

Chapter-III

Performance reviews relating to Statutory Corporation

3 Tamil Nadu Electricity Board

3.1 Implementation of transmission schemes

Highlights

During the Tenth plan period (2002-03 to 2006-07), the Board did not complete 79 sub-stations (33 *per cent*) and 2,768 circuit kilometres of transmission lines (41 *per cent*) compared to their target.

(Paragraph 3.1.9)

The Board did not have time schedule for completion of the transmission schemes and there was no review of progress of the works by the Board. There was no assessment of the actual benefits of the schemes after their completion and the Board did not have information on the final cost of the completed schemes.

(Paragraphs 3.1.12 to 3.1.15)

Delays of 7 to 83 months and 11 to 132 months were noticed in completion of sub-stations and line works respectively, when compared with the Tamil Nadu Electricity Regulatory Commission norms and led to loss of revenue of Rs. 123.97 crore over a period of five years ending March 2008.

(Paragraphs 3.1.16, 3.1.22 and 3.1.32)

The delay in establishing a sub-station for evacuation of power generated by two captive power producers resulted in loss of Rs. 31.71 crore to the Board during September 2006 to September 2007.

(Paragraph 3.1.23)

The Board did not ensure uniform levels of impedance of the power transformers installed in two sub-stations, which resulted in loss of revenue of Rs. 8.62 crore to the Board during 2005-06 to 2007-08.

(Paragraphs 3.1.28 and 3.1.29)

The Board did not synchronise the construction of sub-stations with their related line works in three cases resulting in idling of the line works valued at Rs. 18.51 crore for one to three years up to March 2008.

(Paragraphs 3.1.33 to 3.1.35)

Introduction

3.1.1 The Tamil Nadu Electricity Board (Board) generates power from the hydel and thermal including gas based power plants owned by it. In addition, the Board purchases power from various sources such as power generating stations owned by the Government of India, thermal and wind energy and non-conventional energy produced by the independent power producers (IPPs). The power generated and purchased is transmitted through the sub-stations (SS) and transmission lines to the High Tension (HT) and Low Tension (LT) consumers. An appropriate and efficient transmission network is essential for transmission of power to the consumers, evacuation of power from the point of generation/purchase to the SS and maintenance/improvement of the voltage level in the network. To augment the transmission network, the Board had erected 159 SS and 3,977 circuit kilometer (CKM) of Extra High Tension (EHT) lines during 2002-03 to 2006-07 by spending Rs. 2,126 crore. As of March 2007, the transmission network of the Board comprised of 1,148 SS and 1.54 lakh CKM of EHT and HT lines with an investment of Rs. 8,055.83 crore.

Organisational set up

3.1.2 The governing body of the Board comprises the Chairman, three full time members, *viz.*, Member (Accounts), Member (Generation) and Member (Distribution) and three ex-officio part time members *viz.*, the Secretaries of the Energy, Finance and Industries Department of the Government of Tamil Nadu. The overall planning and execution of the transmission system is looked after by the Member (Distribution), who is assisted by two Chief Engineers for Planning and Transmission at the Headquarters level. The field level transmission works are carried out by six Superintending Engineers of the General Construction Circles (GCC) at Madurai, Trichy, Coimbatore, Salem, Chennai and Chennai Development Circles (DC).

Scope of audit

3.1.3 Performance review of the Transmission and Distribution (T&D) system of the Board was included in the Report of the Comptroller and Auditor General of India (Commercial) for the year ended March 1999 – Government of Tamil Nadu highlighting the lack of synchronisation of SS and associated lines, delay in completion of the T&D schemes and high T&D losses *etc.* The Report was yet to be discussed (October 2008) by the Committee on Public Undertakings.

With a view to ascertain the present position, the performance audit was conducted between January and June 2008, covering 40 out of 159 SS (25 *per cent*) and 962 CKM out of 3,977 CKM of lines (24 *per cent*) executed during

2002-03 to 2006-07 in three[♦] out of the six GCCs. In addition, records in the Board's Headquarters in Chennai were also scrutinised.

Audit objectives

3.1.4 The objectives of the performance audit were to assess whether:

- the system in place with regard to preparation of the annual transmission programmes and the budget was efficient and effective;
- implementation of the transmission schemes was efficient, economical and effective for achieving the desired benefits envisaged in the schemes;
- there was synchronisation and co-ordination of efforts and activities for proper execution and timely completion of the transmission schemes; and
- the transmission network was adequate and effective to ensure efficient evacuation and distribution of quality power.

Audit criteria

3.1.5 The following were the criteria adopted for evaluating the performance of the transmission works:

- Parameters contained in the plans/project reports for construction of the transmission lines and SS.
- Norms/targets and action plans for erection and augmentation of the transmission lines and SS.
- Instructions/guidelines issued by the Board for execution of the projects.
- Guidelines issued by the Central Electricity Authority (CEA) and the Tamil Nadu Electricity Regulatory Commission (TNERC).

Audit Methodology

3.1.6 The Audit followed the following methodology in the performance audit:

At the Headquarters office of the Board

- Analysis of the Board's master plans, Annual Transmission and Distribution programmes, Board's minutes, *etc.*, relating to the execution of transmission schemes by the Board.
- Examination of the budgets prepared for execution of the transmission schemes.

♦ Madurai, Trichy and Coimbatore.

- Scrutiny of records at the offices of the Chief Engineer (Transmission) and Chief Engineer (Planning) to assess the control mechanism in implementing the scheme.

At the General Construction Circles

- Examination of the files relating to scheme proposals, land acquisition, contract documents, break-down details of transmission of power, backing down of power generation at the generating stations, records in respect of inventory and stock registers, etc.

Audit Findings

The Audit findings arising from the performance review were reported (August 2008) to the Board as well as State Government and also discussed in the meeting of Audit Review Committee for State Public Sector Enterprises held on 3 October 2008. The meeting was attended by the Principal Secretary to the Government of Tamil Nadu, Energy Department, Chairman and Members (Generation, Distribution and Accounts) of the Board. The views expressed by the representatives of the State Government/Board in the meeting have been taken into consideration while finalising the performance review. The Audit findings are discussed in the succeeding paragraphs.

Transmission network and its growth

3.1.7 The Board's transmission network as on 31 March 2007 consisted of 696 EHT SS and 0.20 lakh CKM of EHT lines. The transmission and transformation capacity at 110 KV level covered the transmission of power at voltages above and below this level. The cumulative voltage-wise transmission facilities of the Board at EHT level during 2002-03 to 2006-07 are given below:

Particulars	2002-03	2003-04	2004-05	2005-06	2006-07
A. Total power transmitted (In MU)	44,326	47,192	50,244	54,380	61,170
B. EHT Transmission lines* (CKM)					
230 KV	5,326	5,665	5,857	6,152	6,380
110 KV	9,778	10,337	10,677	11,439	11,945
66 KV	1,370	1,370	1,353	1,288	1,257
TOTAL	16,474	17,372	17,887	18,879	19,582
C. Transformers capacity (MVA)					
400 KV	400	400	715	715	1,545
230 KV	8,009	8,249	8,454	9,389	9,739
110 KV	10,751	11,498	12,799	14,370	15,777

♦ There were no 400 KVA EHT transmission lines.

Particulars	2002-03	2003-04	2004-05	2005-06	2006-07
66 KV	227	240	240	240	240
TOTAL	19,387	20,387	22,208	24,714	27,301
D. Voltage-wise number of SS					
400 KV	7	7	7	7	8
230 KV	55	56	57	62	65
110 KV	482	504	532	549	574
66 KV	69	64	60	54	49
TOTAL	613	631	656	672	696

Transmission loss

3.1.8 Sizable portion of the energy purchased and produced in the generating stations and supplied to the consumers through the transmission and distribution networks is lost on account of:

- distance between the points of generation and consumption;
- inherent characteristic of the equipment and conductors used for transmission;
- transformation losses arising out of stepping up and down of the voltage levels at the SS and
- commercial losses resulting from pilferage, defective meter and unmetered supply, *etc.*

Loss on account of the first three items constitutes transmission loss, whereas the fourth item represents distribution loss. Since 2002-03, the Board had been adopting an *ad hoc* figure of 18 *per cent* as its T&D loss. Transmission loss is the difference between the energy injected from the generating stations/inter-state sources and energy fed into the 11/22 KV feeders. CEA had fixed (May 1992) a norm of four *per cent* for transmission losses. Audit scrutiny revealed that the percentage of transmission loss as worked out by the system studies wing of the Board was 10.60, 9.23, 4.55 and 4.64 for the years 2003-04, 2004-05, 2005-06 and 2006-07 respectively. The percentage of transmission loss as worked out by the Board was not correct and realistic as discussed below:

TNERC observed (March 2003) that the T&D losses were arrived at by the Board without any scientific basis and were based only on a random and discontinuous study carried out in selected regions. Therefore, it directed the Board to conduct independent Energy Audit at HT and LT levels and submit a report. However, the Board had not submitted its report to TNERC so far (October 2008).

The Board had assessed that it would require an investment of Rs. 2,200 crore to reduce the T&D loss by one *per cent*. As per the Board's statistics, during 2005-06, the transmission loss was reduced by 4.68 *per cent* from the level

prevalent in 2004-05. But the investment (Rs. 993.20 crore) on T&D programme during that year was meagre which did not match with the stated drastic reduction in the transmission loss in one year.

