5.3 Tashkent Thermal Power Plant (DC "TASHTPP") Financial Situation and Problems

5.3.1 Production (Generation) Contribution of DC "TASHTPP"

This paragraph deals contribution of production by DC "TASHTPP". At the first sub-paragraph, generation at DC "TASHTPP" is compared with total generation in Uzbekistan so as to highlight the performance of DC "TASHTPP" in the comparison. At the second sub-paragraph monthly generation is studied. At the third sub-paragraph relationship with hydro generation, agricultural irrigation and reservoir operation are also described. At the fourth sub-paragraph, fuel being burnt at DC "TASHTPP" is described.

(1) Generation at DC "TASHTPP" in Uzbekistan

The total installed generating capacity of the 12 existing units at Tashkent Thermal Power Plant (DC "TASHTPP") was 2,230MW at their initial name plate rating and is estimated at 1,750MW as present capacity. The capacity 1,750MW corresponds to 18% of total installed capacity 9,669MW of all the thermal, heating and hydro power plants in Uzbekistan, and to 23% of the total thermal power plants capacity in Uzbekistan 7,730MW as shown in Table 5.3-2.

DC "TASHTPP" generates about 20 % of total generation by thermal power plants, heating stations and hydro power plants in Uzbekistan. The gross generation by each power plant is also shown at Table 5.3-2. The fact that DC "TASHTPP" produces 20% of electric power in Uzbekistan is considered that the share is big and generation by it is contributing to people and industry of Uzbekistan as one of the important power plants.

Table 5.3-1 is a comparison of thermal power plants in Uzbekistan.

Table 5.3-1 Generation at Thermal Power Plants in Uzbekistan

Thermal Power Plant	Year of Commissioning	Fuel	Capa-city (MW)	2001 Generation		2002 Generation	
				(MWh)	P. F.	(MWh)	P. F.
Angren	1953	Coal	200	581,853	33.2%	549,624	31.4%
Novo-Angren	1961	Gas-coal	1,750	7,881,617	51.4%	7,674,334	50.1%
Navoi	1962	gas-oil	1,000	6,823,619	77.9%	5,935,548	67.8%
Takhiatash	1962-1974	gas-oil	770	2,933,419	43.5%	2,936,411	43.5%
Tashkent	1963-1971	gas-oil	1,770	10,502,719	67.7%	10,315,266	66.5%
Syrdarya	1972-1981	gas-oil	2,340	12,477,762	60.9%	13,148,310	64.1%
Total			7,830	41,200,989	60.1%	40,559,493	59.1%

P.F. is plant factor calculated by the formula below is one of a reference index to check power plant function and performance.

$$\text{Plant Factor} = \frac{\text{Annual Generation (MWh)}}{\text{Plant Capacity (MW) x Annual Hours (8760Hours)}}$$

Table 5.3-2 Electricity Generation in Uzbekistan

Electricity Generation in Uzbekistan						
Power Plant	Year of Commission	Fuel or River	Name Plate Capacity MW	Present Capacity MW	Generation 2001	Generation 2002
Generation by Thermal Power Plant						
Angren	1953	Coal	272	200	581,853	549,624
Novo-Angren	1961	gas-coal	2,340	1,750	7,881,617	7,674,334
Navoi	1962	gas-oil	1,500	1,000	6,823,619	5,935,548
Takhiatash	1962-1974	gas-oil	1,000	770	2,933,419	2,936,411
Tashkent	1963-1971	gas-oil	2,230	1,770	10,502,719	10,315,266
Syrdarya	1972-1981	gas-oil	3,000	2,340	12,477,762	13,148,310
Talimardjan	(2003)	gas-oil	(800)	(800)		
Thermal Total			**10,342**	**7,830**	**41,200,989**	**40,559,493**
Generation by Heating Stations						
Ferghana	1956	Gas	330	330	668,177	685,676
Mubarek	1980	Gas	166	60	425,664	426,945
Tashkent	1967	Gas	90	30	150,070	175,494
Heat Station Total			**586**	**420**	**1,243,911**	**1,288,115**
Generation by Hydro Power Stations						
Charvak	1970	Chirchik	620	620		
Khodzhikent	1978	Chirchik	165	165	2,612,997	3,641,208
Gazalkent	1980	Chirchik	120	120		
Tavaksk	1941	Chirchik	72	73		
Komsomolysk	1956	Chirchik	88	88	996,987	1,129,033
Akkavask	1946	Chirchik	52	52		
Kubraisk		Chirchik				
Kadyrynsk		Chirchik			313,516	327,275
Saflarsk	1944	Chirchik	10			
Bozelesk		Chirchik				
Sheikhantarck	1954	Chirchik	11		122,729	141,217
Burdjarsk	1936	Chirchik	6			
Akmelinsk		Chirchik				
N-Bozsuysk No.1- 6	1944-1950	Chirchik	54	54	187,596	237,912
Andudjan					59,107	50,412
Samarkand					61,849	47,842
Farkhand	1949		120	120	353,504	469,548
Hydro Station Total				**1,419**	**4,708,285**	**6,044,447**
Grand Total				**9,669**	**47,153,185**	**47,892,055**

The plant factor of DC "TASHTPP" was 67%-68% as shown in Table 5.3-1. In the 6 thermal power plants, Angren and Novo-Angren are situated in Angren area, where coal is produced of about 90% of coal production in Uzbekistan 3 million tons per year. Generation at Angren TPP and Novo-Angren TPP which use coal as fuel has a close relationship with coal production. Takhiatash TPP is located at the west part of Uzbekistan, and mainly supplies electricity to western area. Other three thermal power plants of Navoi TPP, Syrdarya TPP and DC "TASHTPP" burn gas and oil, and are similar among them. Table 5.3-3 as well as Figure 5.3-1 shows recent 10 years generation by thermal power plants in Uzbekistan.

Table 5.3-3 Annual Generation by Thermal Power Plants in Uzbekistan (Unit: GWh)

Year	Tashkent	Syrdarya	Navoi	Novo-Angren	Angren	Takhiatash	Total
1993	9,313	13,805	7,821	3,902	1,303	3,327	39,471
1994	9,263	12,084	7,762	4,904	898	2,852	37,763
1995	10,764	13,084	7,144	5,124	629	2,749	39,494
1996	9,746	11,991	6,327	5,812	657	2,684	37,217
1997	10,048	12,404	6,206	6,574	712	2,693	38,637
1998	8,332	12,606	6,015	6,852	733	2,598	37,136
1999	7,882	12,402	5,984	7,646	835	2,491	37,240
2000	9,583	13,548	5,879	7,376	766	3,353	40,505
2001	10,503	12,478	6,824	7,882	582	2,933	41,202
2002	10,315	13,148	5,936	7,674	550	2,936	40,559

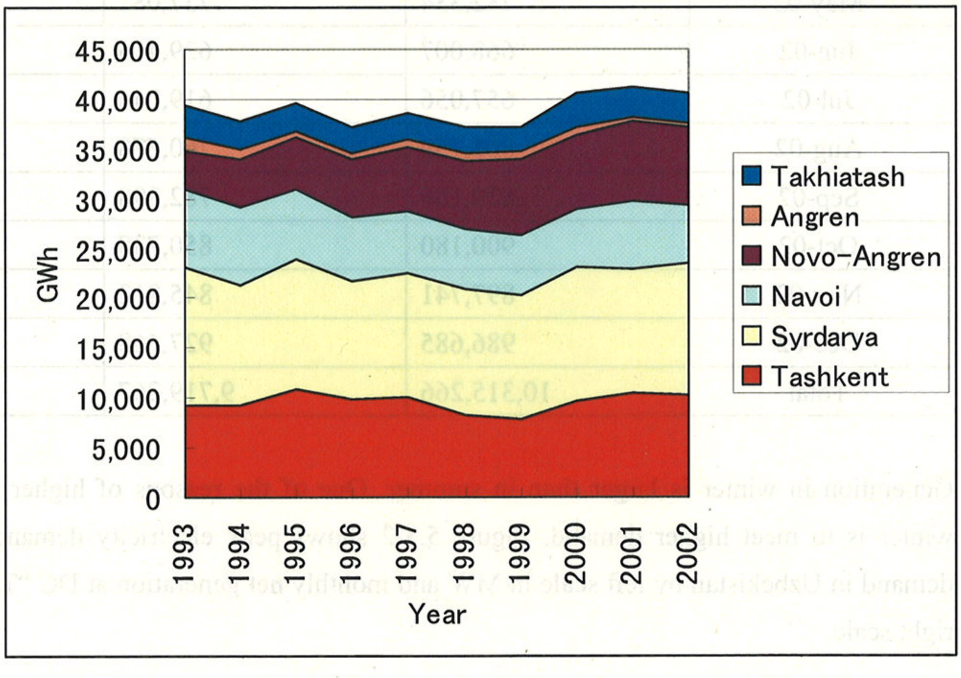


Figure 5.3-1 Recent 10 years Generation by Thermal Power Plants in Uzbekistan

DC "TASHTPP" generation share in total thermal generation is about 25%. The generation performance at DC "TASHTPP" is considered to be a fair reasonable level, and to have been contributed to people and industry in Uzbekistan.

(2) Monthly Generation at DC "TASHTPP"

Table 5.3-4 shows generation in each month at DC "TASHTPP" in 2002, in which Gross Generation means generation at generators terminal and Net Generation means electricity having been supplied to power grid at the DC "TASHTPP" sub-station. The balance between Gross Generation and Net Generation was consumed to be consumed at DC "TASHTPP" for operation such as driving pumps, fans, illuminating, voltage transforming etc.

