An Evaluation of Operational Performance of Thermal Power Generation Corporations

(A Study with Reference to Dr.Narla Tata Rao Thermal Power Generation Station)

***Prof. G.V.Chalam**
****J Durga Prasada Rao**

*Department of Commerce & Business Administration, Acharya Nagarjuna University, Andhra Pradesh, India.
**UGC-FDP Scholar, Department of Commerce & Business Administration, Acharya Nagarjuna University, India.

Abstract

Power is an essential infrastructure for the growth of an economy which plays an important role in the socio economic development of the country. To attain the targeted GDP growth rate along with double digit growth rate, power sector needs to grow in the same proportion. Power sector is also called as the mother sector of all other sectors. Central and State governments have taken enormous initiation in the growth of power sector in India. Among the various power generations, thermal power generation occupies lions share. The contribution of thermal power generation is around 70 per cent. Dr. Narla Tata Rao Thermal Power Station is also one among them, the station is contributing significant portion in the total thermal power generation in India as well as in the State of Andhra Pradesh. This paper examines the consumption of various inputs to generate power by each stage and the entire thermal power station. The paper also analyses that which stage is performing better in the optimum consumption of inputs for power generation among the four stages.

Major findings of the study include are: Stage I and II have completed more than 35 years and 25 years respectively and still these stages are working in good condition and generating power. This is possible only because of high level quality maintenance by the organisation. The average coal consumption of stage IV is observed to be639 grams per unit, which is low, compared to the other stages of the plant as well as the station average. Operating system of stage IV is designed with latest technology and hence less coal is consumed to generate the power. During the study period, PLF of the entire station is varying because of forced outages. These outages are continuously increasing since 2012-13. The average PLF of the selected unit during the period of study is 85.28 per cent.

Key Words: **Operational Performance Evaluation, Ratios, Percentage of growth and Plant Load Factor.**

1.0. Introduction:

Operations management is often used along with the production management in the literary subject. Operations are purposeful activities which are done methodically as part of a plan of work by a process that is designed to achieve the pre-decided objectives. It indicates that operations management consists of tactics such as scheduling work, assigning resources which includes people, equipment, managing inventories, assessing quality standards, process type of decisions and the sequence for making individual items is a product mix set, put it simple. Operations management is understood as the process whereby resources or inputs are converted into more useful products. There is a distinction between production and operations management i.e., production management is more used for a system where tangible goods are produced and operations management is frequently used where various inputs are transformed into intangible services. This indicates operations management will cover the service organisations as well as manufacturing enterprises.

Operational efficiency is a vital component of the operational performance of the organisation that ensures its survival and growth. The ratios in this segment involve subjective analysis and efficiency of management. The management of the organisation can take crucial decisions depending on the risk perception. It sets vision and goals for the organization and sees that it

achieves them. This parameter issued to evaluate management efficiency, has to maintain the better quality ones or discount poorly managed ones.

2.0 Review of Literature:

Chalam.G.V and Nohmaan Ali (2015) "An Evaluation of Operational Performance of Road Transport Corporation - A Case Study of Andhra Pradesh State Road Transport Corporation", depicts the operational performance of APSRTC with different variables in their paper. Alexander Jeevanantham.Y, Muralidharan.S and Karthikeyan.R (2015) in their paper "Review of Power Sector Growth in India", explained various sources of power generation in India and examine the growth of power sector during the various plan periods. Government of Andhra Pradesh(2014) "White Paper on Power Sector in Andhra Pradesh" this bulletin explicit various challenges faced by the power sector in Andhra Pradesh due to bifurcation of state and analysed proactive measures to address the issues plugging the A.P Power Sector. Rama Krishna. K (2014) in his article "Importance of Energy Savings" pointed out the importance of energy savings.

Ankur Omer, SmarajitGhosh and RajnishKaushik (2013) "Indian Power System: Issues and Opportunities",in their article examines the Indian power sector scenario and discuss the various problems facing by the Indian power sector and also explains the future outlook for changing Indian power sector. Shiv PratapRaghuvanshi, Avinash Chandra and Ashok Kumar Raghav (2006) in their paper "Carbon dioxide emissions from coal based power generation in India", pointed out that the CO_2 emissions from the present energy generation and predicts the same for the next two decades and suggested the appropriate and alternative measures to reduce CO_2 emission.

