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Report No. 15227

PROJECT COMPLETION REPORT

INDIA

**COMBINED CYCLE POWER PROJECT
(LOAN 2674-IN)**

DECEMBER 29, 1995

**Energy and Infrastructure Operations Division
South Asia Country Department II**

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COUNTRY EXCHANGE RATES AND ABBREVIATIONS

Currency Unit = Rupee (Rs.)

Rs.1 = Paise 100

RUPEE (Rs.)/US \$ EXCHANGE RATES AND CPI (Yearly Averages)

<u>Fiscal Year</u>	<u>Exchange Rate Rupees/US\$</u>	<u>Consumer Price Index FY 80/81 = 100</u>
February 28, 1986 (SAR)	13.00	148.0
FY 87/88	13.92	163.2
FY 88/89	16.23	176.3
FY 89/90	17.50	190.6
FY 90/91	22.74	216.3
FY 91/92	26.20	237.0 (estimate)
FY 92/93	31.20	
FY93/94	31.46	

Average Rate during project implementation period: US\$ 1 = Rs. 21.60

Government of India and NTPC Fiscal Year : April 1 - March 31

Measures and Equivalents

1 Ton (t)	= 1 metric tonne = 1,000 Kg = 2,204 lbs.
1 Kilovolt	= 1,000 volts (V)
1 Kilovolt ampere (kVA)	= 1,000 volt-amperes (VA)
1 Kilowatt-hour (kWh)	= 1,000 watt-hours
1 Megawatt-hour (MWh)	= 1,000 kilowatt-hours
1 Gigawatt-hour (GWh)	= 1,000,000 kilowatt-hours

ABBREVIATIONS AND ACRONYMS

The Act	:	Electricity (Supply) Act of 1948, as amended
CA	:	Central Appropriations
CEA	:	Central Electricity Authority
CPI	:	Consumer Price Index
CT	:	Combustion Turbine
GAIL	:	Gas Authority of India Limited
GOI	:	Government of India
IBRD	:	International Bank for Reconstruction and Development
ICB	:	International Competitive Bidding
IFC	:	International Finance Corporation
NTPC	:	National Thermal Power Corporation
ONGC	:	Oil and Natural Gas Corporation
PLF	:	Plant Load Factor
QA	:	Quality Assurance
SEB	:	State Electricity Board
ST	:	Steam Turbine-Generator

THE WORLD BANK
Washington, D.C. 20433
U.S.A.

Office of Director-General
Operations Evaluation

December 29, 1995

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

**SUBJECT: Project Completion Report on India
Combined Cycle Power Project (Loan 2674-IN)**

Attached is the Project Completion Report (PCR) on the India: Combined Cycle Power Project (Loan 2674-IN, approved in FY86) prepared by the South Asia Regional Office; Part II was drafted by the sub-borrower and implementing entity, the National Thermal Power Corporation (NTPC).

The loan for US\$485 million equivalent was closed on December 31, 1993, two years after the original date and was fully disbursed. It supported the eleventh operation to assist the power sector in India. The project's main objective was to provide additional least-cost thermal capacity in Northern and Western India to help eliminate power shortages. To relieve pressures on the coal sectors and coal transport by railway, the project helped introduce combined cycle power generation technology in India (the technology relies on the use of the large volumes of excess gas which were previously flared). The physical project consisted of the installation of three combined cycle power plants in three states (Gajarat, Rajasthan and Uttar Pradesh) totaling 1,500 MW and 1,325 kms of high voltage transmission lines.

The project was delayed because of the lengthy procurement process and technical problems with the equipment. Yet, only one of the three plants had a delayed commissioning and a modest transfer of know how in combined cycle technology took place. The three plants are operational and the tariff formula allows recovery of capital and operating costs plus a profit. Sector policy reforms have strengthened NTPC's finances, including the collection of bills. Uncertainties as to the availability of gas have not been removed but the unit can be fired with liquid fuels. The economic analysis was based on the time-slices of NTPC's investments in the Northern and Western Regions, respectively. The economic rates of return are much better than estimated at appraisal (14-16 percent vs. 3-7 percent).

The Operations Evaluation Department (OED) rates the outcome of the project as satisfactory (vs. highly satisfactory in the PCR); its sustainability as likely as in the PCR; and its impact on institutional development as moderate (vs. substantial): the improvement in accounts receivable collection was obtained more as a condition for further lending than as a product of this project's supervision but the transfer of technology on combined cycle technology maintenance was successful. Borrower and Bank performances are rated as satisfactory (as in the PCR). The PCR provides adequate information about project implementation and results.

No audit is planned as a major review of loans to NTPC was done recently by OED.

Attachment



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INDIA
COMBINED CYCLE POWER PROJECT
(LOAN 2674-IN)
PROJECT COMPLETION REPORT
Table of Contents

PREFACE

EVALUATION SUMMARY

PART I: PROJECT REVIEW FROM BANK'S PERSPECTIVE

- Project Identity
- Background
- The Implementing Agency (NTPC) at the Time of Appraisal
- NTPC at the Time of Project Completion
- Financial Aspects
- Project Objectives
- Project Description
- Project Design and Organization
- Project Implementation
 - Loan Effectiveness and Project Startup
 - Implementation Schedule
 - Implementation Process
 - Procurement
- Project Performance
- Merit Order Dispatch and Fuel Pricing
- Environmental Impacts
- Resettlement and Rehabilitation
- Project Costs
- Disbursements
- Project Results
- Project Financing
- Economic Rate of Return
- Project Sustainability
- Bank Performance
- Borrower Performance
- Comparison of Financial Aspects with Combined Cycle SAR Forecasts
- Project Relationship
- Consulting Services
- Project Documentation and Data

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PART II: PROJECT REVIEW FROM BORROWER'S PERSPECTIVE

PART III: STATISTICAL SUMMARY

ANNEXES:

- A. Performance of Individual Plants Under the Project**
- B. Income Statements**
- C. Sources and Applications of Funds**
- D. Balance Sheet**

INDIA
COMBINED CYCLE POWER PROJECT
(LOAN 2674-IN)

PROJECT COMPLETION REPORT

Preface

This is the Project Completion Report (PCR) for the gas-based Combined Cycle Power Project in India, for which Loan 2674-IN in the amount of US\$ 485 million equivalent was signed on 27 October 1986, and made effective 27 March 1987. The loan closed on 31 December 1993 as compared with the original loan closing date of 31 December 1991. The loan amount was fully disbursed by 2 June 1994. Cofinancing was provided by the International Bank of Japan, and French and Belgian export credits. The balance amount was met by the National Thermal Power Corporation (NTPC) from its own internal resources.

The loan, made to India, acting by its President, was onlent to NTPC for implementation. The physical components of the project comprised the installation of three combined cycle power plants in the Northern and Western Regions of India, along with their associated transmission components. The main objective of the project was to provide power in these regions, then suffering from acute power shortages, through the use of combined cycle power plants which entailed reduced environmental impacts and much smaller gestation periods, as well as higher efficiency of energy conversion, compared to conventional coal-fired power generation technology. These objectives were met, albeit with delays in project implementation, some of which was beyond the control of NTPC. There were delays in the investment approval of the project by the Government of India (GOI) resulting in an extension of the implementation schedule envisaged in the SAR. In the case of the Kawas plant, difficulties in concluding a contract with the winning bidder led to the need for a rebidding, which further delayed project implementation. Serious teething problems were experienced in all three plants during the commissioning phase. Project implementation during the construction phase, however, was satisfactory as most of the generating units were synchronized and placed in service ahead of the revised schedules, established at the time of contract award for the respective power plants.

The PCR (Preface, Evaluation Summary, Parts I and III) was prepared by the Energy and Infrastructure Operations Division, South Asia Country Department II, with input from NTPC. Part II (Project Review from the Borrower's Perspective) was prepared by GOI and NTPC (In case the said Part II is not received, the last sentence will be deleted).

Preparation of this PCR started during the Bank's final supervision mission of the project in October 1993, and a follow-up mission in November 1994, and is based, inter alia, on the Staff Appraisal Report (No. 5831-IN), the Loan and Project Agreements, supervision reports, correspondences between the Bank and the Borrower, internal Bank memoranda and the Project Completion Report prepared by NTPC for its own internal evaluation and archives.

INDIA
COMBINED CYCLE POWER PROJECT
(LOAN 2674-IN)

PROJECT COMPLETION REPORT
Evaluation Summary

Introduction

i. At the time the project was initiated, consumption of electricity in India had grown at an average annual rate of 8 percent during the past two decades. Although a number of coal-fired thermal projects was planned for the short-term, the deteriorating quality of coal caused increase in station use and adverse environmental impacts on the one hand, and frequent equipment breakdowns and forced outages on the other, resulting in severe power shortages throughout India. Additionally, the increase in the number of coal-fired power stations imposed burdens on both the coal sector and the railways. The development of the large South Bassein and satellite gas fields in the west coast of India, together with the associated gas available from the Bombay High field, provided considerable economic opportunity to extend the use of gas for power generation in areas that were remote from the coal fields.

Objectives

ii. The main objectives of the project were to provide power in the Northern and Western Regions of India that were suffering from acute power shortages; diversify the fuels used in power generation, through the use of gas or liquid fuels in regions which were short of hydro and coal resources; relieve pressure on the railway and coal sectors; and introduce in India the combined cycle power generation technology that would provide an efficient, clean, flexible and economic source of power. The project has fully achieved its objectives albeit with some delays through successful completion and commissioning of the three gas-based Combined Cycle Power Plants, built in Anta, Auraiya and Kawas.

Implementation Experience

iii. NTPC successfully implemented the project, although initial delays in the investment approval of the project by the GOI necessitated a revision of the original commissioning schedule envisaged in the SAR. Project implementation based on the revised schedules for each power plant was by and large satisfactory: most of the generating units were synchronized ahead of schedule. It is curious to note that serious equipment problems, basically of identical nature, were experienced in all three power plants even though the equipment were supplied by entirely different manufacturers, each of international repute. This is discussed in greater detail in Part I, para. 35. The problems were satisfactorily resolved and the plants were finally put in commercial operation, thereby helping mitigate to a large extent, the acute power shortages in the respective regions. Considering that the project represented the first combined cycle power project in India, NTPC's performance in construction management and subsequent operation of the plants in a commercial mode is rated satisfactory. However, NTPC's management of procurement of the Kawas Power Plant was not impressive and caused additional implementation delays.

Results

iv. The project included power plants at Anta and Auraiya in the northern part of India, and Kawas in the western part of the country, as well as associated 220/400 kV transmission lines. The installed capacity of the northern region increased by 8.3% with the commissioning of 1,065 MW of additional capacity provided by Anta and Auraiya, while that of the western region increased by 4.5% with an additional 644 MW provided by Kawas. Coal-fired power plants typically operate at 36-37% overall thermal efficiency, while the combined cycle technology offers a significantly higher energy conversion efficiency of 45% or higher. Thus, the addition of a total of 1,709 MW of combined cycle generation signified a substantial increase in the overall efficiency of the system. However, non-availability of gas at the Kawas plant has accounted for forced outage of the entire power station on numerous occasions in the recent past. NTPC has already initiated steps to install alternate fuel firing capability at this plant, the construction of which has started.

