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Report No. 18147

PERFORMANCE AUDIT REPORT

INDIA

SECOND FARAKKA THERMAL POWER PROJECT (LOAN 2442-IN)

June 29, 1998

Operations Evaluation Department

Currency Equivalents (annual averages)

Currency Unit = India Rupees (Rs)

1986	US$1.00	Rs. 13.00
1987	US$1.00	Rs. 13.92
1988	US$1.00	Rs. 16.23
1989	US$1.00	Rs. 17.50
1990	US$1.00	Rs. 22.74
1991	US$1.00	Rs. 26.20
1992	US$1.00	Rs. 31.20
1993	US$1.00	Rs. 31.46

Average Rate during project implementation period: US$1 = Rs. 21.80

Abbreviations and Acronyms

CEA	Central Electricity Authority
CIL	Coal India Limited
CPS	Cycle per second
ECL	Eastern Coalfields Limited
EREB	Eastern Regional Electricity Board
ESP	Electrostatic precipitator
GOI	Government of India
KSPS	Kahalgaon Superthermal Power Station
NTPC	National Thermal Power Corporation
OED	Operations Evaluation Department
PAP	Project affected person
PCR	Project Completion Report
PLF	Plant load factor
R&R	Resettlement and rehabilitation
SEB	State Electricity Board
TSP	Total suspended particulate

Fiscal Year

Government: April 1 - March 30

Director General, Operations Evaluation	:	Mr. Robert Picciotto
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The World Bank
Washington, D.C. 20433
U.S.A.

Office of the Director-General
Operations Evaluation

June 29, 1998

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: **Performance Audit Report on India
Second Farakka Thermal Power Project (Loan 2442-IN)**

Attached is the Performance Audit Report prepared by the Operations Evaluation Department (OED) on the above project. The loan, for the amount of US$300.8 million equivalent was approved in FY84 and closed in April 1994 after a 27 month extension. US$54.7 million was canceled.

The primary objectives of the project were to provide additional least-cost generating capacity for India's Eastern Region electricity grid, and thereby assist in gradually eliminating power shortages in the region and to enhance the dialogue on long-range national power development planning. The project components included construction of a 2x500 MW thermal power station and three 400 kV transmission lines for evacuation of the power to the Eastern Regional Grid.

The 2x500 MW power plant was declared operational in 1996 after suffering substantial delays in procurement, land acquisition, delivery of major components, and a cyclone. Furthermore there were serious technical problems during initial start-up which were caused by fundamental design errors. The evacuation transmission lines were completed but demand in the Eastern Region grew much slower than anticipated, and, as a result, the Farakka plant has been operating at below 50 percent plant utilization. Efforts are underway to build additional transmission lines to evacuate the power to energy deficit regional grids.

OED rates the overall project outcome as unsatisfactory (the PCR rating was satisfactory), institutional development impact as negligible (PCR rating was partial), and sustainability as likely (PCR rating was likely). The lower audit ratings reflect long delays in plant startup and the subsequent extremely low levels of plant utilization. OED rates the Bank performance as unsatisfactory (the PCR rates its as satisfactory) because the project was sent to the Board before it was fully ready to be implemented, and because the problem of oversupply of power for the Eastern Region was not expeditiously resolved. OED rates performance of the Borrower, the National Thermal Power Corporation (NTPC) as satisfactory, because it has been able to overcome serious technical design difficulties and bring the plant to full operational capability, and because deficiencies in transmission planning and construction were beyond its control.

The major lessons are:

(a) Over-optimistic demand projections and distribution grid capacity estimates have led to an excess of power generation capacity relative to the Eastern Region's absorptive capacity. The Bank should have reviewed the assumptions underlying the central government's energy demand projection in more depth. NTPC should undertake its own independent analysis of each region's absorptive capabilities, so that it can take timely and appropriate action to ensure that its new capacity will be utilized.

(b) Inadequate power pricing policies have resulted in inefficient operation of power generation facilities and large fluctuations in operating frequency of the eastern region's system. Optimum operating efficiency can only come with a pricing system that better reflects time-of-day market demand and supply conditions.

(c) NTPC's rate of return is substantially below Bank appraisal expectations and the return being offered to independent power producers. One reason is that NTPC is not permitted to revalue its assets in determining its rate structure. To maintain a healthy financial structure, NTPC will need to be allowed to revalue its assets in line with India inflation.

Attachment

Contents

Annexes

This report was prepared by Richard Berney (Task Manager) and Brahm Prasher (Consultant) who audited the project in January 1998. S. Pak provided administrative support.

Principal Ratings

	Loan 2442-IN	
	Audit	*PCR*
Outcome	Unsatisfactory	Satisfactory
Sustainability	Likely	Likely
Institutional Development	Negligible	Partial
Bank Performance	Unsatisfactory	Satisfactory
Borrower Performance	Satisfactory	Satisfactory

Key Staff Responsible

	Loan 2442-IN		
	Task Manager	*Division Chief*	*Country Director*
Appraisal	J. Creasor	H. G. Brandreth	R. J. Cheetham
Midterm	------------------------ no Midterm review ---------------------------		
Completion	A. Ceyhan	J. Bauer	H. Vergin

Preface

This is a Performance Audit Report (PAR) on the Second Farakka Thermal Power Project (Loan 2442-IN) for which the World Bank approved a loan of US$300.8 million equivalent on June 14, 1984. The loan was closed on April 30, 1994, an extension of two years and three months beyond the original closing date, with US$54.7 million unused and canceled.

This report is based on the Project Completion Report (PCR) prepared by the South Asia Region and issued on December 25, 1995, the Staff Appraisal Report, loan documents, project files, and discussions with Bank staff. In addition, an Operations Evaluation Department (OED) mission visited India in January 1998 to discuss the effectiveness of the Bank's assistance with the government and the various project implementation agencies. The cooperation and assistance of government officials and management and staff of the National Thermal Power Corporation (NTPC) is gratefully acknowledged.

Following standard OED procedures, the draft of this PAR was sent to the Borrowers for comments before finalization. These comments have been incorporated into the text of the report and are attached as Annex E.

1. Objectives and Description

1.1 In the early 1980s, the shortage of generating capacity in India's Eastern Region, comprising primarily the states of West Bengal, Orissa, and Bihar, led to widespread rationing, permanent overloading of existing thermal units, and high forced outage rates. The main objective of the Second Farakka Power Project was to provide additional least-cost generating capacity for the Eastern Region's grid, and thereby to assist in gradually eliminating power shortages in the region. The project was also expected to give the Bank an opportunity enhance the dialogue on sector organization and policies for a national power system and on long-range national power development planning.

1.2 The project consisted of the second-stage development of the Farakka Power Station in West Bengal. The first stage, comprising three 200 MW coal-based generating units also financed by the Bank (Loan 1887-IN), was completed successfully in 1989. Project components included construction of a 2x500 MW Super Thermal Power Station and three 400 kV transmission lines for evacuating the power to the Eastern Regional grid.

2. Implementation and Results

Implementation

2.1 The project got off to a slow start. The loan was declared effective 14 months after signing, having been postponed four times, until the National Thermal Power Corporation (NTPC) signed legally binding bulk power supply agreements with all Regional Electricity Boards. As explained in detail in the Project Completion Report (PCR) (Report No. 15243), there were many implementation problems, including delays in tenders, labor unrest at the project site, expanding demands for compensation from project affected persons (PAPs), bankruptcy of a major foreign contractor, delayed delivery of construction materials and major components by domestic contractors, adverse weather conditions (including a cyclone), and finally, serious technical problems during start-up, caused primarily by inadequacies in the design of the boiler units and of the structural framework for the electrostatic precipitators. The transmission lines were built and are functioning without problems. Following three extensions, the Bank closed the loan on April 30, 1994, before the plant was commissioned.

