Chapter 5 : Conclusion And Recommendations

Material management in service industry depends very much on spare parts to ensure reliability and high performance and it is different from material management in other industry. Inventory such as raw materials, work-in-progress and finished goods are more predictable in their usage as compare to industry that is capital intensive. Maintenance of capital intensive facilities requires good planning to minimize downtime. Spare parts play critical role in minimizing downtime.

There are thousands of parts and pieces necessary to be inspected during major shutdown of a generating set. All parts are equally critical in its own operation. Any slight defects will affect the other components. It is critical for unit that rotates at 3000 rpm, like prime mover and generating set, to have highest level of maintenance as failure could cause expensive equipment. Modern world class service company pay a lot of attention on preventive maintenance. Any slight problem is identified at early stage and parts are replaced to avoid expensive damage. Spare parts have been the critical success factor for world class service company to performs its preventive maintenance.

For TNB, situation can be very serious if spares are insufficient as the technologies used are imported and there is long delivery of spare parts. It is quite common for spare parts to be delivered in 6-9 months as manufacture are not keeping spares any more. Manufacture expects client to order their spares long in advance. But the need of spares is unpredictable. Some spares have been idle for the last 10 years. It does

not means such spares are not needed. Such spares are not needed for the time being because maintenance has been carried out effectively and this is due to the good maintenance practice.

In order to achieve highest reliability many utility companies invest in computerized maintenance system. This systems call for good support of inventory in the form of spare parts. With computerized system, the emphasis is on preventive maintenance rather than corrective maintenance. Spares play critical role in achieving good maintenance. Inventory management in power station environment has to be carried out collectively and it needs continuous monitoring. Computerized system in inventory transaction should lead towards effective inventory management. Inventory control has to be top driven.

From the results discussed so far, the material management at SSAAPS should be concentrated on managing activities of plant spares and to certain extend in the control of the various fuel stock. The result could not be expected in short period unless continuous monitoring is carried out with the support of all sections. Team effort is crucial in establishing the effective level of inventory. Inventory is a dynamic process as there are many components or items (at SSAAPS, there are 16,000 items) in the system and their failures are unpredictable. Equipment failure depends on the type of maintenance carried out. Maintenance programme could be in the form of i) corrective ii) preventive and iii) condition maintenance. It is up to the management to decide their policy. For world class utilities the maintenance policy is shifted towards preventive and condition maintenance. Such maintenance policy requires good

support of spare parts. Inventory management or material management in service industry like TNB is going to the cutting edge among players of the industry.

Recommendation for effective inventory management in power station environment :

1) The materials management is the responsibility of Engineering Department of station. This department should establish and document the materials management policies and procedures.

2) Institute an exercise to classify all spares in line with Generation Stock Maintenance Policy that was established at HQ. The Generation Operation Department at HQ has established a spares policy as follows:-

Insurance spares - spares for items that are not expected to fail, but should failure occur it would result in a long outage. Replacement activity is minimal. Spares are purchased during plant construction.

Slow moving spares - spares which are expected to be used in 2 - 7 years of plant operations based on manufacturers' recommendations on replacements. Items are acquired during construction and stock levels are monitored and adjusted base on plant operation and maintenance experience

Running spares (fast moving spares) - spares that are expected to be used within every two 2 years. Policy is to keep 2 years stock, based on operation and maintenance experience.

3) Publish an inventory status report : Current MMIS could not produce status report. MMIS reports could only be obtained through Procurement or Information (EDP) Department in TNB HQ. The reporting facilities should be made available to the users so that local inventory monitoring is independent from any HQ

departments. The capabilities of computerised material management information system (MMIS) is to be fully utilized at station level.

4) Implement training on materials management : Formal training programme for staff in the station Engineering Department and key personnel of Maintenance sections. Through training , concepts such as economic order quantities, ABC inventory analysis, lead time analysis, inventory turnover analysis , forecasting methods and control methods could be used to focus all attentions towards common goal in the inventory management. Currently , personnel are unfamiliar about inventory management.

5) Material standardization : there is little standardization of materials within a generating plant at SSAAPS. This is due to no standardization policy at the planning, project and construction process. Station is burdened with thousands of unique spare parts . Station could standardize equipment usage where possible by :

I) establish a procurement policy that future orders for relays, single and three phase measuring transducers, pressure gauges, limit switches, process measuring transducers and equipment, plant recorders and replacement of obsolete equipment of different types will be of a standard type.