Sustainability

v. The project is clearly sustainable on financial grounds. Power remains in short supply throughout India and specifically the demand for the full output of the three power plants exists. The demand growth for electricity is increasing at the rate of about 8% per annum in the northern and western regions. The present tariff setting procedures for generation from NTPC stations allow recovery of capital and operating costs and provide a reasonable profit margin for capital improvements. The new two-part tariff (to cover fixed and variable costs), introduced with effect from 1 November 1992, provides for incentives to operate the plants efficiently and with high availability. Even though billing and collection have been persistent problems for NTPC for a long time, the recent policy reforms implemented by GOI have changed the commercial operations of NTPC and increased its financial strength to put NTPC in a position to raise funds in both the domestic and international markets (Part I, para. 18). However, GOI and NTPC will need to address some specific policy matters, as detailed in Part I, para. 38, so that the superiority of combined cycle plants over conventional plants is established.

Summary of Project Cost and Financing Arrangements

vi. The actual project cost was Rs. 26,567 million (US\$ 1,229.7 million equivalent), including the associated transmission components and interest during construction. In terms of Rupees, the project cost increased by almost 65% because of the devaluation of the Rupee with respect to the US dollar, while in terms of the US\$ the project cost was slightly lower (Part I, para. 42).

vii. The Bank loan of US\$ 485 million equivalent provided about 40 percent of the total project cost. Financing was also provided by the International Bank of Japan, French and Belgian export credits. The balance of the project cost was met from NTPC's own internal resources.

Implementation Time Table

viii. Project implementation suffered due to: (a) delays in meeting the conditions of loan effectiveness; (b) delay in investment approval for the project by GOI; (c) delays in procurement; in particular, that of the Kawas Power Plant; and (d) serious equipment problems during the commissioning phase of all three plants. The loan closing date had to be extended twice to permit completion of the project, as well as disbursements under the loan.

Summary of Performance of the Borrower and of the Bank

ix. The performance of NTPC was satisfactory in respect of compliance with the loan covenants, except for the one requiring NTPC's accounts receivable to be reduced to a level not exceeding an amount equivalent to the preceding two months of billing. Bill collection has been a persistent problem with NTPC because of the poor financial situation of many SEBs and the lack of an appropriate contractual framework. At the end of FY90, NTPC's level of accounts receivable was equivalent to seven months of sales. In mid-1990, the Bank decided to cancel the processing of a new loan of US\$375 million to NTPC, which was negotiated. From mid-1990 to mid-1993, GOI introduced a number of policy reforms in the power sector which enabled NTPC to take remedial measures to efficiently manage its commercial operations. As a result, better collection from the SEBs and payments by GOI through Central Appropriations (CA) on behalf of the SEBs helped NTPC gradually reduce its accounts receivable. As part of the conditionality under the NTPC Power Generation Project (Ln. 3632-IN; FY93), the Bank agreed that for the purpose of monitoring compliance with the two months accounts receivable covenant, the amounts still due from CA were to be excluded. As of March 31, 1993 (end of FY93), NTPC was in compliance with the accounts receivable covenant thus modified. Based on this data, Ln. 3632-IN was approved by the Board of Executive Directors in June 1993. However, during the first three months of FY94, NTPC bill collection performance dropped again to about 72% and there was little evidence that NTPC was applying the newly adopted commercial policies by regulating power to defaulting SEBs. At the end of various communications between the Bank, GOI and NTPC, in February 1994, the Bank agreed with GOI and NTPC, that GOI and NTPC would refrain from submitting disbursements applications under Ln.2844-IN (National Capital Power project) and under the generation component of Ln.2845-IN (Talcher Thermal Project) until NTPC was in compliance with the agreed receivable covenant. Ln.2674-IN was excluded because the loan was closed on December 31, 1993. In addition to the informal suspension of disbursements, Ln. 3632-IN was not declared effective. Following further remedial actions by GOI and NTPC, the latter was, as of May 31, 1994, able to comply with the covenant, as amended. GOI began once again submitting disbursements applications and the Bank declared Ln. 3632-IN effective. NTPC's accounts receivable performance is being monitored on a monthly basis (Part I, paras. 13-16).

x. The Bank remained intimately involved, from the preparation of the project through project completion. It maintained good relations with GOI and NTPC throughout the execution of the

project, in spite of occasional tensions during the procurement of the Kawas Power Plant and during the period remedies to NTPC's accounts receivable problem were brought by GOI and NTPC. In addition to helping to the liquidation of accumulated arrears of SEBs, the Bank was instrumental in helping NTPC correct a number of shortcomings of broader sectoral concerns in their operations, such as, the introduction of a more comprehensive approach towards environmental protection and resettlement and rehabilitation (R&R) issues and the establishment of a training institute to develop human resources. However, the Bank should have addressed the unsatisfactory accounts receivable position and NTPC's failure to meet the associated loan covenants much earlier on and acted more firmly. The Bank let this default go on far too long before beginning to consider using its remedies, and thus had a more difficult time dealing with the problem which would have been easier if tackled earlier.

Project Outcome

xi. Overall, the project has been successful in meeting its principal objectives. The physical targets of the generation components were achieved. The project assisted in the transfer of know-how through the construction of the first ever combined cycle power plants in India and the improvement of financial discipline in NTPC's operations that has increased its credibility and potential to borrow from commercial sources.

Findings and Lessons Learned

xii. Major findings are as follows:

- (a) The project was instrumental in introducing in India the combined cycle technology for the first time based on a feasibility report prepared in 1985 (Part I, para.4);
- (b) The three combined cycle power plants, using natural gas as fuel, has been able to relieve the pressure on the coal sector, as well as on the railways, correspondingly. Had this been equivalent coal-fired generation, the project would have required at least 5 million tons of coal per year to be moved in more than 71,000 box wagons requiring at least 1,000 trips from the mines to the plant sites (Part I, para. 19);
- (c) Single turn-key contracts for the main plant and equipment, especially for this new technology, proved to be easier to implement and manage (Part I, para. 30);
- (d) The procurement cycle, starting from issuing of bid invitation to contract award, could be significantly shortened. Delays in the procurement cycle caused slippage of the project implementation schedule as compared to the schedule set at appraisal. NTPC should make its own procurement decisions independent of any external involvement in the process (Part I, para. 32);

- (e) Procurement should be completed during the bid validity period to avoid complications. In the event bid validity is extended, the bidders' right to adjust implementation schedule accordingly should also be recognized (Part I, para. 33);
- (f) Technical specifications for equipment should be based on proven technology and proven performance record only (Part I, para 35);
- (g) Departure from the original design concept that would have assured dual-fuel firing capability should not have been made based on the verbal assurance of other government agencies. Written contracts should be required between the concerned parties, even though they may be government concerns, to bind them legally to an agreement (Part I, para. 36);
- (h) The project performance indicates the need for establishing economic prices for the fuels used in power generation in India, particularly for natural gas, so that the power stations may be operated based on comparative efficiencies and economic costs of generation (Part I, para.38);
- (i) The R&R issues had to be revisited again based on Bank guidelines that require the Project Affected Persons (PAP) to be compensated for their losses such that their former living standards and income capacity were at least restored. R&R aspects of a project need to be addressed as a part of the Environmental Impact Assessment and detailed during project preparation (Part I, para. 41);
- (j) Violation of loan covenants, especially those dealing with the financial health of the beneficiary, should be addressed immediately as they occur and with firm, action-oriented plans for ensuring early compliance (Part I, para 53); and,
- (k) The project helped improve NTPC's financial position with the improvement of financial discipline in their operations (Part I, para. 54).

INDIA

COMBINED CYCLE POWER PROJECT (LOAN 2674-IN)

PROJECT COMPLETION REPORT

PART I: PROJECT REVIEW FROM BANK'S PERSPECTIVE

Project Identity

Project Name	: Combined Cycle Power Project
Loan Number	: Loan 2674-IN
RVP Unit	: South Asia Region
Country	: India
Sector:	: Energy
Subsector	: Power

Background

1. In India, responsibility for electricity supply is shared constitutionally between the Government of India (GOI) and the States. The State Electricity Boards (SEB) and the Regional Electricity Boards are controlled by the States; the Department of Power within the Ministry of Energy of the GOI administers the Central Electricity Authority (CEA), the National Thermal Power Corporation (NTPC), the National Hydroelectric Power Corporation (NHPC), the Rural Electrification Corporation (REC), and the Power Finance Corporation (PFC). The SEBs, NTPC and NHPC are charged with the responsibility of promoting the development of the power subsector under the Electricity (Supply) Act of 1948.
2. The performance of SEBs was vitiated by poor quality and persistent unreliability of power systems. Chronic power shortages in the 1970s and the adverse effect these were having on the productive sectors of the economy prompted the GOI to intensify its efforts to balance the demand and supply of electricity. The strategy developed for this purpose was to supplement the efforts of SEBs by installing large power plants, along with associated high voltage transmission lines, in different parts of India where power shortages were acute. The emphasis was on: (a) accelerating the development of hydropower potential and large coal-fired power plants at pit-head locations and in the proximity of load centers; (b) improving the efficiency of the thermal power plants and reducing losses in the transmission and distribution networks; (c) expanding the rural electrification program; and (d) strengthening the organization and management capabilities of the SEBs.
3. Performance of the coal-fired power plants, however, became extremely unreliable because of deteriorating quality of the coal which caused frequent equipment breakdowns. Furthermore, the increase in the number of coal-fired power stations imposed severe burdens on the coal industry and the railways. The finding of natural gas in large quantities in the western off-shore region in the late

1970s, had prompted GOI to adopt the policy of utilizing the gas entirely for the premium markets comprising fertilizer and petrochemical industries. But because of delays in the construction of these industries and the supporting infrastructure, large volumes of excess gas were being flared. This economic opportunity prompted GOI to decide in favor of utilizing some of the gas for power generation. Gas-based power generation is environmentally clean, offers higher efficiency when operated in the combined cycle mode, as well as a much shorter gestation period. As an added advantage, it is possible to operate the plant with the gas turbines alone in an open cycle mode as soon as they could be installed, while the back end of the plant comprising the waste heat recovery boiler and the conventional steam turbine and generator plant was still under construction.

4. A feasibility report in support of the Combined Cycle Power Project was prepared by NTPC in 1985. This report concluded that three power plants could be built at Anta in Rajasthan, Auraiya in Uttar Pradesh and Kawas in Gujarat, totaling a combined generating capacity of about 1,500 MW. These areas were far away from coal mines, and also near the 1,700 km HBJ gas pipeline from Hazira to Jagadishpur, traversing the States of Gujarat, Madhya Pradesh and Uttar Pradesh, with a spur into Rajasthan. Appraisal of the project by the Bank in September 1985 confirmed these conclusions. Project negotiations were held with the Bank in Washington in February 1986 and the loan of US\$ 485.0 equivalent was approved by the Board in April 1986.