Table 5.3-4 Monthly Generation at DC "TASHTPP" in 2002

Unit: kWh

Month	Gross Generation	Net Generation	Station Use
Jan-02	1,050,343	989,594	5.78%
Feb-02	912,425	858,262	5.94%
Mar-02	908,052	855,083	5.83%
Apr-02	916,498	863,791	5.75%
May-02	782,334	737,082	5.78%
Jun-02	668,007	629,415	5.78%
Jul-02	657,056	619,046	5.78%
Aug-02	806,759	760,578	5.72%
Sep-02	829,186	782,398	5.64%
Oct-02	900,180	850,738	5.49%
Nov-02	897,741	845,812	5.78%
Dec-02	986,685	927,468	6.00%
Total	10,315,266	9,719,267	5.78%

Generation in winter is larger than in summer. One of the reasons of higher generation in winter is to meet higher demand. Figure 5.3-2 shows peak electricity demand and bottom demand in Uzbekistan by left scale in MW and monthly net generation at DC "TASHTPP" by right scale.

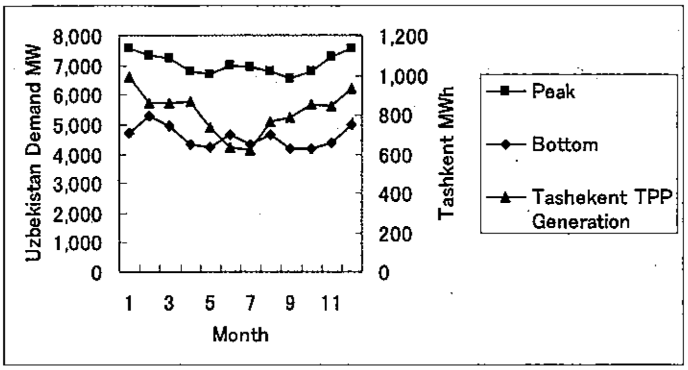


Figure 5.3-2 Uzbekistan Electricity Demand in 2001 vs. DC "TASHTPP" Net Generation in 2002

Data of Uzbekistan Demand used for comparison at Figure 5.3-2 is it in 2001, since 2002 data was not obtained. However, the pattern of monthly demand in 2002 is considered as being similar to that in 2001, and electricity generation at DC "TASHTPP" having been made as demand requires.

(3) Relation with Hydro Power and Irrigation

The graph shapes in Figure 5.3-2 indicate that the generation level at DC "TASHTPP" in June and July is relatively lower than the demand in those months. This implies that availability of hydro generation is high during dry summer months, and that fuel burning for thermal generation can be saved. Water is discharged for irrigation from reservoirs, and it drives hydro turbine generators.

The reservoirs exist not only in Uzbekistan but also in neighboring Asian countries. In upper stream of Syrdarya, there are several reservoirs and hydro power plants in Kyrgyzstan such as 1,200 MW Toktogul power plant, 800 MW Kurpsal power plant and 450MW Tashkumyr power plant. Water discharged from these reservoirs in Kyrgyzstan irrigates the land in Uzbekistan, and also electricity generated at these power plants is exported to Uzbekistan. Similar features are also found in Tajikistan.
A reverse situation occurs in winter. Climate in Central Asia is generally that it rains and snows much from December to April and is dry from May to November. Table 5.3-5 shows recent average rainfall at Tashkent.

Table 5.3-5 Average Rainfall at Tashkent in mm

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall at Tashkent	52.8	46.2	70.6	62.9	31.8	6.8	3.4	1.8	4.0	33.8	43.8	52.1	410.0

Water from rain and snow having been fallen in reservoir upper stream area has to be stored for release during irrigation season. Agriculture is the important industry in Uzbekistan, and its share in terms of GDP value in Uzbekistan is the biggest being about 35%, which is a double of the mining and manufacturing. Cotton and gold are too much important as export items. (Figure 5.5-8 shows foreign exchange inflow in 1997-1999.) Role of the irrigation is very important. For storing water in reservoirs in Kyrgyzstan, operation of hydro generation at Kyrgyzstan during winter has to be restricted to control the discharge of water. In connection with this operation it is necessary for Uzbekistan to export electricity to Kyrgyzstan so as to support the controlled generation. A part of electricity generated in Uzbekistan is exported to Kyrgyzstan and to Tajikistan.

Table 5.3-6 shows electricity export and import during each month in 2002 with neighbor Asian countries. The numbers in MWh shown in the Figure 5.3-6 is net export or import in each month after deducting export amount from import amount, if export is larger, or vise versa.

Table 5.3-6 Electricity Trade of Uzbekistan with Neighboring Asian Countries in 2002

Unit in MWh

Country	to and from Kyrgyzstan		to and from Tajikistan		to and from Turkmenistan		Total	
Month	Export	Import	Export	Import	Export	Import	Export	Import
Jan-02	63,800		32,400				96,200	0
Feb-02	22,900		28,200				51,100	0
Mar-02		65,500	32,400				32,400	65,500
Apr-02		2,900	46,200			4,900	46,200	7,800
May-02	50,000		1,700		6,200		57,900	0
Jun-02		20,500		18,500	100		100	39,000
Jul-02		207,900		49,000	300		300	256,900
Aug-02		203,600		4,400		2,200	0	210,200
Sep-02	59,500		37,800			800	97,300	800
Oct-02	70,500		82,500			600	153,000	600
Nov-02		22,800	30,600			3,300	30,600	26,100
Dec-02			66,200			1,000	66,200	1,000
Total	266,700	523,200	358,000	71,900	6,600	12,800	631,300	607,900

(4) Fuel burnt at DC "TASHTPP"

The boilers at DC "TASHTPP" burn natural gas transported through pipelines from Shurtan field and from Bukhara field, and also heavy fuel oil transported by rail. Table 5.3-7 shows fuel consumption in each month at DC "TASHTPP" in 2002. It is found that the boiler operation depended on heavy fuel oil in winter, during which in the months from December to February 60% - 70% of energy source was heavy fuel oil, and in the months from June to October the boilers were operated only in use of gas.

Uzbekistan produces natural gas of about 56 billion m^3 (2 Tcf) per year, and crude oil of about 8 million tons per year (140,000 b/d). Recent production of both gas and oil is larger than domestic consumption. In winter months energy demand and consumption in Uzbekistan increase for heating uses etc. Use of fuel oil is not easy in comparison with gas. Therefore, if gas is available, gas is preferred by most of users. The burners furnished at the boilers at DC "TASHTPP" can burn either or mixture of gas and oil. The plant has 120m chimney. Though flue gas desulfurization facility is not equipped to the plant, the plant can burn heavy fuel oil. Use of heavy fuel oil at other facilities than thermal power plants is not so good, unless they are equipped with environmental protection facilities.

Table 5.3-7 Fuel Consumption of the Generating Units at DC "TASHTPP" in 2002

	Gas Consumption (thousand M3)		H.F. Oil Consumption	Equivalent Energy Consumption (G.cal)		Ratio of Gas and Oil		Heat Rate (kcal/kWh)	
Month	Shurtan	Bukhara	(000 kg)	Gas	Oil	Gas	Oil	Gross	Net
Jan-02	66,900	32,700	199,000	814,828	1,928,310	29.7%	70.3%	2,612	2,772
Feb-02	88,800	19,000	155,500	881,912	1,506,795	36.9%	63.1%	2,618	2,783
Mar-02	54,900	154,900	65,200	1,716,374	631,788	73.1%	26.9%	2,586	2,746
Apr-02	24,800	243,700	12,900	2,196,599	125,001	94.6%	5.4%	2,533	2,688
May-02	56,600	185,700	1,200	1,982,256	11,628	99.4%	0.6%	2,549	2,705
Jun-02	101,000	107,400	0	1,704,920	0	100.0%	0.0%	2,552	2,709
Jul-02	63,700	140,400	0	1,669,742	0	100.0%	0.0%	2,541	2,697
Aug-02	38,600	212,400	0	2,053,431	0	100.0%	0.0%	2,545	2,700
Sep-02	23,900	232,200	0	2,095,154	0	100.0%	0.0%	2,527	2,678
Oct-02	49,500	226,300	0	2,256,320	0	100.0%	0.0%	2,507	2,652
Nov-02	77,100	139,300	55,000	1,770,368	532,950	76.9%	23.1%	2,566	2,723
Dec-02	70,400	20,600	195,500	744,471	1,894,395	28.2%	71.8%	2,674	2,845
Total	716,200	1,714,600	684,300	19,886,375	6,630,867	75.0%	25.0%	2,571	2,728

The relationship between generation and agricultural irrigation is mentioned in (3) above. For storing water in reservoirs at Kyrgyzstan and at Tajikistan during wet season for discharge in hot months of dry season, Uzbekistan needs to export energy to Kyrgyzstan and Tajikistan. Wet season is winter. Winter at mountainous Kyrgyzstan and Tajikistan is colder than in Uzbekistan. For export of gas to Kyrgyzstan, pipelines are available via Kazakhstan, and to Tajikistan also available pipelines. Gas is more convenient for users and consumers in Kyrgyzstan and in Tajikistan. For this transaction, thermal power plants in Uzbekistan using heavy fuel oil play important role, and support agriculture in Uzbekistan. Thus DC "TASHTPP" contributes to international cooperation as well as to agriculture industry in Uzbekistan.

In the calculation of fuel energy at the Table 5.3-7 it is assumed that net energy content of natural gas is 8, 181 kcal/m^3 and 9,690 kcal/kg for heavy fuel oil. In applying the same conversion energy content rates, average fuel consumption rates (heat rate) were obtained as 2,571 kcal/kWh at generating terminal (equivalent to 33.5% thermal efficiency) and 2,728 kcal/kWh at net power plant heat rate (equivalent to 31.5%). Typical heat rate of similar types of power plant is supposed to be generally better than 2,500 kcal/kWh at net power plant heat rate (equivalent to 34.4% thermal efficiency). The fuel consumption rates of the existing 12 units are not considered to be good, though the fuel energy content is assumption for a reason that gas volume measurement method is not confirmed.