2.2 The plant operating problems that emerged during start-up were the result of deficiencies in design which were beyond the control of NTPC. The most important and serious problem was identified following initial load testing and subsequent firings of the first 500 MW boiler unit. Steam temperatures escalated much above the design level (540° C), despite resort to high injections of water sprays to control temperatures, and the high temperatures caused severe distortion and damage to the boiler's steam superheater coils. The damage has since been repaired. Load testing of the second unit in September 1994 resulted in a similar experience of furnace temperatures beyond permissible levels, but significant damage was avoided. The second major design problem was discovered when the unit was restarted in early 1994 and an electrostatic precipitator (ESP) collapsed, causing extensive damage. The immediate cause of the collapse was a mis-performing probe that failed to indicate the excessive buildup of ash levels in the columns; however, further analysis also indicated that design of the ESP did not provide for adequate safety margins in structural strength to support the column. This problem has been corrected, and the unit was restarted in January 1995.

2.3 After prolonged investigations and negotiations, the three parties to the contract on the boiler units (NTPC, Ansaldo of Italy, and Babcox and Wilcox of Canada) concluded that temperature escalation problems were the result of failure to consider the characteristics of Indian coal, failure of the furnace design to provide for sufficient heat absorption capabilities, or both.[1] Remediation measures have been agreed, but as of the beginning of 1998, the suppliers have not started the modification work.[2] The plants are generating electricity, but at lower efficiency levels than guaranteed. This leisurely pace for response on remediation poses questions about what incentives/penalties need to be incorporated into supplier contracts to ensure prompt action to minimize economic losses. In the meantime, NTPC is operating the two 500 MW units with modified operating procedures and mitigation techniques, including resort to water spray injections to control steam and metal temperatures.

2.4 The project also suffered from other design shortcomings and equipment supply problems including (a) severe vibration problems on the steam turbine on unit 4 during synchronization; (b) mismatch between start-up curves of boiler and turbine on unit 4, making it necessary to change start-up procedures; (c) need to use fuel to support coal combustion on both of the 500 MW units, even when operated at higher loads; and (d) insufficient mill capacity, below guaranteed levels, for grinding feed coal for the two units.

Environmental Mitigation

2.5 Farakka is generally in compliance with current environmental standards for power plant emissions. OED's observations are summarized below, and are given in more detail in Annex B. Ambient air quality is measured once a month using portable devices[3] at three locations at a distance of about 3 to 5 km around the plant site. Total suspended particulate levels are in compliance with India's residential standard for two thirds of the year, and is at all times below India's industrial standard. The ambient SO_2 and NO_X levels are well below residential standards.[4] Effluent water quality data from the coal stockyard settling ponds and the condenser cooler indicate that water quality is generally satisfactory. **However, OED observed appreciable turbid water exiting the ash pond from a number of openings between slabs comprising the walls of the weir. Management informed the mission that they would be taking remedial action to rectify this situation.**

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1. NTPC informed OED that all the 500 MW boilers it had installed prior to the installation of the Farakka units also suffered from problems on high superheat/reheat sprays, overheating of low temperature superheaters, and lack of operational flexibility but have not been damaged.

2. Since dimensions of the structure for the boiler units cannot now be altered, the units will be refurbished and provided with additional heat absorption capability through installation of intermediate stage superheater coils to control furnace and metal temperatures within permissible range.

3. The mission was informed in response to its query that Farakka intends to install air quality monitoring stations around the power plant soon to track air quality regularly and with consistency.

4. This is consistent with the mission's findings on coal quality. Coal used in the Farakka plant has very low sulfur content, ranging between 0.1 to 0.23 percent.

2.6 Farakka has planted about 2.1 million trees since it started operating in 1986. The survival rate for these trees is estimated to be about 90 percent. Afforestation measures appear to have contributed to an improved local ecology, and may have appreciable payoffs in the future for improving local weather, if the planting programs are continued at this significant level.

Resettlement and Rehabilitation

2.7 At appraisal, the resettlement and rehabilitation (R&R) aspects of the project were not formally addressed.[5] A few years after loan approval, the Bank began to focus more attention on rehabilitation issues. In conjunction with the FY93 NTPC Power Generation Project (Loan 3642), NTPC agreed to a series of "retrofit studies" on the socio-economic conditions of PAP, and an Action Plan to resolve outstanding PAP issues, for all its thermal power projects.[6] These studies have been completed and remedial action plans have been prepared, but have not been agreed upon with all PAPs. While OED did not undertaken an in-depth investigation of the R&R aspects of the Farakka power plant programs, it did find, on the basis of the limited on site observation and information provided by NTPC, that at Farakka the outstanding problems appear to have been mostly resolved.[7]

PCR Conclusion and Lessons

2.8 The PCR concludes that even though the physical objectives had not yet been met because the 2x500 MW generating units had not yet stabilized and been placed in commercial operation at the time of the PCR review, the project had accomplished its primary objectives of providing additional least-cost generating capacity to the Eastern Region and installing long-range power development planning capability in NTPC through attendant organizational changes.[8] The PCR also concluded that there are serious questions about the suitability of the site selected for the (see Annex C for a detailed analysis) project,[9] however, OED found no basis for this conclusion.[10]

2.9 The major lessons from the PCR were (a) tender documents for main packages should be prepared before Board presentation; (b) tariffs should be designed to provide a financial incentive

5. About 10,650 families in 12 villages have lost a total of 4,412 acres of agricultural land, but not homes, to the merry-go-round coal transport system from the mine in Bihar to the Farakka station in West Bengal during Stage I and II of the development. Since no homes were lost there is no rehabilitation colony. A total compensation of Rs. 84 million was paid during Stage I in 1980–81 and II in 1989–90. NTPC provided 353 jobs to PAPs at the Farakka site, while about 75 PAPs became contractors for NTPC and some 3,000 obtained temporary jobs with contractors.

6. Office Memo, Back-to-Office Report, November 3, 1988.

7. By the late 1980s, the Farakka plant and site management had also developed a community outreach program and had upgraded/provided infrastructure and community facilities in Murshidabad and Godda districts around the project. Under its community outreach program, NTPC provided new roads, drains, and culverts in villages around the power station; performed repairs on schools in villages, opened adult education centers; and installed 50 tubewells for drinking water in villages around the plant site. NTPC also installed community latrines and bus-stop sheds, provided sports materials to local clubs, and held swimming and athletic events in NTPC's townships. NTPC also performed rehabilitation of electric supply lines for some community facilities and installed public lighting at crossings in villages on the line to the ash pond.

8. Para. 10 of executive summary, INDIA - Second Farakka Thermal Power Project. PCR, Bank Report No. 15243.

9. See para. 6 of part 1. Report No. 15243.

10. In the follow-up NTPC Power Generation Project (Loan 3632 approved FY97), the Bank worked closely with NTPC on financial issues, including bill collection and appication of new commercial and investment policies, and NTPC has, since that time successfully restored its financial viability. It recently received a BB+ credit rating from Standard and Poor.

for merit-order dispatch,[11] so that State Energy Boards (SEBs) "feel comfortable" using the most economic generating sources; and (c) resettlement and rehabilitation (R&R) issues need to be addressed during project preparation.

3. Major Issues

Design and Coal Characterization

3.1 The design problems of the 500 MW boiler unit at Farakka Stage II (and other NTPC plants) suggest that Indian coals, with their high ash content, may have special burning characteristics (Annex D) that affect the appropriate design of scaled-up boilers. Furthermore, international suppliers may not be willing to devote the requisite resources needed to develop appropriate boiler designs based on the requirements of Indian coals, since penalties involved in implementing inadequate designs are not sufficiently onerous. However, the cost of prolonged non-functioning of a plant as a result of inadequate designs is extremely high for the owner, since procurement agreements generally do not cover economic losses due to late plant commissioning. Data and results from clean coal programs is inadequate for predicting the quantitative reaction burn-off characteristics of Indian coals. These coals, with their wide variance from U.S. and European coals in some important characteristics, are likely to behave quite differently. **To minimize design risks for new large-sized boiler units, NTPC needs to develop research data on the reaction and burn-off characteristics of typical Indian coals.**[12]

3.2 In view of NTPC's frequent experience of mal-design 500 MW units by international suppliers of equipment, NTPC is now subjecting the proposed designs submitted during procurement to its own design computer models to evaluate their adequacy and cost effectiveness. To render the bidding procedures fair, equitable, and protest-proof at the time of contract award, NTPC should describe and disclose these models to prospective bidders.