Agarwal.R.S (2002) "Physical, financial and operational efficiency analysis of state transport units: a case study", examined and analysed the performance of the selected units on intra-firm and inter-firm comparison. Tulasi Das. V (1998) in his research "Performance Evaluation of Thermal Power Projects A case study of VTPS" discussed the cost and operational performance and also analyse employees perception on operational and organisational activities of the entire organisation prior reforms period. Venkateswara Rao. A (1986) in his research "Global energy situations" examined the trends of past, present and future production of commercial energy sources and compared them with the likely consumption needs during 1976-1981.

From the review of the earlier studies, it is observed that only a few research studies have been conducted in this area but they have not provided sound theoretical and empirical explanation regarding the various stages of power generation, and which stage is performing well when compared to the other stages of the organisation. The present study is an improvement over the earlier studies, for which the following are the specific objectives of the study.

3.0 Objectives of the Study:

(i) To analyse the power generation of the select organization stage-wise and unit-wise during the period of study.

(ii) To examine the various inputs consumed for power generation and also PLF stage-wise and also across the units.

(iii)To draw the conclusions and offer suggestions for the better performance of the selected organization.

4.0 Methodology of the study:

The study is based on the secondary data which is obtained from the records of the selected organization. The period of study is confined from 2005-06 to 2014-15. The

performance of the select organisation is evaluated by computing the relevant ratios and interpreted based on the trends and also ideal norms.

5.0 Profile of the selected organization:

Dr.Narla Tata Rao Thermal Power Station (formerly Vijayawada Thermal Power Station) is a unique one in the country, unique in its layout and numerous facilities provided for easy operation and maintenance. The high level performance of the selected organization has been a benchmark for the power sector in India. The organisation is expanding and upgrading its generation capacity with a technology basing on the present and future needs. Stage-IV is the latest version in technology as well as in power generation among the remaining stages of the organisation. Winning of awards at national level has been a routine for this unique power station. The station received meritorious production awards from the Government of India for the last 21 years consecutively and also gold medals for 12 years in a row. It has also got incentives for its economic operation by improved specific oil consumption/auxiliary consumption for 12 consecutive years. The selected organization has accredited for ISO 9001:2008 certifications by M/s Lloyds Register Quality Assurance in May, 2010. The thermal power station continues to maintain its prominence among the best performing power stations in the country.

Dr. NTTPS is the biggest power plant in the State of Andhra Pradesh and satisfying maximum power needs of the state, with a generation capacity of 1760 MW in all four stages. For stage-I, II, III each stage consists of 2 x 210 MW units and for Stage-IV the unit is of 500MW rating. The details of production capacity, date of commencement and amount spent so far are provided in Table-I.

Table -1: Date of Commencement and Production Capacity with Investment-Stage-wise and Unit-wise

Stage	Units	Date of Commencement	Production capacity (MW)	Amount spent (Rs. in crores)
I	1	01-11-1979	210	193.00
	2	10-10-1980	210	
II	3	05-10-1989	210	533.33
	4	23-08-1990	210	
III	5	30-03-1994	210	840.00
	6	24-02-1995	210	
IV	7	06-04-2009	500	2100.00

Source: Collected from the Records of the selected organization.

6.0 Operational Performance: It is essential to any organisation to evaluate its operational performance. Quality of the product/services determines the success of business operations. Operational performance of the selected organization is evaluated with the following ratios.

6.1 Stage-wise Power Generation: This ratio examines stage-wise power generation in total power generation and also percentage of change during the period of study. High ratio indicates an outstanding performance and utilizing resources into optimum levels by the stages and low ratio shows that weak performance. Calculation of the ratio is given below.

% of Stage-wise Power Generation = Stage-wise generation/Total generation X 100.