5.3.2 Financial Analysis of Production (Generation) at DC "TASHTPP"

In this paragraph, generation cost at DC "TASHTPP" is studied at sub-paragraph s (1) and (2).. In Uzbekistan a high price inflation still continues, though it is now moderate. Gas price and electricity price recently increase at two months interval. As mentioned in the foregoing paragraph 5.3.1, the boilers in DC "TASHTPP" burns oil in winter. The price of oil at equivalent energy is higher than gas. An adjustment of inflation and of gas and oil mixture is made to study generation cost in DC "TASHTPP".

In the paragraph (3) a value of generation is studied from sales tariff of electricity, and is compared with the generation cost in the first subparagraph (1). The result showed that DC "TASHTPP" is making a financial contribution to SJSC "Uzbekenergo".

(1) Generation Cost at DC "TASHTPP"

Table 5.3-8 shows generation cost in 2000, 2001 and 2002, and Table 5.3-9 shows generation cost at monthly basis in 2002.

Table 5.3-8 Generation Cost at DC "TASHTPP" in Recent Three Years

Unit: 1000 Sum

Year	2,000		2001		2002	
Fuel Cost	16,278,764	88.3%	23,699,804	84.2%	35,291,127	87.6%
Consumables	328,645	1.8%	515,273	1.8%	926,603	2.3%
Maintenance	477,734	2.6%	672,875	2.4%	932,441	2.3%
Staff Salary	677,370	3.7%	940,992	3.3%	1,376,013	3.4%
Insurance Premium	368,128	2.0%	492,248	1.7%	536,506	1.3%
Other Costs	286,174	1.6%	1,732,173	6.2%	855,153	2.1%
Depreciation	29,015	0.2%	82,492	0.3%	365,703	0.9%
Total	18,445,831	100.0%	28,135,857	100.0%	40,283,546	100.0%
Net Generation	9,032,670 MWh		9,881,233 MWh		9,719,267 MWh	
Average Cost/kWh	2.04 Sum/kWh		2.85 Sum/kWh		4.14 Sum/kWh	

In the generation cost from 2000 to 2002, 85% or more was fuel cost. The first unit in DC

"TASHTPP" commenced operation in 1963, and the last unit No. 12 commenced operation in 1971. Since more than 30 years having passed, the recent depreciation cost in generation was very low.

Table 5.3-9 shows generation cost at DC "TASHTPP" in each month of 2002, and Table 5.3-10 shows the same at unit cost per kWh.

Table 5.3-9 Generation Cost at DC "TASHTPP" in 2002

Unit: 1000 Sum

Year	Fuel Cost	Consum-Ables	Mainte-nance	Staff Salary	Insurance Premium	Other Costs	Depreci-Ation	Total
Jan-02	4,222,702	65,682	76,247	95,087	36,952	34,142	30,843	4,561,654
Feb-02	3,215,928	47,579	66,384	100,568	38,060	53,051	27,462	3,549,032
Mar-02	2,565,067	49,166	82,762	96,020	38,915	99,813	31,501	2,963,244
Apr-02	2,550,209	48,943	56,343	115,932	45,214	22,268	31,147	2,870,055
May-02	2,121,068	71,489	70,070	113,958	44,597	87,536	27,886	2,536,604
Jun-02	1,927,682	58,833	62,835	103,586	41,887	76,433	27,111	2,298,367
Jul-02	1,887,833	57,833	78,624	115,504	44,430	41,454	32,140	2,257,817
Aug-02	2,509,610	161,157	73,147	125,654	47,316	48,491	32,194	2,997,569
Sep-02	2,560,450	97,382	84,653	126,024	48,268	55,408	32,157	3,004,340
Oct-02	2,965,252	87,266	85,321	122,243	47,775	47,090	32,002	3,386,949
Nov-02	3,827,357	51,275	118,056	123,862	48,634	179,516	28,406	4,377,106
Dec-02	4,937,971	129,999	78,001	137,576	54,457	109,951	32,854	5,480,810
Total	35,291,127	926,603	932,441	1,376,013	536,506	855,153	365,703	40,283,546

Table 5.3-10 Generation Cost at DC "TASHTPP" in 2002

Unit: Sum/kWh

Year	Fuel Cost	Consum-Ables	Mainte-nance	Staff Salary	Insurance Premium	Other Costs	Depreci-ation	Total
Jan-02	4.27	0.07	0.08	0.10	0.04	0.03	0.03	4.61
Feb-02	3.75	0.06	0.08	0.12	0.04	0.06	0.03	4.14
Mar-02	3.00	0.06	0.10	0.11	0.05	0.12	0.04	3.47
Apr-02	2.95	0.06	0.07	0.13	0.05	0.03	0.04	3.32
May-02	2.88	0.10	0.10	0.15	0.06	0.12	0.04	3.44
Jun-02	3.06	0.09	0.10	0.16	0.07	0.12	0.04	3.65
Jul-02	3.05	0.09	0.13	0.19	0.07	0.07	0.05	3.65
Aug-02	3.30	0.21	0.10	0.17	0.06	0.06	0.04	3.94
Sep-02	3.27	0.12	0.11	0.16	0.06	0.07	0.04	3.84
Oct-02	3.49	0.10	0.10	0.14	0.06	0.06	0.04	3.98
Nov-02	4.53	0.06	0.14	0.15	0.06	0.21	0.03	5.18
Dec-02	5.32	0.14	0.08	0.15	0.06	0.12	0.04	5.91
Total	3.63	0.10	0.10	0.14	0.06	0.09	0.04	4.14

(2) Generation Cost Analysis

Figure 5.3-3 shows monthly movements of each cost element indexed at it in January 2002 as 100.

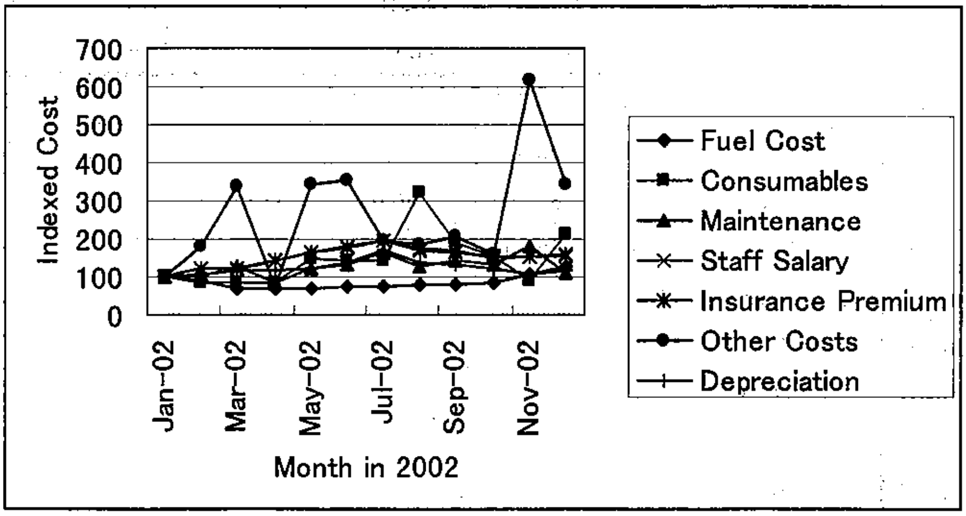


Figure 5.3-3 Indexed Generation in 2002 at DC "TASHTPP" as Jan 2002 = 100

(at the cost Sum/kWh base)

Fuel unit cost in summer is lower than it in winter and other cost elements are higher in summer. For an easier review of the Figure 5.3-3 it is developed into Figure 5.3-4 to show fuel cost indexed at unit cost of Sum/kWh and other costs indexed at the cost in the month January 2002 except the item Other Cost which is excluded due to larger variances. The graph in Figure 5.3-4 is, in other words, based on that fuel cost is variable against generated kWh, and other costs are fixed and independent from kWh generated.

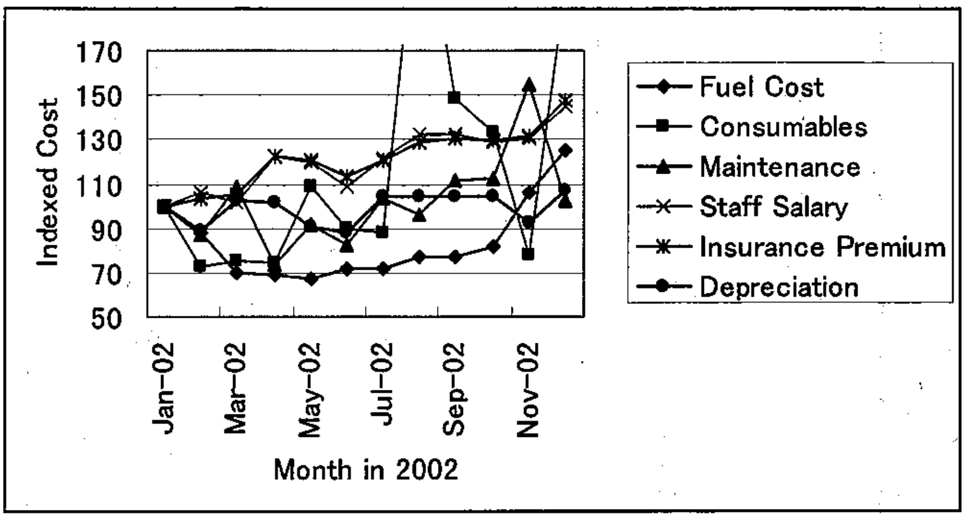


Figure 5.3-4 Indexed Generation in 2002 at DC "TASHTPP" as Jan 2002 = 100

(at the base that fuel cost is variable against kWh and other monthly costs are fixed)

The Figure 5.3-4 shows higher fuel cost in winter. This is considered to be caused by use of heavy fuel oil. The percentages of heavy fuel oil share in January, February, November and December 2002 were 70.3%, 63.1%, 23.1% and 71.8%. Trends of other costs elements in Figure 5.3-4 are that costs in December were higher than in January. This seems mainly due to inflation. The cost elements were again re-indexed into fuel and other single combined cost element, and also it was assumed that all costs were inflated at the same rate. A calculation result is shown at Figure 5.3-5 using gas price movement as inflation index.