II) initiate standardization with other power stations : initiate sharing of spares with other stations that have identical equipment. Thus, creating a pool of spares to be used. Some jointly agreed policies to be established among stations concerned. Meetings set up through each station's Engineering Department. Policy of one item to be maintained under the pool will avoid duplication. Past experience is to be shared in the pool so that inventory management can be effective.

SSAAPS , Malacca Power Station and Serdang Power Station have identical unit of gas turbines. The number of units per station as below :

Station		***Spare as per Table I***
I) SSAAPS -	*3 units of General Electric (G.E) gas turbines*	*RM 15,580,747*
II) Malacca -	*2 units of G.E gas turbine*	*RM 5,482,820*
III) Serdang -	*2 units of G.E gas turbine*	*RM 8,343,621*

(Note: Serdang PS has 2 units of G.E and 3 units of Siemen, Germany gas turbines. Therefore not all spares are for G.E gas turbines.)

Saving on the spares could be implemented by having jointly agreed policy. There is no policy or directive issued by HQ on the spare parts status among the three power stations so far.

6) Station should slowly reduce the common spare parts that can be purchased locally. Such spare parts are bolts , bearings, paints, lubricating oil, lighting equipment and low voltage cables . This will reduce holding cost and save space usage. Above spares should be covered by supply contract on yearly basis. From Table II common spare parts constitute 5% of station spare.

7) Support local industries . Fabrication of pumps, re-engineering and redesigning can reduce our dependent of OEMs products. In this respect we should learn from Proton's vendors development programme in order to encourage local products.

8) Review existing procurement policy as some proposal affect present policy, examples:

I) buying from direct agent who provides cheaper cost. Present policy of cheapest tender is not necessary the cheapest price TNB can get in the market.

II) for gas turbine parts, G.E encourages the users deal directly with them. G.E could offer refurbished parts at lower cost and save downtime. New parts may take long lead time to manufacture.

TABLE I: COST OF STOCK AS AT 30TH SEPTEMBER 1995 FOR TNB POWER STATI

Station	Code	COST OF STOCK HELD			Remarks
		At 30th Sept 1994	At 31st Aug 1995	At 30th Sept 1995	
ENERATION					
ILAYAH					
u Langat Power Station	623	36,866	37,411	37,411	
ELANGOR					
onnaught Bridge	622	21,102,745	10,280,750	14,460,814	
ltan Salahuddin Abdul iz Power Station	624	97,905,600	104,021,790	145.197.560	
rdang Power Station	627	0	8,049,026	8,343,621	
ERAK					
ltan Yussuf P. Stn	641	2,800,601	2,524,105	2,534,841	
latan Idris II P. Stn	646	7,817,419	7,894,345	8,026,630	
enderoh P. Stn	648	1,036,783	1,033,954	1,029,192	
alim Nawar P. Stn	649	156,995	157,054	157,054	
menggor P. Stn	651	11,118,187	19,243,543	17,887,592	
ORTHERN					
ai Power Station	645	91,911,838	15,341,158	34,399,571	
ugor Power Station	647	2,615,613	2,659,278	2,662,085	
luk Ewa P. Stn	654	158,810	156,447	156,447	
OUTHERN					
lacca P. Stn	661	6,345,694	5,526,038	5,482,820	
ltan Ismail P. Stn	662	3,469,099	3,471,197	3,471,197	
anku Jaafar P. Stn	663	39,572,157	32,851,959	27,329,138	
ltan Iskandar P. Stn	664	14,980,743	11,278,818	17,818,681	
STERN					
mal Power Station	682	8,435,115	8,457,765	8,424,979	
Trengganu P. Stn	683	3,746,982	3,731,078	3,718,209	
ltan Ismail P. Stn	685	117,928,238	111,855,717	118,669,370	
ltan Mahmud P. Stn	686	2,414,642	2,512,613	2,339,037	
SUB–TOTAL		**433,554,127**	**351,084,046**	**422,146,449**	
ANMISSION					
LAYAH					
. Sis. Peng(Port Klang)	576	10,440,254	42,489,877	47,471,679	
NTRAL					
E. (Protection & PLC)	591	387,641	387,644	387,641	
ORTHERN					
.E (North)	592	5,586	5,586	5,586	
SUB–TOTAL		**10,833,481**	**42,883,107**	**47,864,906**	

TABLE II - SUMMARY OF TOTAL VALUE OF INVENTORY IN THE STATION (SSAAPS)