Table-2

% of Power Generation in the selected organization - Stage -Wise during 2005-06 to2014-15						
Generation in MU						
Year	Total Power Generation	% of Change	Stage-I Generation (%)	Stage-II Generation (%)	Stage-III Generation (%)	Stage-IV Generation (%)
2005-06	9,755	-	3,114 (31.92)	3,371 (34.56)	3,270 (33.52)	0
2006-07	9,954	2.04	3,209 (32.24)	3,288 (33.03)	3,457 (34.73)	0
2007-08	9,765	-1.90	2,930 (30.01)	3,399 (34.81)	3,436 (35.19)	0
2008-09	10,341	5.90	3,255 (31.48)	3,622 (35.03)	3,464 (33.50)	0
2009-10	10,350	0.09	3,463 (33.46)	3,079 (29.75)	3,164 (30.57)	644 (6.22)
2010-11	12,409	19.89	3,183 (25.65)	3,350 (27.00)	2,125 (17.12)	3,751 (30.23)
2011-12	14,159	14.10	3,286 (23.21)	3,437 (24.27)	3,315 (23.41)	4,121 (29.11)
2012-13	13,411	-5.28	2,965 (22.11)	3,428 (25.56)	3,274 (24.41)	3,744 (27.92)
2013-14	12,833	-4.31	2,745 (21.39)	3,166 (24.67)	3,141 (24.48)	3,781 (29.46)
2014-15	12,705	-1.00	2,978 (23.44)	3,065 (24.12)	3,043 (23.95)	3,619 (28.48)
Stage-wise Average Power Generation		3.28	27.49	29.28	28.09	25.24

Source: Compiled from the records of the selected organization.

Table-2 explains stage-wise percentage of power generation in total generation and its growth of the selected organisation during the period 2005-06 to 2014-15. Average power generation of stage-II is more during the study period i.e.29.28 per cent in the total power generation. The same is low in the case of stage-IV, i.e., 25.24 per cent, because this stage commenced during 2009-10. Though the commencement of stage-IV is on 06-04-2009, the commercial operation declaration was only from 29-01-2010, and hence that period has 6.22 per cent in total generation. The proportion of stage-IV is high in the total power generation in the later years when compared to the other stages. Total power generation of the entire

organisation is high during 2011-12 i.e. 14159MU.From there onwards the growth percentage is deliberately reducing because of increasing more outages. Average percentage of change of the selected organization during the period of study is 3.28%.

6.2 % of Stage-Wise Coal Consumption: Coal is the major source of fuel to the thermal power generation stations. This ratio indicates the percentage of coal consumption by each stage to the total coal consumption to generate power during the period of study. This ratio is to be calculated with the following formula.

%Stage-Wise Coal Consumption= Stage-wise Coal consumption/Total Coal Consumption X 100

Table-3

% of Coal Consumption in the selected organization - Stage -Wise during 2005-06 to 2014-15

Total Coal consumption MT

Year	Total Coal Consumption	% of Change	Stage-I Total (%)	Stage-II Total (%)	Stage-III Total (%)	Stage-IV Total (%)
2005-06	68,06,922	-	21,95,233 (32.25)	24,18,266 (35.53)	21,93,423 (32.22)	0
2006-07	69,32,750	1.85	22,72,831 (32.78)	23,20,765 (33.48)	23,39,154 (33.74)	0
2007-08	71,13,564	2.61	21,77,459 (30.61)	25,28,047 (35.54)	24,08,058 (33.85)	0
2008-09	72,54,799	1.99	23,10,633 (31.85)	25,69,939 (35.42)	23,74,227 (32.73)	0
2009-10	73,89,703	1.86	25,40,025 (34.37)	22,50,820 (30.46)	21,96,970 (29.73)	4,01,888 (5.44)
2010-11	86,48,608	17.04	24,02,704 (27.78)	25,14,183 (29.07)	14,61,302 (16.90)	22,70,419 (26.25)
2011-12	98,01,494	13.33	24,04,575 (24.53)	25,05,912 (25.57)	23,35,279 (23.83)	25,55,728 (26.07)
2012-13	98,18,218	0.17	23,20,213 (23.63)	26,27,619 (26.76)	24,68,694 (25.14)	24,01,692 (24.46)
2013-14	95,73,818	-2.49	21,58,395 (22.54)	24,48,217 (25.57)	24,24,326 (25.32)	25,42,880 (26.56)
2014-15	95,17,054	-0.59	23,41,400 (24.60)	23,94,626 (25.16)	23,58,159 (24.78)	24,22,869 (25.46)
Stage-wise Average Coal Consumption		3.97	28.50	30.26	27.82	22.37

Source: Compiled from the records of the selected organization.