Total energy transmitted into the SS and net energy supplied to the consumers, as recorded by the data cell of the Board, is detailed below:

(Units in MU)

Sl.No	Particulars	2003-04	2004-05	2005-06	2006-07
1.	Total energy available for sale	47,192	50,244	54,380	61,170
2.	Net Energy supplied for consumption in the circles	39,990	44,272	46,893	54,016
3.	Transmission loss (1) – (2)	7,202	5,972	7,487	7,154
4.	Percentage of transmission loss (3/1 X 100)	15.26	11.89	13.77	11.70

The percentage of transmission loss reported by the Board was not correct.

It could be seen from the above that the percentage of transmission loss ranged from 15.26 to 11.70 during the four years from 2003-04 to 2006-07. This indicated that the transmission loss being reported by the Board was not correct.

The Board stated (September 2008) that the calculation of transmission loss was based on simultaneous reading at all the locations of the entire grid of Board as per TNERC guidelines. But the fact remained that the figures worked out by the Board were not realistic in view of the details given above.

Thus, the Board needs to re-examine its methodology for working out the transmission loss and ensure accuracy by reconciling the data compiled by the data cell and the system studies wing of the Board.

Target and achievement

3.1.9 The Master Plan of the Board, *inter alia*, includes the transmission schemes and its execution during the next five years based on the present load of the SS and future demand for power. The schemes included in the master plan are divided into Annual T&D programme. The Board, as per its Tenth Master Plan (financial year 2002-03 to 2006-07), planned to execute 297 SS works but included only 194 SS works in its Annual Plans and did not take up 103 SS works for execution. Instead, it included 34 SS, which were not completed in the Ninth Plan period up to 2001-02. Audit also noticed that the Board included 10 SS works in the Annual T&D programme without including the same in its Master Plan, on the ground of urgent requirement. The Board, however, could complete only 159 SS out of planned 238 SS.

Similarly, the Board planned 6,745 CKM of transmission lines during the Ten Plan period. But the Board could complete only 3,977 CKM of transmission lines during the same period.

During the period from 2002-03 to 2006-07, the Board did not complete 33 per cent of SS and 41 per cent of line works targeted by it.

The Board could not complete 79 SS (33 per cent) and 2,768 CKM of line work (41 per cent). The reasons for the shortfall as analysed by Audit were:

- delay in identification/purchase of land for SS works (*vide* Paragraphs 3.1.17 and 3.1.18);
- delay in commencement of the work indicating deficient planning (*vide* Paragraph 3.1.20); and
- delay in procurement of transformer, tower materials, *etc.*, (*vide* Paragraphs 3.1.21 and 3.1.22).

Instances of avoidable delays in execution of the SS schemes are discussed under Paragraphs 3.1.16 to 3.1.22.

Budgeting

3.1.10 The State Planning Commission approved an outlay of Rs. 5,914 crore for the T&D programme during Tenth Plan for development of power in Tamil Nadu. The annual allocation and the actual expenditure incurred on T&D programme is given below:

(Rupees in crore)

Year	Budget allocation			Revised allocation			Actual expenditure		
	Trans- mission	Distri- bution	Total	Trans- mission	Distri- bution	Total	Trans- mission	Distri- bution	Total
2002-03	245.00	287.00	532.00	240.58	287.00	527.58	316.71	291.76	608.47
2003-04	268.65	353.29	621.94	268.65	400.84	669.49	342.32	486.45	828.77
2004-05	480.63	569.83	1,050.46	338.63	320.48	659.11	305.69	335.43	641.12
2005-06	436.47	517.90	954.37	410.12	515.70	925.82	413.80	579.40	993.20
2006-07	524.09	416.90	940.99	584.00	676.01	1,260.01	747.89	739.83	1,487.72
TOTAL	1,954.84	2,144.92	4,099.76	1,841.98	2,200.03	4,042.01	2,126.41	2,432.87	4,559.28

Against the sanctioned outlay of Rs. 5,914 crore, the Board was allocated only Rs. 4,099.76 crore (69 per cent) and it spent Rs. 4,559.28 crore (77 per cent) on the T&D programme leaving a shortfall of 23 per cent during the Tenth Plan period. An amount of Rs. 459.52 crore was spent by the Board from its internal resources. Consequently, the Board could not take up all the schemes as envisaged in the Tenth Plan.

Execution of the projects

3.1.11 The transmission schemes consist of augmentation of the 230/110 KV SS and related feeders, laying of transmission lines, installation of power transformers and establishment of new SS. The schemes are implemented by different wings of the Board, *viz.*, (i) Planning wing at the Headquarters, examines the feasibility of the schemes and provides budget allocation, (ii) Transmission wing at the Headquarters procures the materials/equipments (iii) Operation and Maintenance units of the circle offices identify and acquire the

required land and (iv) General Construction Circles execute the schemes. Multiplicity of agencies under different Chief Engineers affected progress of the transmission works.

For effective implementation and timely completion of the schemes, a proper co-ordination among these agencies is desirable. Further, there should be a monitoring mechanism at the apex level of the Board. Audit observed that the Board did not have an effective system of co-ordination and monitoring of the transmission schemes as discussed below:

Absence of control mechanism

Absence of time schedule for completion of the works

The Board had not fixed any time schedule for completion of transmission schemes and it did not monitor the delays.

3.1.12 The Board had not fixed any time schedule for completion of the HT/EHT/SS works. TNERC, however, had prescribed (September 2004) the time schedule for completion of the HT/EHT works as under:

Sl.No.	Category	Time schedule for works	
		High Tension	Extra High Tension
1.	Involving extension and improvement	60 days	150 days
2.	Involving enhancement of power transformer/addition of power transformer	120 days	180 days
3.	Involving commissioning of new SS	180 days	270 days

Audit noticed that there were inordinate delays in completion of works as discussed in the subsequent paragraphs. The delays were not analysed by the Board to ascertain the causes, fix responsibilities and take corrective measures.

The Board stated (September 2008) that as per its norms, the time taken for establishment of 400 KV, 230 KV and 110 KV SS were 18, 12 and 9 months respectively after taking over the land required for the SS and finalisation of tenders. The reply is not acceptable as during subsequent verification, Audit found that no such norms were either fixed by the Board or communicated to its implementing circles.

Deficiencies in Management Information System

3.1.13 The GCCs prepared monthly returns on physical and financial progress of the transmission works implemented by them. The returns on financial progress were to be forwarded to the Chief Financial Controller (CFC) and the returns on physical progress were to be sent to the Chief Engineer (Transmission) of the Board.

Audit observed that CFC did not conduct review of the returns on financial progress of schemes defeating the purpose of generation of this MIS. Audit also noticed that in none of the schemes selected for audit (40 SS works), the

actual expenditure as on March 2007 indicated in the monthly returns sent to the CFC and CE (Transmission) tallied with the ledger account of the concerned GCC. The percentage of variation ranged between 3 and 612 in the three circles indicating casual approach in preparation of these returns.

The Board stated (September 2008) that the performance of the GCC was reviewed at Headquarters and further stated that based on the Audit observation, necessary instructions were being issued to follow up the MIS and use the same for managerial controls and decision making.

Absence of review of the envisaged benefits of T&D schemes

3.1.14 The Board, while approving the T&D schemes had stipulated the envisaged benefits in terms of reduction in line loss, improvement in voltage level and the load growth to be met by the schemes. However, the Board had not evolved a system to assess the actual benefits accrued and to verify effectiveness of the T&D schemes.

The Board stated (September 2008) that instructions had been issued to the field to furnish the details of reduction in line loss, improved voltage level, load growth and incremental sales after commissioning of the T&D schemes so as to ensure that the actual benefits as envisaged in the sanctioned scheme were really achieved.

Non-reconciliation of the cost of T&D schemes

3.1.15 The work order register maintained by the GCCs reflect the cost of T&D scheme as per the completion report. The asset-wise statement of expenditure from the work order register is also posted in the Capital Expenditure Register. In addition, the GCCs prepare a monthly statement of accounts indicating the cost of materials, works and equipments of the T&D schemes as reflected in the stores pricing ledgers and records of the accounts.

Audit observed that there was no mechanism to compare the cost of T&D schemes as reflected in the monthly statement of accounts with that of the capital expenditure statement to ensure correctness of the cost of the works. It was also observed that there was no system for analysing the variances between the estimated cost and actual cost on account of time over run, change in specifications, *etc.*, to have an effective control on the work and cost.

The Board stated (September 2008) that as per the existing instructions, the respective Superintending Engineers are required to analyse the reasons for the deviation between the estimated and the actual cost of the completed schemes and obtain revised approval of the competent authority if the actual cost exceeds by five *per cent.* But the fact remained that in none of the schemes test checked, such analysis was either done by the Superintending Engineer or by the Headquarter of the Board.

There was no system in the Board to arrive at the final cost of the completed schemes so as to analyse the variation between the sanctioned and the actual cost.

Execution of sub-station schemes

Delay in commissioning of the sub-stations

3.1.16 Establishment of a SS involves acquisition of land, leveling of the site, civil works, procurement and erection of transformers and other materials and energising the transmission lines. As such, timely commissioning of the SS requires proper planning and synchronisation of all the activities. During the five year period from 2002-03 to 2006-07, the Board commissioned 72 SS in the three GCCs at Madurai, Coimbatore and Trichy.

Out of 40 SS works, 21 were executed with the time overrun of 7 to 83 months.

