Chapter 1 : INTRODUCTION

The Sultan Salahuddin Abdul Aziz Power Station (SSAAPS) is located on the west coast of Peninsular Malaysia approximately 50 kilometers (km) due west of Kuala Lumpur. The site lives between the mouths of two rivers, Kapar Besar and Serdang Kecil, and is 5 kilometers west of Kapar-Kuala Selangor road. The site covers an area of 208 hectares of reclaimed mangrove swamp.

The site construction of Power Station begins in 1980 and the station is proposed to be built in 4 phases. The current output of station is 1724 Megawatts (MW), comprising the following units:-

1. *Phase I - 2 units of 300MW machinery of conventional power generating plant that, use fuel oil or gas or combination for generation of electricity. The two units were installed in 1985. Total capacity is 600MW.*

2. *Phase II - additional 2 units of 300MW machinery of conventional power generating plant that fuse fuel oil or gas or coal or combination for generating of electricity. The units were installed in 1988. Total capacity is 600MW.*

3. *Phase IV - 10 units of generating plant using Gas Turbine technology of various sizes were installed between 1993 and 1994. Gas Turbine units take about 6 months to 1 year for complete installation. This installation period is very much faster than the conventional power generating plant which takes between 3.5 - 5 years for complete installation. The total install capacity of Gas Turbine units is 524 MW, consisting of :-*

   (I) 3 units of 110MW each

   (ii) 5 units of various size between 20MW to 30MW with combined (total) output of 194MW.

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4. *Phase III - This project is under construction for 2 units of 500MW of conventional power generating plant that use fuel oil or gas or coal or combination for generating electricity. The tendering stage of project begins in 1993 and the project is due for complete installation in early 1998. With the completion of Phase III project. The station maximum capacity will be 2724 MW.*

The present output of 1724MW represents the largest installation in the Peninsular Malaysia. It represents about 20% of today maximum demand of electricity. The 300MW unit is the largest single unit currently installed in the country, including units installed by the Independent Power Producers (IPPs).

The units and its related equipments and machineries are installed under internationally bid tenders. About 70% of equipment and machineries are imported from Japan and remaining portion from Europe and United States.

The local content represents small portion of the total installed equipments.

1.1. Inventory In Power Station

Inventory in a stock of materials held to satisfy some eventual demand. As of manufacturing process, inventory can be classified three types, raw materials, work-in-process and finished goods. In the case of Power Station or TNB, the finished goods which is required to be produced to meet customer demand is Electricity. TNB as a service utility cannot store electricity. Electricity has to be continuously produced to meet the instant demand. The demand last for 24 hours with varying degree. The electricity which cannot be stored, brings greatest challenge to TNB in the aspect of material management. The main focus area in the material management is the inventory management.

What are the inventories involved in the process of producing electricity. Basically there are two kind of inventory. The first is in the form of fuels. There are four type of fuels that are used in the power station (referring to Sultan Salahuddin Abdul Aziz Power Station only). They are oil, gas, distillate (diesel group) and coal. All the fuels, except gas, have to be purchased and stored before they are used to produce electricity. Fuel in the form of chemical energy is transformed to mechanical energy before finally converted to electrical energy. Basically fuel is burnt in a boiler to turn water into steam energy. Steam is used to turn prime mover which is directly connected or coupled to electric generator to produce electricity. In the case of SSAA Power Station, steam is used to turn prime mover and electric generator at 3000 revolutions per minute (rpm) to produce electricity at various output. The maximum output from electric generator in 300MW. Above is simple illustration of electricity generation by the conventional power plant (refer Figure 1 for simplified process of generating electricity at SSAAPS).