The Implementing Agency (NTPC) at the Time of Project Appraisal

5. GOI was the Borrower of the loan; NTPC was the implementing agency with the Borrower's assistance, under a subsidiary loan agreement. NTPC was formed in 1975 to construct and operate large power stations and associated transmission facilities. It sells bulk power to the SEBs for distribution. At appraisal, NTPC was in the tenth year of an investment program under which it planned to construct and commission by 1999/2000 several large power plants with an aggregate capacity of about 26,000 MW and about 24,000 km of high voltage transmission lines. By the end of 1984/85, NTPC's installed capacity was 2,200 MW. Its very first 200 MW generating unit at Singrauli began commercial operation in 1982. Since then, ten additional 200 MW units were commissioned; four at Singrauli, three at Korba, and three at Ramagundam.

6. NTPC's net earnings in 1983/84 exceeded forecasts and yielded a rate of return (ROR) of about 11 percent based on historically valued assets. The equivalent ROR on revalued assets, calculated on a proforma basis, was slightly more than 5 percent. Cash generation measured as a percentage of average annual capital investment requirements was, however, only about 3 percent, primarily because of the scale of existing operations and a very large investment program. NTPC's debt-equity ratio at the end of 1983/84 was 26:74; however, it already had serious bill collection problems at the time. By and large, its overall financial performance in 1983/84 and its financial position at year end were satisfactory.

NTPC at the Time of Project Completion

7. By end 1993, NTPC operated about 18 percent of India's total installed generating capacity and 26 percent of the thermal capacity. Its share in India's total power supplies reached about 22 percent of total generation. NTPC has demonstrated that Government owned power utilities can also be operated at acceptable efficiency levels. It is managed by a corporate culture based on professional pride of successful accomplishments through a highly motivated staff.

8. As a part of the Bank's ongoing dialogue with GOI and NTPC, the Government has introduced a number of policy reforms aimed at increasing commercialization and efficiency of NTPC's operations, as well as fostering private sector participation in the generation of power. These reforms include: (a) improvement of generating efficiency; (b) transfer of NTPC's transmission systems and corresponding liabilities, including associated personnel, to the POWERGRID, created in 1989; (c) introduction of commercial and investment policies that permit NTPC to cut off power to consumers, whenever physically and technically feasible, for non-compliance with agreed terms of bulk power supply agreements, while delaying investments in non-complying states; (d) undertaking projects in one region with a substantial part of the output allocated to other regions; (e) entering into undertakings with foreign and local private partners to develop power projects either from its own resources or those offered by others; and (f) introducing two-part bulk tariff, comprising a fixed-cost part and a variable-cost part, which allows NTPC to set its tariff under the fixed cost part well in line with the LRMC and pass fuel price variations to the consumers under the variable part. The fixed-cost part of the tariff will, however, slowly (in line with inflation) fall below the LRMC as assets are not revalued.

Financial Aspects

9. NTPC's operating data, summarized in the table below, reflect the significant growth the Corporation experienced. During the last seven years, from FY88 to FY94, generating capacity was added continuously at an average annual rate of 26% and the value of average net fixed assets grew at an average annual rate of 29%. The pace of growth, however, has been declining. The level of capital investment has been stagnant since FY91 (except for an increase in FY92 due to the transfer of Unchahar assets to NTPC). During FY88-94 capital investment grew annually at a rate of 5%, but in real terms the growth rate was negative (-5%). Capital works in progress remained flat from FY88 to FY91, but there has been some modest increase since FY92.

NTPC's Operating and Financial Performance, 1988-94														
Comparison of Actual Data and Combined Cycle Power Project SAR Forecasts														
DESCRIPTION	1988		1989		1990		1991		1992		1993		1994	
	SAR Forecast	Actual												
Net Fixed Assets in Operation (Rs Million)	50537	28439	99216	41716	115011	65418	136779	85548	161484	120344	174275	105839	198572	112120
Capital Works in Progress (Rs Million)	60861	52187	42961	57062	53067	52360	58207	56039	64876	70080	83582	68865	97609	80798
Installed Capacity (MW)	—	3600	—	5220	—	7418	—	9205	—	11333	—	13054	—	14529
Electricity Sales (GWh)	16371	17533	27556	24875	39713	35421	51169	40306	80854	58857	88253	60467	73533	70283
Average Bulk Tariff (P/kWh) (Generation)	57	41	61	46	64	52	68	53	74	61	78	74	83	84
Net Profit after Tax & Provision (Rs Million)	2411	3024	2259	3308	2358	5366	6836	7009	9850	10176	12217	9177	15692	11036
Average Net Fixed Assets (Historic)	38542	23856	74877	35078	107114	53567	125895	75462	149132	102945	167880	113092	186424	108979
Rate of Return on Historic Assets (%)	10.9	16.4	8.1	14.8	7.8	14.9	11.5	12.8	12.8	15.3	13.7	12.8	14.6	16.7
Return on Capital Employed (%)	9.1	11.5	6.2	10.6	7.2	10.6	10.4	9.7	11.7	11.9	13.0	9.7	13.6	11.8
Operating Ratio (%)	54.7	54.7	63.7	59.3	67.2	61.1	58.8	60.2	57.5	60.6	58.8	69.0	55.1	69.5
Debt/Equity Ratio	38/62	43/57	38/62	47/53	43/57	47/53	44/56	43/57	40/60	48/52	37/63	48/54	36/64	43/57
Current Ratio	0.39	1.68	0.68	1.81	1.03	1.79	1.34	1.90	1.21	1.54	1.23	2.47	1.18	2.55
Accounts Receivable (# of days) (1)	61	177	61	175	61	210	61	183	61	101	61	98	61	104
Contr to Construction (Annual) %	6.8%	39.8%	7.2%	-1.8%	10.2%	18.8%	27.2%	17.0%	39.6%	31.3%	42.6%	16.2%	45.1%	46.5%
Contr to Construction (3 year Average) %	9.0%	38.6%	7.3%	-1.8%	9.8%	17.5%	25.9%	14.2%	41.3%	45.7%	40.4%	12.2%	49.2%	47.6%
Debt Service Coverage	2.82	3.89	2.02	2.37	1.85	2.49	2.30	2.54	2.38	2.36	2.30	2.05	2.39	1.98

(1) Accounts receivable calculated as per the Bank covenant and including amounts to be recovered through the Central Appropriations.

10. A more detailed tabulation of NTPC's actual financial performance as compared to the SAR projections made at the time of appraisal, can be found in Part III, Table 12.

11. At the end of FY94, NTPC was in a relatively strong financial position. Only 47% of its capital structure was funded through long-term borrowing, and 53% was funded through equity. In contrast, the debt capital funding in most power utilities around the world ranges from 60% to 80%.

12. NTPC's exposure to foreign exchange fluctuations has been increasing, and at the end of FY94 about 60% of its long-term debt was denominated in foreign currencies. NTPC's net income is protected from exchange rate and fuel price fluctuations through its cost based tariff policy. NTPC's return on net average fixed assets in operation (historically valued) declined from a high of 16% in FY88 to 13% in FY91 and FY93. The main reason for the decline was the non-recovery of higher capital costs of 500MW plants whose output was priced on the basis of the capital costs of 200 MW plants commissioned earlier. With the notification of revised tariffs in 1993 the declining trend in the rate of return has been reversed, and in FY94 it climbed back to 17%. The returns achieved were well in excess of the rates required under the financial covenants (7% through FY90 and 9.5% during FY91 through FY95). At the end of FY94, NTPC's debt service coverage was 1.98 and its current ratio was 2.55, indicating that NTPC had adequate resources to service its long-term debt and to pay off its current obligations as well.

13. Billing and collection have been persistent problems for NTPC for a long time, because of the poor financial situation of many SEBs and the lack of an appropriate contractual framework. A covenant specifying the level of accounts receivable not to exceed an amount equivalent to the proceeds of NTPC's sales of power for the two preceding months, was first introduced for NTPC under Ln. 2555-IN for the Rihand Power Transmission Project (approved in May 1985) with effect from the end of the FY86. The covenant was repeated in three subsequent loans including Ln.2674-IN, but NTPC has never been able to comply. At the end of FY90, NTPC's level of accounts receivable had risen to seven months of sales equivalent. At that time Bank management decided not to exercise the remedies available under the loan agreement such as suspension of disbursements, partly because of concern about jeopardizing India's ongoing development program. Other non-power sector reasons might be that the Bank was also worried about the impact of such a suspension of disbursements on the overall India-Bank relations and on the level of disbursements to India, when India was experiencing an economic crisis. However, the Bank decided to cancel in mid-1990, the processing of a new loan of US\$375 million to NTPC after completion of the negotiations.

14. To help correct the situation, GOI took in June 1990 the drastic measure of allowing NTPC through the Central Appropriations (CA), to recover over a period of four years, Rs. 10,205 million of arrears accumulated as of the end of May 31, 1990. In February 1992, NTPC acquired the Unchahar power station from the Government of Uttar Pradesh in lieu of arrears (about Rs 4,800 million) accumulated by UPSEB. In October 1992, GOI agreed to recover an additional amount of Rs. 7,500 million of arrears through CA over a period of four years. Combined with other bill collection efforts, NTPC was able to reduce its level of accounts receivable despite the rapid increase in sales. In FY92, NTPC realized about 79% of total billing in cash from the SEBs, but combined with the CA and the take over of Unchahar, bill realization rose to 99% and at the end of the fiscal year the level of accounts receivable had come down to 3.4 months of sales equivalent. In FY93, NTPC realized 81% of billing in cash from the SEBs and 91% including payments made by GOI through CA. At the end of the fiscal year, the level of accounts receivable in terms of months of sales equivalent was about 3.3 months, but excluding the amount still to be paid through CA it was about 1.4 months of sales equivalent.