Audit noticed that out of 40 SS works, 21 SS works (52.5 per cent) were commissioned with time over-run of 7 to 83 months as compared to the schedule of nine months prescribed by TNERC (detailed vide **Annexure-19**). The major reasons for delays are discussed below:

Pre-acquisition delays

Delays in identification of land

3.1.17 As per the existing procedure of the Board, the required land is to be identified by the Distribution circle and after obtaining the suitability report from the concerned GCC and after acquisition, land is handed over to the GCC for commencement of the work. Audit noticed that there were delays of six to 48 months in identification of the land in respect of three SS works*. An illustrative case of avoidable delay in identification of the land is discussed below:

In respect of the 230/110 KV SS at Palladam, the Distribution Circle, Coimbatore identified (March 2004) the land (value: Rs. 25.63 lakh). However, the same was not purchased as the Headquarters of the Board advised (August 2004) the Circle Office to explore the possibilities of reducing the price. As the seller refused to reduce the price, the Circle Office purchased (April 2006) other land at a cost of Rs. 42.42 lakh. Thus, the Board lost two years in the process. Non-purchase of the first identified land, price of which was marginally (four per cent) higher than the prevailing market price resulted in not only delay in completion of the SS but also payment of extra amount of Rs. 16.79 lakh on purchase of the alternate land. Thus, delay in completion of the SS deprived benefit to the Board by way of reduction in line loss to the extent of Rs. 12.90 crore per annum.

The Board stated (September 2008) that the land identified in March 2004 could not be purchased on account of the quoted price being higher than the guideline price. The decision of the Board was not prudent because the price demanded by the owner was only four per cent higher than the guideline value, whereas the cost of the alternate land purchased was higher by 66 per cent of the price of the first offer (March 2004). Had the Board finalised the

• Sub-stations at Palladam, Thaniamangalam and Karuvalur.

first offer, it would have also avoided the delay of two years in completion of the SS works.

Delays in acquisition of land

3.1.18 As per the procedure, the identified land is to be acquired within three months of identification. However, Audit noticed that there were delays ranging from 4 to 65 months in acquisition of the land for 13⁹ SS on account of:

- indecision about area of land;
- change of location of land;
- delay in inspection of land;
- furnishing inadequate data on proposed land to the Board's headquarters; and
- protracted correspondence between two wings of the Board.

The reasons for the delays in acquisition are given in **Annexure-19**.

Delays in handing over the land

3.1.19 The land acquired by the Distribution circle is to be handed over to the GCC without any delay. However, Audit noticed that there were delays in handing over the acquired land ranging from two to four months in respect of two SS[♦] for which there were no reasons on record.

Post acquisition delays

Delays in commencement of the works

3.1.20 As per the procedure in vogue, after taking over the land, the SS work is to be executed by the GCC. Before execution of these works, the GCC is required to finalise the route profile for the EHT line. In case the EHT line works are to be carried out along or within the boundaries of Railways and Telecom, necessary clearances from the concerned departments are also required to be obtained.

Audit noticed that there were delays ranging from 3 to 57 months in commencement of the SS works, finalising the route profile and getting approval from the Railways/Telecom for line works in respect of 11 SS* works. One such case as analysed in audit is given below by way of illustration.

In 11 SS works there were delays in commencement of works ranging from 3 to 57 months.

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- 9 Palladam, Thengampudur, Thaniamangalam, Othakalmandapam, Karamadai, Kalapatti, Devarayapuram, Karuvalur, Vadugampalayam, Neelambur, Vanur, A.Sathanur and Vaiyampatti
 - ♦ Vanur and A.Sathanur.
 - * Thengampudur, Thaniamangalam, Palayam, Othakalmandapam, A.Sathanur, Thanthoni, , Thozhuthur, Vaduvur, Vadugampalayam, Vanur and Vaiyampatti.
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The Board approved (June 2004) the proposal to upgrade the existing 66 KV Servalar power house switchyard into 110 KV SS at an estimated cost of Rs. 2.76 crore as revised (April 2005). Audit noticed that the scheme scheduled for completion during 2005-06 was completed in June 2008 as the work could not be taken up till April 2008 in the absence of line clearance by Board's Load Despatch Centre without assigning any reasons. In the meantime, the Board revised (May 2007) the cost estimate to Rs. 4.20 crore. The generation transformer purchased in November 2006 at a cost of Rs. 1.23 crore also remained unutilised up to June 2008. Due to the delay, the estimated scheme cost had escalated by Rs. 1.44 crore.

Delays due to non-availability of transformer

3.1.21 In execution of the substation works, erection of the required power transformer is to be ensured along with completion of the SS works so as to commission the SS without delay. Audit noticed in respect of five SS* works that the Board did not synchronise erection of the power transformers with the completion of SS and the delay ranged between 3 and 31 months. In addition, in respect of two SS* works, the Board failed to decide the capacity of power transformers in time.

Three such cases of delays are discussed below:

- The construction of 230/110 KV SS at Renganathapuram was completed at a cost of Rs. 18.51 crore in September 2007. After allotment (July 2007) of one number of 50 MVA power transformer, the Dindigul Electricity Distribution Circle Office requested for allotment of two numbers of 100 MVA power transformers in view of growing demand for power in that area. However, the Chief Engineer (Transmission) again allotted only one 50 MVA transformer, which was received in March 2008. The second transformer was yet to be received (October 2008). Thus, indecisiveness about the capacity of power transformer and subsequent delay in supplying the power transformers resulted in delay in commissioning of the SS.

The Board stated (September 2008) that it had not been procuring 50 MVA transformers in the recent years and the SS was commissioned in March 2008 by releasing transformer from other SS. The reply is not acceptable because the transformer allotted originally for this SS was cancelled (July 2007) on the request of the circle office to allot one 100 MVA transformer. The Board did not allot 100 MVA transformer as requested and allotted (March 2008) only a 50 MVA transformer by releasing it from another SS. Thus, the delay of eight months was mainly due to deciding the capacity of transformer which was avoidable.

- 110 KV SS at Chidambaram completed at a cost of Rs. 1.28 crore in May 2005 could not be operationalised till March 2007 due to non-availability of the required power transformer for which reasons were not on record.

♣ Renganathapuram, Karamadai, Vadugampalam, A.Sathanur and Chidambaram.
• Renganathapuram and Karamadai.

- 110/11 KV SS completed at Thiruviruthanpulli at a cost of Rs. 1.72 crore in February 2007 could be commissioned only in March 2008 due to delay in allotment of one 10 MVA power transformer.

The Board stated (September 2008) in general terms that the transformers were being allotted based on priority and at times transformers become unavailable to less needy SS. The reply is not tenable because when the Board completed the above mentioned SS in May 2005 and February 2007, immediate allotment of transformer had become imminent. However, the Board failed to prioritise allotment of the transformers till March 2007/March 2008.

Non-supply of the required materials

3.1.22 Audit observed that the Board did not provide the materials required for civil work and other SS work contributing to the delays of 3 to 18 months in completion of seven[#] SS works.

Delays in completion of SS works led to idle investment of Rs. 23.37 crore and loss of envisaged benefit of Rs. 116.29 crore.

The delays noticed in audit reflected deficient planning and co-ordination among the various wings responsible for implementation of the transmission works. Consequently, the avoidable time overrun had resulted in non-utilisation of materials/equipment purchased at a cost of Rs. 23.37 crore and erected at SS could not be commissioned for want of other materials. This also resulted in loss of envisaged benefit of Rs. 116.29 crore in the form of additional power evacuation, reduction in backing down of power and forced outages during the intervening period of delay, in addition to depriving the society of improved power supply (**Annexure-19**).

The Board, *inter alia*, stated (September 2008) that non/delayed supply of materials after placing the orders was mainly due to escalation in cost of the items and efforts were being taken to procure the material in time.

Loss of revenue due to delay in construction of sub-station

3.1.23 To evacuate 400 MW of power generated by an IPP and the Board's own gas turbine power plant in Ramnad district, the Board decided (January 2005) to establish a 230/110 KV SS at Valuthur at a cost of Rs. 80.47 crore. The turnkey contract for SS was awarded (February 2006) to EMCO Limited, Thane with a completion schedule of 12 months. The erection of the line work was also awarded on turnkey basis to two other firms (Bajaj Electricals, Mumbai and ICOMM Tele Limited, Hyderabad) in February and March 2006, with schedule of completion by September 2006.

Audit noticed that the turnkey contractors of both SS and line works completed the work only in September 2007, *i.e.*, after a delay of six months in establishment of the SS and 11 months in the case of the line works. Time overrun was due to delay in awarding the work and its execution by the contractors. During the period of delay of 11 months in commissioning the

Thaniamangalam, Renganathapuram, Palayam, Vanur, Vaiyampatti, Vaduvur and Vilathikulam.

SS, the Board resorted to back down of 215.97 MU of captive power generation from two captive power producers (Arkay Energy (Rameswaram) Limited and Sai Regency Power Corporation Private Limited), resulting in loss of revenue of Rs. 31.71 crore to the Board.

The Board stated (September 2008) that the delay in commissioning of the SS did not cause any loss to the Board as there was no fixed cost paid to the captive power generator. The reply is not acceptable as the Board resorted to backing down of less costly power due to delay which resulted in loss to the Board.

Establishment of a sub-station without demand

3.1.24 To mitigate the low voltage problems and based on the demand of people of Thuvarangkuruchi, the Board accorded (October 2003) approval for establishment of a 33/11 KV SS with eight MVA power transformer at Thuvarangkuruchi in Tanjore district at an estimated cost of Rs. 80 lakh. The SS work was commenced in May 2006. The Board also decided (August 2006) to establish a SS of the same capacity at Tamarankottai within a distance of three Km from Thuvarangkuruchi as the demand of public was endorsed by the Minister for Electricity. Accordingly, both the SSs were constructed and commissioned in November 2007 at a total cost of Rs. 2.48 crore having a capacity of eight MVA each.