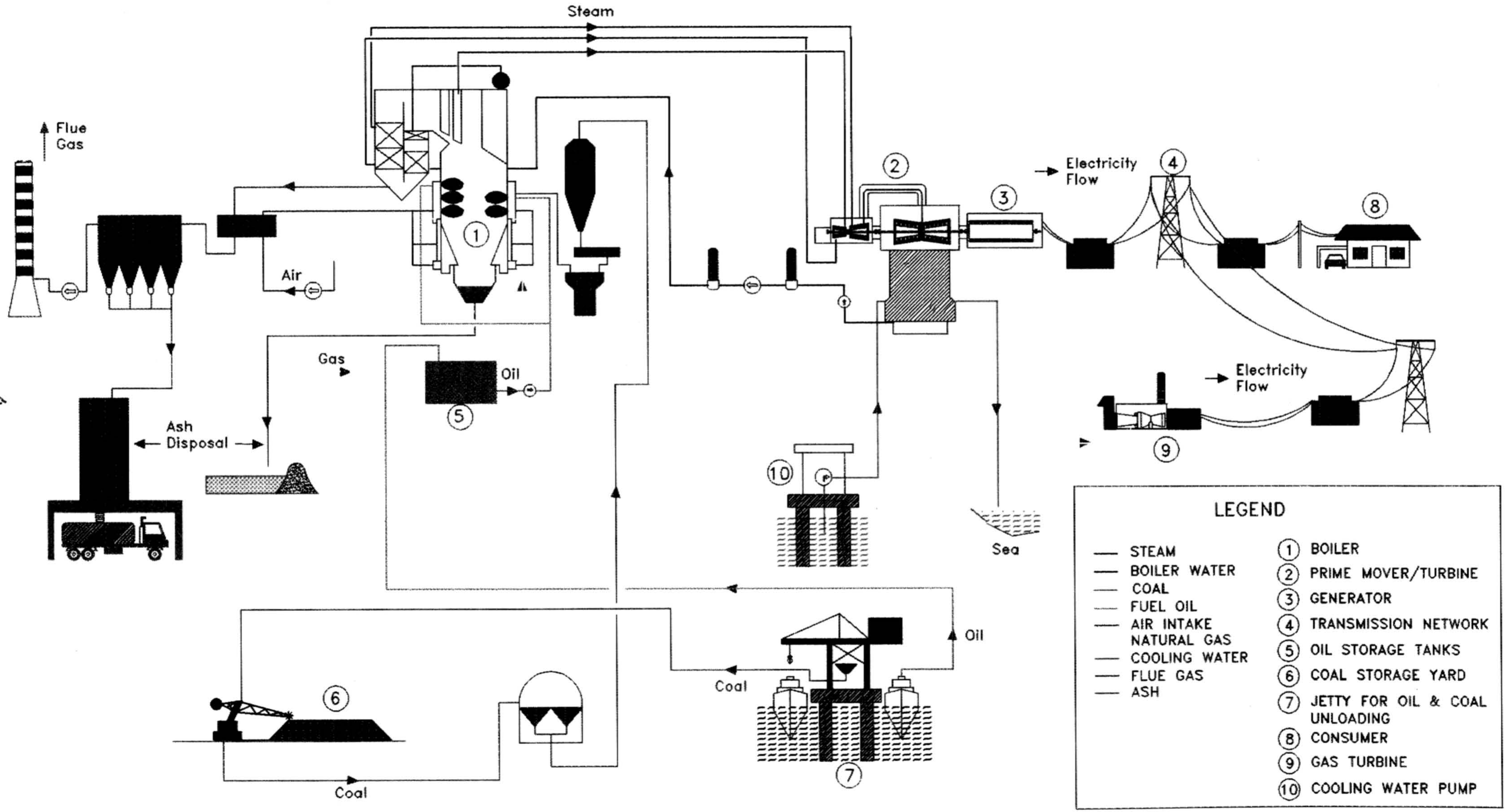
In the case of gas turbine technology, fuel, i.e. distillate or gas, is burnt inside combustion chamber and the resultant hot gases in directed to prime mover to turn it at 3000 rpm. The prime mover is directly coupled to electric generator and electricity is produced by the prime mover action.

There is no storage facility for gas. Gas is being piped into the power station from the supplier. The gas will be burnt as required by the power plant. Therefore there is no inventory stock for gas fuel is concerned. The other form of inventory is in the form of spare parts for continuous operation of machineries for electricity generations. The revenue is delivered from selling electricity. Revenue is maximized by having generation plant operating at high efficiency. The availability of spare parts is critical to ensure that all equipment are subjected to proper maintenance.