15. In early-1993, during the preparation and negotiations of the NTPC Power Generation Project, GOI adopted new commercial and investment policies for NTPC which allowed it to shut-off or restrict power to the SEBs in case of non-compliance with agreed terms of supply. As part of the conditionality agreed under the said project, the Bank agreed that for the purpose of monitoring compliance with the two months accounts receivable covenant, the amounts still due from CA were to be excluded. As of March 31, 1993 (end of FY93), NTPC was in compliance with the accounts receivable covenant thus modified. Based on this data, Ln. 3632-IN for the above mentioned NTPC Power Generation Project was approved by the Board of Executive Directors in June 1993. However, during the first three months of FY94

(April to June 1993), NTPC bill collection performance dropped again to about 72% and there was little evidence that NTPC was applying the newly adopted commercial policies by regulating power to defaulting SEBs. On October 21, 1993, the Bank advised GOI that unless NTPC's level of accounts receivable was brought down to 2 months of sales equivalent by January 15, 1994, the Bank would, with effect from that date, suspend India's rights to make withdrawals from Ln.2844-IN (National Capital Power Project) and from the generation component of Ln.2845-IN (Talcher Thermal Power Project) until NTPC was in compliance with the agreed receivable covenant. NTPC was also informed that Ln.3632-IN would not be declared effective until NTPC was in compliance with the receivable covenant. Ln.2674-IN was excluded because the loan was closed on December 31, 1993. On February 2, 1994, the Bank agreed to keep formal suspension actions in abeyance up to May 1994, in recognition of NTPC's progress in dealing with its bill collection problems and its applications of the new commercial policies, while GOI and NTPC agreed to refrain from submitting withdrawal applications under Ln 2844 and 2845-IN from March 1, 1994..

16. As part of the conditionality agreed under Ln. 3632-IN, NTPC was to conclude new Bulk Power Supply Agreements and tariffs had to be notified for all stations because lack of a transparent and agreed basis of billing had been the cause of several billing disputes between NTPC and the SEBs. In April 1994, NTPC had, for the first time in its history, commercial contracts in place for all its power stations. Another round of CA to recover arrears accumulated since 1992 was approved in May 1994. Total realization of current bills (excluding the amounts recovered through CA) improved to 92% for FY94. In particular, from July 1993 to March 1994, realization of current bills was 98% and in the last three months of the fiscal year it was 105%. All these actions combined with improved bill collection and better application of the new commercial policies, led to the Bank lifting the above mentioned informal suspension and declaring Ln.3236-IN effective on June 6, 1994. Although relations between the Bank and, GOI and NTPC were tense at times, the Bank's persistence on commercial behavior by NTPC have led to positive results and is, in fact, much appreciated now by NTPC. Although not all problems have been resolved in the Northern region and another warning had to be issued by the Bank in October 1994, the cumulative realization of current bills for the period April to December 1994 has been 102% and the level of accounts receivable as of December 31, 1994, was 1.7 months of sales equivalent (excluding the amount still to be recovered through CA). Status of NTPC's accounts receivable is being followed up by the Bank on a monthly basis.

17. Combination of improved accounts receivables position and a stagnant investment program resulted in a better self-financing ratio for NTPC in FY94. Since FY90 the self-financing ratio has been improving steadily, and in FY94, contribution of internal funds to capital expenditure (3-year average) was 47.6%, well above the 20% required in the covenant introduced under Ln. 3632-IN. This also brings out a flaw in the self-financing ratio

requirement which simply considers the ratio of internal cash generation to investment needs, and if the investments are not growing the ratio may not be that meaningful.

18. The financial strength of NTPC has put the Corporation in a position to raise funds in both the domestic and international markets. Currently NTPC has the financial capability to accelerate the implementation of its investment program, but so far NTPC has not exploited this opportunity to expand its assets base.

Project Objectives

19. The primary objective of the project was to help meet the demand for electricity in the Northern and Western Regions of India by providing additional power generation capacity of about 1,500 MW using combined cycle technology to provide an efficient, reliable, and economic source of power. Secondary objectives of the project were to diversify the fuels used in power generation through the use of gas or liquid fuels in regions that were short of hydro and coal resources; relieve pressure on the railways and the coal sectors; and introduce the combined cycle technology in India.

Project Description

20. The project comprised the following components, as established at appraisal:

- (a) three combined cycle power plants -- at Anta (Rajasthan), Auraiya (Uttar Pradesh) and Kawas (Gajarat) -- comprising combustion turbogenerators, heat recovery boilers and steam turbine-generators, with a total installed capacity of about 1,500 MW; electrical and mechanical auxiliary equipment; associated civil works and ancillary facilities;
- (b) about 950 km of 220 kV and 375 km of 400 kV single-circuit and double-circuit transmission lines, connecting the Anta station with Bhilwara and Dausa in Rajasthan, the Auraiya station with Agra and Ballabgarh in Uttar Pradesh, and the Kawas station with Navsari, Bharuch and Valthan in Gujarat, together with new or extended substations and associated auxiliaries; and
- (c) technical assistance for engineering, testing and commissioning of the combined cycle power stations.

Project Design and Organization

21. The feasibility report of the project was prepared jointly by NTPC and its consultants in September 1985 (Part I, para. 4). The basic design was completed in 1986. The project was initially conceived to install about 1,500 MW of power, using natural gas and the combined cycle technology for the first time in India. The primary fuel was to be natural gas with liquid fuel as its alternate in the

event quantity of the gas supplied fell short of requirements. The gas was to be provided essentially from the off-shore South Bassein gas field and through the Hazira-Bijaypur-Jagdishpur (HBJ) gas pipeline. As bids were received, the total installed generating capacity of the three plants, with the specified design parameters, added up to 1,709 MW (Part I, para. 19). The combined cycle concept features a waste heat recovery boiler installed at the discharge of each combustion turbine to recover the thermal energy in the combustion turbine exhaust to generate steam and supply it at high pressure and temperature to a conventional steam turbine. Electricity is thus generated in separate generators, those coupled to each combustion turbine and one coupled to the steam turbine. The thermal efficiency of a combined cycle power plant is therefore, much higher than that of other conventional forms of power generation. The overall design of the power plants reflects state-of-the-art for combined cycle power plant technologies at the time.

22. The final configuration of the three power plants was as follows:

	<u>Anta</u>	<u>Auraiya</u>	<u>Kawas</u>
CT-I ^{1/}	88.0 MW	112.0 MW	106.0 MW
CT-II	88.0 MW	112.0 MW	106.0 MW
CT-III	88.0 MW	112.0 MW	106.0 MW
CT-IV	-	112.0 MW	106.0 MW
ST-I ^{2/}	149.0 MW	102.0 MW	110.0 MW
<u>ST - II</u>	<u>-</u>	<u>102.0MW</u>	<u>110.0 MW</u>
TOTAL	413.0 MW	652.0 MW	644.0 MW

GRAND TOTAL = 1,709 MW

^{1/} CT : Combustion Turbine ^{2/} ST : Steam Turbine

23. NTPC, at the time of appraisal, had a three-tier organization structure: Corporate level, Regional level and Project level. The organization changed over time to answer NTPC's changing responsibilities, from a fully investment-oriented enterprise towards a public utility. NTPC underwent a major organizational change on August 16, 1991, following GOI's decision to entrust the transmission assets (operation and maintenance, as well as those under construction) to the National Power Transmission Corporation, later renamed as Power Grid Corporation of India, Ltd (POWERGRID). Subsequently, on January 8, 1993, the NTPC, NHPC and NEEPCO (Acquisition and Transfer of Power Transmission Systems) Ordinance, 1993, promulgated by the President of India, provided for the transfer of transmission systems of these entities, including all the rights, titles and other interests related to the transmission systems of each of the corporations retroactively with effect from 1 April 1992.

24. The Corporation is headed by a Chairman and Managing Director (CMD), who is assisted by five full-time functional Directors: for Projects, Technical, Operations, Finance, and Personnel.

At the corporate office, Corporate Planning, Central Procurement and Vigilance functions are headed by Executive Directors reporting to the CMD. For the purpose of administration and execution of work at the sites, the Corporation is divided into five regions -- North, West, South, East and National Capital -- whose headquarters are located at Allahabad, Nagpur, Hyderabad, Patna and Delhi respectively. These regions are under the control of Regional Executive Directors who are responsible for the implementation and operation and maintenance of power plants in their respective regions. Each power plant is headed by a General Manager, reporting to the Regional Executive Director.

Project Implementation

25. Loan Effectiveness and Project Startup. Loan 2674-IN was approved by the Board on April 1, 1986; the Loan Agreement was signed on October 27, 1986. Signing of a contract between ONGC and GAIL for the construction of the HBJ pipeline and the signing of a Subsidiary Loan Agreement, satisfactory to the Bank, between GOI and NTPC were conditions of loan effectiveness. These conditions took a long time to satisfy and the last date of effectiveness of the loan had to be extended twice. The loan became effective on 27 March 1987.

26. Investment approval of the project by GOI (Cabinet Committee on Economic Affairs) took an inordinately long time. While CEA's techno-economic clearance was accorded in October 1985, the feasibility report was scrutinized by various government agencies until the Cabinet Committee on Economic Affairs decided to have the gas pricing policy for the power sector finalized by a group of Ministers prior to making the investment decision for the project. But the project was conceived with a definite schedule of implementation, dictated by the demand growth in the regions. For the Combined Cycle Power Project, the situation was quite critical as the areas where the power plants were to be built were already suffering from acute power shortages. Because of GOI's delay in approving the project, bid opening had to be deferred from February 1986 to November 1986. Thus, the project implementation schedule that was negotiated with the Bank, had to be revised at the very outset. If this delay of nine months is quantified in terms of cost to the national economy, it would translate to a staggering figure of approximately Rs. 232.5 billion (23,250 crores in Indian terms, or US\$ 7,416 million) equivalent at 70 per cent PLF, if it is assumed that the cost of unserved energy is a modest Rs. 30/kWh.

27. Implementation Schedule. By project appraisal, NTPC had already completed the basic design for the proposed project. Bids for the major contracts were invited in February 1986, before Board date, and it was envisaged that contract awards would be announced in December 1986. The transmission components were scheduled for completion by June 1989. Project completion was set at appraisal for 1990. However, bid opening for the main plant package had to be extended till the receipt of investment approval of the project by GOI, as well as signing of the loan agreement between the Bank and GOI. Both these activities were completed in October 1986, facilitating

opening of the bids in November 1986. This extension of the bid opening date resulted in consequent delays in the project schedule.

28. Implementation Process. Contract packaging was done on the basis of one turnkey contract for each power plant. After opening of the bids in November 1986, bid evaluation was completed in June 1987. Contract awards, however, could be made to the respective lowest evaluated bidders for Anta and Auraiya only, in August 1987 and September 1987 respectively.

29. Contract award for Kawas was delayed owing to protracted and inconclusive pre-award discussion with the lowest evaluated bidder. Basically, it stemmed from the winning bidder's (GE/Alstom) refusal to accept the liability clauses as provided for in the bidding documents. The Bank had originally recommended that, in view of the inconclusive pre-award discussions with the winning bidder, the award for Kawas be made to the second lowest evaluated bidder (MHI, Japan) based on the original bids, but NTPC preferred not to accept the Bank's recommendation because the value of the Japanese Yen was appreciating rapidly and suspected that the final price of the contract would continue to remain fluid and uncertain. NTPC therefore decided to have a rebidding for the Kawas plant; the Bank concurred. Bids were invited in September 1988, from a total of 6 bidders, including those who had submitted bids in response to the original invitation. Bids were received from 4 bidders only; but the rebid prices were found to be much higher than those in the original bid proposals due to the variation in the Rs-\$-Yen exchange rates in the interim, as noted above, that was further exacerbated by local inflation. By the time bid evaluation was completed, the original bid validity period had already expired. The winning bidder expressed its inability to deliver in accordance with the schedule specified in the bid documents. NTPC would not consider the second lowest evaluated bidder, because one of its combustion turbines of similar design had suffered failure elsewhere, and recommended the contract be awarded to the third lowest evaluated bidder. The Bank did not accept this recommendation as the reasons given by NTPC were deemed insufficient for rejecting the lowest or the next lowest evaluated bidders. The Bank also felt that it was unreasonable to adhere to the original delivery dates stipulated in the bid documents when there had been a delay of 4 months in awarding the contract. Upon the Bank making its views very clear, and under threat of cancellation of the balance of the loan, NTPC entered into negotiations with the lowest evaluated bidder, resolved the differences, and finally awarded the Contract in March 1990.