Audit observed that the requirement of two SSs within a distance of less than three Km was not justified as the combined peak demand from November 2007 to August 2008 was only 6.28 MVA, which was well within the capacity of eight MVA transformer of a single SS. Thus, establishment of the two SSs without assessing the requirement resulted in avoidable expenditure of Rs. 1.31 crore.

The Board stated (September 2008) that both these places were load growth centres and two SS were erected considering future load growth and to mitigate the prevailing low voltage. However, the Board was aware that the new SS at one place was sufficient to cater to the low voltage problem of both the places and hence commissioning of two SS was not justified.

Purchase of land without complete verification of title of land

3.1.25 To improve the voltage at tail end areas in Kodanad, the Board proposed establishment of a 33/11 KV SS at Honatty in Nilgiris district and purchased (February 2006) the required land at a cost of Rs. 1.56 lakh after seeking the legal opinion regarding title of the land. When the construction of SS work was in progress, a petition was filed (December 2006) in the court questioning the legality of sale of land to the Board. Though, the work of construction of the SS was completed in March 2007 at a cost of Rs. 1.39 crore, the completed SS could not be put to use till date (October 2008) due to court case.

Audit observed that the Board purchased the land from an agent on a power of attorney. It was also observed that while purchasing the land (21 February

2006) the Board had not verified the encumbrance of the land up to date. In fact, some outside person had purchased 4.10 acre of land (8 April 2005) within the same survey number with overlapping boundaries. Consequently, the SS completed at a cost of Rs. 1.39 crore could not be put to use till date (October 2008).

The Board stated (September 2008) that the legal case was being closely followed up. But it did not elaborate on the above mentioned lapse.

Non-recovery of the cost of erection of SS from Government of Puducherry

3.1.26 During the years from 1999 to 2001, the Board executed erection of one 230 KV and three 110 KV SS works on behalf of the Government of Puducherry as deposit works. The cost of the works incurred by the Board, the amount received from the Government of Puducherry and the balance amount recoverable as on April 2008 are detailed below:

Sl. No.	Name of the work	Period of completion	Amount incurred	Amount recovered so far	Date of claiming the final bill	Balance amount to be realised
			(Rupees in crore)			
1.	110/KV SS at T.R.Patinam	January 2001	2.53	2.53	January 2006	NIL
2.	230/110 KV SS at Bagur	January 2001	18.43	17.61	November 2007	0.82
3.	110/22 KV SS at Eripakkam	March 1999	11.45	10.95	December 2007	0.50
4.	Upgradation of Karikal SS	January 2001	N.A	N.A	Not yet prepared	N.A.
	TOTAL		32.41	31.09		1.32

N.A: Not Available

From the above, it could be seen that the Board had taken more than five years for working out the final cost of the three projects after their completion and was yet to receive Rs. 1.32 crore. In respect of one project (serial number-4 of the table), the Board was neither aware of the final cost nor had the details of amount recovered from the Government of Puducherry even though the work was executed in 2001. The delay in realisation was due to delay in raising the claims by the Board as was evident from the fact that the Government of Puducherry had been sending repeated reminders to the Board calling for the details of final cost. However, the Board had taken its own time for working out the cost. Thus, the slackness of the Board in realising its dues led to an avoidable interest loss of Rs. 1.15 crore.

The Board stated (September 2008) that all efforts were being taken to realise the balance amount.

Installation of transformers for evacuation of power

Non-maintenance of transformers with equal levels of impedance

3.1.27 For evacuation of power from the generating stations through a 230/110 KV SS, two or more number of auto power transformers are required to be installed in parallel operation mode with identical and uniform levels of impedance (resistance). Any mismatch in the impedance levels of the power transformers would reduce the evacuation capacity of the SS and would ultimately result in either backing down of the power generation or forced load shedding.

Audit noticed that the Board did not install the power transformers with identical levels of impedance in two SSs as discussed below:

Shenbagaramanpudur 230/110 KV sub-station

3.1.28 Two numbers of 100 MVA auto power transformers in the 230/110 KV auto SS at Shenbagaraman (SR) Pudur in Kanyakumari district were commissioned in June 1998 and September 1999 and a third 100 MVA auto power transformer was commissioned in March 2006 to evacuate more power from the nearby newly developed wind electric generators.

It was noticed by Audit that the third auto transformer erected was having impedance of 9.98 *per cent*, whereas the earlier transformers had the impedance of 12.90 *per cent* and 12.23 *per cent* respectively. Due to this mismatch, the combined load had to be restricted to a maximum of 200 to 220 MVA only instead of 300 MVA and the wind mill generators were forced to backing down power generation to avoid overloading of the third auto transformer.

With a view to avoid overloading of the third transformer and to evacuate power at the full capacity, the Superintending Engineer (Wind Energy Development Circle), Tirunelveli requested (March 2006) the CE (Non-Conventional Energy Sources) of the Board to replace the third transformer with another one having impedance equal to the first two transformers. But, the third transformer had not been replaced so far (October 2008). This resulted in non-evacuation of available power of 16.35 MU during April 2006 to December 2007 and the Board had to forego a revenue of Rs. 80.09 lakh.

Ingur 230/110 KV sub-station

3.1.29 In respect of Ingur 230 KV SS (4X 50 MVA), Audit noticed that all the four auto transformers erected were having different impedance levels, *i.e.*, 12.26, 13.10, 10.50 and 11.84 respectively. As the impedance of the third auto transformer was less, the remaining auto transformers could not be loaded to their full rated capacity. As such, the combined load of power had to be restricted to a maximum of 171 MVA only instead of 200 MVA. The Ingur SS officials proposed (June 1999) to replace the existing four 50 MVA auto transformers with two 100 MVA auto transformers having identical percentage of impedance. While the first 100 MVA transformer was

commissioned in June 2007, the second one was commissioned in December 2007. Thus, from 2005-06 to 2007-08[◇], the Board resorted to load shedding, resulting in non-transmission of 24.53 MU of power involving loss of revenue of Rs. 7.82 crore.

The Board stated (September 2008) that it was difficult to match the percentage of impedance on all occasions. The reply is not acceptable because there was possibility of maintaining equal levels of impedance as proposed by the Board's own circle offices, but the Board failed to implement the same.

Delay in procurement of additional power transformers

3.1.30 For drawal of wind energy, the Board approved (October 2002) erection of 2X100 MVA auto transformers in the 230 KV SS at Kodikuruchi in Tirunelveli district. The first 100 MVA power transformer was commissioned in October 2005 and the second one was commissioned only in August 2007 after a delay of 21 months. The delay in erection of the second transformer caused overloading of the first transformer up to July 2007 necessitating the Board to back down the generation of available wind power to the extent of 60.55 MU resulting in loss of Rs. 2.97 crore during the above mentioned period.

3.1.31 Since commissioning of the SS at Othakalmandapam in Coimbatore District in April 2005, the SS was having only one 100 MVA auto power transformer against the sanction of two 100 MVA transformers. The second transformer was commissioned only in January 2007. Consequently, during the period of delay of 20 months from May 2005 to December 2006, the Board resorted to backing down of 13.64 MU of wind energy to avoid overloading of the lone transformer resulting in loss of Rs. 54.50 lakh. Thus, delay in procuring power transformers had not only resulted in loss of revenue to the Board but also deprived the benefit of providing adequate power to the consumers.

The Board stated (September 2008) that the second transformer would be generally commissioned after taking into account the loading of the existing transformer of such SS. But the fact remained that the second transformer was not allotted to these SS even after the condition of overloading of the first transformer as was evident from the report of the respective circle offices.

Execution of line works

Delay in replacement of the existing line

3.1.32 During the period 2002-03 to 2006-07, the Board executed 40 line works involving 3,977 CKM. Audit examined 14 line works involving 962 CKM (24 *per cent*) and noticed that the Board had not fixed any time schedule for completion of the transmission lines. However, the TNERC's Standard Performance Regulations 2004 had prescribed time limit for completion of the transmission works, which *inter alia*, stipulated that the improvement in EHT lines was to be completed within five months. Audit noticed that against this

◇ To the extent details of load shedding were available in the records of the Board.

norm, the Board had taken time ranging between 11 and 132 months for execution of eight line works which are detailed in **Annexure-20**.

From the annexure, it could be seen that the delays in line works were due to

- non-commencement of the work in time in four[♦] works for which there were no recorded reasons available at the GCCs;
- non-availability of line materials and tower parts in five[#] works;
- delay in obtaining the line clearances from the load despatch centre of the Board and administrative approval from the Board in respect of five^{*} works; and
- non-availability of bay for erection of the line in one^³ work.

Thus, the Board had not synchronised its activities to avoid the bottlenecks and consequently, it had to forgo the benefit of Rs. 7.68 crore on account of backing down of 89.15 MUs of wind and hydel energy and outage of 8.97 MUs during the delayed period of work. Further, the anticipated benefits such as reduction in transmission and distribution loss, stable transmission of power and supply of improved quality power to the consumers could not be ensured. The delays also resulted in non-utilisation of the line material of Rs. 10.28 crore. Illustrative cases of mismatch of activities causing delay are discussed below:

Due to delay in completion of line works, the Board lost revenue of Rs. 7.68 crore and on the other hand locked up funds of Rs. 10.28 crore on line materials.