Utilization of Capacity

3.3 With completion of Stage II of the plant, the Farakka Super Thermal Power Station (Farakka) is capable of operating at the rated maximum capacity of 1,600 MW. However, it is usually operated at a rate of less than 1,200 MW (Annex C, Table 1), primarily because India's eastern region has excess generating capacity. Demand projections for energy in the Eastern Region had severely overestimated growth in consumption (see Annex C, Table 2). Economic growth in the 1980s and 1990s was far lower than had been forecast, and even if growth had been higher, under-investment in the sub-transmission and distribution system limited the amount of electricity that the system could use. Unfortunately the power cannot be evacuated to other regions of the country that are in deficit, because the necessary interregional transmission links are yet to be built. Thus, while most other regions of India have a large shortage of capacity, the

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11. Generation from the plants with the lowest marginal cost.

12. To avoid these problems, NTPC needs to go beyond the research data generated under clean coal programs of the 1970s, especially in the United States, to relate the reaction, burn-off, and pyrolysis behavior of coals to their physical and chemical characteristics. While data and results from these external sources may be useful to understand general behavior of coals under various reaction conditions, it cannot generally be extrapolated with confidence over a wide characterization range.

eastern region's excess capacity remains idle. In FY97–98, the Farakka's plant load factor (PLF) for Stage II (1,000 MW) was about 38 percent and the PLF for the station as a whole (1,600 MW) was in the mid forties (Annex C, Table 3). And Farakka is not unique; all of NTPC's plants in the Eastern Region suffer from low generation levels (Annex C, Table 4 and 5). New transmission lines are currently being built to evacuate this power to other regions of the country.[13]

3.4 The Bank was aware of the eastern region's over-capacity problems since the early 1990s. A 1993 project supervision mission reported that, as a result of limitations in the absorption capacity of the grid and distribution system in the region and a lack of inter-connections to other regions, "NTPC is, particularly in the eastern region, no longer able to run its power stations at maximum load factors ... we expect that soon to be commissioned power stations, such as Farakka II and Kahalgaon, may be under-utilized."[14] Although project records of 1993 indicate that NTPC and the Government of India (GOI) were, by that time, also fully aware of these problems, these records do not mention any agreements on actions needed to resolve the problem.

3.5 Timely and decisive actions might well have resolved the problem before it became serious. However, solutions such as building new transmission lines to evacuate the power from the eastern region, have only begun to be implemented in the past three years. In fact, some of the proposed lines are still not under implementation. Given the Bank's long-standing interest in development of a national power grid and the need for inter-regional grid connections to achieve this goal, which it had advocated as early as the mid 1980s, it is surprising how passive the Bank was during this period.[15]

3.6 The big question is why the national planners did not recognize this problem five years earlier, in the late 1980s, and take steps to resolve it then. One reason may be that the demand projections used at the national level were highly overoptimistic. Even if the projections of underlying demand were correct, the inadequate distribution systems would have kept actual demand from growing in line with the projections. Another possibility is the unreliable power supply caused by adequate distribution facilities slowed the growth of demand. Both explanations are valid. However, both suggest that the methodology used for making projections about expected growth in electricity consumption was deficient.

3.7 Electricity demand projections are carried out by the central government's planning groups (primarily the Central Electricity Authority (CEA)) in conjunction with its five-year investment planning exercises. The input data for these projections are based on data provided by the SEBs. NTPC has taken these planning estimates at face value and used them as the basis for a long-term power generation construction program. Since CEA has primary responsibility for making the demand projections, it also uses them in its investment approval process. This process may have been adequate as long as NTPC provided only a small portion of the power

13. To mitigate the current excess capacity problem, NTPC in 1997 began reallocating energy from the eastern region, with 150 MW to APSEB in the southern region, 150 MW to MPEB in the western region, and 100 MW to Assam in the northeastern region. NTPC also intends to begin supplying 100 MW to Kerala in the near future. Other prospects for evacuating this excess capacity (including, possibly, supplying Bangladesh and Nepal) will take two to five years to materialize.

14. Back-to-Office Report, November 2, 1993.

15. NTPC's plants in the northern region have also been unable to operate at high PLFs because of evacuation problems and lack of interconnections. "Power in Asia" (December 1, 1997) reports that in late 1997 the generation loss in the northern region had been "pegged at 10 percent of installed capacity."

needs of any one SEB, but it is no longer adequate for an NTPC, that is now the largest power producer in India. Demand projections are too important to leave to a government office that focuses on five-year updates in its projections. Entities, such as NTPC, whose profitability depends, fundamentally, on the reliability of these projections need to take in-house responsibility for checking their veracity, updating them annually, and modifying their investment plans, as necessary, to reflect any major revisions. And the Bank, in its appraisal process, should pay more attention to demand forecasting and investment programming projections and to assure itself that projections made by the GOI are thoroughly reviewed.

3.8 **OED believes that NTPC should expand its own demand analysis capabilities, and establish a market research and demand analysis group within its corporate structure. This group should focus on determining the absorptive capacities of each SEB, as well as their financial capability to undertake the investment program needed to service the projected increase in power demand.**

Power Pricing

3.9 The current bulk supply tariff system (in use in January 1998) encourages the SEBs to make economically inefficient dispatching decisions, because it creates a financial incentive for them to operate their own plants, even when merit-order dispatch would have called for NTPC's plants to operate. This tariff system also encouraged SEBs to run their generation plants in ways that have caused large fluctuations in system frequency.

3.10 The Eastern Regional Electricity Board (EREB) instituted a two-part tariff formula (with a fixed cost and a variable cost component) in November 1992. NTPC gets its full cost recovery (fixed plus variable cost), and it maximizes its profits by using a merit-order system for dispatch from its own plants. However, the way that the EREB implemented the regulations for the purchasers of power (the SEBs) has effectively eliminated any incentive for the SEBs to accept system-wide merit-order dispatch. The problem is caused by the way that the EREB has allocated the fixed costs of NTPC's power among the SEBs. Rather than allocating fixed costs on the basis of the long-term purchasing commitment that each SEB made before an NTPC generation plant was built, the EREB uses a monthly allocation of fixed cost among the participating SEBs, based on the percentage of power that each SEB uses that month. The effect of this procedure is to make both the "variable cost" and the "fixed cost" components of the SEB's payments a linear function of the amount of power that the SEB draws from the grid. Thus, from the purchasing SEB's viewpoint, there is no fixed cost component for grid electricity. As a result, SEBs minimize their costs by using their own generating units during off peak times, rather than purchase power from the NTPC units, even though the variable cost of the NTPC units is less than the variable cost of their units.

3.11 The problem of excess supply during off-peak hours is further exacerbated by the lack of time-of-day pricing for bulk power. Since the system does not use time-of-day metering, peak load power and off-peak power prices are the same. The effect is that when SEBs supply their excess power to the grid, the are able to subtract this amount from their consumption during other time periods. As a result, they pay only for the net power they consume, and have a strong financial incentive to draw power at peak load times and supply the grid at off-peak times. And they have no incentive to build peaking power plants. The West Bengal SEB has taken full advantage of this lack of time-of-day metering. With a large surplus during off-peak periods, it has been able to get net power consumption very low, often close to zero. It has effectively been able to exchange its off-peak power for an equal amount of peak power supply.

3.12 Profit-maximizing behavior by the SEBs creates significant operating problems for NTPC plants and for the system as a whole. NTPC plants have had to back-down major portions of their capacity during off-peak hours, even though these units operate more efficiently and at lower costs than the SEB units. The audit mission observed that Farakka's output varied from 1,100 MW in the morning to 650 MW in the early afternoon. Steep changes in plant load factors at Farakka also result in higher operating costs, since appreciable oil support is necessary and marginally lower fuel efficiencies result at low load factors. As a whole, the present system is unable to establish any grid discipline. With the SEBs trying to offset their peak deficits by maintaining high generation levels in off-peak hours, the system's frequency has become highly variable. The audit mission observed movements in the frequency of the power system from 48+ to 52+ cps several times over the day. In addition to putting strains on all the system's generating equipment, this high variation in system frequency creates significant further costs for the final consumers, whose equipment is much less efficient at these non-optimum frequencies.