30. Procurement. The project was implemented on the basis of single turnkey contracts for each of the power stations, covering the Combustion Turbines and the Combined Cycle Modules primarily dictated by Performance Guarantee reasons. Consultant services were also funded under the Bank loan. NTPC had initially suggested to split the contracts into several packages for each of the plants, but this could not be supported by the Bank because procurement through a single supplier on a turnkey basis, offered simplified supervision and project implementation, as well as facilitate training of the staff, since the three combined cycle units were scheduled to be

commissioned within a year of each other. Experience with project implementation confirmed the validity of these assumptions.

31. In accordance with the Project Agreement, associated civil works and erection were also made part of the respective turnkey contracts for the three plants. International competitive bidding procedures were followed, and it was agreed during loan negotiations that the Industrial Formula for Domestic Preference would apply, since a significant domestic capability was expected to cater to some of the major equipment supplies. In the end, however, it was not necessary to apply this formula. To assist NTPC in carrying out the project, consultants were employed based on the Bank's Guidelines for the Selection of Consultants, whose terms and conditions of employment were satisfactory to the Bank.

32. The Bank had expressed concern to NTPC management on a number of occasions that the time spent on bid evaluation and for the approval of contract awards was too long and that appropriate measures should be taken to simplify the bidding process. NTPC should consider how to introduce better efficiency in procurement. Being an autonomous corporation with full accountability to the government for its actions, NTPC should make its own procurement decisions independent of any external involvement in the process. Specifically, the lengthy procurement process and the delays in making timely decision caused serious disruptions in the implementation schedule for the Kawas Combined Cycle Power Plant.

33. It needs to be recognized that a bidder has the right to ask for adjustments in the price of its bid if there are delays in making the contract award beyond the original bid validity period. The price adjustment is admissible based on commercial principles that recognize the movement, in the interim, of internationally published indices for material and labor that the bidder might have used to develop the price of its product or services. The bidder is, however, required to substantiate its claim for the price increase. This principle has been enshrined in the new procurement guidelines of the Bank that provides for automatic adjustment of the bid price (in case of fixed-price bids) in case of such delays. In any case, this matter should not have been an issue because the bid documents provided for price adjustment during the course of project implementation based on the movement of the variable indices. Similarly, procurement should be completed within the bid validity period. In the event bid validity is extended, the bidders' right to extend the implementation schedule correspondingly, should also be recognized.

34. Contract award recommendations of NTPC in respect of the Anta and the Auraiya plants were accepted by the Bank. There was one instance of representation by a consultant against not opening its priced bid although it considered its proposal to be technically at par with the other proposals. The bid evaluation procedure stipulated that NTPC would rate the technical merit of the proposals first and open priced bids only of those that scored above a predetermined threshold. The bidder accepted NTPC's explanation. There was a complaint from one of the other bidders over the bid evaluation in respect of Kawas combined cycle plant, where it was relegated from a higher

to a lower rank in accordance with the evaluation criteria specified in the bidding documents. NTPC's position in this matter was tenable and the complainant did not pursue the matter when explained the rationale behind the bid evaluation process.

Project Performance

35. Serious teething problems and operational difficulties were experienced in all three power plants during the commissioning phase. It took several months for the required modifications to be identified and implemented to stabilize the operation of these plants. It is curious to note that, even though the manufacturers of the three plants were different the combustion turbine components in all three plants suffered damage due to high temperatures and inadequate clearances between the compressor rotor and the casing. For more details, refer to Part III, Annex A.

36. The technical specifications called for dual-fuel firing capability in all units, but the installation of the alternate liquid fuel firing system at the Kawas plant was deleted by NTPC as desired by GOI, on basis of an assurance given by GAIL/ONGC that gas would be made available at all times for this plant. Even though no written contract was signed by any party to this effect, the recommendation for the deletion of alternate fuel firing capability at the Kawas plant bound GAIL/ONGC to a tacit commitment to keep it supplied with the required quantity of gas. Now that there has been a failure of that commitment, NTPC has had to award a supplementary contract to GEC/Alstom for the installation, at NTPC's cost, of alternate fuel firing capability in all four combustion turbines. The contract was signed in May 1994, to be implemented over a period of 18 months. Gas supply to the plant has become sporadic with the result that the plant has to be shut down every now and then for the non-availability of gas. The plant has to live with this situation until the dual-fuel firing capability is installed.

37. The associated 220 kV and 400 kV transmission lines, even though not funded under the Bank loan, were commissioned into service on time to facilitate evacuation of power from the three power plants. Since August 1991, the said transmission facilities are being managed by POWERGRID (Part I, para.23).

Merit Order Dispatch and Fuel Pricing

38. In order to derive a merit order for generation dispatch purposes, it is usual to rank generating units in order of their short run marginal costs: the costs of production excluding fixed charges associated with meeting capital requirements, operation and maintenance costs and other fixed costs that would exist whether the units generate or not. The marginal cost for scheduling purposes should only be the cost of producing the next kWh of output. In accordance with a GOI notification, the tariff associated with the output of each centrally owned power station, is set notionally in two parts; in terms of a capacity charge and an

energy charge. However, the way these tariffs operate is such as to make them appear as one part tariffs based on energy drawn by the SEBs. This apparent energy charge does not relate solely to the short run marginal cost of the stations; instead, it lumps together capital items with marginal operating cost items which makes the cost of the next kWh of production, as viewed by the SEBs, appear to be high in relation to their own real short run cost of production. The result is that it is cheaper for the SEBs to generate on their own inefficient units rather than to import from the central stations. The prevailing distortions as a result of the GOI notification and the administered fuel pricing, need to be removed as early as possible.

Environmental Impacts

39. During construction, the project had only minor environmental impact. Operation of gas based combined cycle power plants present significantly less environmental problems than those created by coal-fired power stations, since natural gas is a much cleaner fuel to burn, and the project requires far less land. The sulfur content of the natural gas used in the power plants built under the project is very low. Also, due to natural gas having a larger hydrogen-to-carbon ratio than coal, its combustion automatically releases less CO₂. The combustion turbines were specifically designed to minimize NO_x emission. Cooling water requirement for the plants also is minimal because cooling towers were built. Effluent water from the power stations is neutralized in waste water treatment plants. Sound attenuation provides safety against unacceptable noise levels.

Resettlement and Rehabilitation (R&R)

40. The project entailed acquisition of about 391 acres (158 ha) for Anta, 298 acres (121 ha) for Auraiya, and 568 acres (230 ha) for the Kawas power plants. Land acquisition was completed satisfactorily. Project Affected Persons (PAP) were compensated by cash payment in accordance with GOI regulations. Some of the PAPs found permanent jobs at the plants. Others were helped to start businesses of their own; such as, maintenance contracts, shops, etc. Community development schemes in the affected villages were implemented.

41. NTPC operates in several states and to ensure a common approach, it formalized in 1993 its own comprehensive R&R policy for PAPs. This policy is consistent with the Bank's operational directives. With the adoption of the formalized and comprehensive R&R policy, NTPC is reappraising the already completed the resettlement component of the Combined Cycle Project to make sure that the objectives of the basic R&R policy have been met. These, inter alia, include ensuring that the PAPs improve, or at least regain, their previous standard of living. Details of R&R measures are included in Part III, Annex A.

Project Costs

42. At appraisal, the total cost of the project, including the transmission component, contingencies, taxes and duties, but without interest during construction, was estimated at about Rs. 16,143 million (US\$ 1,241.3 million equivalent at an exchange rate of US\$ = Rs. 13.00), of which Rs. 8,663 million (US\$ 665.6 million) represented the foreign exchange cost. The actual cost of the project, including the transmission component, was Rs. 26,567 million (US\$ 1,229.7 million equivalent at an average exchange rate of US\$=Rs.21.60), representing an increase by about 65 percent in rupee terms. An increase of Rs. 9,754.2 million was due to the devaluation of the rupee with respect to the US dollar.

43. Taxes and duties were estimated in the SAR at Rs.1,653 million (US\$ 127.3 million equivalent). The project was exempted by GOI from the levy of Customs Duty on imports of the plant equipment. Sales Tax and Excise Duties were also not applicable for imported equipment. The taxes and duties, however, were paid on local supplies only which constituted an insignificant part of the total procurement under the project. It is estimated that taxes and duties paid for the Mechanical/Electrical Works amounted to Rs. 243.6 million (US\$ 11.3 million equivalent) and those for the Transmission System another Rs. 337 million (US\$ 15.6 million equivalent) for a total of Rs. 580.6 million (US\$ 26.9 million equivalent). The estimate in the SAR for interest during construction was Rs. 929.3 million (US\$ 44.7 million equivalent); the actual amount was Rs.2,405.1 million (US\$ 111.4 million equivalent).

Disbursements.

44. The estimated and actual disbursements under the loan are given in Part III, Table 4. The delays that occurred at the start of the project, coupled with equipment problems experienced in all three power plants that delayed contract closeout, adversely affected the disbursements. The actual disbursements were thus later than the appraisal estimates which projected that the loan would be closed by 31 December 1991. The closing date of the loan had to be extended twice, by one year each time, to 31 December 1993, to allow for completion of procurement and disbursements. The loan amount of US\$ 485.0 million equivalent was fully disbursed by 2 June 1994.

Project Results

45. Overall, the project was successful in meeting its principal objectives of: (a) providing the Northern and Western Regions of India with the much needed power; (b) diversifying the fuels used in power generation through the use of natural gas or liquid fuels; (c) relieving pressure on the railway and the coal sector; and (d) introducing into India the combined cycle technology.