Table-3 examines stage-wise coal consumption in the total coal consumption and also growth percentage in total coal consumption from 2005-06 to 2014-15. During the study period stage-II consumed more coal i.e. 30.26 per cent because stage II has generated more power compared to the other stages. In the year 2010-11 unit 6 of stage-III was shut down due to generator problem throughout the year, which has influence on the coal consumption as well as power generation of the stage. So the coal consumption of stage-III in 2010-11 is only 16.90 per cent. During the period of study average coal consumptions of stage-I, III and IV are 28.50 per cent, 27.82 per cent and 22.37 per cent respectively. Growth in coal consumption is high during 2010-11 compared to the previous year because more power was generated during the year; there onwards the same was declined gradually because of declining the power generation. This is reflected on coal consumption. Average growth of coal consumption during the period of study is 3.97 per cent.

6.3 Coal Consumption per unit of power generation: This ratio examines the quantity of coal consumption to generate one unit of power generation. Less quantity of coal consumption to generate power indicates the efficiency of the stage, at the same time high quality of coal is essential to generate power; otherwise more coal is to be consumed for generation. This ratio is calculated in the following manner.

Per unit Coal Consumption = Coal consumption/Power generation

Table-4

Coal Consumption per unit of power generation - Stage-wise analysis during 2005-06 to 15-16					
Total Coal Consumption MT					
Generation in MU					
Per unit = Kilo Gram					
Year	Stage-I	Stage-II	Stage-III	Stage-IV	Total Station
2005-06	0.705	0.717	0.671	0	0.698
2006-07	0.708	0.706	0.677	0	0.696
2007-08	0.743	0.744	0.701	0	0.728
2008-09	0.710	0.710	0.685	0	0.702
2009-10	0.733	0.731	0.694	0.624	0.714
2010-11	0.755	0.751	0.688	0.605	0.697
2011-12	0.732	0.729	0.704	0.620	0.692
2012-13	0.783	0.767	0.754	0.641	0.732
2013-14	0.786	0.773	0.772	0.673	0.746
2014-15	0.786	0.781	0.775	0.669	0.749
Per Unit Average Coal Consumption	0.744	0.741	0.712	0.639	0.715

Source: Compiled from the records of the selected organization.

Table-4 analyses the station and stage-wise coal consumption per unit of the selected organization during the study period. Stage I is consuming more coal to generate one unit of power, where the average during the period is .744 grams followed by stage-II and III

recording.741 grams and .712 grams respectively. The average coal consumption of stage-IV is .639 grams, which is low compared to the other stages, as well as in the station average. The operating system of stage-IV is designed with latest technology; hence less coal is consumed to generate one unit of power. During the period of study coal consumption to generate one unit of power is .715 grams.

6.4. % of oil consumption: Next to the coal, oil is one of the important factors for generating power. This ratio gives out the percentage of stage-wise oil consumption in the total oil consumption and also growth percentage in oil consumption of the selected organization during the period of study. Calculation of the ratio is given below.

% of oil consumption-stage-wise = Stage-wise oil consumption/Total oil consumption X 100

Table - 5

Amount of Oil Consumption and % of Oil Consumption - Stage-wise during 2005-15						
Oil Consumption KL						
Year	Total Oil Consumption	% of Change	Stage-I	Stage-II	Stage-III	Stage-IV
2005-06	2,450.798	-	1,033.957 (42.19)	628.007 (25.62)	788.834 (32.19)	0
2006-07	2,788.158	13.77	1,160.796 (41.63)	652.960 (23.42)	974.402 (34.95)	0
2007-08	2,789.367	0.04	1,228.529 (44.04)	720.105 (25.82)	840.733 (30.14)	0
2008-09	2,960.192	6.12	1,471.972 (49.73)	668.290 (22.58)	819.930 (27.70)	0
2009-10	4,321.951	46.00	1,416.061 (32.76)	1,005.620 (23.27)	593.280 (13.73)	1,306.990 (30.24)
2010-11	5,880.354	36.06	1,884.837 (32.05)	1,240.804 (21.10)	1,002.573 (17.05)	1,752.140 (29.80)
2011-12	7,263.107	23.51	2,231.191 (30.72)	1,403.406 (19.32)	2,581.760 (35.55)	1,046.750 (14.41)
2012-13	21,887.523	201.35	8,311.493 (37.97)	3,825.630 (17.48)	7,830.900 (35.78)	1,919.500 (8.77)
2013-14	11,228.400	-48.70	1,765.550 (15.72)	2,545.950 (22.67)	5,797.900 (51.64)	1,119.000 (9.97)
2014-15	14,980.564	33.42	2,887.180 (19.27)	4,668.578 (31.16)	5,993.806 (40.01)	1,431.000 (9.55)
Stage-wise Average Oil Consumption		34.62	34.61	23.24	31.87	17.12

Source: Compiled from the records of the selected organization.