Catalogue Series Block	*Description*	*Value in RM*
	Electrical Fittings and Equipment	
04/	*Lanterns, lamps, Control Gear and motor*	*96,199.66*
05/	*Lighting arrestors, Isolators, Switches*	*24,084.77*
06/	*fuses and Elements*	*55,919.61*
	Cable Wire of Insulation Materials	
10/	*Underground cables & Accessories*	*9,392.98*
11/	*Insulated cables*	*50,718.07*
13/	*Insulating materials*	*15,736.38*
14/	*Wires, Copper*	*3,447.81*
	Other Materials	
20/	*Construction Materials*	*328.15*
21/	*Fuel*	*36,712,371.81*
22/	*Raw materials*	*1,030,354.27*
23/	*Fixing parts*	*99,996.58*
25/	*Tools measuring instruments*	*12,743.60*
28/	*Stationery*	*5,014.37*
29/	*Miscellaneous items*	*24,199.06*

	Electrical & Mechanical Spares	
30/	*Electrical apparatus spares*	*610.80*
39/	*Hydraulic jacks*	*99.90*
41/	*Metal plates*	*8,665.96*
42/	*Plumbing materials*	*8,160.19*
50/	*Bearings*	*458,746.42*
64/	*Port Dickson Power Station spares*	*139,238.42*
68/	*Station spares*	*79,012,130.83*
69/	*25MW Gas Turbine Spares*	*547.00*
70/	*25MW Gas Turbine Spares*	*1,462,866.08*
71/	*25MW Gas Turbine Spares*	*532,115.00*
72/	*25MW Gas Turbine Spares*	*1,694,093.00*
	TOTAL	*121,463,760.45*

TABLE II (a) - SUMMARY OF TOTAL VALUE OF INVENTORY IN THE STATION (SSAAPS)