46. The physical targets of the generation components were achieved, albeit behind the original schedule set at appraisal due to delays described in Part I, paras. 23 and 29, which caused the

commissioning schedule for the generating units to be revised even before the project got started. However, NTPC's performance with respect to the respective construction schedules, revised at the time of award of contracts, was highly satisfactory. All generating units in the Anta Combined Cycle Plant were commissioned by NTPC ahead of the revised schedule. For the Auraiya Combined Cycle Plant, while the units were synchronized close to the revised schedule, there were delays in placing the units in commercial operation due to serious operational difficulties that led to extensive modifications of the combustion turbines and other components. The Kawas Combined Cycle Plant was delayed due to rebidding, and the length of time NTPC took to make contract award decisions; however, the units were synchronized ahead of the revised schedule. But commercial operation was delayed due to serious equipment problems in the initial stages of operation. The transmission component, not financed by the Bank, was commissioned in time to facilitate evacuation of power from the respective plants. The HBJ gas line was installed on schedule for the generating units to operate on natural gas. However, fuel supply constraints at the Kawas plant are now affecting generation.

47. The project assisted in the transfer of know-how through the construction of the first ever combined cycle power plant in India. NTPC engineers were trained abroad in engineering and design aspects, as well as in the construction management and operation and maintenance of such power plants.

48. The covenanted requirement for NTPC to reduce recoverables to less than two months of billing, which was finally accomplished towards the close of the project on current billing, helped NTPC improve its financial standing.

Project Financing

49. The Bank loan of US\$ 485.0 million equivalent was envisaged to provide for 39 percent of the total project cost, net of duties and taxes and IDC, and expected to cover about 73 percent of the estimated foreign cost of the project. The balance of the foreign exchange financing requirement, amounting to US\$221 million was to be met from external borrowing or GOI foreign exchange reserves. The remainder was to be arranged by NTPC through internal cash generation plus equity and loans from GOI. Financing remained basically in line with the one envisaged at appraisal (Part III, Table 7B). The final project cost was of US\$ 1,229.7 million equivalent, inclusive of contingencies, taxes and duties, interest during construction. The share of the Bank financing was 39.4 percent of the total project cost. About US\$ 437 million of the Bank loan was utilized for imports, and the balance of US\$ 48 million was used for financing expenditures in local currency. Cofinancing was provided by: (i) International Bank of Japan (US\$ 138.1 million equivalent); (ii) French Banks (US\$ 416.7 million equivalent); (iii) Belgian Banks (US\$ 56.4 million equivalent); and (iv) Domestic Resources (US\$ 133.5 million equivalent).

Financing of the Project					
Sources		SAR		Actual	
		(US\$ million)	%	(US\$ million)	%
I	IBRD	485.0	37.7	485.0	39.4
II	IBJ }	138.1	11.2		
III	France }	696.2	54.1	416.7	33.9
IV	Belgium }	56.4	4.6		
V	Domestic	104.8	8.2	133.5	10.9
Total		1,286.0	100.0	1,229.7	100.0

Economic Rate of Return

50. Benefits of the three power stations included in the project could not be readily separated from those of other investments in generation, transmission and distribution in the Northern and Western Regions. Therefore, an economic analysis was carried out based on the "time slices" of investment programs of the two regions. Capital costs of the investment programs (covering generation, transmission and distribution) together with incremental operating and fuel costs are given in Part III, Tables 8A and 8B. The benefits of the investment program relate mainly to the incremental consumption which they make possible. A minimum measure of benefits, ignoring consumer surplus, was then derived from incremental sales revenue. Electricity tariffs in application for each power plant were expressed in constant November 1994 prices. A Standard Conversion Factor of 0.9 was used. On this basis, the ex-ante internal rate of return (IERR) achieved by the Northern region is 16%, as against an appraisal estimate of 3%. The ex-ante IERR for the Western Region on the same basis works out at 14%, as compared to the appraisal estimate of 7%.

Project Sustainability

51. The project is sustainable for the following reasons: (a) the demand for the output of each of the power stations exists in the two regions; and (b) the current tariff setting procedures and tariffs are adequate enough to permit recovery of capital and operating costs. The new two-part tariffs, which were introduced 1 November 1992, would serve to reinforce incentives to operate the plants efficiently and with high availability. However, availability of gas at the three power plants needs to be ensured. There is a continuing shortfall in the gas supply to all three power plants and ONGC/GAIL are unable to meet the supplies stipulated in the original linkage. Specifically, non-availability of gas is seriously affecting the operation of the Kawas plant (Part I, para. 36).

52. The initial teething problems of the power plants, which were of serious nature, have been resolved. Except for the Kawas plant which has gas availability problems, the PLF and availability achieved in 1993-94 have been quite impressive, as shown below:

<u>Station</u>	<u>Capacity Factor (PLF), %</u>	<u>Availability Factor</u>
Anta	71.7	83.7
Auraiya	61.9	72.4
Kawas	42.9	50.0

Bank Performance

53. The performance of the Bank from project preparation through project completion was by and large satisfactory. The Bank had good relations with GOI and NTPC throughout the execution of the project and fostered an environment conducive to increased Bank interaction with NTPC, in spite of occasional tensions during the procurement of the Kawas Power Plant and during the period remedies were brought by GOI and NTPC to NTPC's accounts receivable problem. However, NTPC's unsatisfactory accounts receivable position and its failure to meet the associated loan covenants, should have been dealt with more firmly and remedies under the ongoing loan agreements should have been invoked much earlier to correct the situation. To date, the Bank Group has assisted NTPC in implementing in all 15 projects, with a total loan of about US\$ 4 billion. The Bank has had enough leverage to strengthen the institutional and financial viability of NTPC through firm actions.

54. The Bank has also continued to address a number of shortcomings of broader sectoral concern in the operations of NTPC, with appreciable success. The major items are:

- (a) Transformation of NTPC from a construction-oriented organization to one of the largest generating utilities in the developing world;
- (b) Introduction of two-part tariff to help mobilization of resources from internal cash generation to finance investment programs. However, the intended benefit has not yet been derived due to global accounting system exercised through the regional SEBs, as described in Part I, para.38, which is an obstacle to merit order dispatching. A study has been made as a part of POWERGRID operations and its recommendations are to be implemented through the POWERGRID System Development Project (Ln.3577-IN);
- (c) Implementation of the new commercial and investment policies, agreed under Ln.3632-IN; and,
- (d) Adoption of a more comprehensive and up-front approach towards environmental protection and R&R issues. An Environmental Action plan, aimed to complement

earlier efforts, has already been drawn up for all NTPC power projects, including the Combined Cycle Project.

Borrower Performance

55. Part III, Table 1, contains the review of performance of the Borrowers and the Implementing Agencies. The performance of GOI was less than satisfactory because of the delay in according investment approval of the project. Performance of NTPC was satisfactory in respect of implementation and compliance with covenants, except for NTPC's less than satisfactory performance in the procurement of the Kawas Power Plant and the covenant requiring receivables to be reduced to less than 60 days of billing. It was only towards the end of the project that NTPC finally satisfied this covenant in respect of current billing.

56. The performance of NTPC in project implementation was generally satisfactory because the project objectives were met in the end. The following deficiencies were, however, noteworthy: (a) lengthy procurement cycles and delayed contract awards (Part I, paras. 25-30, 32 and 33); and (b) equipment problems (Part I, paras. 35 and 36). NTPC was finally able to overcome these problems and place the three plants in commercial operation.

57. Positive contributions by NTPC to the project consisted of the following: (a) Key operation and maintenance personnel, including the engineering and managerial staff were given intensive training and involved in the installation of the equipment during the construction phase of the project, with concentration on the preoperational phases of activity such as planning, design and construction; (b) the senior management and site management of NTPC paid close attention to the coordination and monitoring of all headquarters and field activities, equipment supplies, transport, erection services and commissioning; and (c) a sound reporting system and supervision strategy was established and daily reports from various fronts at the different sites were obtained. The analysis of these reports provided the right tool to intervene appropriately to avoid delays.

Comparison of Financial Aspects with Combined Cycle SAR Forecasts

58. Viewed in isolation, the statistics presented in Part I, para. 9, and Part III, Tables 12A, 12B and 12C, indicate that NTPC's operational and financial performance have been successful. Capacity addition and generation of electricity increased at high rates, and rates of return were higher than the returns required according to the covenants. However, while electricity generation and revenues were comparable to forecasts in the SAR, capital investments and net fixed assets were significantly below the forecast levels.

59. At the end of FY94 investments were only about half of their projected level, and net fixed assets were 43.5% lower than expectations. Fuel costs have been considerably higher in recent years (in 1994 fuel costs were 33.3% higher than SAR forecasts) leading to higher operating

expenses. Actual fuel costs grew 50.0% per year against a forecast of 45.8% increase per year, but growth of operation and maintenance costs was slower (actual 40.5% against a forecast of 38.5%). Actual bulk tariff in 1994 was comparable to the SAR forecasts, but the SAR forecasts of tariff were based on a lower level of operating expense, and therefore, the actual tariff was insufficient to generate the rates of return assumed in the SAR. The actual operating profit was 33.3% lower than SAR forecasts. Interest costs charged to revenue were considerably lower than the projections, because of lower levels of borrowing and lower interest rates (average interest rates assumed in the SAR during the 90s were 9-10% but the actual average turned out to be 4-5%). Therefore, although the operating income before interest was much less than SAR forecasts, net income after interest usually exceeded the forecasts.

60. In summary, although NTPC's operational and financial performance have been satisfactory, except with respect to bill collection (Part I, para.13), they have been well below the level of performance predicted in the SAR forecasts. The reasons are several - there have been delays in project implementation leading to lower levels of assets; lags in proper tariff notification have led to lower revenues; problems in bill collection and maintaining a larger inventory of spare parts have limited NTPC's internal contribution to new investments; NTPC had occasional problems in receiving external financial assistance as well as raising capital in domestic markets which further eroded its capacity expansion program. Timely resolution of these problems would have resulted in an even better performance record.

Project Relationship

61. The Bank's relationship with NTPC and with the GOI has been good, in spite of occasional tension during the resolution of the accounts receivable problem.

Consulting Services

62. Two international and one Indian consultants carried out the project feasibility studies and laid down the basic design parameters for the three combined cycle power plants, provided detailed engineering and design services. Performance of the consultants have been satisfactory except that the Consultants for detailed engineering could have foreseen the difficulties encountered during commissioning, as described in Part I, para.35. From the initiation of the project till completion, project engineering review meetings, development of the detailed equipment specifications, and final layouts were held regularly in NTPC's offices in New Delhi. Later these review meetings were also extended to the individual sites to resolve site specific questions. Transfer of knowledge was accorded priority. NTPC seconded its own engineers to form part of the consultants' engineering and design, project management and supervisory teams. Consultants were also responsible for the full quality assurance program at contractor's works, and assisted in expediting supplies of the equipment on schedule, thereby helping flesh out problems as they arose.

Project Documentation and Data

63. The project's legal arrangements adequately reflected the Bank's interests in achieving the objectives of the project. The SAR of the project provided a very useful framework for both the Bank and the Borrower during project implementation.

64. NTPC regularly submitted quarterly progress reports for the project. These have been used for review of physical and financial performance as well as for planning the visits of the supervision missions to India which often included site visits in addition to review meetings at NTPC's corporate head quarters in New Delhi.