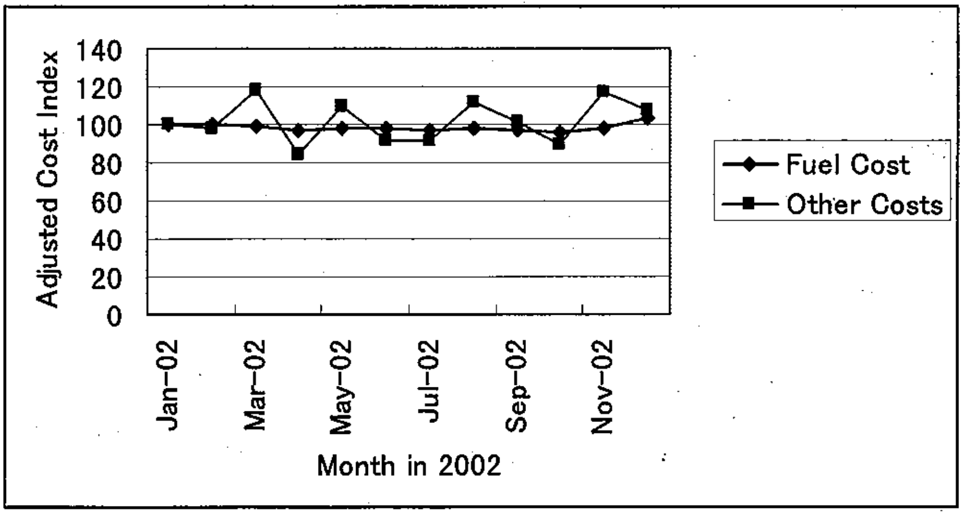


Figure 5.3-5 Adjusted Index of Monthly Generation Cost in 2002 at DC "TASHTPP"

From Figure 5.3-5 it may be able to be considered as follows:
(a) generation cost can be divided to two elements,
(b) one cost element is variable cost for kWh generation, which is mainly fuel cost, and
(c) other cost is fixed cost not varying against kWh generated, which is mainly other costs than fuel.

Table 5.3-11 shows fuel prices in Uzbekistan in 2002.

Table 5.3-11 Fuel Prices in Uzbekistan in 2002 Unit: Sum

	Jan-Mar 2002	Apr-May 2002	Jun-July 2002	Aug-Sep 2002	Oct-Nov 2002	Dec. 2002	2002 Average	Average per 1000 kcal
Gas /m^3	9.28	10.4	11.1	12.0	12.9	13.8	11.20	1.37
H.F.Oil/ton	15,098	18,181	19,081	20,081	21,181	24,904	18,937	1.95
Coal /ton	11,777	11,777	11,777	*12,355	*14,333	14,333	12,328	*2.24

(Note) Price is inclusive of applicable VAT 20%.

Coal price of Sum 12,355 was applicable on and after 15 August 2002.

Coal price of Sum 14,333 was applicable on and after 1 November 2002.

Coal energy is assumed as 5,500 kcal/kg (as delivered base).

The average fuel cost in generation at DC "TASHTPP" is considered to be average fuel purchase price of equivalent energy 2,728 kcal for one kWh net generation mentioned in the Table 5.3-7. Applying the fuel as of 1 December 2002 in the Table 5.3-11, the fuel cost per kWh generation at price in December 2002 is calculated as;

Natural Gas:	Sum 4.60/kWh including VAT	Sum 3.83/kWh excluding VAT
Heavy Fuel Oil:	Sum 7.01/kWh including VAT	Sum 5.84/kWh excluding VAT

The fixed cost also can be expressed against the capacity 1,770MW as at Sum 9.52/kW-day at price in December 2002.

(3) Financial Contribution of DC "TASHTPP"

Electricity tariff in Uzbekistan in 2002 is shown in Table 5.3-12.

Table 5.3-12 Uzbekistan Electricity Tariff including VAT in 2002

in Sum

Group		Jan-Mar 2002	Apr-May 2002	Jun-July 2002	Aug-Sep 2002	Oct-Nov 2002	Dec. 2002
I	Industrial user not less than 750kVA	12,800	14,080	15,000	16,300	17,800	19,300
		5.90	6.50	7.00	7.60	8.40	9.05
II	Industrial user less than 750kVA	10.00	11.40	12.30	13.15	14.35	15.55
III	Agriculture	6.45	7.30	7.90	8.70	9.50	10.30
IV	Transport	9.35	10.60	11.45	12.45	13.60	14.75
	City Transport	9.35	10.60	11.45	12.45	13.60	14.75
V	Public Organization	7.75	8.80	9.50	10.30	11.25	12.20
VI	Commercial User	26.90	30.60	33.00	33.05	33.50	34.00
VII	Residential	6.50	7.40	8.00	8.70	9.50	10.30
	Residential for Electric Stove	3.25	3.70	4.00	4.35	4.75	5.15
VIII	Heating and Air-conditioning	26.90	33.60	33.00	33.05	33.50	34.00
IX	Advertisement	92.00	104.70	105.00	110.00	110.00	110.00
X	Energy System Use	5.90	6.70	7.30	8.00	8.90	9.70
Weighted Average Unit Price		9.45	10.75	11.60	12.37	13.32	14.27

(Note)

- The tariff at upper column of Group I Industrial User is applied per 1 kW of contract capacity per year, and other tariff is applicable per 1 kWh consumed.
- Weighted Average Unit Price is calculated at an assumption that consumption composition was 38.2% for industrial users, 32.9% for agricultural use, 7.1% for commercial users, 15.6% for residential use, and 6.2% for transportation and other use.

(Reference)

- Tariff in Group X; Energy System Use is for such use as thermal power plant station consumption.
- Tariff for residential use under Group VII is designed to be low, because this tariff directly relates to expenses of people.
- Annual weighted average tariff in 2002 through January to December is calculated as Sum 11.56/kWh including VAT and Sum 9.63/kWh excluding VAT.

Table 5.3-13 shows generation, import, demand and system loss in past 10 years of Uzbekistan electricity supply system.

Table 5.3-13 Generation, Import, Demand and System Loss in Past 10 Years Unit:GWh

Year	Hydro	Thermal	Heat St.	Total	Import	Gene. Total	Demand	System Loss
1,992	5,160	44,423	1,297	50,880	1,845	52,725	42,328	19.7%
1,993	6,330	41,586	1,205	49,121	1,508	50,629	41,185	18.7%
1,994	6,934	39,549	1,254	47,737	1,438	49,175	39,166	20.4%
1,995	5,337	41,086	1,006	47,429	1,224	48,653	38,867	20.1%
1,996	5,291	38,735	1,375	45,401	2,160	47,561	39,466	17.0%
1,997	5,044	40,089	867	46,000	1,800	47,800	39,937	16.4%
1,998	6,009	38,495	1,408	45,912	728	46,640	40,422	13.3%
1,999	5,326	38,607	1,386	45,319	1,654	46,973	41,431	11.8%
2,000	4,248	41,787	806	46,841	2,239	49,080	41,505	15.4%
2,001	4,708	41,201	1,244	47,153	2,239	49,392	40,870	17.3%
Total	54,387	405,558	11,848	471,793	16,835	488,628	405,177	17.1%

The station consumption at DC "TASHTPP" in 2002 was 5.78% at generation in 2002. If this power plant generation consumption of 5.78% was common to all of the thermal generation, transmission and distribution loss is 12.9% of power plant net out. In electricity supply industry generation cost is roughly 50%-70% of total cost including transmission and distribution.

Assuming that sold energy is 87.1% of dispatched energy from power plants and 65% of electricity tariff belongs to generation, value of generation in Uzbekistan can be calculated as Sum 5.45/kWh excluding VAT against 2002 weighted average sales price Sum 9.63/kWh excluding VAT. On the other hand the average generation cost per kWh on net electrical output base at DC "TASHTPP" in 2002 is calculated as Sum 4.14/kWh excluding VAT as in the Table 5.3-8 and in the Table 5.3-10. The difference is Sum 1.31/kWh, which corresponds to ad-value by DC "TASHTPP". The value in 2002 at this calculation is Sum 12,838 million for 9,800GWh generation of plant net electricity output.

It is considered that DC "TASHTPP" is making a financial contribution to SJSC "Uzbekenergo".

5.3.3 Issues and Suggestions under Financial Analysis

5.3.2 (3) tells that DC "TASHTPP" is contributing Sum 1.31/kWh at 2002 average price. This value becomes Sum 12,838 million at 9,800GWh of plant net out electricity per year. In other words, there is a possibility that DC "TASHTPP" may be able to spend more Sum 12,838 million as the maximum allowable expenses per year.

Therefore it is necessary to study whether DC "TASHTPP" is better to spend more expenses or has such good investments as to meet spending Sum 12-13 billion. The first unit at DC "TASHTPP" commenced in 1963, and the last unit No. 12 commenced in 1971. The ages of 12 units are between 32 and 40 years. They are not young, and there may be risks that some of the units would not be operated well. Therefore, if life of the units can be extended by investment within annual expenditure of Sum 12-13 billion or an additional maintenance to spend Sum 12-13 billion can make the units operated reliably, it is considered that DC "TASHTPP" should spend additional Sum 12-13 million for maintenance.