Table-5 shows the stage-wise percentage of oil consumption to the total oil consumption and changes from 2005-06 to 2014-15. During the study period average oil

consumption of stage I is more in the total oil consumption as well as the other stages of the organisation followed by stage III. They are 34.61 per cent and 31.87 per cent respectively. In the initial years of stage IV, this unit consumed more oil as huge oil is required for the commencement of the plant. The average oil consumption of stage-IV is 17.12 per cent; stage-II is also performing well with an average of 23.24 per cent. Though more power is generated through these stages but consumption of oil is less when compared to the stage I and III. During 2012-13 oil consumption is raised sharply because of scarcity of coal, oil is used as a substitute for coal in that year to generate power. So during the year the percentage of growth in oil consumption is 201.35 compared to 2011-12 and reduced instantly in 2013-14. Average growth in oil consumption of the selected organisation during the period of study is 34.62%.

6.5 Oil Consumption to generate per unit of power: This ratio indicates the consumption of oil to generate one unit of power. Less consumption of oil to generate power is better to the organisation. This ratio gives out which is better to the organisation among the four stages of Dr. NTTPS. Calculation of the ratio is given below.

Oil consumption to generate per unit of power = Oil Consumption/Power generation X 1000

Table -6

Oil consumption in the selected organization to generate for per unit of power					
Per unit oil consumption: ML					
Year	Stage-I	Stage-II	Stage-III	Stage-IV	Total Station
2005-06	0.332	0.186	0.241	-	0.251
2006-07	0.362	0.199	0.282	-	0.280
2007-08	0.419	0.212	0.245	-	0.286
2008-09	0.452	0.185	0.237	-	0.286
2009-10	0.409	0.327	0.188	2.029	0.418
2010-11	0.592	0.370	0.472	0.467	0.474
2011-12	0.679	0.408	0.779	0.254	0.513
2012-13	2.803	1.116	2.392	0.513	1.632
2013-14	0.643	0.804	1.846	0.296	0.875
2014-15	0.970	1.523	1.970	0.395	1.179
Per unit Average Oil Consumption	0.766	0.533	0.865	0.659	0.619

Source: Compiled from the records of the selected organization.

Table-6 examines the station and stage-wise oil consumption to generate one unit of power of the selected organisation. During the period of study stage III is consuming more oil for one unit power generation i.e. 0.865ml because of many breakdowns compared to the other stages, followed by stage I, which is consuming 0.766ml per unit. Stage-II is consuming oil economically though it is generating more power per unit, average oil consumption of the stage is 0.533ml. Stage IV consumed more oil in the initial years, from 2011-12 onwards the same is consuming less oil per unit of generation compared to the other stages. During the period of study the average oil consumption per unit is 0.659ml. In the year 2012-13 due to the scarcity of coal, oil is used to generate power so more oil is consumed to produce one unit of power. The average consumption of oil per unit of power of the selected organization during the study period is 0.619ml.

6.6. % of Water Consumption: Water is also one of the essential components for thermal power generation stations for generating power. This ratio shows that how much water is consuming by each stage in the total water consumed by the organisation. This ratio is calculated in the following manner.

% of water consumption Stage-wise = Stage-wise water consumption/Total water consumption X 100