3.13 The GOI has been struggling with this problem for several years. Its innovative solution for improving grid discipline sets marginal pricing based on system frequency. Time-of-day meters will be used to measure bulk supply, and the tariff structure will incorporate penalties (through lower prices) for sending more than the contracted amount of power into the grid when the grid frequency is too high, and rewards (with higher prices) for providing more than the contracted amount of power to the grid when the frequency is too low. It has taken may years to convince the states to adopt this new payment structure. The benefits of greatly reducing dispatch practices that have, in the past, promoted system instability should be substantial both in terms of improvements in the efficiency of the generation system and improvement in quality of power available to consumers. However, while the use of system frequency to establish marginal pricing is an improvement over the old procedures, it will not fully solve the problem of inefficient use of the system's generation resources. **Efficient operation of the system can only be accomplished through a more complex market-oriented pricing system that establishes prices based on supply and demand conditions in short (possibly 15 minute) time intervals. OED recommends that the Bank work with the GOI to begin introducing such system, at least on an experimental basis.**

Coal Supply

3.14 Farakka was designed to use coal nearby Rajmahal field, which was to be developed by Coal India's Eastern Coalfields Limited (ECL) as an opencast mine in parallel with the Farakka station. Coal is shipped to Farakka over an 85 km line operated by NTPC. In addition to Farakka, the Rajmahal mines also supply coal to NTPC's 800 MW Kahalgaon Superthermal Power Station (KSPS). At full production the two NTPC plants will need 13 million tons of coal from Rajmahal based on current quality (8.8 million tons for Farakka and 4.2 million tons for Kahalgaon).[16] However, Farakka currently receives only 6 to 7 million tons of coal from this mine, with the result that in addition to generation losses due to evacuation and grid-related

16. To be reimbursed 100 percent of the fixed costs, Farakka has to achieve an annual "deemed" load factor of 62.6 percent. Under the present tariff structure, Farakka would begin earning incentive bonuses when it operates at above 68.5 PLF. It expects to be able to operate at an average of 75 percent.

constraints, there has on occasion also been an appreciable loss of generation due to coal shortage (Annex C, Table 3).

3.15 Currently, the Rajmahal mines have a production capacity of 10.5 million tons, and ECL has developed options for producing an additional 1.5 million tons from other mines by FY99 for the Farakka and Kahalgaon plants. However, when inter-regional power transmission linkages are completed so that power plants can be operated at PLFs above 75 percent, Farakka and Kahalgaon's total requirements for coal will be at least 14 million tons per year. To meet this expected level of demand, NTPC and ECL are negotiating to develop the Hurra C block of the Rajmahal field for an additional capacity of 5 million tons, which could be made available by about 2001. ECL does not have the funds to make the required investment, however. It is not clear who will provide the investment capital needed for this new mine, and what guarantees they will be given, in terms of a long-term purchase contract, that will cover their investment costs.

3.16 The question of who will bear the risk for this new investment has yet to be resolved. Under the current coal sales regime, ECL bears the risk of lower-than-anticipated coal purchases due to lower-than-projected demand for power. And with an average 42 percent capacity utilization at Farakka, the cost has been substantial. This leads to a fundamental imbalance in risk allocation. NTPC bears no risk on the purchase of coal or on its sales of electricity, as it is fully reimbursed for the fixed part of the tariff by the EREB. However, in the long run such a relationship is untenable, since ECL also needs to minimize the risks of investing in capacity expansion and manpower development if it is to sustain the growth of supply of coal. Therefore, NTPC needs to work with ECL to design supply agreements for expanded capacity that will minimize its risks for developing the needed capacity. The fixed costs of this agreement will need to be incorporated into the fixed cost of bulk electricity. NTPC and ECL need to also work out a system that will tie coal prices to delivered quality and calorie content. Such an incentive-based agreement is necessary to overcome the problems of poor coal quality at the Farakka power station. **OED believes that the GOI needs to develop a framework coal supply contract that provides a level of security for the coal mine investor (whether it be ECL, CIL, or a separate independent entity) equal to the level of security for recovery of investment that NTPC has in its power supply contracts.**[17]

Return on Investment

3.17 In the 1980s the Bank endeavored to establish a power pricing mechanism that would provide NTPC with a real rate of return of about 10 percent. Implicitly, it was thus agreed that the rate of return on revalued assets should be between 9 and 10 percent. The GOI was unwilling to introduce the concept of asset revaluation and agreed instead to gradually increase NTPC's nominal rate of return from 7 percent in 1984–85 to 14.7 percent by 1995–96.[18] This compromise was acceptable to the Bank, first, because NTPC was a relatively young organization whose historical assets were small relative to its investment program, and second, because the difference between the rates of return on revalued assets and on book-valued assets were

17 In its comments (Annex E), NTPC indicates that negotiations are underway with CIL/respective subsidiaries on fuel supply arrangements.

18. NTPC will be allowed a 16 percent ror for new plants.

estimated to be on the order of 5 or 6 percent, so a 14.7 percent return on book value was likely to be equivalent to a 9 to 10 percent real return.[19]

3.18 However, inflation in India has been significantly higher than anticipated, and the rate of return significantly lower (Annex C, Table 8). Over the period 1986-1997, the implicit GDP deflator ranged between 7 and 13 percent. NTPC's rate of return on net worth during this period ranged between 10 to 12 percent range, never reaching 14.7 percent. It would appear, therefore, that after taking inflation into account, NTPC inflation adjusted return on its real assets has been quite low, and definitely far below the 9-10 percent that the Bank had expected. These low returns are, in effect, an additional subsidy to the SEBs, thereby providing additional support for their inefficient operations. These low returns will also make it more difficult for the GOI to privatize NTPC. As long as the book value of equity is below its real value, and the return to its equity is based on this low book value, the GOI will be unable to receive fair value for its investment in NTPC. If the assets are sold at their current worth, any future improvement in electricity prices to reflect a competitive rate of return on its real assets will accrue primarily to its new equity holders.

3.19 Farakka's rate of return clearly reflects the impact of fixed returns to book value assets in an economy with high inflation and subsequent currency revaluation. The Farakka power plant (Stage I plus II) will lose of about Rs. 140 million (US$3.5 million)[20] in FY98 under the prevailing tariff (see Annex C, Table 6 for details) primarily because the GOI has been slow in processing tariff requests. However, even under the currently accepted Rao Committee formulas, reimbursements for the fixed costs would be inadequate to make a reasonable profit on the plant's real investment cost, since depreciation charges and profit margins are computed based on historical asset values in rupees, and take no account of inflation.[21]

3.20 In terms of its rate of return to real resources used, the Stage II plant will generate a payment to cover fixed costs of only about 10 percent of its dollar cost, which, with the current allowable depreciation rate of 7.6 percent is equivalent to a real rate of return of only 3 to 4 percent.[22] The reimbursement to NTPC for fixed costs in 2001 will be only Rs. 0.47 per kWh, or US$0.035 cents at current exchange rates,[23] compared with a rate being negotiated with independent power providers in excess of US$0.05 (plus inflation adjustments) for similar coal-based power plants. **OED believes that for NTPC to maintain a healthy financial structure, it will need to be allowed to revalue its assets in line with Indian inflation.**

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19. Bank Memo on "Conclusion of Negotiations" from Acting VP (SA) to SVP of Operations, May 21, 1984.

20. Amounts expressed in US$ are calculated using exchange rates prevailing on the last day of the fiscal year.

21. Stage I was completed in 1988; most of the costs and procurements were made when the exchange rate was about Rs. 12 per dollar or much lower. Stage II, completed in the 1990s, was procured at much higher exchange rates. Between 1985 and 1995, the exchange rate increased from about Rs. 12 to Rs. 34. GOI allowed plant depreciation rate of 3.6 percent before April 1992. Since January 1995 the rate allowed was increased to 7.6 percent.