The Table 5.3-9 mentions that DC "TASHTPP" spent Sum 932 million in 2002 for maintenance. 13-14 times of expenses can be spent for maintenance, if it provides a good availability and reliability of the 12 units at DC "TASHTPP".

5.4 Operation Management Plan for Existing Power Plant

5.4.1 Proposal for Organizational Review

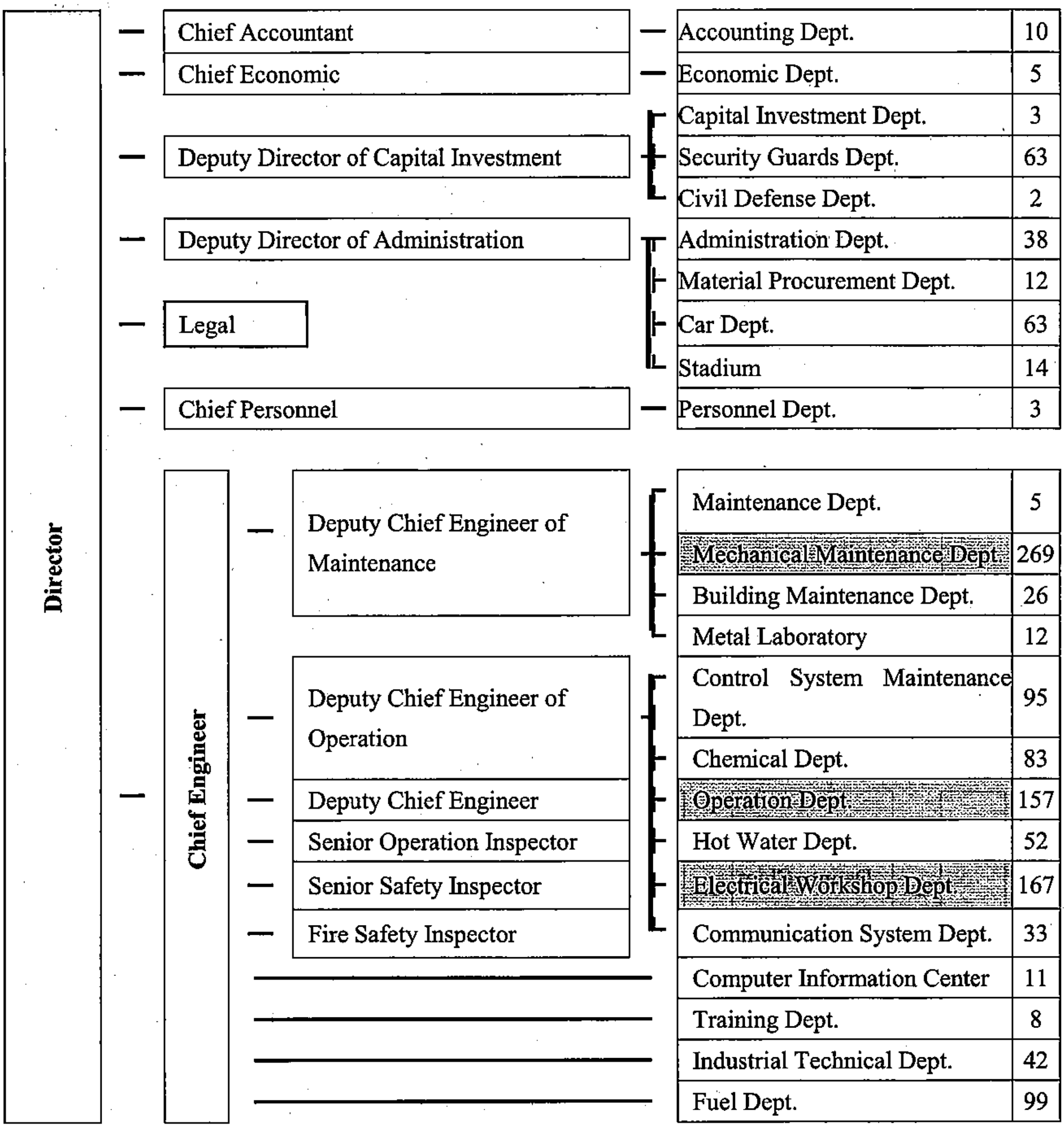
The DC "TASHTPP" is scheduled to become a legally independent corporation by around 2008. However, the DC "TASHTPP" is financially dependent on Uzbekenergo, and it is not in a position to operate as an independent power plant.

As of the end of 2002, the power plant had a staff of nearly 1,300 people. The organization is arranged as shown in Figure 5.4-1. Under the Director, there are coordinators of the various departments that are directly under the director and about 200 indirect department staff. The Chief Engineer is in charge of both the Operation and Maintenance Departments, and oversees the work of over 1,000 employees.

In terms of operating the power plant, the current organization is quite suitable. However, if the intention is for the power plant to become an independent profitable corporation, the financial constitution needs to be improved by improving efficiency and availability. Further, although at present the proportion of generating costs represented by personnel costs is low, and less than 10%, labor costs are expected to rise. While they are still low, commissioning or subcontracting work to outside firms should be considered as means of reducing the overall cost of labor.

The composition of power plant personnel is fairly rational, at a ratio of one indirect department employee for every five direct department employees. Considering that there are about three times as many employees as there are in a Japanese thermal power plant of the same capacity, it would seem that substantial staff reductions could be made. Because staff reductions are not desirable at the DC "TASHTPP" from the standpoint of providing employment, the following proposals offer ways of reducing the power plant staff while maintaining employment.

Organization Chart of Tashkent Thermal Power Plant



Note: See the detailed organization charts provided below for the shaded areas.

Figure 5.4-1 Tashkent Thermal Power Plant Organization Chart

Figure 5.4-2, Figure 5.4-3 and Figure 5.4-4 show the organizational charts for the Operation Department, the Mechanical Maintenance Department and the Electrical Workshop respectively.

2 Workshops

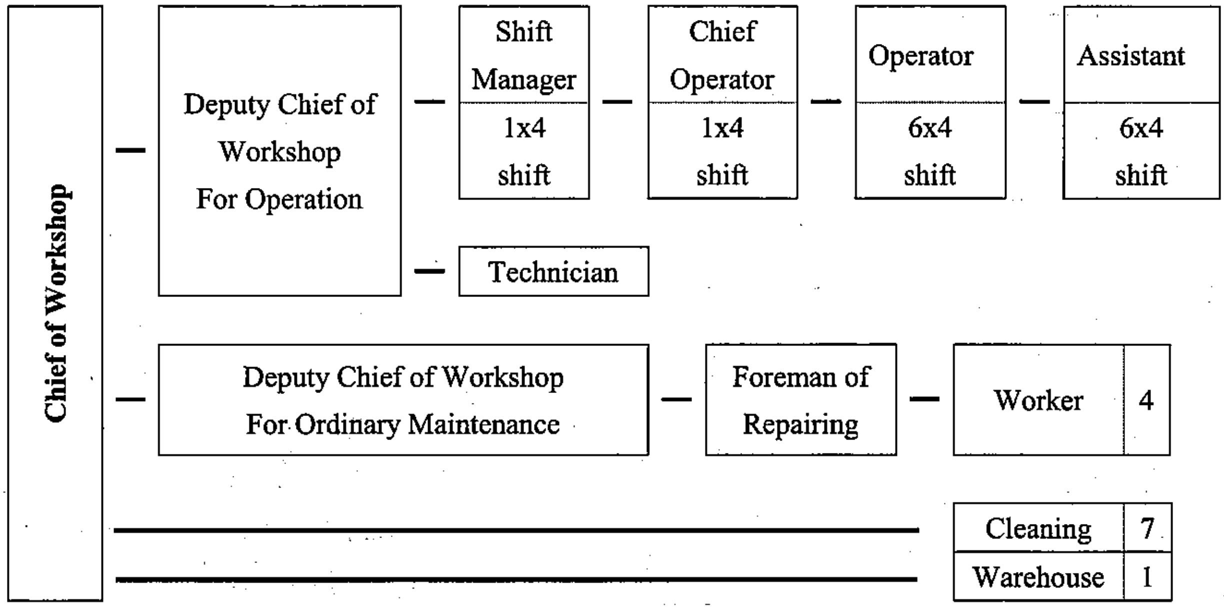


Figure 5.4-2 Operation Department Organization Chart

Organization Chart of Mechanical Maintenance Dept.