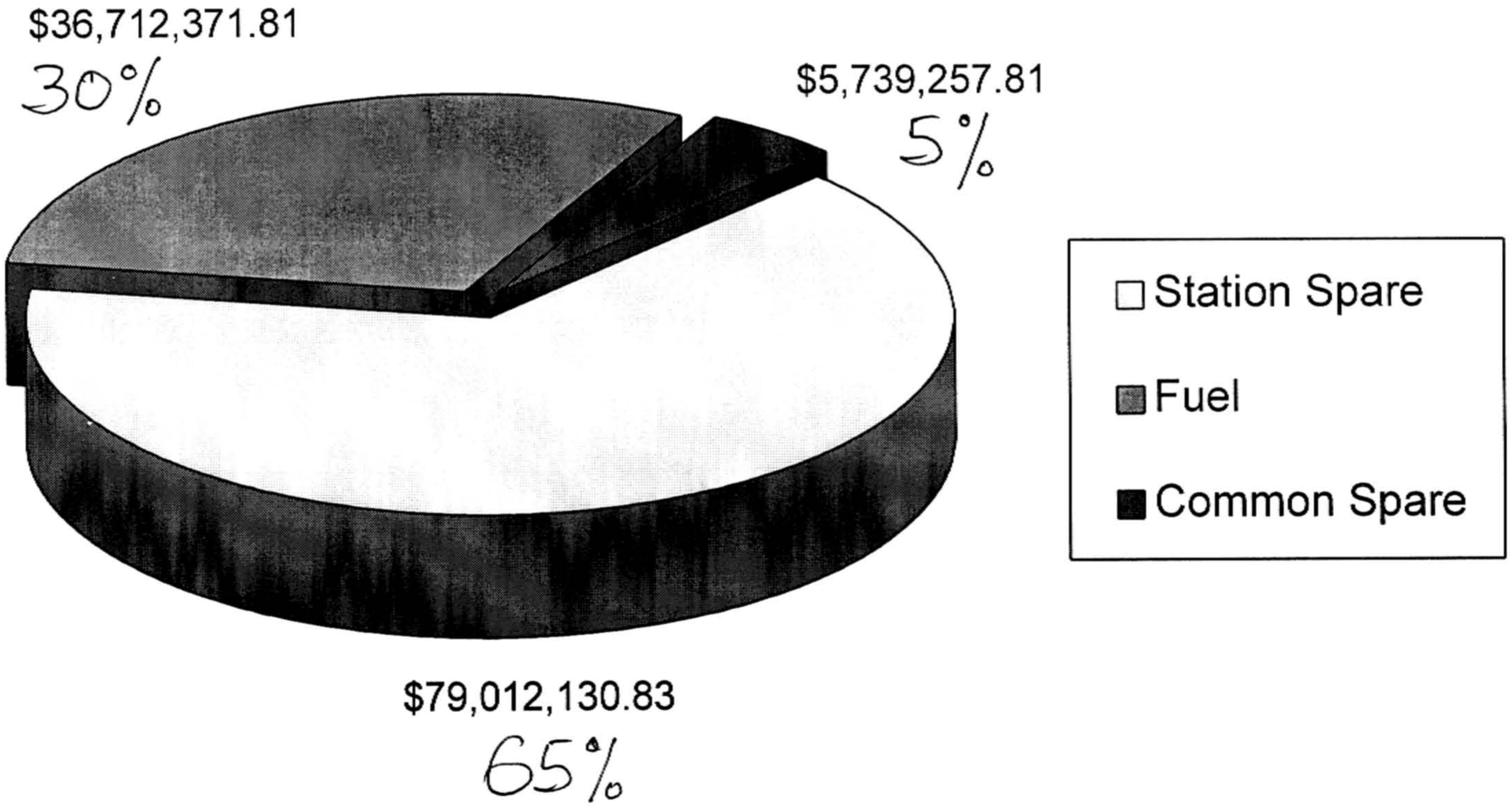


TABLE III - THE BREAKDOWN OF STATION SPARES (SSAAPS) INTO VARIOUS SUBGROUP AS PER PLANT FUNCTION BETWEEN PHASE 1 AND PHASE 2

No	Catalogue Series Block	Description	Total No. of Items	Total Quantity	Value RM
1	68/10	Turbine equipment for phase I & plant	562	122,511	8,666,108.50
2	68/30	Turbine equipment for phase II & plant	632	9,083	2,122,831.61
3	68/11	Boiler equipment for phase I	706	31,918	4,892,667.69
4	68/21	Boiler equipment for phase I	351	1,139	48,267.00
5	68/31	Boiler equipment for phase II	440	13,233	6,738,451.68
6	68/41	Boiler equipment for phase II	270	27,461	6,619,343.78
7	68/13	Electrical equipment - phase I	517	19,812	1,716,314.14
8	68/14	Electrical equipment - phase I	357	16,296	609,379.64
9	68/23	Electrical equipment- phase I	332	5772	629,500.18
10	68/33	Electrical equipment - phase II	434	2,760	475,555.30
11	68/34	Electrical equipment - phase II	338	5,769	712,793.80
12	68/17	Control and Instrument equipment for phase I	1028	37,641	4,718,921.82
13	68/27	Control and Instrument equipment for phase I	952	12,826	3,804,569.32
14	68/37	Control and Instrument equipment for phase II	347	2726	2,124,148.70
15	68/44	Coal Handling (Electrical)	548	5629	1,495,776.35
16	68/45	Coal Handling (Mechanical)	320	12,479	6,691,308.21
17	68/35	Coal Handling (Mechanical)	232	110,426	3,476,414.16
18	68/19	Phase I Crane, lift, chimney, Workshop	318	5634	204,175.52
19	68/39	Phase II Crane, lift, Chimney	100	568	17,241.00
20	68/16	Phase I CWP, BFP	595	59,638	1,993,884.31
21	68/36	Phase II CWP, BFP	190	5,457	126,178.43
22	68/15	Phase I Fuel Oil, ignition system	69	992	45,635.89
23	68/12	110MW Gas Turbine Spares	662	4079	15,289,342.56
24	68/32	30MW Gas Turbine-(EGT)	105	1,477	243,138.22
25	66/22	27MW Gas Turbine (IHI)	260	1,139	48,267.00
26	68/29	Fire Fighting, Civil phase I	302	72,075	564,221.14
27	68/38	Electrochlorination plant & WTP phase II	353	2,466	1,789,578.96
28	68/18	Electrochlorination plant & WTP phase I	354	14,150	1,558,811.94
29	68/28	Phase I Air Cond. Diesel Set	229	2550	389,493.23
		TOTAL	**11,934**	**507,507**	**RM79,151,224.20**

TABLE IV - <u>REGROUPING OF SPARES AS PER MAIN SECTIONS (MAINTENANCE GROUPS) FOR WHOLE STATION</u>

Section	*Total No. Of Items*	*Total quantity*	*Value (RM)*
Turbine	*1194*	*231594*	*14,572,403.38*
Boiler	*1767*	*123751*	*18,548,541.56*
Electrical	*1978*	*55409*	*5,828,532.91*
Control & Instrumentation	*2327*	*53193*	*10,647,639.84*
Coal Handling	*1100*	*28534*	*11,663,498.72*
Gas Turbine	*1027*	*6695*	*15,580,747.78*
Workshop	*2541*	*8331*	*2,309,860.01*
TOTAL	***11934***	***507507***	***79,151,224.20***