65. NTPC has provided a completion report for the project and subsequent additional financial information. The NTPC report consisted of the first draft of Parts I and III of the report based on which this Project Completion Report has been finalized.

PART II : PROJECT REVIEW FROM BORROWER'S PERSPECTIVE

NOT RECEIVED YET FROM THE BORROWER.

INDIA

**COMBINED CYCLE POWER PROJECT
(Loan 2674-IN)**

Part III : Statistical Tables

Table 1: Summary of Assessments

A. <u>Achievement of Objectives</u>	Substantial	Partial	Negligible	Not Applicable
Macroeconomic policies	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Sector policies	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Financial objectives	<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Institutional development	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Physical objectives	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Poverty reduction	<input type="checkbox"/>		<input type="checkbox"/>	<input checked="" type="checkbox"/>
Gender concerns	<input type="checkbox"/>		<input type="checkbox"/>	<input checked="" type="checkbox"/>
Other social objectives	<input type="checkbox"/>		<input type="checkbox"/>	<input checked="" type="checkbox"/>
Environmental objectives	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public sector management	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Private sector development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
B. <u>Project Sustainability</u>	<u>Likely</u>	<u>Unlikely</u>	<u>Uncertain</u>	
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
C. <u>Bank Performance</u>	<u>Highly satisfactory</u>	<u>Satisfactory</u>	<u>Deficient</u>	
Identification	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Preparation assistance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Appraisal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Supervision	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
D. <u>Borrower Performance</u>	<u>Highly satisfactory</u>	<u>Satisfactory</u>	<u>Deficient</u>	
Preparation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Implementation	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Covenant compliance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Operation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
E. <u>Assessment of Outcome</u>	<u>Highly satisfactory</u>	<u>Satisfactory</u>	<u>Deficient</u>	
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 2: Related Bank Loans/Credits

<u>Loan/credit title</u>	<u>Purpose</u>	<u>Year of approval</u>	<u>Status</u>
<u>Preceding Operations</u>			
Ramagundam Thermal	3x200 MW thermal	1/79	Complete
Farakka Thermal	See under IDA credits	6/80	Complete
Second Ramagundam Thermal	3x500 MW thermal	12/81	Complete
Central Power Transmission	400/220 kV transmission	5/83	Complete
Second Farakka Thermal	2x500 MW thermal	6/84	Complete
Rihand Power Transmission	500kV HVDC+400kV AC	5/85	Complete
Combined Cycle Power	413 MW (Anta)	4/86	Complete
	652 MW (Auraiya)		Complete
	644 MW (Kawas)		Complete
Talcher Thermal	2x500 MW thermal	6/87	
National Capital Power Supply	4x210 MW thermal	6/87	
Northern Region Transmission	765/400/220 kV Transmission	6/90	
NTPC Power Generation	System Coord.&Control	6/93	
	+ Transmission Reinforcement		

Total Loans 11

IDA Credits

<u>Preceding Operations</u>			
Singrauli Thermal	3x200 MW+400kV AC	4/77	Complete
Second Singrauli Thermal	2x500 MW thermal	5/80	Complete
Farakka Thermal	3x200 MW thermal	6/80	Complete
Second Korba Thermal	3x500 MW thermal	7/81	Complete

Total IDA credits 4

Sectoral Objectives Common to the Above Projects

In addition to the above project-specific objectives, the sectoral objective was to assist NTPC become a model utility for the poorly performing SEBs. However, this was not specifically mentioned in the SAR.

Table 3: Project Timetable

Steps in project cycle	Date planned	Date actual
Identification		1985
Preparation	3/85	3/85
Appraisal	5/85	5/85
Negotiations	11/85	2/86
Board presentation	1/86	4/86
Signing		10/86
Effectiveness	1/87	3/87
Project completion : Anta	3/90	8/90
Auraiya	6/90	12/90
Kawas	6/90	11/93
Loan closing	12/31/91	12/31/93

Table 4: Loan disbursements: Cumulative Estimated and Actual

	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94
Appraisal Estimate	36.0	170.0	320.0	410.0	460.0	485.0		
Actual	0.46	59.33	257.02	370.78	425.27	438.67	459.61	485.0
Actual as % of estimate	1.3	34.9	80.3	90.4	92.5	90.4	94.8	100.0
Date of final disbursement	2 June 1994							

Table 5: Key Indicators for Project Implementation

I. Key Implementation Indicators
in SAR/President's Report

1. Procurement

Package	Bidding		Documents		Evaluation		Contract	LOA
	To Bank	Bank Approve	Sale	Open	To Bank	Bank Approve	Award	To Bank
Planned		3/86			12/86		12/86	
Anta	12/85	2/86	2/86	11/86	6/87	6/87	8/87	4/88
Auraiya	12/85	2/86	2/86	11/86	6/87	6/87	9/87	6/88
Kawas	7/88	9/88	9/88	11/88	4/89	5/89	3/90	3/90
Consultant	9/85	10/85	11/85	12/85	8/86	8/86	8/86	3/87
2. Plant			Planned (P)			Actual (A)		
Main Plant Order Placed			12/86			Anta: 8/87 Auraiya: 9/87 Kawas: 3/90		

II. Modified Indicators (for commissioning)

Indicator	Plant	CT 1		CT 2		CT 3		CT 4		ST 1		ST 2	
		P	A	P	A	P	A	P	A	P	A	P	A
Turbine	Anta	8/89	1/89	10/89	3/89	12/90	5/89	-	-	8/90	3/90	-	-
Erection	Auraiya	9/89	3/89	11/89	7/89	1/90	8/89	3/90	9/89	9/90	12/89	1/91	6/90
Started	Kawas	3/92	3/92	5/92	5/92	7/92	6/92	9/92	8/92	3/93	2/93	7/93	3/93

CT: Combustion Turbine (gas turbine)

ST: Steam Turbine-Generator

Table 6: Key Indicators for Project Operation

Plant	Indicator	CT 1		CT 2		CT 3		CT 4		ST 1		ST 2	
		P	A	P	A	P	A	P	A	P	A	P	A
Anta	Commercial		4/89		5/89		7/89	-	-		8/90	-	-
Auraiya	Commercial		10/90		10/90		11/90		11/90		11/90		12/90
Kawas	Commercial		6/92		8/92		9/92		11/92		11/93		9/93

Table 7A: Project Costs

	Appraisal estimate (US\$M)			Actual (US\$M)		
	Local	Foreign	Total	Local	Foreign	Total
Preliminary and Civil Works	59.9	4.4	64.3	43.4	-	43.4
Main Electromechanical Equipment	158.9	411.2	570.1			
Auxiliary Electromechanical Equipment	67.6	80.8	148.4	70.1	864.1	934.2
Fuel Supply Equipment	4.4	9.0	13.4			
Transmission System	110.1	15.1	125.2	97.3	-	97.3
Consultancy and Technical Assistance	5.6	5.2	10.8	-	2.0	2.0
Engineering and Administration	62.2	-	62.2	37.1		37.1
Total Base Cost	468.7	525.7	994.4			
Physical Contingencies	24.2	27.5	51.7			
Price Contingencies	82.8	112.4	195.2			
Total Project Cost	575.7	665.6	1,241.3	247.9	866.1	1,114.0
Interest During Construction						
Bank	-	37.4	37.4		115.7	115.7
Other	4.3	3.0	7.3			
Total Financing Required	580.0	706.0	1,286.0	247.9	981.8	1,229.7

NOTE: Because of turnkey nature of the contracts, it has not been possible to capture project costs in the same format as in the SAR.

Table 7B: Project Financing

Source	Appraisal Estimate (US\$M)			Actual (US\$M)		
	Local costs	Foreign costs	Total	Local costs	Foreign costs	Total
IBRD	-	485.0	485.0	-	485.0	485.0
GOI/External Borrowing	475.2	221.0	696.2			
Int'l Bank of Japan				-	138.1	138.1
French Banks				-	416.7	416.7
Belgian Banks				-	56.4	56.4
NTPC	104.8	-	104.8	133.5	-	133.5
Total	580.0	706.0	1,286.0	133.5	1,096.2	1,229.7

Table 8: Economic Costs and Benefits

A. Northern Region Investment Program

Fin year	Capital Exp.	O&M	Fuel	Total Cost	Incr. Sales	Net Benefit
1986	3			3		-3
1987	34			34		-34
1988	840			840		-840
1989	4382			4382		-4382
1990	3195	23	955	4172	1339	-2833
1991	836	81	1612	2529	2847	318
1992	965	153	3173	4291	6159	1868
1993	596	190	2808	3594	5449	1855
1994	419	380	3345	4144	5377	1233
1995		380	3345	3726	5377	1652
1996		380	3345	3726	5377	1652
1997		380	3345	3726	5377	1652
1998		380	3345	3726	5377	1652
1999		380	3345	3726	5377	1652
2000		380	3345	3726	5377	1652
2001		380	3345	3726	5377	1652
2002		380	3345	3726	5377	1652
2003		380	3345	3726	5377	1652
2004		380	3345	3726	5377	1652
2005		380	3345	3726	5377	1652
2006		380	3345	3726	5377	1652
2007		380	3345	3726	5377	1652
2008		380	3345	3726	5377	1652
2009		380	3345	3726	5377	1652
2010		380	3345	3726	5377	1652
2011		380	3345	3726	5377	1652
2012		380	3345	3726	5377	1652
2013		380	3345	3726	5377	1652
2014		380	3345	3726	5377	1652
2015		380	3345	3726	5377	1652
2016		380	3345	3726	5377	1652
2017		380	3345	3726	5377	1652
2018		380	3345	3726	5377	1652
2019		380	3345	3726	5377	1652
2020		380	3345	3726	5377	1652
2021		380	3345	3726	5377	1652

IRR = 16%. Capital Expenditures: Foreign 78%; Local 22%. O&M Expenditures: Foreign 65%; Local 35%
 Fuel: 100% local. Sales 100% local.
 Tariffs in application for each power plant were expressed in constant November 1994 prices.
 Standard Conversion Factor: 0.9

B. Western Region Investment Program

Fin. Year	Capital Exp.	O&M	Fuel	Total Cost	Incr. Sales	Net Benefit
1986	7			7		-7
1987	17			17		-17
1988	79			79		-79
1989	142			142		-142
1990	95			95		-95
1991	1252			1252		-1252
1992	6158			6158		-6158
1993	3532	34	961	4527	1772	-2755
1994	957	109	1408	2473	3398	925
1995		109	1408	1517	3398	1881
1996		109	1408	1517	3398	1881
1997		109	1408	1517	3398	1881
1998		109	1408	1517	3398	1881
1999		109	1408	1517	3398	1881
2000		109	1408	1517	3398	1881
2001		109	1408	1517	3398	1881
2002		109	1408	1517	3398	1881
2003		109	1408	1517	3398	1881
2004		109	1408	1517	3398	1881
2005		109	1408	1517	3398	1881
2006		109	1408	1517	3398	1881
2007		109	1408	1517	3398	1881
2008		109	1408	1517	3398	1881
2009		109	1408	1517	3398	1881
2010		109	1408	1517	3398	1881
2011		109	1408	1517	3398	1881
2012		109	1408	1517	3398	1881
2013		109	1408	1517	3398	1881
2014		109	1408	1517	3398	1881
2015		109	1408	1517	3398	1881
2016		109	1408	1517	3398	1881
2017		109	1408	1517	3398	1881
2018		109	1408	1517	3398	1881
2019		109	1408	1517	3398	1881
2020		109	1408	1517	3398	1881
2021		109	1408	1517	3398	1881