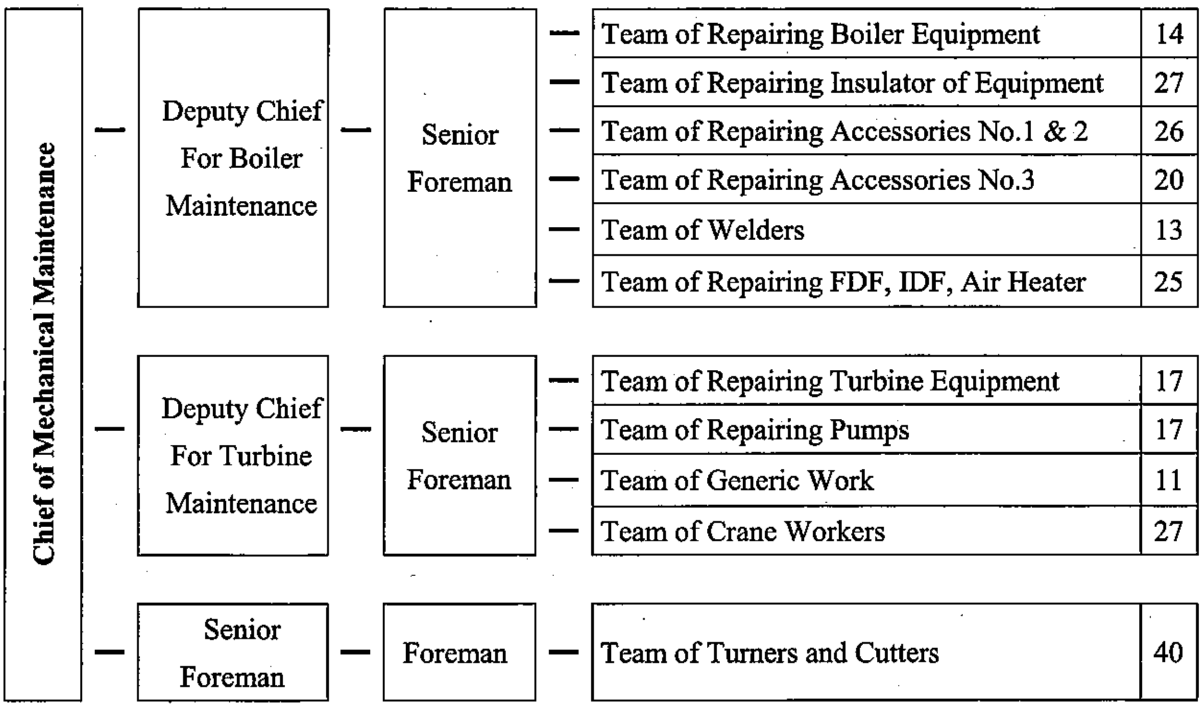


Figure 5.4-3 Mechanical Maintenance Department Organization Chart

Organization Chart of Electrical Workshop

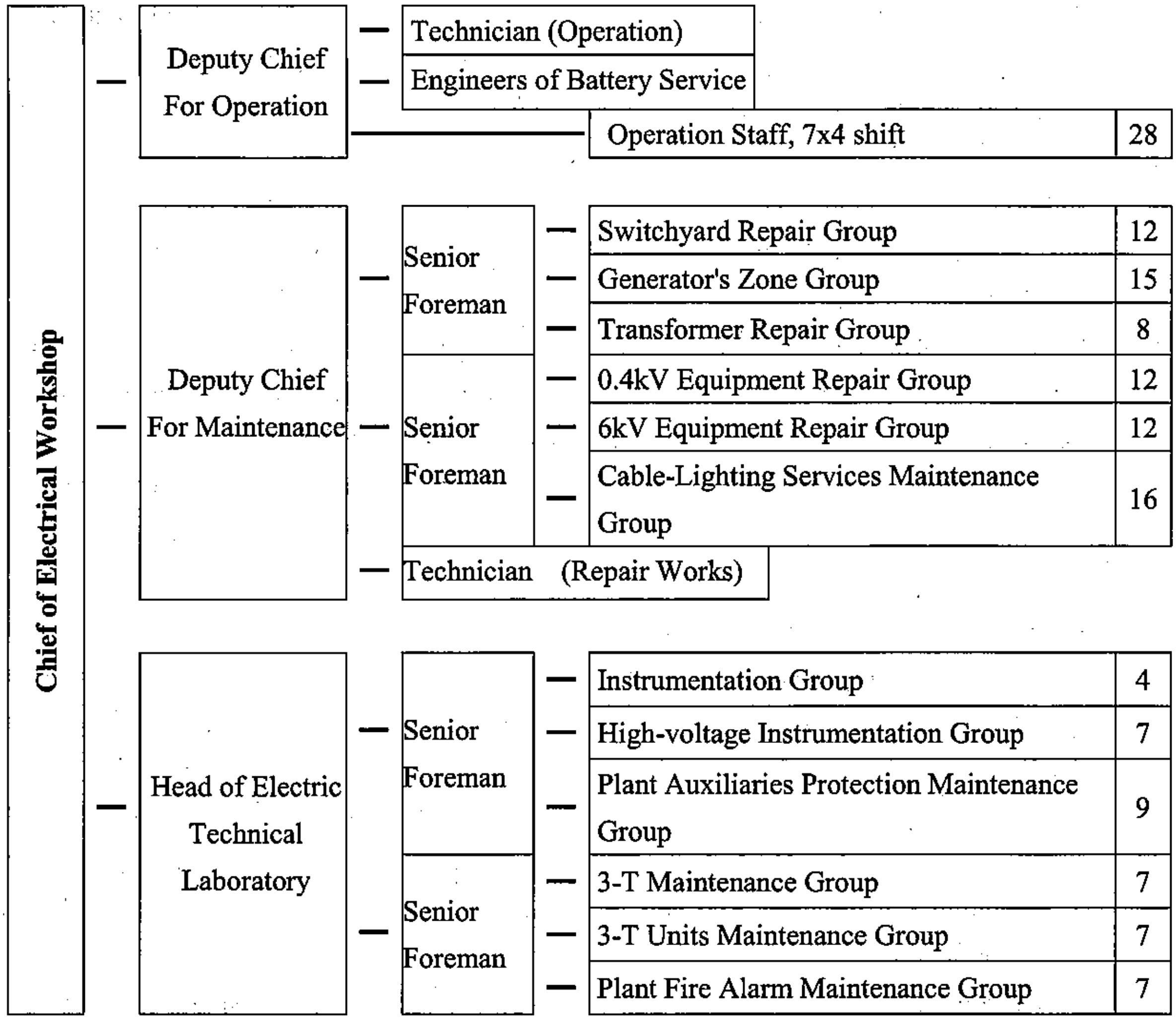


Figure 5.4-4 Electrical Workshop Organization Chart

(1) Reorganizing the Technical Departments

The organization of the technical departments under the Chief Engineer is complex, and as shown by the shaded parts of Figure 5.4-1, the difference between the operation departments and the maintenance departments is not clear.

The employees of the technical departments have a high level of technical skills. They handle the old equipment carefully and they operate the generating equipment, referring to various manual, almost entirely with manual adjustments. Personnel in the Maintenance Department handle most of the equipment failures that occur at the power plant. However, due to the high skill level of the employees, there is too much specialization and a strong sense of territorialism that makes the organization inflexible and could even lead to a decreased adaptability among staff members. In order to utilize the right person for the right job, a system in which employees with highly specialized skills are given an opportunity to demonstrate their capabilities in a variety of areas.

At present, the Operation Department and the Maintenance Department exist as separate departments under the Chief Engineer. Both departments have a Deputy Chief Engineer, and at first glance it appears as if there is a clear division of labor. However, compared to the relatively simple organization of the mechanical maintenance department, the electrical maintenance department is the Electrical Workshop in the Operation Department. In addition to the Operation Department shift workers that operate the units, there is an electrical operation division in the Electrical Workshop, which monitors and operates the electrical equipment.

In this complex organization, it is difficult to coordinate the activities of the different departments responsible for maintenance and repairs. At times such as the periodic maintenance, where the safety of workers must be ensured in the turning over of equipment from the operation department to the maintenance department, the chain of command is not clear, so the possibility of accidents exists. In the event that an accident did occur, the location of responsibility is not clear.

Upon reviewing the organization as a whole in consideration of such issues, the study team proposes that the operation department and the maintenance department be clearly separated, and that departments within the organization be given equal status. The following are detailed proposals for each organization.

a. All work relating to generating equipment operation and monitoring, and the related operation management, such as efficiency management, should be centralized in the Operation Department. The aim of this department should be to ensure the efficient operation of the equipment.

b. The aim of the Maintenance Department should be to rationalize maintenance and repair work. Daily minor maintenance jobs should be performed by the Maintenance Department itself, while big jobs such as periodic maintenance should be performed from the standpoint of the contractor. The Maintenance Department should prepare a schedule and a budget for the maintenance work, and should manage the contracting and supervision of the work. The Maintenance Department should also include a mechanical maintenance group and an electrical maintenance group, and the equipment with which each group is concerned should be clearly defined. The practice of having one worker manage only one item of equipment each should be abandoned in favor of a system in which each member of a group is thoroughly familiar with all of the equipment for which the group is responsible. The system should be arranged to allow flexible allocation of personnel.

c. A new technical department should be established to manage the operation of water processing equipment and other shared equipment, as well as fuel.

d. The indirect departments should be centralized under a general administration department directly under the Director.

e. A safety management department should be newly established.

(2) Establishment of Safety Management Department

Currently, the responsibility for safety matters rests with the Senior Safety Inspector and the Fire Safety Inspector, both of whom are under the Chief Engineer. Neither of these positions has subordinate organizations, nor it seems that a commitment to safety is weak in the organization as a whole. Of course, some workers on site can be seen to be wearing helmets, but on the whole, not many people wear them, or any other protective gear. There is a system in place whereby the responsible safety inspector makes unannounced inspections and fines workers who are found not to be wearing helmets etc., and it has some effects.

There were five on-the-job accidents at the DC "TASHTPP" in 2002. There were no deaths, and five accidents is not a large number. Maximum effort should be made to prevent accidents. To achieve this, the level of safety awareness in the workplace must be raised, and all unsafe practices must be thoroughly eliminated. The elimination of on-the-job accidents should be understood to be one of the main objectives of the DC "TASHTPP", along with achieving high unit efficiency and availability. We propose that a safety department be established directly under the Director to strongly promote the creation of a safe and hygienic workplace. This department would support the Director, who is ultimately responsible for safety. The surplus personnel from the maintenance department after it is rationalized could be allocated to the safety department. Such people would be well-qualified to ensure thorough safety management on site, as they would know the areas in which safety is most likely to be a problem. Such an arrangement can be expected to help reduce on-the-job accidents.