Table-7

Amount of Water and % of Water Consumption - Stage-wise during 2005-06 to 14-15						
Water Consumption : CMT						
Year	Total Water Consumption	% of Change	Stage-ITotal (%)	Stage-II Total (%)	Stage-III Total (%)	Stage-IV Total (%)
2005-06	814,328		4,77,495 (58.64)	1,53,419 (18.84)	1,83,414 (22.52)	-
2006-07	847,923	4.13	4,60,827 (54.35)	1,71,655 (20.24)	2,15,441 (25.41)	-
2007-08	728,798	-14.05	3,71,794 (51.01)	1,62,599 (22.31)	1,94,405 (26.67)	-
2008-09	615,358	-15.57	2,60,385 (42.31)	1,67,222 (27.17)	1,87,751 (30.51)	-
2009-10	672,671	9.31	2,84,813 (42.34)	1,59,961 (23.78)	1,82,461 (27.12)	45,536 (6.75)
2010-11	913,589	35.82	3,37,702 (36.96)	1,77,700 (19.45)	1,72,180 (18.85)	2,26,007 (25)
2011-12	934,414	2.28	2,98,756 (31.97)	1,77,815 (19.03)	2,75,459 (29.48)	1,82,384 (20)
2012-13	881,519	-5.66	3,09,043 (35.06)	1,77,429 (20.13)	2,21,927 (25.18)	1,73,120 (20)
2013-14	785,847	-10.85	2,31,875 (29.51)	1,88,815 (24.03)	2,25,918 (28.75)	1,39,239 (18)
2014-15	798,479	1.61	2,66,911 (33.43)	1,71,916 (21.53)	2,29,559 (28.75)	1,30,093 (16)
Stage-wise Average Water Consumption		0.78	41.56	21.65	26.32	17.44

Source: Compiled from the records of the selected organization.

Table-7 examines the stage-wise water consumption in the total water consumption and also percentage of change from 2005-06 to 2014-15. Stage-I is consuming maximum quantity of water to generate power; the average consumption of water of the stage during the period of study is 41.56 per cent. The stage-III is also consuming more water compared to stage-II and

IV because of more outages of this stage. Water is to be applied again when it restarts. Stage-IV is unique one in its lay out, so this is consuming water in an organised manner followed by stage-II, they are 17.44 per cent and 21.65 per cent respectively. Percentage of growth in the water consumption compared to the previous years is fluctuating. It is high during the year 2010-11 and low during 2008-09. Average change of water consumption during the study period is 0.78 per cent.

6.7 Water Consumption to generate per unit of Power: In the thermal power generation stations water is an essential element in power generation. This ratio indicates that how much of water is consuming by the stages in generating one unit of power. Less consumption of water to generate power shows the efficiency of the stage. This is the principle for calculation of this ratio.

Water Consumption to Generate per Unit of Power = Water Consumption / Power generation X 1000

Table-8

Water Consumption to Generate per unit of Power - Stage-wise during 2005-06 to 14-15					
Water consumption : Litre					
				Production in MU	
Year	Stage-I	Stage-II	Stage-III	Stage-IV	Total Station
2005-06	0.153	0.046	0.056	--	0.083
2006-07	0.144	0.052	0.062	--	0.082
2007-08	0.127	0.048	0.057	--	0.077
2008-09	0.080	0.046	0.054	--	0.060
2009-10	0.082	0.052	0.058	0.071	0.066
2010-11	0.106	0.053	0.081	0.060	0.074
2011-12	0.091	0.052	0.083	0.044	0.059
2012-13	0.104	0.052	0.068	0.046	0.070
2013-14	0.084	0.060	0.072	0.037	0.061
2014-15	0.090	0.056	0.075	0.036	0.063
Per Unit Average Water Consumption	0.106	0.052	0.067	0.049	0.069

Source: Compiled from the records of the selected organization.

Table-8 analyses the station and stage-wise water consumption to generate one unit. The stage-I is consuming more water for one unit of power generation, the average per unit consumption of water during the period of study is 0.106 litres, because this stage has more evaporation losses. The stage-III is also consuming more water compared to the stage-II and IV stage. The average consumption of stage-III is 0.067 litres followed by stage II and IV. Stage-IV is consuming less water i.e. 0.049 litres per unit, because of layout and advanced design of the plant. Average consumption of water of the selected organisation during the study period is 0.069 litres per a unit generation.

6.8Deemed Plant Load Factor (PLF): PLF is the ratio between the actual energy generated by the plant to the maximum possible energy that can be generated with the plant working at its rated power and its duration in a year. No power plant operates 100 per cent of its capacity. Therefore, deemed PLF is to be calculated considering the installed capacity, age of the plant, past performance planned outages and availability of resources. Following is the principle for the calculation of deemed PLF.