ELECTRICITY GENERATION PROCESS (Simplified)

AT

SULTAN SALAHUDDIN ABDUL AZIZ POWER STATION

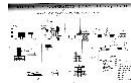


LEGEND

- STEAM
- BOILER WATER
- COAL
- FUEL OIL
- AIR INTAKE
- NATURAL GAS
- COOLING WATER
- FLUE GAS
- ASH

1. BOILER
2. PRIME MOVER/TURBINE
3. GENERATOR
4. TRANSMISSION NETWORK
5. OIL STORAGE TANKS
6. COAL STORAGE YARD
7. JETTY FOR OIL & COAL UNLOADING
8. CONSUMER
9. GAS TURBINE
10. COOLING WATER PUMP

FIGURE 1



The reliability of machinery also depends on proper stock of spare parts. TNB has to ensure that electricity is produced to meet instant demand in order to provided reliable and uninterrupted power supply. The instant demand is due to people switching on their electrical appliances or industries using electricity. In both instant TNB has no control to decide when they can use electricity. Reliable service with little breakdown is the critical success factor to ensure customer satisfaction.

Inventory management in power station is a critical managerial issues in order to provide good service to customer in turn of continuous and uninterrupted power supply. Stock spare parts forms a large financial investment that today management could not take a risk as the inventory represent an idle investment for demand that is unpredictable in the future. Spare parts forms the highest percentage of inventory in any power station set up (more than 65% of inventory is spare parts).

1.2 Objectives Of Inventory Management

The objective of inventory management in TNB's power station application is to ensure improve plant service availability. By ensuring sufficient quantity of spares, major breakdowns can be reduced. Machines are kept running and operating continuously in order to meet customer demand. If there is a need to shut down machine for component repair or replacement, the period of unavailability is kept to a minimum. TNB has to ensure that there are enough machines installed in the a system so that for a particular machine to be out there are enough standby machines that could be put in service customers do not see disruption of electricity supply.

Inventory management could also assist in efficient production of electricity through proper utilization of right quantity of spares or materials. A car could not function efficiently if the components of the car are of sub-standard

and unreliable machines need to be fed with correct fuel in order to convert chemical energy into useful and efficient production of electricity, the same manner as human being need to be fed with proper food to perform and function efficiently. Fuel (food) needs to be sourced and managed effectively.

Improved availability and efficient production of electricity would ensure good return of investment for the organization. In the current situation i.e. emergence of Independent Power Producer (IPPs), it cannot overemphasize the important of efficient and improved service that TNB must deliver to its customer. Profit is seen through satisfying customer requirement.

In the case of manufacturing sector, it is easy to ensure right quantity of inventory stock as the production is continuously transforming the raw materials into work-in-progress and finally the finished goods. For TNB, service sector, inventory is in the form of spares (generally finished goods) that need to be bought and kept and made available when needed. It is difficult to see the usage or movement of these spares as machine failure is unpredictable. The risk of keeping too high spares inventory could not be ruled out. Spares that originated from overseas are normally required long lead time to order. Inventory management in the form of spares management is optimized through past records of material usage, engineering experience and the period to obtain spare.

It is also the objective of inventory management to ensure the right supplier with the right cost. The right supplier would ensure the intention of buying is clearly and rightfully identified. There are cases when TNB has to reject item that was wrongly supplied and it takes a long time to manufacture and deliver the items. Under such circumstances, it could effect the availability and efficiency of TNB's machine. It is important to note that most of the technologies and equipment in TNB's power stations are imported from overseas. Equipment like turbine , boiler, generator, switchgears,

transformers, process control, motors and high voltage cable are imported and expensive. Low voltage cable, lighting equipment and less specialized items are procured locally. There are also variety of equipment doing the same function, as the result of international

tenders and conditions imposed by loan providers. It is important to get a right supplier as local suppliers are not the agent of original equipment manufacturer (O.E.M.). Most local agents are merely businessmen that participate in tendering activities.

