section. Based on the conventional work culture, both operation and maintenance are hard to be synergized and always become two different island. It has caused significant barrier in communication and work collaboration. Thus, Jimah has introduced third party between the two groups which seem to be essential to close the work culture gap known as business support services comprises both technical and non-technical team.

The technical team known as technical support group are formed with three key functional areas including Outage and Project Management (OPM), Reliability and Chemical and Environment Services (CES) Team. Based on the nature of the work, these groups directly involve with both operation and maintenance thus required high interpersonal and communication skill in ensuring the successful of work to be executed. The challenge is mainly in getting their commitment and continuous support within certain period. On the other hand, people skills also play a big role to ensure smooth execution of certain work from the beginning until the end.

Under OPM, they responsible to lead the outage program from initiating, planning, executing, controlling and monitoring and closing used to close the gap between operation and maintenance for every outage. The approach seems to be successful except for the planning part that contribute to major failure of the incompletion of planned job as well as plenty of quality issue causes plant tripping and rework after the plant start up. The detail of roles and responsibility of OPM will be discussed further in Chapter 4.

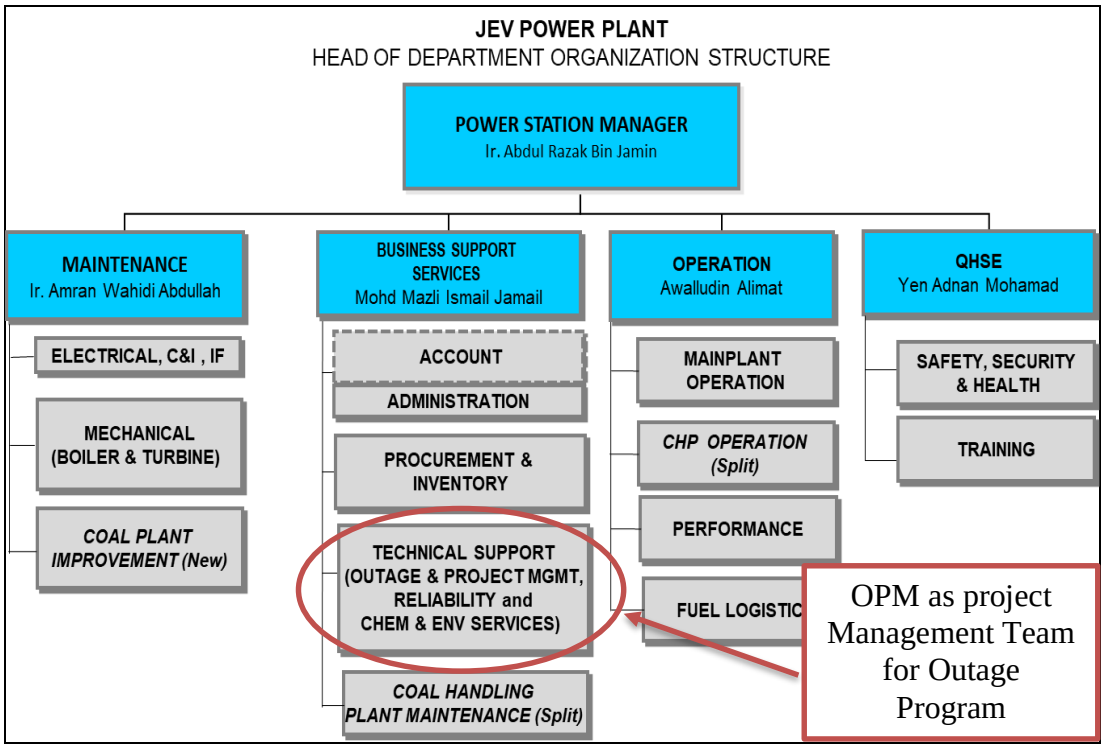


Figure 1.5 Organizational Structure of Jimah Power Plant

1.3 Problem Statement

As one of the Independent Power Producer (IPP) in Malaysia, Jimah Power Plant is bound to the contract of Power Purchase Agreement (PPA) for 25 years with Tenaga Nasional Berhad (TNB). Under this contract, Jimah must maintain its availability within Unplanned Outage Rate (UOR) limit that should not exceed than 6% throughout contract year block which equivalent 22 days per year for both units. However, under the new owner Chinese Group of Nuclear (CGN), Jimah is expected to increase their performance with lower UOR which is 4%, two percent (2%) is higher than the limit as stipulated in Power Purchase Agreement (PPA). This new expectation has forced Jimah management team to find ways in determining the best approach in operating and maintaining the plant efficiently. Agrawal (2018) has determined that unplanned outages also known as forced outage act as a source of operational uncertainty for hydropower companies like BC Hydro. Forced outages reduce plant availability and causes loss of system flexibility and revenues. A combination of both likelihood of occurrence (frequency) and severity of outage event (duration) truly

represents the risks posed by forced outages. Energy studies, using simulation and optimization models, are carried out by utility companies to incorporate different sources of uncertainties and maximize benefits in multipurpose, multi-reservoir systems. The impacts of planned outage on forced outages were quantified and suitable probabilistic distributions were developed to represent frequency and duration of outages.