TABLE IV (a) - REGROUPING OF SPARES AS PER MAIN SECTIONS (MAINTENANCE GROUP) FOR WHOLE STATION

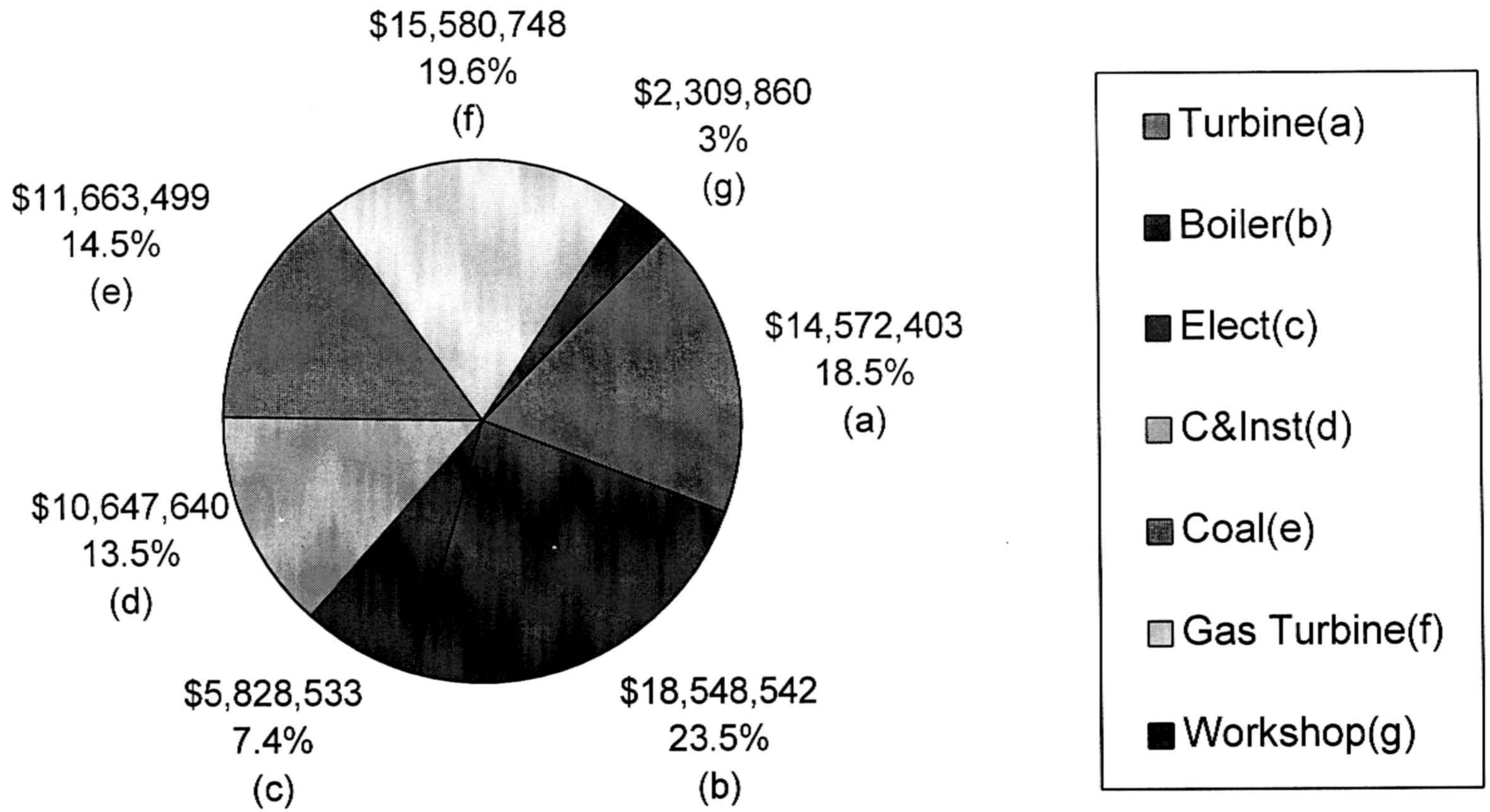


TABLE V - STOCK OF FUEL OIL FOR YEAR 1995

MONTH	BEGINNING STOCK (METRIC TONNES)	AVE.OIL PRICE RM 235/MT
Jan-95	78,435.051	
Feb-95	32,024.571	
Mar-95	36,349.806	
Apr-95	57,431.045	
May-95	84,126.331	
Jun-95	67,612.760	
Jul-95	84,272.698	
Aug-95	59,723.373	
Sep-95	49,704.734	
Oct-95	32,148.006	
Nov-95	47,263.040	
Dec-95	58,711.960	