- The requirement for replacement of 110 KV Pasumalai - Sembatty feeder was included in the T&D Programme of 2002-03. As the scheme required approval of route profile by the Power Telecom Co-ordination Committee (PTCC), the Board forwarded the route profile to PTCC in November 2003. However, PTCC gave approval for the route profile in November 2005, due to delay in furnishing requisite information by the Board itself. Audit observed that even after the line clearance, the work was not yet completed (October 2008) in full as the Board did not provide the required tower materials for the scheme. Between April 2003 and December 2007, the Board lost 5.26 MUs of energy valued at Rs. 1.85 crore, due to forced outages due to major breakdowns.
- The scheme of conversion of 110 KV single circuit line into 110 KV double circuit (DC) lines from Thuckalay to Kodayar power house for a route length of 40 Kms was included in the T&D Programme for 2000-01. The work was yet (October 2008) to be completed as there was delay in line clearance and issue of line material in time. This delay could have been avoided had the line clearance and materials were received in time. The delay of over seven years resulted in loss

♦ Ingur – Udumalpet, Arasur – Palladam, Udumalpet – Kongalnagaram and Kayathar – Checkanurani.

Ingur – Udumalpet, Negamam – Anthiyur, Kayathar – Checkanurani, Pasumalai – Sembatti and Nagercoil – Kodayar.

* Ingur – Udumalpet, Arasur – Palladam, Negamam – Anthiyur, Papanasam – Kayathar and Pasumalai – Sembatti.

³ Papanasam – Kayathar.

of 3.71 MU due to forced outages resulting in loss of Rs. 1.15 crore to the Board.

The Board stated (September 2008) that there were operational difficulties due to which line clearance could not be given and the budget availability was far less when compared to the number of pending schemes. The fact remained that had the Board provided funds in time, it could have avoided the occurrences of revenue losses and locking up of funds.

Mismatch in construction of sub-station and line work

3.1.33 Due to inadequacy of the existing 110 KV line to evacuate the anticipated additional wind energy of 100 MW to be generated by Suzlon Energy Limited (Suzlon), the Board approved (July 2005) establishment of a separate 230/33 KV SS at Amuthapuram and permitted Suzlon to construct the SS.

Audit noticed that though the related line works from Amuthapuram to Checkanurani and Kodikuruchi were completed (September 2007) at an estimated cost of Rs. 13.32 crore, the SS work was not yet completed (October 2008) by Suzlon as its wind energy farm was not ready for generation. Thus, mismatch in erection of line with SS erection resulted in locking up of funds of Rs. 13.32 crore.

The Board stated (September 2008) that the Amuthapuram SS works were nearing completion and the lines erected had facilitated evacuation of wind power from Kodikurichi to Checkanurani. The fact remained that the line was mainly for evacuation of wind energy to be generated by Suzlon. As Suzlon had not yet started wind energy generation till date (October 2008), optimum utilisation of the above line could not be achieved.

3.1.34 The Board took up (December 2005) conversion of the single circuit 110 KV line into DC lines between the SS at Pudupalayam and Negamam and completed (March 2006) the same at a cost of Rs. 3.77 crore. But one circuit of the DC lines could not be energised due to non-completion of the SS at Negamam, which resulted in idling of the line and deprived the consumers of the intended benefits.

3.1.35 Similarly, the conversion of Pollachi – Negamam 110 KV SC line with raccoon conductor into DC line with panther conductor was approved in July 2002. Out of the two circuits, one was completed and energised in April 2005 and the other circuit completed at a cost of Rs. 1.42 crore in January 2006, was kept idle till date (October 2008) due to non-provision of bay at Negamam SS. It reflected lack of synchronization of the related activities at Board's level.

The Board stated (September 2008) that the conversion work would be completed in November 2008.

Loss due to interfacing of wind mill generation

3.1.36 The Tuticorin Thermal Power Station (TTPS) has 10 numbers of 230 KV feeders to evacuate 1,050 MW of power generated from the power stations and 50 MW of wind power received from the S.R. Pudur SS through its switchyard. Wind power received in the TTPS switchyard could not be

evenly distributed among the 10 feeders due to low current carrying capacity of the feeders. Whenever the wind energy was imported into the TTPS feeders exceeding 50 MW, the generation of TTPS was forced to be reduced to avoid overloading of the feeders.

To avoid such grid disturbances, the CE (TTPS) requested (June 2005) to transmit the wind power directly to the load centre through some other transmission network and suggested (July 2005) that S.R. Pudur – TTPS line should be delinked at TTPS and connected at SIPCOT SS. However, these proposals were not considered by the Board till date (October 2008) and the power evacuation problem continued to persist at TTPS. The interfacing of wind mill generation was done in the existing feeders of TTPS, which led to back down of power generated at TTPS to the extent of 21.52 MU during March 2006 to March 2008. This resulted in a loss of profit* of Rs. 1.06 crore to the Board.

The Board admitted (September 2008) the problem of mismatch and stated that the same was resolved consequent to the completion of Abhisekapatty SS and the transmission lines between Kayathar and Checkanurani.

Non-recovery of the cost of dedicated transmission line

3.1.37 EID Parry (India) Limited, a co-generating power producer (CPP) having a captive power generation plant of 18 MW sold the surplus power to the Board for which the Board installed (March 2006) a dedicated 110 KV double circuit line for a length of seven Km at an estimated cost of Rs. 1.11 crore. Audit noticed that though the cost was to be borne by the CPP in view of Section 10 of the Electricity Act, 2003, the Board had not recovered the same from the CPP so far (October 2008).

The Board stated (September 2008) that work was carried out at its cost as per the Board's order of April 1999, which provided for bearing of the cost by the Board. The reply is not acceptable because the cost of the dedicated line was to be recovered as per the Electricity Act, which came into effect from 2003 *i.e.*, before installation of the said line.

Non-recovery of liquidated damages from an IPP

3.1.38 The Board entered (August 2004) into a power purchase agreement (PPA) with Arkay Energy Limited, an independent power producer (IPP), for purchase of power generated from its gas based power plant with a capacity of 52.8 MW at Valuthur village in Ramanathapuram district. The project was to be completed by 18 November 2005 and the Board was required to lay transmission line for evacuating the power. The Board laid transmission line for evacuation of power 60 days prior to the scheduled date of completion and thereby fulfilled its obligation. However, IPP commenced commercial operation only on 1 July 2006 *i.e.*, after a delay of 225 days for which the IPP was liable to pay liquidated damages (LD) of Rs. 3.80 crore to the Board as

Liquidated damages of Rs.3.80 crore was not recovered from an Independent Power Producer for the delay in completion of the project.

* Being the difference between the cost of generation of TTPS and wind mill.

per the terms of PPA. The Board had not raised any claim for LD so far (October 2008).

The Board stated (September 2008) that a committee was formed to study the various aspects involved in the delayed completion of the project and its report dated 20 February 2008 was being put up to the Board for approval.

Conclusion

The Board, to keep pace with the increase in generation capacity within and outside the State and to overcome the problem of overloading of the existing transmission facilities, had been establishing sub-stations and the connected transmission lines by framing schemes. But the schemes suffered from large scale delays. The Board did not monitor progress of the schemes by fixing time schedule for completion of the works. There were many deficiencies in execution of works and avoidable delays in acquisition of land, procurement of materials, equipments and power transformers due to non-synchronisation of the activities at Board's level. After completion of the transmission works, the Board did not assess the actual benefits accrued out of the schemes by comparing with the envisaged benefits. The progressive delays in overall completion of the schemes coupled with non-erection of required power transformers for the completed sub-station and non-maintenance of equal levels of impedance of transformers resulted in loss to the Board in the form of forced outages and backing down of the power, besides depriving the consumers of the uninterrupted quality power supply. The Board did not assess the transmission losses correctly. Thus, the Board is yet to carry out its transmission programmes in a systematic manner.

Recommendations

The Board should consider to:

- monitor the works execution by synchronising various activities *viz.*, acquisition of land, procurement and supply of line materials, *etc*;
- improve its Management Information System for monitoring and arresting the time overrun and cost overrun of the schemes;
- evolve a system for analysing the variance between the estimated and actual cost on account of time overrun, change in specification, *etc.*, to have control on the work and cost;
- assess the post implementation benefits of the transmission schemes *vis-a-vis* the targeted benefits; and
- assess the transmission losses in a scientific manner and take measures to reduce the same.

The matter was reported to the Government in August 2008; their reply was awaited (October 2008).

3.2 Operations of Natural Gas Turbine Power Stations

Highlights

Failure to undertake the maintenance works, as scheduled, resulted in additional expenditure of Rs. 17.49 crore on replacement of critical components of the gas turbines and payment of Rs. 7.55 crore to the Gas Authority of India Limited towards unutilised gas besides loss of generation of 154.85 MU during May 2004 to August 2005.

(Paragraphs 3.2.11 and 3.2.12)

Gas turbine generator tripped due to improper upkeep of backup resulting in a major break down at Kuttalam Gas Turbine Power Station leading to loss of generation of 808.74 MU from December 2006 to February 2008.

(Paragraph 3.2.14)

Regular maintenance of Gas Turbine Power Stations suffered due to want of spares resulting in loss of generation of 73.04 MU during June 2003 to April 2007.

(Paragraphs 3.2.15 and 3.2.16)

Due to lack of training of the engineers in the operation of gas turbine power stations, Dry Low Nox system could not be preset at Valuthur and Kuttalam gas turbine power stations which resulted in tripping of generators and consequential loss of generation of 35.60 MU during December 2003 to September 2006.