1.3 Problems Associated With Inventory Management

It is important to appreciate the problems associated with inventory management in service sector like TNB in order to fulfill the objective and the roles/functions to be played by the Inventory Department.

In order to support electrical industry, TNB in its operation has to ensure continuous supply of electricity by ensuring it has enough stock of fuel to burn in order to generate electricity. Furthermore, TNB has no direct control for the supply of fuel to its various power stations located in different parts of West Malaysia. TNB has to purchase its fuel oil from Petronas. Due to supply constraint, Sultan Salahuddin Abdul Aziz Power Station has to keep stock of fuel equivalent to 15 days of operation. Such stock has been estimated on current price to cost about RM 9 million. This is a lot of holding cost which TNB has to undertake in order to ensure continuous supply of electricity. The station is also to keep large quantity of coal as fuel stock to avoid sudden problem in shipment of coal as coal has to be imported from Australia, China and small quantity from Indonesia and Sarawak. Amount of coal stock is estimated about RM 15 million.

Slow moving items or spares are common problem facing TNB's power station. Sufficient amount of spare is to be maintained in order to ensure

machines operate continuously. As machines are maintained efficiently and properly, there is less likely a particular spare is needed. But without such spare, a machine could be disabled for number of days or months. It is difficult to identify a good correlation/pattern in the above situation. Similarly

frequent breakdown of machine could lead to too much of one part of spare. The experience of maintenance staff/engineer has strong bearing on the quantity of stock. Frequent transfer of maintenance personnel could lead to above problems.

Power Station is a huge asset for TNB and the technology used is mainly imported. Structures and equipment are huge and numerous. The machines and equipment are multi-international manufactures. Process of spares identification is normally lengthy, laborious and by manual. This has contributed to poor inventory management.

It is difficult to get reliable source of supplier as there are few OEM's agent in this country. Lack of technical knowledge among local suppliers has delayed in supplying urgent equipment from overseas. Some equipment take too long to be manufactured as they are not stocked sufficiently by manufacturer. All these, at time, lead to overstocking of certain spares

1.4 Functions of Engineering Department.

The material management is the responsibility of Engineering Department.The department manages the administrative and store functions of the station.All inventory activities are carried out by staff in the Store Section.The Store Section is managed by a very Senior Clerk.The Administration Officer oversees the activities of staff in the Store (Figure 2 is the main organisation chart of SSAAPS) . Inventory management involves in proper identifying the functions or activities of an Engineering Department. The functions are numerous and wide. Some of the functions are listed below :-

1. *To support the operation and maintenance departments with an uninterrupted flow of materials and work services.*

2. *To keep inventory investment at a practical minimum level.*

3. *To buy competitively and wisely.*

4. *To develop reliable and effective source of supply.*

5. *To administer the material management and procurement functions in a professional and cost effective manner.*

6. *To develop good relationship with vendor community and continuing relationship with suppliers.*

7. *To maintain purchase and price records.*

8. *To catalogue and components identification.*

9. *To carry out stock checks at regular internal.*

10. *To keep with latest technology / knowledge in material management activities.*

11. *To carry out receiving and storing activities within stores, warehouses and building / factory compound.*

1.5 Objectives of Research

The objective of this study is to comprehend the current inventory level and effort to reduce inventories eventually. The next step is how to maximize spares effectively and efficiently without putting minimum constrain on TNB financial situation and at the same time optimize the machine availability.

Current practice of maintenance and servicing facilities would also be reviewed in trying to optimise the stock level of inventory. Sub-contracting or privatizing some existing services should be considered in order to reduce the inventory stock.

Spares may be reclassified into (1) locally produced, (2) imported, (3) essential, (4) critical, (5) non-essential so that specific strategy could be established to reduce the inventory. There is a tendency to utilize local technology as the country progress towards fully industrialized in the year 2020.

Last, but not least, some aspect of management involvement and TNB purchasing policies will be touched in order to have the overall impact of inventory management in the power station.