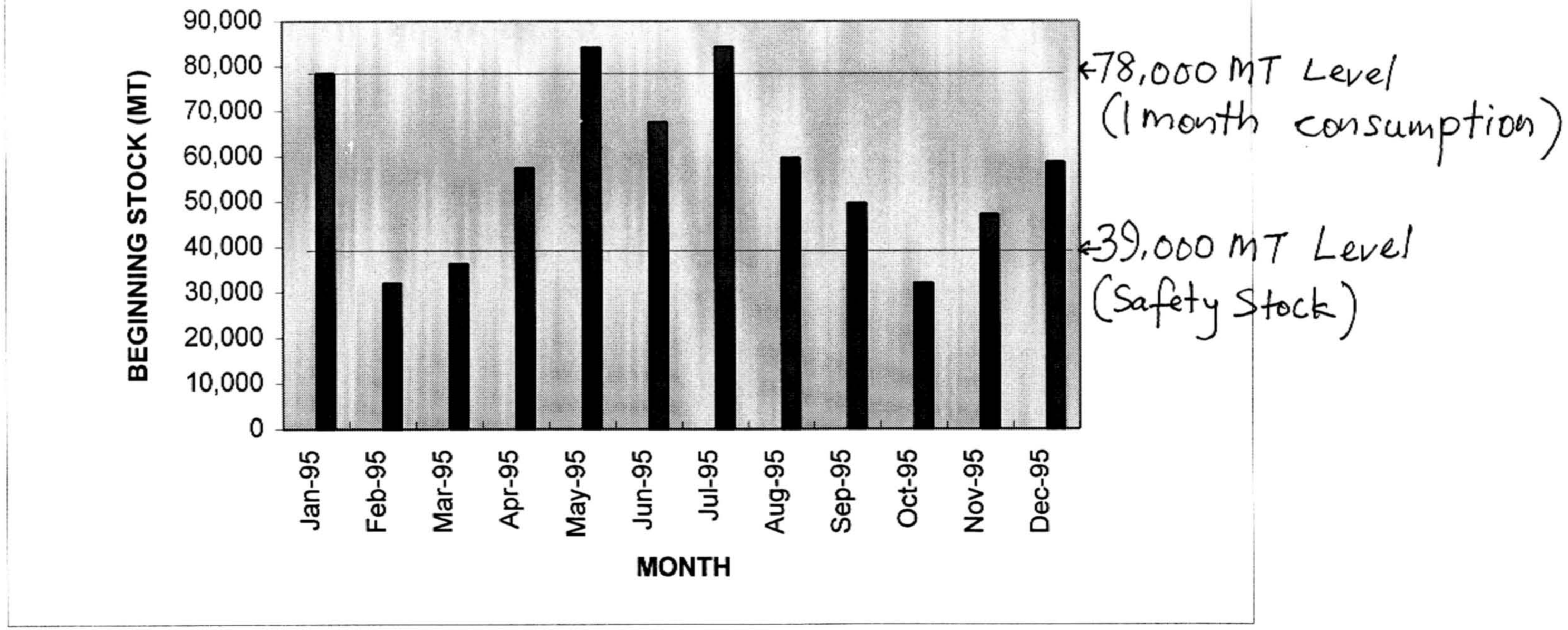


TABLE VI - STOCK OF DISTILLATE FOR EMERGENCY OPERATION OF 3 X 110 MW GAS TURBINE UNITS

MONTH	BEGINNING STOCK(LITRE)	AVE.PRICE RM 0.5313/LITRE
Jan-95	15962390	
Feb-95	15899728	
Mar-95	15889266	
Apr-95	15886142	
May-95	15882019	
Jun-95	14686594	
Jul-95	13838910	
Aug-95	13792378	
Sep-95	13772392	
Oct-95	13113592	
Nov-95	9660263	
Dec-95	9338456	