(3) Mutual Personnel Exchanges between the Operation and Maintenance Departments

It seems that personnel in the technical departments do not move easily to other departments once they are assigned. As a result, staff members develop highly specialized expertise with regard to their particular area. These people become indispensable specialists in their fields, but a side-effect is that the work is overly specialized, and people do not seem to have much interest in other areas of the operation. It seems that this arrangement denies employees the chance to obtain wide-ranging expertise.

We propose that personnel from the technical departments are circulated to the operation and maintenance departments, so as to develop wide-ranging expertise and learn to view the strengths and shortcomings of different departments objectively. This practice will develop a staff that is able to analyze problems and make improvements. In addition, a system of promoting and increasing the wages of people who have acquired a wealth of knowledge helpful in their work will make the power plant a dynamic and attractive place to work. It will motivate each employee to improve, and will also revolutionize the organization, enabling it to respond flexibly to changes in society.

(4) Spin-off of Maintenance Department

Currently, the employees in the maintenance department not only maintain and repair the equipment; they also have the technical skill to make by themselves the kind of simple parts that it is easy to buy in Japan. This high level of skills could be actively put to use in maintenance work for other factories as well as within the power plant.

It would seem that employees in the maintenance department, especially those who directly repair and maintain the equipment, could be of use in a wide range of areas. We propose that such skilled repairmen be gathered together into a subsidiary company for general maintenance and repair work. This company would accept orders from the power plant for maintenance and repair work as a subcontractor, but would also actively pursue work outside of the power plant. Once a financial foundation is established, the power plant will be able to reduce personnel and maintenance costs, reducing the unit generation cost.

By establishing such a subsidiary, the power plant will be relieved of surplus personnel, but employment will be maintained. It would therefore be a very significant and beneficial move.

Proposed Organization Chart of DC "TASHTPP"

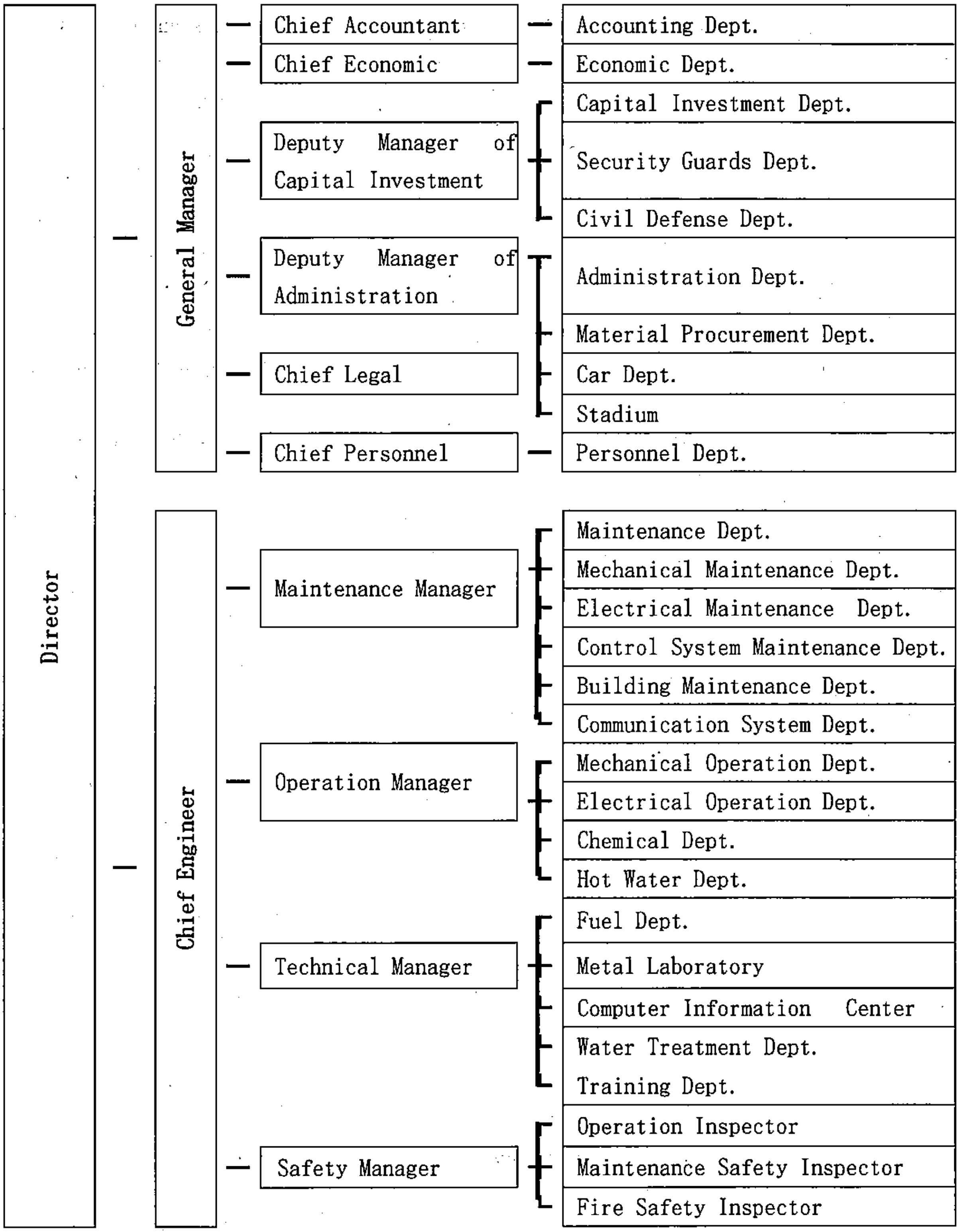


Figure 5.4-5 Proposed Organization Chart of DC "TASHTPP"

5.4.2 Equipment Operation Management

The job of a thermal power plant is to take the heat energy from fuel and convert it to good quality electrical energy as efficiently as possible, using boilers, turbines, and generators. It is therefore important that the reliability of power plant equipment be maintained, and that the equipment always be operated at high availability and high efficiency.

When we were analyzing the operation data we obtained on several visits to inspect the site, we encountered the problem that when we requested the same type of data on different occasions, we were given different numerical data. This problem is evidence that data is not being centrally maintained, and leads us to expect that inspection data as well as operation data is not being properly managed.

Keeping in mind the problems discussed above, we propose the following improvements for the work of primarily the employees who operate the equipment, identifying problem areas in the area of equipment operation.

The work of managing the operation of generating equipment includes the following areas. First, the equipment must be monitored and patrolled to gain an understanding of the operating condition of each piece of equipment. Operation target values must be maintained, efficiency managed, and the performance of the equipment checked and managed. Finally, the equipment must be maintained to keep it in sound condition, as this ensures reliability and maintained thermal efficiency.

(1) Operation Management

a. Monitoring Equipment Proposals

A unit's operating status varies from one minute to the next depending on demand. It is necessary for the equipment to be able to operate stably and at high efficiency for any level of demand within its operating range. Therefore, it is necessary that the operators working in the operation rooms constantly monitor the status of the equipment. They must pay careful attention to the monitoring instruments at all times, so as not to miss even minor changes.

It must also be remembered that it is impossible to completely eliminate the possibility of human error due to inattentiveness. It is important that all measures be taken to prevent accidents due to mistaken understanding or operation. This is why the operators stationed in the operating room monitor the operating condition of each unit via the output of the monitoring instruments such as indicators, recorders and warning devices. These devices need to provide excellent visibility. The indicators for pressure meters and thermometers and other instruments need to have some marking to indicate the desired level, so that even operators with differing levels of monitoring expertise can determine whether the condition is good or bad.

b. Monitoring Capability Improvements

The people working in relation to the operation of the equipment need to have knowledge and experience sufficient to allow them to determine if the results of an equipment inspection are normal or not. Therefore, the operators need to work with the maintenance department in the following ways:

- Creating a checklist of the equipment that requires monitoring and the criteria for judging the equipment's condition
- Learning inspection procedures
- Touring the inside of facilities when they are opened for periodic maintenance
- Touring sites where problems have occurred

Such means should be employed to provide operators with as many opportunities as possible to see the actual equipment and expand their knowledge and improve their level of technical expertise through hands-on experience. It is also important that people who have more experience, including experience of problems, should not keep their knowledge to themselves. When a problem happens, the people involved should write detailed reports of the circumstances of the problem, the cause, and the measures taken, so as to ensure that the operators in other groups share the same information. Based on these reports, groups can imagine problem scenarios and discuss possible solutions, which will improve the groups' technical skill level and facilitate communication within the groups. By sharing understanding, the groups can work together to operate the units.

(2) Performance Management

The purpose of managing the performance of the generating units in thermal power plant is to accurately understand the operating status of the units at all times, so as to improve thermal efficiency. To achieve this, an understanding of the performance of each unit should be reflected in the operation of the units. Important methods for accomplishing this are as follows.

a. Standard values should be set for representative numeric data related to the units, and the units managed based on the deviation between the actual data and the set values. The standard values for each piece of equipment should be values that can be expected to be attained in normal operation (the designed values and values obtained in actual operating experience). There are two types of values: the operating status values such as temperature and pressure, and performance values such as unit efficiency and boiler/turbine efficiency. As the latter numeric values vary depending on outside conditions, it is necessary to correct them to reflect consistent conditions for the purpose of comparison.

b. From the daily operation records, it is possible to gain an understanding of the operating status. In addition, representative values affecting performance (such as condenser vacuum level deviation, exhaust gas temperature and exhaust gas CO_2) should be examined to manage daily, weekly and monthly variation trends.

c. To evaluate the effectiveness of measures taken during periodic maintenance to improve performance and thermal efficiency, performance test items (such as high pressure turbine internal efficiency, air heater efficiency and feed water heater) should be understood. Further, records should be kept for each unit as a whole, to facilitate precise management.