(Paragraph 3.2.18)

The Auxiliary consumption of power by the Gas Turbine Power Stations was in excess of the norm prescribed by the Central Electricity Authority during 2003-04 to 2007-08 resulting in loss of 74 MU.

(Paragraph 3.2.20)

Constraints in evacuation of power resulted in running the TGTPS, KGTPS and VGTPS at partial loads and frequent trippings of generators leading to loss of generation of 82.94 MU during February 2002 to April 2006.

(Paragraph 3.2.21)

Introduction

3.2.1 Consequent to the findings of natural gas in the Cauvery basin and Ramanathapuram District, the Tamil Nadu Electricity Board (Board) decided between October 1996 and March 1999 to establish gas turbine power stations (GTPS) on combined cycle mode at Tirumakottai, Valuthur and Kuttalam. After obtaining techno economic clearance from the Central Electricity Authority (CEA) between February 2001 and December 2002, these power stations were commissioned during February 2001 to March 2004. While the power station at Tirumakottai (TGTPS) was commissioned in February 2001 with an installed capacity of 107.88 MW at a cost of Rs. 305 crore, the power stations at Valuthur (VGTPS) and Kuttalam (KGTPS) were commissioned in March 2003 and March 2004 with installed capacity of 95 MW and 101 MW at a cost of Rs. 346 crore and Rs. 345 crore respectively. The natural gas required for these power stations was to be supplied by Gas Authority of India Limited (GAIL) as per the agreements between GAIL and the Board. These power stations are designed to operate gas turbine under the open cycle* mode and gas turbine and steam turbine together under the combined cycle♦ mode. As these power stations were in operation for four to seven years, the operational performance of these power stations was reviewed by Audit.

Scope of Audit

3.2.2 The performance audit was conducted between September 2007 and April 2008 covering the operational performance of all the three gas based power stations during the period from 2003-04 to 2007-08. The audit checks were conducted covering 60 files on three Engineering Procurement and Construction (EPC) contracts valued at Rs. 1,040 crore, gas allocation files and records relating to construction of evacuation feeders costing Rs. 27.83 crore. Daily log books relating to operation and maintenance of GTPS and eight major purchase orders valuing Rs. 52.09 crore relating to repair and records of periodical inspections of the plants were also scrutinised.

Audit objectives

3.2.3 The performance review was conducted with a view to ascertain whether:

- the operational performance of the plants was in accordance with the designed parameters;
- the plants were operated economically, efficiently, and effectively; and
- the projects complied with the requirements to safeguard the environment.

♣ The operation of gas turbine alone for power generation.

♦ The operation of gas turbine and steam turbine simultaneously for power generation.

Audit criteria

3.2.4 The criteria adopted for assessing the achievement of audit objectives were:

- parameters and norms fixed for operation of the gas turbines and other equipments;
- terms of the gas supply agreement with the GAIL; and
- environmental laws and provisions contained in the Water (Prevention and Control of Pollution) Cess Act, 1977 and Air (Prevention and Control of Pollution) Act, 1981.

Audit methodology

3.2.5 The audit methodology adopted for attaining the audit objectives with reference to the audit criteria included examination of the Detailed Project Reports (DPRs); sanctions accorded by the Government, CEA and other regulatory bodies; minutes and agenda notes of the meetings of the Board; budgets, targets and reports submitted by the plants; tender and purchase files; operational records; records relating to pollution control; MIS reports and issue of audit enquiries and interaction with the Management.

Audit findings

Audit findings arising from the performance review were reported (August 2008) to the State Government and the Board and also discussed in the meeting of Audit Review Committee for State Public Sector Enterprises held on 3 October 2008. The Principal Secretary to the Government of Tamil Nadu, Energy Department and the Chairman and Members (Generation, Distribution and Accounts) of the Board attended the meeting. The views expressed by the representatives of the Board had been taken into consideration while finalising the performance review. The Audit findings are discussed in the succeeding paragraphs.

Operational performance

Process

3.2.6 The natural gas is mixed with air for combustion and the energy generated therefrom is used to run the gas turbine. The heat of the exhaust hot gas from the above operation is utilised to generate steam, which is used to run the steam turbine.

3.2.7 Based on the installed capacity and ambient temperature, Tamil Nadu Electricity Regulatory Commission (TNERC) fixes annual target for generation at 80 *per cent* of the Plant Load Factor (PLF) for each gas based power station. Accordingly, the Board regulates the operations of the GTPS.

Generation of power

3.2.8 The following table gives the details of targets for generation fixed by TNERC, actual generation of power, shortfall in generation and PLF by all the GTPS during 2003-04 to 2007-08:

Sl. No.	Performance Indicators	Name of the GTPS	2003-04	2004-05	2005-06	2006-07	2007-08
1.	Installed Capacity	TGTPS	107.88 MW				
		VGTPS	95.00 MW				
		KGTPS	101.00 MW				
2	Target for Generation (in Million Units)	TGTPS	756	756	756	756	756
		VGTPS	665	665	665	665	665
		KGTPS	---	707	707	707	707
3	Actual generation (in Million Units)	TGTPS	724	763	573	704	679
		VGTPS	666	558	697	728	611
		KGTPS	---	641	654	455	68
4	Shortfall in generation (in Million Units)	TGTPS	32	---	183	52	77
		VGTPS	---	107	---	---	54
		KGTPS	---	66	53	252	639
5	Plant Load Factor (In percentage)	TGTPS	77	81	61	74	72
		VGTPS	80	67	84	87	93
		KGTPS	---	73	75	69	8

It could be seen from the table that:

- Except for 2004-05, there was shortfall in generation which ranged from 32 to 183 MU of power in TGTPS.
- VGTPS could not achieve the targeted generation only in the years 2004-05 and 2007-08;
- In KGTPS shortfall in generation increased from 66 MU in 2004-05 to 639 MU in 2007-08; and
- During 2007-08, the actual generation was lower than the target in all the three plants.

Thus, failure to achieve the generation target resulted in shortfall of 1,515 MU of power in all the three stations during the period 2003-04 to 2007-08. The reasons for shortfall are discussed in the subsequent paragraph (3.2.9). In the light of good performance of VGTPS, it is necessary that the Board makes efforts to increase the performance of the other two units at par with VGTPS.

As regards PLF, it could be seen from the table that only VGTPS could achieve PLF of 80 *per cent* fixed by TNERC in all the five years except during 2004-05, TGTPS could achieve the target in 2004-05 only and KGTPS could not achieve the target in any of the five years.

Shortfall in generation

3.2.9 The shortfall in generation occurred due to operation of the GTPS under partial load and due to forced outages. Audit analysed the reasons for shortfall in generation as under:

- partial load operation of the power stations due to operation of the power stations below standard PLF and constraints in evacuation of power;
- forced outages of GTPS; and
- reduction in flow and pressure of the gas supplied to GTPS.

While the first two reasons for shortfall were controllable through effective monitoring of operations of the plants, the other reason stated was beyond the control of the Board. The controllable factors are discussed in succeeding paragraphs.

Forced outages

3.2.10 Forced outages are unscheduled outages caused by factors like lack of preventive maintenance, lack of spares and deficiencies in operation of the plant, *etc.* Details of total available hour, actual hours operated, shut down hours and hours of planned outages and hours of forced outages are given in **Annexure-21**.

It could be seen from the Annexure that forced outages:

- increased from 325 hours in 2003-04 to 471 hours in 2005-06 and further declined to 159 hours in 2007-08 in TGTPS.
- increased from 1,126 hours in 2004-05 to 7,622 hours in 2007-08 in KGTPS.
- remained high in VGTPS during 2004-05 and 2007-08.

Audit analysis revealed that the shortfall in generation due to forced outages (16,275 hours) was 13.27 *per cent* of the total available hours (1,22,640 hours). Thus, the Board had lost generation of 1,367.67 MU. Occurrence of the forced outages was mainly due to controllable reasons like non-adhering to maintenance schedule (Paragraph 3.2.12 to 3.2.14), non-replacement of equipments in time (Paragraph 3.2.15 and 3.2.16), acceptance of machinery without conducting initial mandatory test (Paragraph 3.2.17) and inadequate training in the operation of GTPS (Paragraph 3.2.18).

Maintenance

3.2.11 For economic and efficient operations of power plant, regular maintenance of machinery is necessary. Maintenance are of two types *viz.*, scheduled maintenance of machinery as prescribed by Original Equipment Manufacturer (OEM), and routine day-to-day maintenance of machinery. As per the recommendation of OEM, the scheduled maintenance was to be carried out after every 8,000 hours *i.e.*, annually for combustion inspection and after

Failure to take up scheduled/routine maintenance resulted in additional expenditure of Rs. 17.49 crore besides payment of Rs. 8.51 crore to GAIL without drawal of gas.

24,000 hours of operation, hot gas path inspection (HGPI) is also to be carried. CEA, while emphasising the maintenance management, had stressed the necessity to have a written maintenance policy for the power plants. However, the Board had not evolved its maintenance policy incorporating the recommendations of OEM regarding combustion inspection, HGPI, etc.