22. An example for FY98 clearly demonstrates the impact of inflation on NTPC's ability to recoup its costs. Under the Rao Commission principles, NTPC is requesting Rs. 3,948 million to cover depreciation, interest, and profit in FY98, which is equivalent to 18.2 percent of the investment cost of Rs. 21,683 million NTPC shows for Farakka Stage II (Annex C, Table 8). However, when inflation is taken into account by translating the actual investment cost into U.S. dollars (but not taking into account inflation of the U.S. dollar) the requested reimbursement for fixed costs of US$99.8 million is only 10.7 percent of the US$935.91 million dollar investment cost. The Project Completion Report (PCR) for the project, dated December 29, 1995 about a year before Stage II was commissioned, provides a project completion cost of Rs. 21,148 million and US$970.1, in Rs and US$, respectively.

23. With stage II output utilization to reach a plant load factor of at least 62.6 percent.

Loan Closing

3.21 By the early 1990s NTPC's financial solvency was becoming a critical element in the Bank's sector dialogue with the GOI. The major concern was the growth of outstanding receivables from the SEBs, who were for the most part themselves financially insolvent. By late 1993, despite the covenant in three active projects (Loans 2674-IN, 2844-IN, and 2845-IN) to keep receivable to below two months' sales, and the commitment under the recently negotiated NTPC Power Development loan (Loan 3632-IN) to implement new commercial policies to reduce the SEBs' accounts receivables to acceptable levels, receivables had grown to more than six months' sales, and NTPC was in a liquidity crisis. The Bank felt that NTPC and GOI were not demonstrating a real commitment to resolving this problem with the SEBs, and did all it could to impress the GOI with the seriousness of the situation, including delaying effectiveness of Loan 3632.

3.22 As part of its new get-tough strategy, in October 1993 the Bank took the precipitous step of informing GOI that it would not extend the closing date of the loan for Farakka beyond April 1994 (a four-month extension) unless NTPC came into compliance with the receivables covenant by January 15, 1994, and made satisfactory arrangements for avoiding further delays.[24] NTPC and the GOI protested this decision on the grounds that the 1984 Farakka loan did not have a covenant on accounts receivable and therefore NTPC was actually in compliance with all of the loan's covenants. They further pointed out that technical difficulties in commissioning the plant had delayed final payments on major contracts (see para. 2.2), and the serious financial costs that NTPC would have to bear if the contractors lost the tax advantages of "deemed export" status of goods paid for by a Bank loan.

3.23 The Bank, however, was determined to close the loan. NTPC was unable to meet the timetable for resolving Farakka's technical problems. The Bank closed the loan in April 1994.[25] Subsequently, it was shown that Farakka's problems were more serious than what Bank technical staff had perceived, and required much more effort over a long period to conduct all diagnostic tests and analysis, compare this with the assumption used in the design of the boiler units, and negotiate with designer and equipment suppliers remedies appropriate to resolve the boiler units' problems.

3.24 The Bank had little insight during this period on the nature of the commissioning problems and therefore blamed them on operational deficiencies. In establishing conditions for extending the loan closing date, it did not hesitate to issue strictures and set timetables for NTPC to accomplish diagnostic milestones and plant start-up.[26] It pressed NTPC to come to agreement with the suppliers on adequate diagnostic tests and subsequently to "agree with the manufacturer on the causes of the problems developed in the boilers and on the correction to be made. NTPC will provide the Bank with the results and agreed actions and timetable for rectification and will

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24. Office Memo from the Chief (SA2EG), through the Director (SA2DR), to the vice-president (SASVP), October 21, 1993.

25. It did, however, agree to reduce the impact of this closing by allowing NTPC to use US$33 million from Loan 2674 (for the Talcher power plant) to complete payments, under the condition that NTPC satisfied accounts receivable conditionalities that were relevant for loan 2674, but not for the Farakka project.

26. Just before loan closing, in an office memo dated April 25, 1994, the Region's technical staff reported that: "The reason for the incident in Boiler 4 superheater is operational. No major changes are required in the boiler." This conclusion does not appear to be consistent with the facts available at the time, of the concurrent problems of uncontrollable temperatures despite resort to water spraying, inability to maintain high plant load, and damage to steam coils due to high localized temperatures during the firing up. It was at the least premature and eventually proved to be incorrect.

begin such corrections."[27] Without any certainty or insight on the nature of the problems, this kind of pressure is likely to be counterproductive from the procurement and quality assurance perspectives, since such pressure could lead to acceptance of remedies/solutions that are not optimal. The Bank subjected NTPC to this pressure, while the contractors and/suppliers, providing design and equipment under bilateral funding, had little pressure on them to provide satisfaction. However, the Bank had no leverage or pressure on the contractors at fault, both for poor performance on the design and for being less than promptly responsive on their responsibilities for remediation. **OED believes sector policy issues are a poor basis for deciding to eliminate Bank support for a project during the last year of implementation. On the technical level, OED believes that the Bank needs to be much more careful in assigning fault for technical problems and more even-handed in pressuring both sides to agree to a rapid solution. If the Bank wishes to help matters, it should participate as an impartial observer in the entire review and negotiations process.**

4. Ratings

4.1 *OED rates the project's overall outcome as unsatisfactory*, because two years after startup (and four years after planned startup), there was insufficient demand for power to operate both of the 500 MW units. The PCR rates the outcome as satisfactory, because "the primary objectives of the project have been accomplished; viz., additional least-cost thermal capacity in the region has been installed." In the same paragraph, however, it notes that the project has not yet been successful in meeting its physical objectives because the two generating units had not yet been stabilized and placed in commercial operation.

4.2 *OED rates the sustainability of the project's benefits as likely* because NTPC has an excellent operational record and is likely to be able to operate the units at a high load factor once additional inter-regional transmission lines are built. The PCR rates sustainability as likely because "the demand for the full output of the 2x500 MW power generating units exists." At the same time, it admits that "There is, however, a need for further strengthening the subtransmission and distribution network in the region to absorb the full output of the plant."

4.3 *OED rates the project's institutional impact as negligible.* The project failed to meet its institutional objectives of establishing policies for a national power system and long range national power development planning. The PCR rates institutional development as partial because the policy reforms implemented by GOI have significantly changed the commercial operations of NTPC and increased its financial strength. NTPC did become a much stronger and more effective institution during the 10 years between project approval and closing. However, it is not clear that this project played a significant role in these changes. And the policy reforms had been introduced under other projects not implemented under the Farakka loan. The major reform under the project was the implementation of bulk supply contracts with the SEBs, but it was ineffective, because the contracts did not ensure adequate implementation of two-part tariff system.

27. Bank Telex to the Department of Economic Affairs (GOI), with copies to the Ministry of Power, NTPC and Powergrid, January 14, 1994.

4.4 *OED rates Bank performance unsatisfactory.* The quality at entry was poor: bidding documents had not been prepared and approved by the GOI, and tariffs for electricity sales to SEBs did not provide incentives for merit-order dispatch. Supervision was unsatisfactory because it failed to take early note of inadequate growth of realizable electricity demand in the region, and, when two-part tariffs were introduced in 1992, failed to advise the Eastern Regional Electricity Board that "global accounting" would negate its effectiveness. The PCR rates Bank performance in preparation, implementation, and operation as satisfactory, presumably because the Bank did help NTPC establish a more comprehensive approach toward environmental protection and R&R issues.

4.5 *OED rates borrower performance as satisfactory, as does the PCR.* NTPC did an excellent job of resolving the serious technical design problems that had a negative impact on project completion and appears to have been able to compensate for the low quality of the coal received. The PCR incorrectly blames the startup problems on NTPC, rather than on deficiencies in the suppliers' equipment designs for these new 500 MW units. It therefore rates the NTPC's implementation and operation performance as unsatisfactory.

5. Major Lessons and Conclusions

5.1 *Over-optimistic demand projections and distribution grid capacity estimates have led to an excess of power generation capacity relative to the Eastern Region's absorptive capacity.* The Bank should have reviewed the assumptions underlying the central government's energy demand projection in more depth. NTPC should establish a market research and demand analysis group should take responsibility for its own so that it can undertake its own independent analysis of each region's absorptive capabilities, so that it can take timely and appropriate action to ensure that its new capacity will be utilized.