The data described above is very important to the operation of generating equipment, and should be managed appropriately. At the very least, improvements must be made to ensure that a minimal level of data centralization, sufficient to enable staff members to immediately provide data when requested by a visiting study group.

As a means of achieving the above level of data management, heat input and heat output for each item should be managed using a heat balance chart, which is used to understand the level of utilization of the heat supplied to the units. This method balances the distribution of heat based on analysis of the processes of the generation, absorption and loss of heat from fuel combustion to power generation. This heat balance chart is important in determining whether or not the thermal power plant is operating well or not, and in considering ways to improve thermal efficiency. A representative sample is provided in Figure 5.4-6.

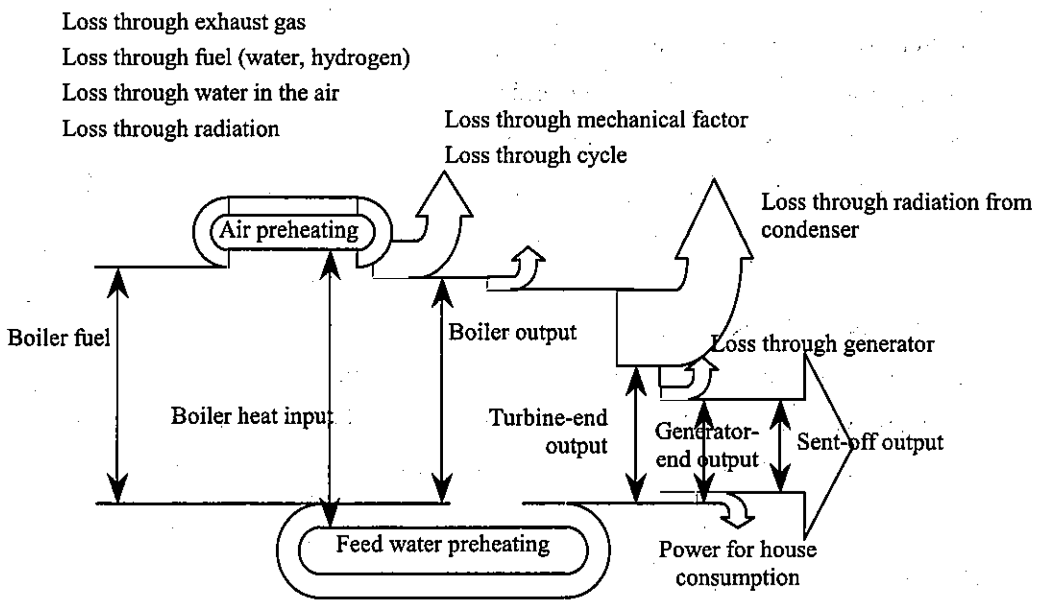


Figure 5.4-6 Sample Heat Balance Chart

(3) Maintenance

It is no exaggeration to say that the most important issues in generating equipment that must be used for extended periods of time are ensuring reliability and maintaining thermal efficiency. Therefore, it is necessary to perform appropriate maintenance, taking steps to prevent failures, learning about preventive maintenance and inspection techniques, and fully understanding the deterioration/improvement status of the aging generating equipment. It is important to implement preventive maintenance measures for the generating equipment and keep the equipment in sound working order.

a. Introduction of Preventive Maintenance Technology

The existing generating facilities of the DC "TASHTPP" are generally well maintained and managed. However, decreased performance and problems due to aging are unavoidable in equipment that was constructed over 30 years ago. In order to detect failures before they occur, based on responses to past problems, and ensure that future power needs can be met, the introduction of preventive maintenance technology is crucial. This technology allows the detection of problems before they occur for equipment that is closely related to the operation of the main equipment, making it possible to prevent problems by replacing vulnerable parts in advance.

Implementing preventive maintenance in a thermal power plant and thoroughly inspecting and repairing the equipment ensures the safety of the equipment and prevents unplanned shutdowns. This makes stable supply and cost reduction possible.

Ideally, equipment should operate stably and continuously except for planned stoppages. To achieve this, the first requirement is to perform various diagnoses and inspections (using service life evaluation and diagnostic technology) during periodic maintenance and inspection. Then the causes of deterioration in every part can be ascertained, which allows the prevention of various problems. It is also necessary to thoroughly inspect problem areas and implement appropriate measures such as planned parts renovation and equipment repair.

b. Equipment Required for Preventive Maintenance

In the performance of preventive maintenance and remaining service life diagnosis, a thorough understanding of the condition of the equipment is vital. To ensure an accurate understanding of the equipment condition, it is necessary to perform detailed inspections of all the important generating equipment. The following are representative examples of equipment requiring detailed inspection.

- Boiler tubes, headers, and drums that make up of boiler and through which hot, high pressure fluids flow

- Moving and stationary turbine blades, rotors, turbine casings
- Valve seats, valve rods and valve boxes of main valves (high pressure valves)
- Pumps and fans
- Generator and motor winding
- Bearings for rotating equipment

5.4.3 Safety and Hygiene

Safety and hygiene programs give top priority to human safety on site, and aim to prevent accidents before they occur so as to avoid situations where people would be in danger. They also aim to improve the work environment to ensure that the health of power station employees is maintained.

Safety and hygiene is therefore related to maintaining the equipment in sound condition, and as such is one of the most important elements in operating the generating equipment at high availability and efficiency. This connection needs to be understood by all power station staff members, who should be encouraged to always be aware of the importance of safety and hygiene.

In Japan, sites are maintained in line with a thoroughgoing policy of orderliness and cleanliness. Ensuring site safety is understood to start with efforts to keep the site in good hygienic condition. Corridors that are regularly patrolled by operators and areas where maintenance workers perform inspections and adjustments are always clean and orderly. At the DC "TASHTPP", however, it seems that in most areas of the site, workers have not developed that level of awareness; the equipment is dusty and their work clothes are by no means clean. On the walkways around boilers, we found a flame resistant material remains lying where it fell.

(1) Working Condition

Maintaining a proper work environment on site is an important measure to ensure that workers can concentrate on their monitoring work when they are operating or patrolling the equipment, without being distracted by anything else. Concentration allows them to detect problem areas in the equipment at an early stage and also to detect minute changes during periodic maintenance and inspection. Below are some measures that we recommend to resolve problem areas we noted on site.

a. Walking inside, especially in the turbine auxiliaries building, it is dark, and there are many areas with substandard lighting. In some places, it is even difficult to see one's feet, which is extremely dangerous. These conditions impair the vision of people working on site and prevent them from maintaining a high level of precision in their equipment inspection and maintenance work and from detecting dangerous areas early. Sufficient lighting is also necessary to prevent mistaken operation that could result from misperception in the central operation room. To maintain proper lighting, it is not enough to install the necessary lamps. Lighting standards should be set for all areas, and lighting inspections should be performed periodically once lighting is installed to ensure that lighting levels are maintained. Managers should establish systems for promptly taking remedial measures when lighting is found to be substandard. In addition, it is important to understand how many light fixtures and light bulbs are used in a year and to keep a supply on hand so that they can be immediately replaced as necessary. In on-site working areas, spot lights should be provided and used to illuminate the workers' hands, in addition to the normal indoor lighting. Of course, the location of electrical outlets for such lighting need to be known in advance, and additional outlets provided as necessary in advance.

b. Respiratory ailments are more common among the power plant workers than other types of ailments, and this needs to be included in consideration of the outdoor work environment. The study group supposes that one cause of respiratory problems among workers is the fact that in the winter, when heavy oil is burned, the exhaust gases descend on the power plant site and are inhaled by workers because they are not dispersed, especially when there is little wind. As a remedial measure, workers should wear dust masks when working outside in the winter. In addition, there are many gas leaks around the boilers, and so there is a danger that, especially near the top of the boilers, where exhaust gases are concentrated, workers could suffer from oxygen deficiency as well as dust inhalation. Therefore, the leaks should be fixed promptly to improve the work environment around the boilers. This will also result in increased boiler efficiency.

c. There are a number of areas where the sound level exceeds the standard (80 dB (A)), including the areas around boilers and turbines and inside the turbine auxiliary equipment building. In order to prevent impaired hearing in workers who work in these areas for extended periods, it is necessary to take measures such as wearing earplugs.

To ensure that such measures have the desired effect, areas of the site should be color coded on a site map to indicate the sound levels, and areas especially requiring protective gear such as earplugs should be clearly identified and marked by means such as chains around the borders.

(2) Labor Safety

On any site, safety should be the first priority. The safety management department should take the lead in periodically patrolling the site to prevent hazards due to equipment failures and human error before they occur. It is important not only to prevent hazards and thoroughly implement activities to detect dangers, but also to involve all staff members in safety programs to prevent accidents and injuries.

To achieve this, first the manager as well as every employee must recognize that the continuation of such efforts will have the optimum consequences for the management of the power plant. They must also endeavor to keep the work site safe and build up such an environment as to take the initiative in behaving for safety. In addition to this, individual sections and their subsidiary groups must set security of the work site as their goal by organization, and the company must institute a prize according to its achievement level for establishment of the safety action.

As will be understood, the manager and every employee need to perform proper operation, and maintenance and control of the units for preventing any accident from occurring. If an unfortunate accident should occur, prompt and appropriate measures must be taken to prevent secondary injuries. The cause of any accident should be identified and effective solutions implemented so as to prevent the reoccurrence of a similar accident. To prevent accidents, fire drills and safety meetings should be held on a regular basis, involving the entire staff of the power plant, to further increase safety awareness.