Instances of failure of the Board to carry out scheduled maintenance and routine maintenance leading to loss of generation of 1,036.63 MU besides incurring avoidable expenditure on procurement of spares for replacement amounting to Rs. 17.49 crore and payment of Rs. 8.51 crore for unutilised gas are discussed below:

Scheduled maintenance

3.2.12 Audit scrutiny of operation and maintenance records of GTPS revealed that the first combustion inspection which was to be carried out after completion of 8,000 hours of operation of GTPS, was conducted after 12,298, 11,228 and 11,745 hours in TGTPS, VGTPS and KGTPS respectively. However, the management did not record reasons for not adhering to the schedule of inspection. Failure to take up the inspection as per time schedule in two GTPS and its consequences are discussed below:

- Combustion inspection at VGTPS was taken up after tripping of the gas turbine in May 2004 after operation of 11,228 hours. After carrying out replacement of damaged parts of gas turbine and calibration of fuel nozzle at a cost of Rs. 8.03 crore, the GTPS commenced operation on 1 August 2004. Consequently, VGTPS suffered loss of generation of 96.67 MU[♣] and paid Rs. 5.02 crore for the Minimum Guaranteed Off-take quantity of gas to GAIL as per the agreement.
- Similarly, KGTPS was also forced to shut down during July and August 2005 for carrying out the combustion inspection and replacement of damaged equipments at a cost of Rs. 9.46 crore. This resulted in loss of generation of 58.18 MU[♠] and payment of Rs. 2.53 crore for unutilised gas.
- In both the cases, the GTPS were yet to be taken over from BHEL. Therefore, the Board asked BHEL to carry out the above inspection and repairs. However, BHEL refused to attend the maintenance work stating that it was the responsibility of the Board. The matter was yet to be resolved (October 2008).

The Board stated (October 2008) that BHEL was requested to attend the defects in VGTPS and KGTPS. As BHEL did not respond for replacing the damaged parts, the Board had to procure the required parts and the plants were recommissioned. The Board added that as the plant was under the control of BHEL even when the gas turbine had worked for more than 11,000 fixed hours, the entire responsibility to carry out any mandatory inspection at 8,000

♣ Worked out for 53 days multiplied by 95 MW capacity at 80 per cent PLF.
♠ Worked out for 30 days multiplied by 101 MW capacity at 80 per cent PLF.

hours rested with BHEL only. The Board further stated that the cost of spares, the charges paid to service providers and the charges paid to GAIL for non-utilisation of gas were fully recovered from BHEL. However, the fact remains that the amount in respect of VGTPS had been withheld by the Board and the matter was yet to be settled by BHEL. Further, Board had not initiated any action to recover the amount in respect of KGTPS.

Regular maintenance

3.2.13 Regular maintenance of critical parts of machinery and back ups for running the machinery even after tripping are vital not only for smooth operation of GTPS but also to avoid tripping of running machinery and consequential damages to such machinery. Audit noticed lapses in such maintenance, as discussed in succeeding paragraphs.

3.2.14 110 KV Tiruvarur feeder connected to KGTPS tripped on 23 December 2006. This created cascading effect of tripping in all the other feeders linked to KGTPS leading to black out condition. Under such circumstances, the gas turbine would run even after tripping for about 20 minutes and lubricant oil was to be supplied either from the auxiliary oil pump or from the emergency oil pump to avoid damage to the bearings and the turbine generator shaft. As back up for supply of lubricant oil, diesel generator (DG) set and 125 Volt DC battery (VDC) were to be maintained. In case of failure of power, the emergency oil pump would become functional either with the help of battery or diesel generator set.

Failure to ensure proper upkeep of back ups for supply of lubricant oil to the gas turbine generator during tripping resulted in a major breakdown of gas turbine generator leading to loss of 808.74 MU.

Audit noticed that both the back ups did not work on 23 December 2006. Consequently, the lubricant oil supply to the gas turbine was cut off and the gas turbine, gear box and the generator got heavily damaged leading to shutdown of the plant up to 11 February 2008 resulting in loss of generation of 808.74 MU. A High Level Committee formed to ascertain the causes of failure and to fix responsibility concluded that damage to the machinery occurred due to mechanical fault.

Audit analysis revealed the following:

- The DG set tripped due to overload condition, which could have been avoided by limiting the load connected to the DG set only to the essential requirements in the plant.
- Single Valve Regulated Lead Acid (VRLA) battery was not reliable for power station operations.
- The battery had failed on many occasions in the past to render proper service. Thus, the battery was not kept in the state of readiness.
- The VRLA battery and the DG set were not subjected to daily checks.

Thus, the failure to ensure proper upkeep of the battery and overloading of the DG set caused the break down.

The Board stated (October 2008) that non-availability of emergency oil pump was due to misbehaviour of the VRLA battery bank, which was unexpected.

The reply is contradictory to the fact that VRLA battery bank had failed on various occasions even prior to 23 December 2006 as seen from the log book and review of the log book would have enabled the Board to take corrective action to maintain the VRLA battery bank in proper working condition. However, this was not carried out.

Non-maintenance of spares

3.2.15 The GTPS draws atmospheric air through inlet air filters for the purpose of combustion of gas. The filters help to maintain the air purity. Apart from regular maintenance of these filters they are required to be replaced at least once in two years as per the recommendation of OEM or earlier if the ambient air around the plant was polluted sooner than the specified period.

Audit, however, noticed that the Board did not change the air filters since commissioning of these units and no action was taken to keep enough stock of air filters to meet contingency of failure.

A review of the log books of KGTPS relating to the year 2006-07 revealed that the output of gas turbine had reduced to a large extent due to the problem of inlet air condition to the gas turbine as detailed below:

- On 27 February 2006, the gas turbine tripped due to high inlet air differential pressure. Later to cope up with the high inlet air differential pressure, the load of the gas turbine generator was maintained around 40 MW and the Steam Turbine Generator at 26 MW against the target of 80.8 MW fixed by the TNERC. The position continued up to the end of April 2006.
- Periodical replacement of the air filters was not carried out which had resulted in lower output of the gas turbine and steam turbine leading to loss of generation of 21.67 MU during February 2006 to April 2006.
- Even though the unit tripped several times during May 2006 to April 2007 till the filters were changed, the Board had attributed different reasons for the trippings.
- Similarly, the load of the gas turbine in VGTPS also reduced frequently from October 2006 to April 2007 due to choking of the inlet air filters. As a result, the load of the VGTPS was reduced to avoid trippings of the unit resulting in loss of generation of 6.78 MU.
- Despite above problems, the order for purchase of 842 sets of air filters was placed with Oman Filter Industry Company, Oman only in September 2006 and the defective filters were changed in all the three GTPS in April 2007.

The Board stated (October 2008) that the OEM had not mentioned that the inlet air filters were to be renewed every two years. VGTPS was established in dry area conducive for the operation of Gas Turbine Power Plant. However, there was unexpected heavy snow/fog during the reported period in VGTPS and KGTPS, which caused running of the plant at reduced capacity

temporarily. The reply is not convincing as the expected life of filters was two years and the Board was aware of the need for replacement of the air filters. Further, the fact remained that the load reductions were resorted to in these GTPS during day time also when there was no problem of fog/snow.

3.2.16 In TGTPS two Gas Booster Compressors (GBC) were installed to operate alternatively, to avoid shutdown of the plant due to non-availability of GBC. When the dry gas seal in one of the GBCs failed at the time of erection (January 2001), BHEL utilised the spare one available under mandatory spares. Subsequently, when one of the GBC failed, the other was put into operation again after reconditioning of the gas seal. As this failed again, the Board depended on only GBC available for operation of the plant. The new seal for the replacement of the one taken from the mandatory spares was supplied in August 2003. Meanwhile, during June and July 2003, TGTPS faced shut downs due to failure of the only working GBC and suffered loss of generation of 44.59 MU[♥] and had to pay Rs. 96.08 lakh for unutilised gas.

Acceptance of defective machinery

3.2.17 EPC contract awarded (December 2002) to BHEL for a value of Rs. 345 crore provided for inspection of generators at manufacturer's site prior to their transportation to the GTPS.

Audit noticed that:

- the Board had not inspected the generators at the manufacturer's (GE) site prior to transportation to the respective GTPS.
- even during the trial run (December 2003) vibrations in the exciter were noticed in KGTPS which were rectified by the supplier.
- the unit, again tripped on 12 May 2004 due to high vibration in the stator of the exciter due to loosening of one of the permanent magnets which caused damage to the stator, distortion to the bearing housing and permanent magnet pedestal. Consequently, the exciter shaft and the permanent magnet assembly were sent (18 May 2004) to BHEL for rectification. The assembly was received back on 8 June 2004.
- Though the gas turbine could be started on 19 June 2004 after the rectification work, yet it could be synchronised with the grid only on 6 July 2004 due to persistent vibration and high exhaust temperature resulting in outage for 54 days. This, in turn resulted in loss of generation of 28.39 MU.

Persistent vibration and high exhaust temperature due to non-carrying out site inspection of gas turbine assembly led to loss of generation of 28.39 MU.

Had the inspection of the gas turbine assembly at the GE site been undertaken by the Board, the loss of generation could have been avoided.

The Board stated (October 2008) that the "full speed no load tests" were not conducted at GE's work as it would cause delay in supply of the gas turbine and BHEL's works at Hyderabad had no facility of fuel supply for conducting the test. However, the fact remains that full speed no load test was not

♥ Worked out on the basis of generation for previous month.

conducted either at the GEs work or at the unit of BHEL, which would have enabled the Board to ascertain the vibration in the exciter at the time of procurement itself.