Deemed PLF =Deemed Generation /Generation Capacity X 100

Table-9

% of Station and Stage-Wise Deemed Plant Load Factor (PLF) during 2005-06 to 2014-15					
Deemed PLF in Percentage					
Year	Stage-I	Stage-II	Stage-III	Stage-IV	Total Station
2005-06	91.30	96.87	95.79	--	94.65
2006-07	88.94	91.06	95.84	--	91.95
2007-08	81.73	95.03	95.79	--	90.85
2008-09	89.07	99.08	94.70	--	94.28
2009-10	94.92	84.40	86.79	--	63.50
2010-11	89.10	93.29	58.85	87.01	82.29
2011-12	90.54	94.37	91.14	96.83	93.38
2012-13	81.82	94.32	89.92	88.58	88.66
2013-14	76.49	88.69	87.88	92.21	86.59
2014-15	84.45	86.35	85.54	86.85	85.85
Average Deemed PLF	86.84	92.35	88.22	90.30	87.20

Source: Compiled from the records of the selected organization.

Table-9 explains the station and stage-wise Deemed Plant Load Factor of the selected organization from 2005-06 to 2014-15. During the period of study deemed PLF of stage-II is more compared to the other stages of the organisation with the PLF of 92.35 per cent, which indicates the ability of the stage, deemed PLF where stage IV is also more than 90 per cent. Stage III in third position because of more outages and stage one is in last position because of life time of the units in stage I have been completed more than 35 years. The deemed PLF of the entire station during the period of study is 87.20 per cent. Average deemed PLFs of all stages ofthe selected organization is more than 85 per cent only because the plants and machinery are maintained with high quality. So stage-I is generating power even after 35 years of service.

6.9Actual Plant Load Factor: Though the plants in the stages can generate power upto the deemed generation but it is generating the power based on the instructions from the grid. When demand of power is more, plants can generate power up to the deemed generation and less when less demand. The working of the plants is stopped by compulsion when demand falls further; it is called as force outages. These outages determine the actual PLF of the plant. The calculation of the ratio is given below.

Actual Plant Load Factor = Actual Generation/Generation CapacityX100

Table-10

% of Actual Plant Load Factor (PLF) - Stage-wise during the period 2005-06 to 14-15					
Actual PLF in Percentage					
Year	Stage-I	Stage-II	Stage-III	Stage-IV	Total Station
2005-06	84.64	91.63	88.88	--	88.38
2006-07	87.22	89.37	93.97	--	90.19
2007-08	79.64	92.39	93.39	--	88.48
2008-09	88.48	98.45	94.16	--	93.69
2009-10	94.13	83.69	86.00	14.70	67.13
2010-11	86.52	91.06	57.76	85.64	80.49
2011-12	89.32	93.42	90.11	94.09	91.84
2012-13	80.59	93.18	88.99	85.48	86.99
2013-14	74.61	86.06	85.38	86.32	83.24
2014-15	80.95	83.31	82.71	82.63	82.41
Average of Actual PLF	84.61	90.26	86.13	74.81	85.28

Source: Compiled from the records of the selected organization.

Table-10 explains station and stage-wise plant load factor and also the entire station. Difference between deemed PLF and actual PLF is occurred because of forced outages, which includes lack of demand, grid failures and plant repairs. During the period of study plant load factor of stage-II is more with a PLF of 90.26 per cent, which indicates this stage is performing outstandingly in the selected organisation. PLF of stage-III stood in second place with a PLF of 86.13 per cent among the four stages of Dr. NTTPS, followed by stage-I and IV with PLFs of 84.61 and 74.81 per cent respectively. During the year 2009-10 stage-IV operated only few hours, where this reflected on the entire PLF of the stage. During the study period PLF of the entire station is varying because of forced outages. These outages are relentlessly increasing from the year 2012-13 onwards. During 2008-09 PLF of the entire station is high i.e. 93.69 per cent and low during 2009-10 i.e., 67.13 per cent and the average percentage of the select organization during the period of study is 85.28.

7.0 Findings of the study:

(i) Though stage-I and II have completed more than 35 years and 25 years respectively, still these stages are working efficiently with good condition, which is possible only because of high quality maintenance of plants by the organisation.

(ii) Growth in coal consumption is high during 2010-11 compared to the earlier period because more power was generated during this year; from there onwards the same was reduced gradually because of declining the power generation. This is reflected on coal consumption of the selected organization. Average growth of coal consumption during the period of study is 3.97 per cent.