5.2 *Inadequate power pricing policies have resulted in inefficient operation of power generation facilities and large fluctuations in operating frequency of the eastern region's system.* Two-part tariffs are only a partial solution to this problem, even when they are effectively implemented. Optimum operating efficiency can only come with a pricing system that better reflects time-of-day market demand and supply conditions.

5.3 NTPC's rate of return is substantially below Bank appraisal expectations and the return being offered to independent power producers. One reason is that NTPC is not permitted to revalue its assets in determining its rate structure. To maintain a healthy financial structure, NTPC will need to be allowed to revalue its assets in line with India inflation.

Annex A

Basic Data Sheet

INDIA: SECOND FARAKKA THERMAL POWER PROJECT (LOAN 2442-IN)

Key Project Data *(amounts in US$ million)*

	Appraisal estimate	*Actual or current estimate*	*Actual as % of appraisal estimate*
Total project costs	1340.5	970.1	72
Loan amount	300.8	246.1	82
Cofinancing	1039.7	724.0	70
KfW		29.1	
Government of Italy		91.9	
Bankers Trust Co.		10.7	
Exim Bank of Japan		73.0	
NTPC	84.0	-	
Domestic Loans & Internal resources	955.7	417.7	44
Cancellation		54.7	18*

* as a percent of original loan.

Cumulative Estimated and Actual Disbursements

	FY85	*FY86*	*FY87*	*FY88*	*FY89*	*FY90*	*FY91*	*FY92*	*FY93*	*FY94*
Appraisal estimate (US$M)*	18.0	40.0	63.0	51.0	57.0	36.0	23.0	12.8		
Actual (US$M)	4.8	1.2	16.9	23.2	37.2	79.1	42.5	20.3	15.2	5.7
Actual as % of appraisal	26.7	3.0	26.8	45.5	65.3	219.7	184.8	158.6		
Date of final disbursement:	September 13, 1994									

* Based on original loan amount of US$300.8 million, later revised to US$246.1 million.

Project Dates

	Original	*Actual*
Identification	-	1983
Appraisal	-	11-12/83
Negotiation	-	4-5/84
Board approval	-	6/14/84
Signing	-	6/29/84
Effectiveness	-	8/30/85
Closing date	12/31/91	4/30/94

Annex A

Staff Inputs (staff weeks)

	Actual
	Staff Weeks
Project preparation	7.3
Appraisal	39.2
Loan Negotiations	10.2
Board through loan effectiveness	5.4
Supervision	58.1
Completion	4.0
Total	124.2

Mission Data

	Date (month/year)	*No. of persons*	*Staff days in field*	*Specializations represented*[a]	*Performance rating*[b]	*Types of problems*[c]
Identification/ Preparation[d]						
Appraisal[d]	11-12/83					
Supervision	6/85	1		E	2	D, C, R
	10/86	1		E	1	
	9/87	1		E	1	
	3/88	1		E	2	PR, PM
	8/89	1		E	1	
	2/90	1		E	2	F, ENV
	7/90	1		E	2	F, ENV
	8/91	1		E	2	F, ENV
	11/92	2		E, FA	2	F, ENV
	6/93	4		E, FA, PR	2	I
	11/93	2		E, FA	2	I
	2/94	6		E, FA, EN	2	I, ENV, EP
	6/94	4		E, FA, EN	2	I, ENV, EP
Completion						

a. E=Engineer; FA-Financial Analyst; PR=Procurement Specialist; En=Environment Specialist.
b. 1=No or Minor Problems; 2=Moderate Problems; 3=Major Problems.
c. I=Implementation delays; P=Procurement delays; EP=Equipment Problems; FN=Financial Problems/Noncompliance with Financial Covenants; ENV=Environmental Problems (esp. Relative to Resettlement Action Plan).
d. Identification by GOI in 1983. Preparation and Preappraisal by NTPC in 1983.

Annex A

Other Project Data

Borrower/Executing Agency:

Follow-on Operations

Operation	*Loan no.*	*Amount (US$ million)*	*Board date*
National Capital Power Supply Project	2844	485	6/17/87
Thalcher Thermal Project	2845	375	6/17/87
NTPC Power Generation Project	3632	400	6/29/93

Annex B

Location Of Plant And Feasibility

The PCR for the project has questioned the "suitability of the selected site" on the grounds that all the main conditions which normally govern site selection, viz. availability of fuel, abundance of cooling water, and proximity to the load center, appear to have not been adequately satisfied and that as a consequence "technical and economic merit appear[ed]" to have been subjugated to other "extraneous considerations in the selection of this of this particular site." OED's investigation of the issues does not support the PCR's judgments.

With regard to the supply of coal, OED's mission finds that potentially there is ample coal available at the Rajmahal coalfield, which can support both the Farakka and the Kahalgaon station. The cost of transporting coal to Farakka over a distance of 85 km on the merry-go-round owned by NTPC is only about US$1 per ton. The reasons why the Rajmahal coalfield has not been developed fully to provide the production capacity has more to do with uncertainty on the need for power in the eastern region at this time and the reluctance of ECL, a financially troubled coal company, to develop this capacity without being certain that it would be reimbursed for costly mine development and operation in case the coal is not used fully to feed the powerplants.

On the issue of water supply, OED finds no support for the PCR's claim that its supply in the future is in question. It is true that there was a shortage in the late 1980s; however, the cause of this shortage was primarily caused by poor maintenance of the diversion and intake canal, which was unlined and eroding. This situation has been rectified through remediation of the intake from the main canal. In addition, there may be short periods during the dry season when there is small deficit of supply. However, such shortages, while inconvenient, can be made up through pumping of groundwater, which was to be the primary source of water at Jangipur, the alternate sight for this powerplant. However, Jangipur was located even farther away from the mines. The only alternative was at the mine mouth. But the mining areas themselves were a totally unfit location, since they were in a hilly remote area with no nearby water.

It is true that markets have not developed in the eastern region for this power. But this is an argument for the construction of HVDC transmission lines to evacuate the power, not for locating the power plant in another region far from the coal mines. It is amply clear from the Region's many writings on the issues that (near) minemouth production is the cheapest option for producing electricity, given the reality that rail transportation of coal in India, if arrangeable, is one of the costliest from among major coal producing countries, and additionally most Indian thermal coals are of poor quality, containing only about 50 to 65 percent of the Btu's of tradable coals. To cite a case example on this issue, for the Badarpur powerplant on the outskirts of Delhi, the cost of transporting coal from the mine over a distance of 1,000 km is about US$23 per ton. The landed cost of this (G-grade) coal is about US$84 per ton coal equivalent.[1]

1. Indian coal, having large amounts of (total) ash and moisture, has low calorific value compared to standard (Australian) coal assumed to contain 12,000 Btu's per lb. A ton of Indian coal is roughly assumed to be about 0.6 ton coal equivalent (tce) (12,000 Btu/lb is equivalent to 6,666 Kcal/kg).

Annex B

At an efficiency of about 33 percent, the fuel cost is about 0.033 U.S. cents per Kwh of electricity, which is about 250 percent of the fuel cost for Farakka Stage II.

The conclusion from this is that in India minemouth, or near minemouth electricity generation as in the case of Farakka, is more cost-effective, even after factoring in the cost of transmission. The mission's findings suggested that Farakka satisfied most of the conditions for locating the plant at the site. The lack of a market for this electricity has more to do with the bad projections for energy demand in the eastern region, and/or failure in taking appropriate and timely actions to develop inter-regional connections to areas of the country where power shortages have been serious.