Inadequate training in operation

3.2.18 The Dry Low NOx (DLN) system regulates the flow of air fuel mixture to the combustion chamber of the gas turbine according to the load and minimises the exhaust emissions. Audit noticed that whenever the load of VGTPS and KGTPS was reduced beyond a certain limit, due to high exhaust temperature, the DLN system and the gas turbine tripped resulting in shutdown of the plants. This required special training to the operating personnel for presetting the DLN system. However, the Board did not train its staff. Hence, the failure to preset the DLN tuning to the actual operating conditions resulted in trippings of the generators and consequently 35.60 MU of generation was lost during the period from December 2003 to September 2006. These trippings could have been avoided had the Board preferred to train its engineers at the contractor's work place in the operation and maintenance of the GTPS as contemplated in the contract.

The Board stated (October 2008) that as the DLN system was proprietary in nature, GE/BHEL were not willing to train the Board's staff to tune the DLN system. The reply is not convincing as the EPC contract provided for training of the Board's staff in the operation of GTPS at OEM's works and there was no record to show that the Board approached BHEL for training its staff.

Cost of generation

3.2.19 The unit cost of generation as envisaged in the DPR of each of the GTPS, actual unit cost of generation and average realisation per unit for five years period ending 31 March 2008 are detailed in the **Annexure-22**. It could be seen therefrom that though the unit cost of generation was lower than the sales realisation in respect of all the GTPS, yet it:

- was higher than the DPR cost by 4 paise to 45 paise in KGTPS; and
- was well below or equal to DPR cost in VGTPS and TGTPS.

The reasons, as analysed by audit, for increase in the cost of generation at KGTPS were:

- avoidable expenditure on maintenance and payments made for unutilised gas due to forced outages and
- auxiliary consumption in excess of norm.

The Board stated (October 2008) that tariff furnished in DPR was only tentative and this would vary according to the fuel cost and as per the actual capital investments. Lower generation due to supply of lesser quantity of gas by GAIL and increase in fuel cost were the factors, which contributed to the increase in tariff. However, fact remains that the forced outages pointed out by audit were controllable and would have resulted in reduction in cost of generation at KGTPS.

Auxiliary consumption of power

3.2.20 Auxiliary consumption is the energy used by the power station for running its machinery and common services. CEA, while according the techno economic clearance, had taken into account the auxiliary consumption of power by the Gas Booster compressor of 2.5 MW capacity installed in all the three power stations to boost the gas pressure from 2 kg/cm² to 26 kg/cm² and fixed (2001/2002) the norm for auxiliary consumption in respect of TGTPS at 4.73 per cent, VGTPS at 5.26 per cent and for KGTPS at 5.30 per cent. On the other hand, TNERC fixed (March 2003) the norm of three per cent.

Failure to achieve the CEA norms for auxiliary consumption resulted in loss of 74 MU.

The details of gross generation, norms fixed by TNERC and CEA, excess auxiliary consumption over norms, cost of generation per unit and loss of revenue are detailed in **Annexure-23**. It could be seen from the Annexure that all the three units failed to achieve even the CEA norm during the period under review (except for VGTPS in 2003-04). The excess auxiliary consumption resulted in loss of 74 MU. Reasons, as analysed by audit, for excess auxiliary consumption were:

- the auxiliaries were required to run/maintain normally even when plants were operated at partial loads.
- frequent trippings of the generating units due to mechanical defects and poor maintenance of the machinery led to frequent start ups which increased the auxiliaries consumption.
- power stations after every restart took minimum period of five to six hours to attain maximum generation during which period the auxiliaries were required to be maintained in normal working condition.

The Board, *inter alia*, stated (October 2008) that the performance of the gas turbine was fully dependant on the ambient air conditions like temperature and humidity. In respect of TGTPS, GAIL was extending gas supply ranging from 3.60 to 4.00 lakh SCMD against 4.50 lakh SCMD due to non-availability of gas. Though this forced the plant to operate at partial load, all the auxiliaries were to be kept in service continuously resulting in excess auxiliary consumption. The reply of the Company is not convincing as CEA had fixed all the norms considering the norm for auxiliary consumption of power after taking into account the ambient temperature, *etc.* prevalent in each station.

Infrastructural constraints

During February 2002 to April 2006, there were frequent trippings due to constraints in evacuation of power, which led to loss of generation of 82.94 MU.

3.2.21 The Board planned (between August 1999 and December 2002) erection of feeders for evacuation of power from GTPS and they were to be completed by the time GTPS were commissioned. However, Audit noticed that there were delays in erection of or to make available the required feeders for evacuation of power leading to operation of GTPS at partial loads and consequent loss of generation as discussed below:

- The Board did not assess the space required for additional bay at Pattukotai and did not make available three numbers of current

transformers in time. This delayed the commissioning of two^o of the three feeders forcing TGTPS to operate at partial load besides forced outages during February 2002 to November 2004. It resulted in loss of generation of 10.23 MU.

- Failure to strengthen the conductors of two^o “Line in and Line Out” 110 KV feeders and non-completion of the third feeder for want of tower materials forced load reduction and tripping of generators of KGTPS leading to loss of generation of 29.44 MU during April 2004 to April 2006.
- Linking of an independent power producer and three Captive Power Producers (CPP) with the grid through the switchyard of VGTPS forced reduction of load at VGTPS resulting in loss of generation of 14.93 MU.
- The Board allowed a CPP (Arkay Energy Ramaeswaram Limited) connected to the switchyard of VGTPS to generate in excess of the permitted limit forcing VGTPS to reduce generation by 28.34 MU during March 2006 to July 2007.

The Board stated (October 2008) that the delay in TGTPS was due to various practical difficulties experienced at site which were inevitable. As per the directions of TNERC, whenever any margin was available due to reduction in generation of any or all of the generating plants, the Arkay CPP was permitted by the load despatch centre to generate in excess. However, Audit noticed that at various occasions VGTPS was directed by the load despatch centre to reduce the load and at the same time the CPP was allowed to generate in excess. Therefore, the reply was not based on facts.

Environmental issues

3.2.22 The Ministry of Environment and Forest accorded (August 2002) provisional clearance for the VGTPS. Tamil Nadu Pollution Control Board (TNPCB) issued (October 2002) the consent to establish the project and its operation subject to fulfilment of certain conditions. Audit observed that:

- even after four years of commissioning of the power station, regular monitoring of the ambient air quality was not carried out by the Board;
- though online monitoring mechanism was provided in the power station to monitor the pollutants in the flue gas, readings were not taken regularly to analyse the impact of flue gases on the environment. Moreover, such readings were not furnished periodically to the TNPCB and
- all the parameters in the effluent water samples were in excess of the norms.

^o 1. TGTPS - Madhukur – Pattukottai and 2. TGTPS - Tiruvarur.

^o 1. KGTPS – Palaiyur – Kadalangudi and 2. KGTPS – Kumbakonam - Mayiladuthurai

Interest subsidy

3.2.23 The Board availed loans of Rs. 720 crore from Power Finance Corporation Limited (PFC) for execution of the three projects at interest rates ranging from 8.25 to 15 *per cent per annum*. As per the loan agreements entered with PFC, these projects were to be completed by January 2001, December 2002 and March 2005 respectively. For timely completion, the Board was eligible to get interest subsidy of four *per cent* (which was reduced to three *per cent* from April 2002) from the Government of India under the Accelerated Generation and Supply Programme through PFC. These projects were commissioned in February 2001, March 2003 and March 2004.

Audit noticed that:

- Only Rs. 2.01 crore was received as interest subsidy as against the eligible subsidy of Rs. 31.28 crore in respect of VGTPS.
- The Board did not approach PFC for obtaining the interest subsidy of Rs. 17.18 crore in respect of TGTPS.
- The Board did not have any system or mechanism to ascertain the correctness or otherwise of the amount received as interest subsidy from PFC.

The Board stated (October 2008) that whenever the subsidy was released by the Ministry of Power, the same was passed on to the Board. However, the Board did not furnish the details of subsidy received and there was no record to show that the Board had claimed the interest subsidy from PFC.

Conclusion

Shortfall in generation due to partial load operations of gas turbine power stations and forced outages resulted in loss of generation of 1,515 MU during a period of five years ended March 2008. In spite of longer forced outages, operational performance of Valuthur Gas Turbine Power Station was consistently above the norm except during 2004-05 and 2007-08 when its generation fell marginally below the target fixed by Tamil Nadu Electricity Regulatory Commission. On the other hand, it was below the norm in Tirumakottai Gas Turbine Power Station and Kuttalam Gas Turbine Power Station during the above period. Lack of scheduled and regular maintenance resulted in loss of generation on account of forced outages besides, damage to critical equipments. Further, payments for unutilised gas to Gas Authority of India Limited were made on account of forced outages. Acceptance of machinery without initial inspection and lack of training to Board's Engineers aggravated the above problems. The Board failed to monitor and control the auxiliary consumption of power. Inadequate feeder facility for evacuation of power generated, resulted in frequent instances of partial load operations, backing down of generation and tripping of turbines. Power stations did not monitor regularly the quality of ambient air and effluents to maintain them within the norms.

Recommendations

The Board should consider to:

- **achieve stipulated Plant Load Factor by closely monitoring the functioning of deficient plants;**
- **ensure timely maintenance of the plants, as recommended by the original equipment manufacturers;**
- **maintain adequate stock of mandatory spares;**
- **ensure the availability of adequate and effective transmission system to evacuate the power well before the commencement of generations in the power plants; and**
- **monitor the quality of ambient air and effluents to maintain them within the standards prescribed by the Tamil Nadu Pollution Control Board.**

The matter was reported to the Government in August 2008, their reply was awaited (October 2008).