SIMPLIFIED STATION ORGANISATION CHART

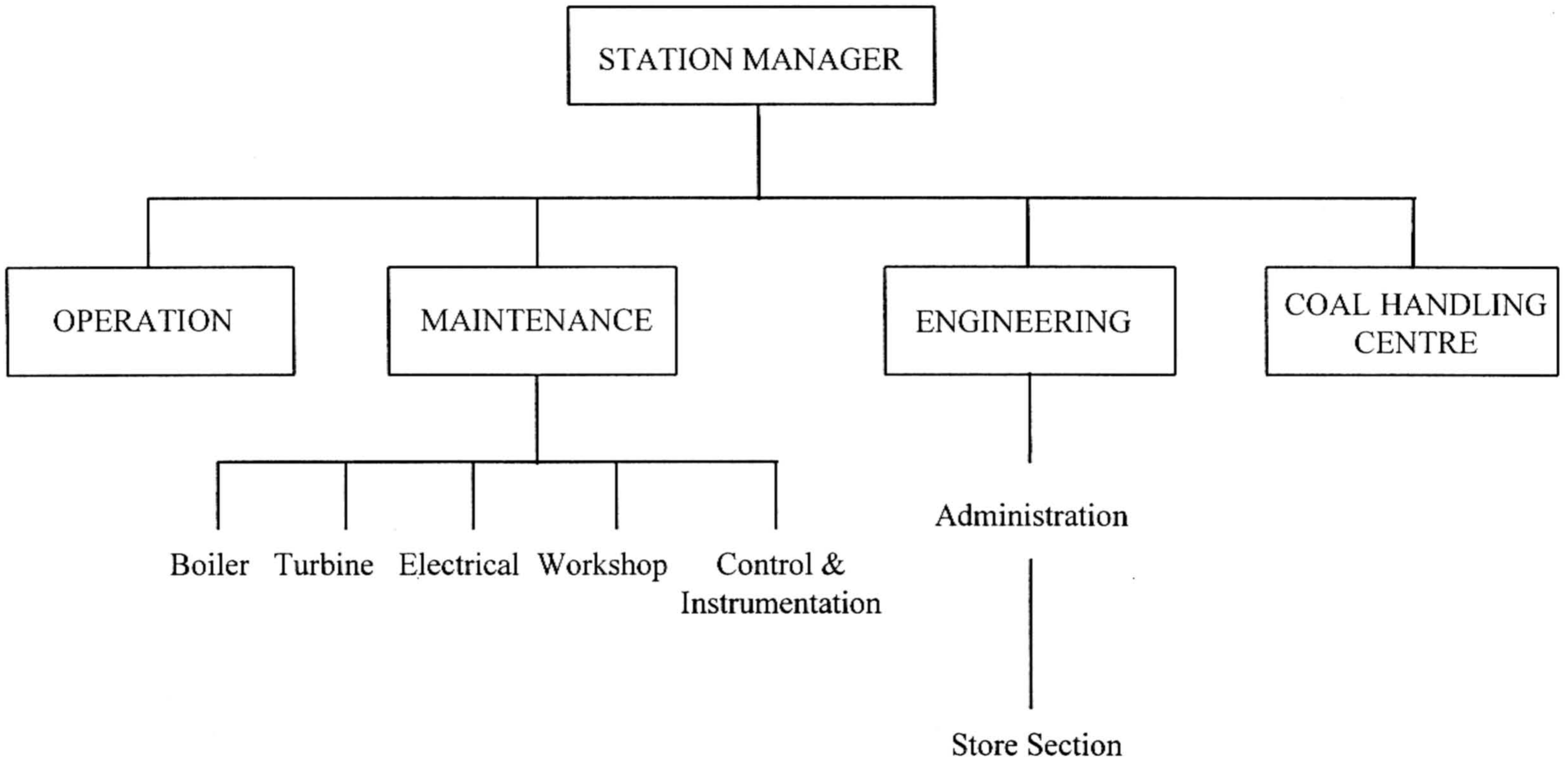


Figure 2