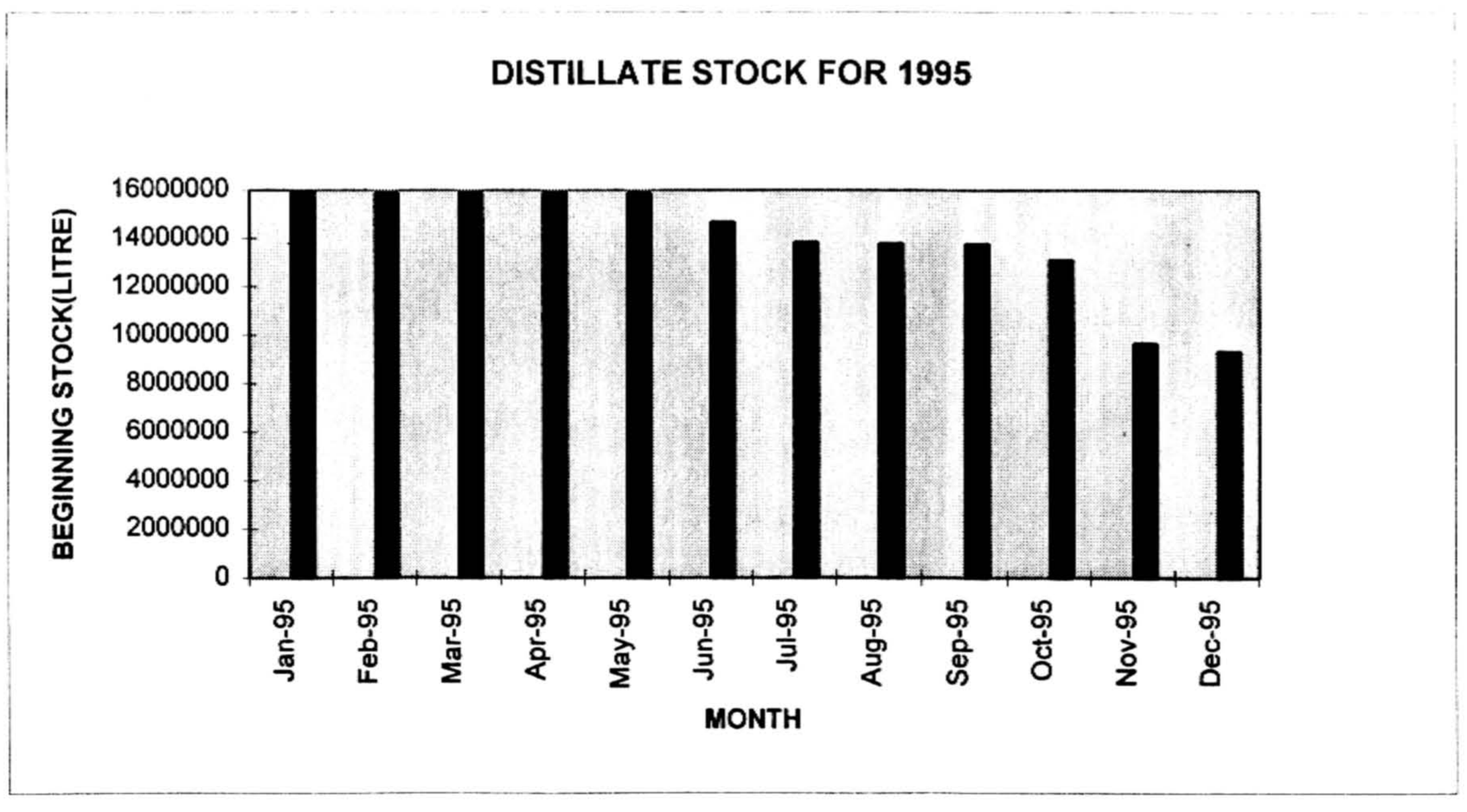
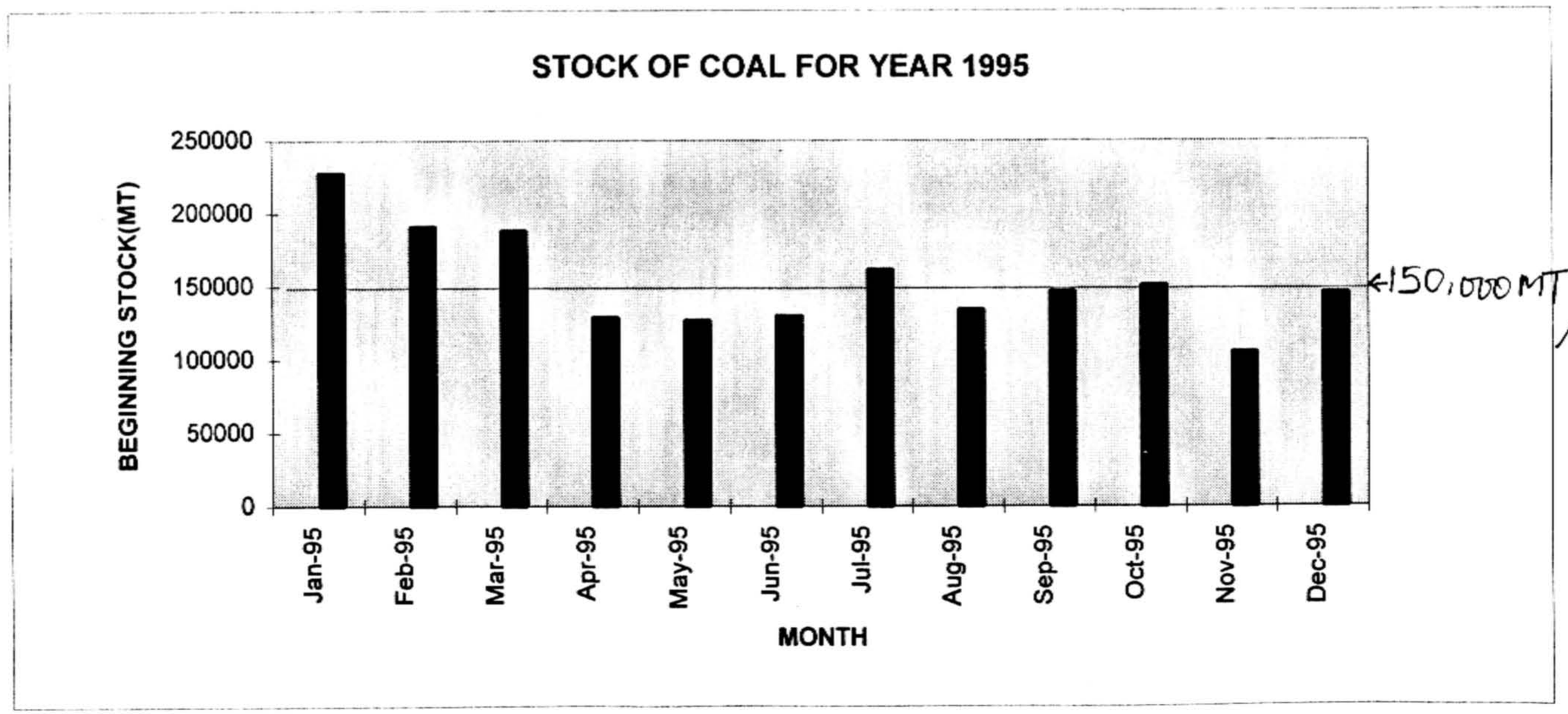