(iii) Average coal consumption of stage-IV to generate per unit of power is0.639 grams, which is low compared to the other stages as well as the station average. The operating system of

stage-IV is designed with latest technology, hence less coal is consumed to generate per unit of power.

(iv)The average oil consumption of stage-IV is 17.12 per cent; stage-II is also performing well with an average of 23.24 per cent during the period of study. Though more power is generated through these two stages, but consuming less oil compared to stage-I and III. During 2012-13 oil consumption is raised sharply because of scarcity of coal, oil is used as a substitute for coal in that year to generate power.

(v) Though stage-II is generating more power but per unit consumption of oil is very less compared to the other stages as well as to the station average. Per unit average oil consumption of stage-II during the period of study is .533Ml.

(vi) Stage-I is consuming maximum quantity of water to generate power because this stage has more evaporation losses, the average consumption of water of this stage during the period of study is 41.56 per cent. The stage- III is also consuming more water compared to stage-II and IV because more outages of the stage.

(vii)The stage-IV is consuming less water, i.e., 0.049 litres per unit of power generation, because of its layout and design of the plant, whereas, the average consumption of water of the selected organisation during the study period is 0.069 litres per unit generation.

(viii) The deemed PLF ratio indicates stage-II is performing effectively when it is compared to the other stages. The average deemed PLF of stage-II during the period of study is 92.35 per cent. The average deemed PLF of the selected organization is more than 85 per cent; this is possible with the high quality of maintenance of the plant.

(ix) During the study period, the PLF of the entire station is varying because of forced outages. These outages are continuously increasing from the year 2012-13 onwards. The average PLF of the selected organization during the period of study is 85.28.

8.0 Conclusion:

Among the four stages of the selected power generating organization, stage-IV is producing more power consistently and consuming less coal, oil and water compared to the other stages. There is a further room to enhance its productivity because of this stage is designed with new technology and efficient operating system. Though stage-I and II have completed more than 25 years in power generation, these stages are performing very well, this is possible only because of efficient maintenance of the plant. The operational performance of stage-II is better than stage-III. Due to the more outages in stage-III the more oil and water required for generation. The average PLF of the station during the period of study is 85.28%. It is suggested to the management to reduce the outages, which increases the power generation.

9.0 References:

1. Agarwal.R.S (2002) “Physical, financial & operational efficiency analysis of state transport units: A Case Study”, The Management Accountant, June, 2002.

2. Alexander Jeevanantham.Y, Muralidharan.S and Karthikeyan.R (2015) “Review of Power Sector Growth in India”, International Journal of Latest Trends in Engineering and Technology Vol.5 (3) May 2015.

3. Ankur Omer, Smarajit Ghosh and Rajnish Kaushik (2013) “Indian Power System: Issues and Opportunities”. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol.2 (3), March 2013.

4. Annual Operational Records of Dr. Narla Tata Rao Thermal Power Station.

5. Annual Report (Power & Energy Division) of Planning Commission, 2013-14.

6. Annual Reports of Andhra Pradesh Power Generation Corporation limited.

7. Chalam. G.V and Nohmman Ali (2015) "An Evaluation of Operational Performance of Road Transport Corporation A Case Study of Andhra Pradesh State Road Transport Corporation", Pezzottaite Journals Vol. 4 (3) July-September 2015.

8. Government of Andhra Pradesh "Approach to the 12th Five Year Plan" final draft, January, 2013.

9. Government of Andhra Pradesh "White Paper on Power Sector in Andhra Pradesh". Special Bulletin, dt. 08-05-2014.

10. International Institute for Sustainable Development Report, March, 2014.

11. Ramakrishna "Importance of Energy Savings" Yojana, Vol. 42 (12), October 2014.

12. Shiv Pratap Raghuvanshi, Avinash Chandra and Ashok Kumar Raghav (2006) "Corbon dioxide emissions from coal based power generation in India". Elsevier, Energy Conversion Management 47(2006) 427-441.

13. Tulasi Das. V "Performance Evaluation of Thermal Power Projects A case study of VTPS" thesis submitted to Andhra University, Visakha Patnam Andhra Pradesh 1998.

14. Venkateswara Rao. A. "Global Energy Situations", Thesis submitted to Nagarjuna University, A.P. September 1986.