It has become a culture to both technical and management team to carry out planned job during plant shutdown due to low risk such as loss of production. However, engineers face difficulty to plan properly due to their commitment to day to day work which currently under phenomenon of “Run to Fail” situation. Under this phenomenon, the ability to do well planning is limited. It causes delay in identifying scope of work and securing resources for the work which later can be accumulated as plant backlog. Based on the previous practice, every section does their planning individually without co-ordination from a dedicated team to integrate the various functional areas such as mechanical, electrical and control and instrumentation including operation. Better approach allows everyone look into one prism to ensure total health of the system condition and its functionality. The scheduled outage management program lead by dedicated outage team helps reducing the gap in managing plant performance efficiently.

In producing the effective scheduled outage program, detail study has to be carried out in determining the right method to ensure total clearance of defects in maintaining plant at good condition for reliability and sustainability. The method shall be established and accepted from all working level in ensuring the successful of its implementation. However, the right method alone does not confirm well execution of the work. In this case, right workforce and culture are equally important for the contribution of successful completion of the work plan.

1.4 Research Goal

The research goal is to explore the best approach in developing scheduled outage program that simple in structure but able to provide a practical and objective way of managing plant backlog. On top of that, the program shall able to improve the integration between operation and maintenance through an effective communication method via systematic work process that helps in promoting the self-belonging among staff in Jimah power plant using the traits “Everybody’s Responsibility”. According to Gao et.al (2013), they found that China in urgent need of establishing an appropriate type of simulation system to rapidly improve operation efficiency and the level of maintainers, which aim at the integrated operation of substation operation and maintenance service. It was done through an introduction of a simulation training system which is designed for operation-skills training in electrical systems. By the composition of the multiple subjects and skills training for operations staff, this system can provide human guarantee and intellectual support for the "Big-Centralized Overhaul".

On the other hand, Maggard and Rhyne (1992) proclaimed that in manufacturing systems the requirement of significant and rapid changes in design and delivery maintenance for plant systems was the performance criteria of world class manufacturing systems. Operating requirements of rapid changes, short production and lead times and zero level of defect, disturbance and failures are major challenge for maintenance. These challenges look similar to the requirement of this study in term of continuous production in generating power to the national grid. Similarly, they also applied the nontraditional approach to plant maintenance that is complementary with TQM, Just In Time (JIT), total employee involvement (TEI), continuous performance improvement (CPI) and other world class strategies already developed and successfully implemented. They also agreed that the orientation of work cultures toward excellence, the presence of effective work teams and a basic maintenance management system functioning reasonably well will enhance and accelerate TPM implementation.

1.4.1 Research Objectives

The objective has been to develop a scheduled outage program with the application of world standard asset management model that simple in structure but able to provide a practical and objective way in ensuring total clearance of plant defectiveness for better performance upon plant start up. They are;

1. To identify the current practice of maintenance strategies in managing plant backlog toward 30 systems in Jimah power plant,
2. To review the plant performance through UOR indicator and determine it correlation to poor maintenance management of current practice,
3. To propose a comprehensive scheduled outage program for every type of outages; Mini, Minor and Major Outage.

1.5 Significant of the Study

Since 2009 until 2018, Jimah power plant has completed 25 numbers of plant outages at both Unit 1 and Unit 2 as shown in the Table 1.2 below;

Table 1.2 List of Performed Scheduled Outage

Unit	Mini Outage	Minor Outage	Major Outage
Unit 1	7	5	2
Unit 2	5	5	1
Total	12	10	3

Every outage has the same common problem in planning which causes a lot of issues causes delay in securing resource, poor site preparation and plant readiness. Several management practice has been implemented but none was successful. This study helps in determining the best approach to practice planning and managing outages in meeting the expectation from the new owner. The outcome from seem to be give a drastic impact to the current management due to the requirement of dedicated team to lead outage program which may increase internal resources with high technical and interpersonal skill in ensuring the effectiveness of the work plan.

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