TABLE VII - STOCK OF COAL FOR YEAR 1995

MONTH	BEGINNING STOCK(MT)	AVE.COAL PRICE RM90-100/MT
Jan-95	228,071	
Feb-95	191,292	
Mar-95	188,540	
Apr-95	129,112	
May-95	127,037	
Jun-95	130,228	
Jul-95	161,676	
Aug-95	134,480	
Sep-95	146,680	
Oct-95	151,094	
Nov-95	105,477	
Dec-95	146,369	



←150,000 MT / 30 DAYS CONSUMPTION LEVEL

46

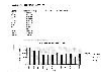


TABLE VIII - ***<u>SLOW MOVING ITEMS FOR SPARE PARTS IN THE LAST 5 YEARS (90 - 95)</u>***

	5 YEARS (1990 -1995)	
Total Stock / Inventory	*RM 45,338,049.57*	
Total No. of Items	*4866*	
Inventory splits into main sections		
- *Turbine*	*RM 6,652,043.68*	*14.6%*
- *Boiler*	*RM 19,605,583.57*	*43.4%*
- *Electrical*	*RM 3,505,060.37*	*7.8%*
- *Control & Instrumentation*	*RM 8,295,096.48*	*18.2%*
- *Coal Handling*	*RM 6,346,572.12*	*14%*
- *Workshop*	*RM 933,693.35*	*2%*