Annex C

Statistical Data

Table 1. Peak and Minimum Generation At FSPS Station (1600 MW)

Month/Year	*Peak, MW*	*Min., MW*	*Comments*
4/96	1320	485	
5/96	1027	200	
6/96	1085	252	
7/96	1081	196	
8/96	1076	140	
9/96	693	0	Power regulation: to reduce supply to SEBs due to outstanding bills.
10/96	1612	250	High capacity drawn during peaking in dry season
11/96	1491	356	
12/96	1460	182	
1/97	1404	171	
2/97	794	251	
3/97	1243	256	
4/97	1207	396	
5/97	1271	152	
6/97	1227	391	
7/97	1213	101	Coal problems: old stacked coal from mine containing lots of moisture due to monsoon rains.
8/97	976	110	
9/97	976	180	
10/97	1106	160	
11/97	1381	484	
12/97	990	396	

Annex C

Table 2. Projected Demand, Actual Requirements and Consumption In the Eastern Region

	Projections in 1987 for FY95	*Projections in 1989 for FY97*	*Actual for FY97*
Installed Capacity, MW	18,103		13,752
Peak Demand, MW	10,177	8,092	6,800
Peak Availability, MW	9,261		
Surplus/Deficit, MW	-961		
Energy Requirment, Million Kwh	56,097	46,471	38,437

Table 3. Performance Parameters for Farakka Superthermal Power Station

FY Ending March	*1995*	*1996*	*1997*	*1998**
Stage I (3 x 200 MW):				
Gross Generation (Million Kwh)	4,282	3,314	2,295	2,090
Plant Load Factor (%)	81.5	62.6	57.0	52.8
Availability Factor (%)	90.0	74.9	74.4	77.5
Auxiliary Power Consum (%)	10.0	11.2	12.9	12.7
Specific Oil Consum (ml/Kwh)	0.8	1.9	2.20	5.35
Specific Coal Consum (kg/Kwh)	0.87	0.87	0.86	0.88
Heat Rate (Kcal/kg)	2,622	2,610	2,614	2,650
Partial Loading (%)	9.56	16.04	23.4	31.9
Stage II (2 x 500 MW):				
Gross Generation (Million Kwh)		3,197	3,397	2,562
Plant Load Factor (%)		50.5	38.6	38.8
Availability Factor (%)		65.9	57.9	67.3
Auxiliary Power Consum. (%)		7.91	9.4	10.2
Specific Oil Consum. (kg/Kwh)		4.4	4.69	4.89
Specific Coal Consum (ml/Kwh)		0.80	0.81	0.86
Heat Rate (Kcal/Kwh)		2,471	2,501	2,553
Partial Loading (%)		23.4	33.3	42.3
Stage I & II:				
Capacity, MW	600	1,100	1,600	1,600
Gross Generation (Million Kwh)	5,402	6,512	6,392	4,653
Load Factor (%)	81.5	57.2	46.1	44.1
Plant Load Factor Loss	0.9	16.6	38.1	31.2
Availability Factor (%)	90.1	70.8	64.6	71.1
Overall Heat Rate (Kal/Kwh)	2,620	2,559	2,559	2,592
Ave. GCU of Coal (Kcal/kg)		3,008	3,026	2,913
Generation Losses Due to:				
Grid Constraints (Mill Kwh)	84	881	3,643	1,446
Coal Supply (Mill Kwh)	0	1,456	1,219	1,657
Cooling Water Supply (Mill Kwh)	0	10	10	197

*For first nine months of fiscal year.

Annex C

Table 4. Actual and Deemed Generation for FSPS (in Million Kwh)

	FY93	FY94	FY95	FY96	FY97	FY98*
Deemed Generation	3,878	3,663	5,486	8,849	11,019	7,950
Actual Generation	3,850	3,575	5,402	6,512	6,392	4,653
Loss in Generation	28	88	84	2,337	4,627	3,287
% Loss in Generation	0.7	2.4	1.5	26.4	42.0	41.1

Table 5. NTPC's Generation Losses Due to Evacuation Constraints in Eastern Region[a]

	Generation Loss in FY97		*Generation Loss in FY98**	
Station	*Million Kwh*	*%***	*Million Kwh*	*%***
Farakka STPP	1,751	13.4	1,096	18.7
Kahalgoon STPP	387	5.74	267	8.6
Talchar STPP	181	9.33	373	14.4
Total	2,319		1,736	

a. NTPC's capacity of 3,900 MW in the Eastern Region [Farakka (1,600 MW), Kahalgaon (840 MW), Talcher SPS (1,000 MW), Talcher TPS (460 MW)] is 33% of the thermal and 29% of the total capacity in the region.

* For the first six months (Apr.-Aug.) in FY.

**As a percentage of total station generation.

Table 6. Current Reimbursements and Costs for Stage I & II (1600 MW)
(In Million Rs)

	FY97			*FY98**		
	Reim-bursement	*Actual Cost*	*Net Benefit*	*Reim-bursement*	*Actual Cost*	*Net Benefit*
Fuel Cost	2,662	2,631	31	2,572	2,576	-4
O & M Cost	1,023	1,005	18	806	689	117
Depreciation	757	1,420	-663	597	1633	-1037
Interest	1070	1047	23	843	831	13
Return to Equity	973	0	973	767	0	767
Other Costs	38	114	-76	40	0	40
Net Profit			305			-104

*For the first nine months of the FY.

Annex C

Table 7. Reimbursements for Stage II (2 x 500 MW)

	FY97	*FY98*	*FY99*	*FY00*	*FY01*
Current Based on Stage I Tariff					
A. Sales (M Kwh)	3,078	3,385	3,893	4,477	5,115
B. Ave. Tariff (Rs/Kwh)	1.19	1.19	1.10	1.01	0.94
C. Revenue (Mill Rs)	3,659	4,034	4,268	4,538	4,833
D. Fuel Cost (Mill Rs)	1,303	1,581	1,818	2,091	2,389
E. Fuel Cost/Kwh (Rs)	0.42	0.47	0.47	0.47	0.47
F. O & M (Mill Rs)	598	657	723	795	875
G. Depreciation, Interest & Profit (Mill Rs) (C-D-F)	1,759	1,795	1,727	1,651	1,568
Requested Based on the K.P. Rao Commission Principles					
I. Ave. Tariff (Rs/Kwh)		1.83	1.65	1.49	1.37
J. Revenue (Mill Rs)		6,186	6,421	6,690	6,985
K. Fuel Cost (Mill Rs)		1,581	1,818	2,095	2,389
L. Fuel Cost/Kwh (Rs)		0.47	0.47	0.47	0.47
M. O & M (Mill Rs)		657	723	795	875
N. Depreciation, Interest & Profit (Mill Rs) (J-K-M)		3,948	3,879	3,804	3,721

Annex C

Table 8. Investment Costs For Construction of Farakka Stage II (2 x 500 MW)

FY Ending March	*Expenditure in Mill Rs*	*Conversion Rate (US$ to Rs)*	*Expenditure in Mill US$*
1986	86.5	12.29	7.04
1987	190.5	12.93	14.73
1988	629.9	12.95	48.64
1989	861.0	15.66	54.98
1990	2,648.7	17.16	154.35
1991	3,758.1	19.23	195.42
1992	4,486.8	25.89	173.30
1993	2,902.7	31.28	92.80
1994	2982.2	31.37	95.06
1995	3,119.6	31.64	98.60
1996	480.5	34.56	13.90
1997	(463.3)*	35.87	(12.91)*
Total (FY86-97)	**21,683.0**	**Average: 23.16**	**935.91**

* Adjustment for payments made in the past for Farakka I.

Annex D

Coal Reactions and Burning Characteristics

Indian coals have high very high ash content and this ash can play a very important part in the transformation and reactions of coal particles under high heating rate conditions in turbulent medium and elevated furnace temperatures. In theory there are countervailing and compensating phenomena which can speed or slow certain coal transformation reactions, depending on the specific conditions and chemistries of the coal ash.

The presence of dispersed fine ash material in the particle can block pore spaces in the coal particle when particle undergoes rapid heating in the first few milliseconds in the turbulent medium. Due to blockage of the pore spaces pyrolytic hydrocarbon material formed during the particles initial heating can cause pressure buildup in the particle, which can lead to the disintegration of the particle into many (more) smaller particles. The smaller particles formed from the intial particle have faster burnoff/reaction rates, because of the increase in particle surface area and reduction of diffusion limitations due to much smaller particle diameters.

On the other hand, high mineral matter content in coal, particularly with respect to species based on alkali and alkaline earth elements, can promote carbonization of hydrocarbon products formed during initial pyrolysis of the coal. Due to this ability of ash materials to promote higher degree of carbonization, two countervailing effects may be possible based on the phenomenon. Hyrocarbon combustion occurs more readily and rapidly than the burning of the carbon matrix, and therefore the minimization of release of hydrocarbons due to the effects of ash slows the compnent of the reaction rate contributed by hydrocarbon combustion. Carbon (or coke) formed from hydrocarbons is relatively inactive; hence its combustion occurs more slowly than that of either the hydocarbon or the carbon matrix of the coal. Hence, the carbonized particles tend to have longer life within a combustion furnace. One overall effect of the formation of significant amount of carbonized material is the prolongation of the life of the particle in the furnace.

Alkali, alkaline earth and certain metal species present in coal are also recognized to possess catalytic effects in combustion and other gas-carbon reactions. Thus, ash species in some ways can expedite coal combustion and other carbon-gas reactions. In this way, the presence of significant ash in the particle also compensates for carbonization effects of ash. High ash content in gas space may also block radiation to metal surfaces, and result in higher gas temperatures in combustion chamber.

NTPC's statement that Indian coals have different heat effects when introduced into a furnace compared to other coals should not be taken lightly. The discussion on the combustion effects of Indian coals can be continued at length with a lot more technical detail. However, this is not the objective here, except to emphasize that some research and test effort should be required to supplement the design work for larger and new type of combustion plants/technology equipment to minimize design risks.

Annex E

नेशनल थर्मल पावर कारपोरेशन लिमिटेड
(भारत सरकार का उद्यम)
National Thermal Power Corporation Ltd.
(A Government of India Enterprise)

केन्द्रीय कार्यालय
CORPORATE CENTRE

S.L. KAPUR
Executive Director (Corp. Planning)

01/CP/5.103
June 24,1998

Dear Mr. Bernie,

I want to thank you for sending a copy of the Draft audit report for the Farakka STPP Stage II (Loan No. 2442-IN). The comments of NTPC regarding NCTPP have already been sent to you(additional information w.r.t. NCPP is enclosed). With respect to overall rating of the project outcome of Farakka II, the same comments, as communicated with respect to NCTPP, hold good for this project also.

In Page 3 of the Report, it is stated that the principal rating of **the project outcome is unsatisfactory**.

In Page 26, Para 4 states : **"OED rates the project's overall outcome as unsatisfactory, because two years after start up (and four years after planning start up), there was insufficient demand for power to operate both of the 500 Mw units."**

While NTPC does not question the evaluation rating of the project by OED, it is requested that a footnote in Page 3 explaining NTPC's position about the reasons which are beyond the control of NTPC (as explained by OED in the main report) for unsatisfactory rating. This may greatly help outsiders who may not study the detailed audit report and are assessing NTPC's capability in power generation.

In our future projects, NTPC will definitely take into account your valued guidelines, as mentioned in the report. Already, as suggested by you, NTPC has incorporated its own demand analysis activity in the Corporate Plan.

The latest status on coal arrangement , power surplus problem and tariff fixation with respect to Farakka-II project is enclosed at Annexure-I.

Also enclosed the detail status on Coal quality /benefication /pricing/supply contract with respect to NCPP at Annexure-II.

With regards,

Yours sincerely,

(S.L. Kapur)
Executive Director (CP)

Annex E

Annexure-I

COMEMNTS ON DRAFT AUDIT REPORT FOR FARAKKA-II (LOAN 2442-IN)

On Coal:

PARA 3.16 (Page 20-21)

Negotiations for signing of fuel supply agreements between NTPC and CIL/respective subsidiaries are in advance stage. Necessary clauses for supply of annual contracted quantities/minimum quantity obligations as well as required quality parameters have been incorporated.

Annexure-D (Page 41)

Indian coals have high ash content. Various techniques viz. Fluidized Bed Boilers , IGCC etc. are being developed as " pilot projects" for utilisation of these coals . While these are on small scale only for the time being , efforts are going on to make these commercially viable. Regarding combustion effects of Indian coals and their behaviour pattern in the furnaces, discussions/ reference to R&D may be worthwhile.

On utilisation of Installed Capacity:

NTPC has an installed capacity of 3900 MW in Eastern Region. (Farakka-1600, Kahalgaon-840 MW, Talcher-1000 MW & TTPS-460 MW (supply to GRIDCO).

SEBs & others have a capacity of 9852 MW making a total of 13,752 MW (excluding Chukha HEP). In addition, captive plants in the region have a total capacity of 2030 MW.

Regional Demand

Peak Demand 6800 MW

Off-Peak Demand 3700 MW

Thus, there is huge surplus in the region since only half of installed capacity is required for meeting the peak demand. During off-peak hours the requirement is less that 30 percent of the installed capacity.

NTPC has embarked upon a crash programme with the help of CEA and MOP to export surplus power to other regions and the following arrangements have been tied up.

Assam	:	13.8% (of unallocated capacity of 748 MW) supply

Annex E

		commenced w.e.f. 28.2.97
Andhra Pradesh	:	20.6% (of unallocated capacity of 748 MW) Since 20.2.97. The supply is resumed w.e.f. 17.1.98 after being discontinued by APSEB on since August'97.
Western Region	:	20.6% (of unallocated capacity of 748 MW) supply commenced w.e.f. 19.5.97
Tamil Nadu	:	13.8% (of unallocated capacity of 748 MW) supply commenced w.e.f. 17.5.98
Kerala	:	17.2% (of unallocated capacity of 748 MW) supply commenced w.e.f. 1.2.98

Existing Links

Power against the above allocations is presently flowing over the following links:

Region	Link	Utilisation by
Southern Region	Balimela (Orissa) Upper Sileru (AP) (220 KV S/C	APSEB
Western Region	Budhipadar (Orissa) Korba (MP) (220 KV D/C)	MPEB, DD, DNH GEB KSEB
Northern Region	Dehri (Bihar) Sadhupuri (UP) (220KV S/C)	TNEB
North-East Region	Birpara (WB) Bongaigaon (Assam) (220 KV D/C)	APSEB

New Links

The new links are being added/proposed to be added which would enhance the power transmission capacity from Eastern Region to other Regions. Some of these links are :

a) Dehri – Karamnasa 132 KV (2nd circuit) – schedule d to be commissioned by the end of this year and would enable transfer of additional 100 MW to Northern Region.
b) Budhipadar – Korba 220 KV (3rd circuit) – schedule d to be commissioned by mid 99 and would enable transfer of additional 150 MW to Western Region.
c) Jeypore – Guzuwaka 400 KV D/C line – scheduled to be commissioned shortly and would enable transfer of additional 400 MW to APSEB.
d) Bongaigaon – Malda 400 KV D/C – schedule d to be commissioned by mid this year and would enable transfer of additional 800 MW between the regions (North-Eastern and Eastern).
e) 500 MW HVDC back to back line at Sasaram – This line would connect Eastern Region with Northern Region for transfer of 500 MW of power. This scheme has been approved by CEA and processed for PIB and Govt. of India approval is under way. The commissioned schedule is 2001-2002.

Annex E

Arrangements for export of power from Eastern Region to Bangladesh and Nepal which have direct boundaries with the Eastern Region States is also being explored and modalities are being finalised with Govt. of Bangladesh and Nepal.

On Tariff:

The entire issue is one of policy and NTPC is bound by parameters currently accepted and laid down by GOI by notification or otherwise , as per which all parameters including Rate of Return and Depreciation are based on historical costs and not on revalued costs. Even the proposal of NTPC to increase rate of return for exiting projects to 16% is still pending decision of Govt. of India . If Schedule VI of the Electricity (Supply) Act,1948 is to be applicable to NTPC (consequent to the recently passed bill on Regulatory Commissions), tariffs will be based on Net Fixed Assets and will be much lower than even at present.

NTPC fully agrees with the OED' s conclusion that **for NTPC to maintain a healthy financial structure , it will need to be allowed to revalue its assets in line with Indian Inflation.**