IRR =14%. Capital Expenditures: Foreign 78%; Local 22%. OEM Expenditures: Foreign 65%; Local 35%
 Fuel: 100% local. Sales 100% local.
 Tariffs in application for each power plant were expressed in constant November 1994 prices.
 Standard Conversion Factor: 0.9

**Table 9: Status of Legal Covenants
INDIA
Combined Cycle Power Project (Loan 2674-IN)**

<u>Ref.</u>	<u>COVENANT</u>	<u>COMPLIED</u>
PA 3.02	NTPC shall take out insurance against risks in such amounts as will be consistent with appropriate practice	yes
3.04	NTPC shall not later than 6 months prior to commissioning of the first unit, enter into a satisfactory contract for the supply of gas for the project	yes
3.05	NTPC shall: (I) furnish report of committee on uniform tariff (ii) carry out a study of its bulk supply tariff structure under TOR and timetable acceptable to the Bank	yes yes
4.01	NTPC shall submit audited financial statements and auditors' report within 7 months of FY end	yes
4.02	NTPC shall maintain from March 31, 1986 onwards its accounts receivable at not more than an amount equal to power sales revenues for the two preceding months	no (Refer Part I, Para. 13)
4.03	NTPC shall achieve an annual rate of return of not less than 7% for FY1984/85 through FY1989/90; 9½% for FY1990/91 through FY1994/95 and, 14.7% for FY 1995/96, and at satisfactory levels thereafter	Yes
PA Schedule I Section II	NTPC shall employ satisfactory consultants to assist in the engineering, testing and commissioning of the power stations	Yes
LA 3.01 (b)	GOI will enter into a subsidiary loan agreement with NTPC under terms satisfactory to the Bank	Yes
(c)	GOI to provide NTPC amounts from loan account, on specified terms and conditions, in the first month of the quarter following the quarter in which amounts are withdrawn by GOI	Yes
4.01	GOI to ensure, to the extent gas is available, liquid fuels are made available to NTPC in an economic manner and in quantities to permit designed operation of facilities to be constructed under the project	Yes (Refer Part I, para. 37)

Table 10: Bank Resources: Staff Inputs

Staff inputs in carrying out the various tasks through the project cycle from preparation in FY85 through completion in FY94 were as follows:

<u>Task</u>	<u>Input (Staff-Weeks)</u>
Project Preparation	13.2
Project Appraisal	37.0
Loan Negotiations	8.0
Board through Loan Effectiveness	14.0
Project Supervision	35.9
Project Completion	7.0

Table 11: Bank Resources: Missions

<u>Project Cycle</u>	<u>Month/Year</u>	<u>Number of Persons</u>	<u>Days in Field</u>	<u>Specialization /a</u>	<u>Performance Rating /b</u>	<u>Type of Problems /c</u>
<u>Through Appraisal</u>						
Identification	/d					
Preparation	/d					
Preappraisal	/d					
Appraisal	5/85					
<u>Supervision</u>						
Supervision 1	10/87	1	4	E	1	PR
Supervision 2	8/88	1	3	E	1	PR
Supervision 3	10/88	1	3	E	1	I, PR
Supervision 4	8/89	1	3	E	2	PR, EP
Supervision 5	2/90	1	3	E	2	PR, EP
Supervision 6	7/90	1	2	E	1	EP
Supervision 7	8/91	1	3	E	1	EP
Supervision 8	11/92	2	4	E, FA	1	EP
Supervision 9	6/93	4	5	E, FA, EN, C	1	EP
Supervision 10	10/93	2	4	E, FA	2	EP
Supervision 11	2/94	4	5	E, FA, EN, C	3	FN/IN
Supervision 12	6/94	4	5	E, FA, EN, C	HS	

/a E: Engineer; FA: Financial Analyst; EN: Environmental Specialist; C: Consultant (Env)

/b 1 = No or Minor problems; 2 = Moderate problems; 3 = Major problems

/c I = Implementation delays; PR = Procurement delays; EP = Equipment Problems;

FN/IN = Financial/Institutional Problems

/d Identification by GOI in 1984. Preparation and Preappraisal by NTPC in 1985.

Annex A

Construction of Individual Plants under the Project

The contracts for all three plants were to be awarded in December 1986 in accordance with the original implementation schedule.

Anta Combined Cycle Power Plant

1. The main plant package was awarded in August 1987. The commissioning of the plant, that is synchronizing and placing in commercial operation, took place in accordance with the following schedule:

<u>Event</u>	<u>SAR Schedule</u>	<u>Revised Schedule</u>	<u>Actual/Sync.^{1/}</u>	<u>Commercial Operation</u>
Contract Award	December 86		August 87	
Combustion Turbine 1	April 89	August 89	January 89	April 89
Combustion Turbine 2	June 89	October 89	March 89	May 89
Combustion Turbine 3	August 89	December 90	May 89	July 89
<u>Steam Turbine 1</u>	October 90	August 90	March 90	August 90

^{1/} Synchronized

2. Significant problems were experienced during initial operation of the combustion turbines; such as, dislodging of blade tips in the first stage moving blades, bulging of combustor chamber inserts, cracking of first stage stationary vanes, crack in the hot gas casing collars, cracking of cables, as well as condenser fouling, and vibration in the generators. The manufacturer performed the required modifications and successfully rectified the defects. The performance of the plant has since been satisfactory. Till the end of March 1994, this plant had generated 10,230 GWh of energy (cumulative). PLF of 1993-94 was 71.7% at an availability factor of 83.7%.

Auraiya Combined Cycle Power Plant

3. The main plant contract was awarded in September 1987. Plant commissioning was accomplished in accordance with the following schedule:

<u>Event</u>	<u>SAR Schedule</u>	<u>Revised Schedule</u>	<u>Actual/Sync.</u>	<u>Commercial Operation</u>
Contract Award	December 86	September 87		
Combustion Turbine 1	March 89	September 89	March 89	October 90
Combustion Turbine 2	May 89	November 89	July 89	October 90
Combustion Turbine 3	July 89	January 90	August 89	November 90
Combustion Turbine 4	September 89	March 90	September 89	November 90
Steam Turbine 1	September 90	November 90	December 89	November 90
Steam Turbine 2	December 90	January 91	June 90	December 90

4. The plant was beset with serious teething problems, some of which were: Failure of the CT compressor, shifting of compressor blades and rubbing of blades in CT 1 and 4, combustor basket failure, passing in guillotine and bypass dampers, cracks in louvers of the bypass dampers, blockage in air intake filters, etc. Modifications were carried out and the defects were successfully rectified. The Performance Test of the combined cycle plant, however, was completed in April 1994 because of delays in proving liquid fuel (naphtha) firing capability. Test results were satisfactory. The plant has since been operating well. Till the end of March 1994, this plant had generated 12,484 GWh of energy (cumulative). PLF in 1993-94 was 61.9% at an availability factor of 72.4%.

Kawas Combined Cycle Power Plant

5. Award of contract for the Kawas plant was delayed until March 1990. Implementation record of the plant was as follows:

<u>Event</u>	<u>SAR Schedule</u>	<u>Revised Schedule</u>	<u>Actual/Sync.</u>	<u>Commercial Operation</u>
Contract Award	December 86	March 90		
Combustion Turbine 1	December 88	March 92	March 92	June 92
Combustion Turbine 2	February 89	May 92	May 92	August 92
Combustion Turbine 3	May 89	July 92	June 92	September 92
Combustion Turbine 4	July 89	September 92	August 92	November 92
Steam Turbine 1	April 90	March 93	February 93	November 93
Steam Turbine 2	August 90	July 93	March 93	September 93

6. Serious operational difficulties were experienced during test operations of the plant. These, inter alia, were: Burning of combustion Turbine 1B generator transformer carbon shield between the core and the high voltage coil, overheating of neutral side braided flexible connections on Combustion Turbine 1A Generator, repeated tube failures in the high pressure second stage superheater, high vibration in steam turbine HP exhaust side bearing during start up, etc. These defects were successfully rectified; however, the superheater problem and the high turbine bearing vibration phenomenon are still being monitored. Performance Tests were performed on all four combustion turbines operating in the open cycle mode and on combined cycle block 2. Results of the test were satisfactory. Even though the plant has since been working satisfactorily, gas supply to the plant is sporadic, with the result that the entire plant has had to be shut down on many occasions due to non-availability of gas. Meanwhile, the plant has to live with the generation constraints mentioned above. Till the end of March 1994, Kawas plant had generated 3,225 GWh of energy (cumulative). PLF of 1993-94 was 42.9% at an availability factor of 50%.

7. It is curious to note that, even though the manufacturers of the three plants were different, the combustion turbine components in all cases suffered damage due to high temperature, while the compressor parts got rubbed due to inadequate clearances. At the time these power plants were built, experience on large combustion turbines, as well as on the combined cycle technology, in general, was still evolving.

8. Transmission Lines. Even though not funded under the Bank loan, the associated transmission lines were a part of the project. The following lines were constructed in time for the evacuation of power from the combined cycle plants:

<u>Line</u>	<u>Actual Length (ckt. km)</u>	<u>Date Commissioned</u>
220 kV Anta-Bhilwara D/C ^{1/}	460	March 89
220 kV Anta-Jaipur D/C	600	December 89
220 kV Auraiya-Agra D/C	332	March 89
400 kV Auraiya-Agra D/C	331	March 90
400 kV Agra-Ballabgarh S/C ^{2/}	175	January 92
220 kV Kawas-Navsari D/C	94	February 92
220 kV Kawas-Valthan D/C	73	October 90
<u>220 kV Kawas-Bharuch D/C</u>	<u>162</u>	<u>September 92</u>

1/ Double Circuit 2/ Single Circuit

Since August 1991, the transmission facilities implemented under the project are being managed by the newly created POWERGRID Ltd. (Part I; para. 21).

Environment, Resettlement and Rehabilitation

9. The project presents significantly less environmental problems compared to those posed by coal-fired power stations. Since the natural-gas fuel contains almost no sulfur (less than 0.001 ppm), the combustion of the gas causes very little atmospheric pollution. Also, due to natural gas having a larger hydrogen-to-carbon ratio than coal, its combustion automatically releases less CO₂. In the event liquid fuels are required to be used as substitute to natural gas, it is envisaged that these fuels will be natural gas liquids (NGL) or naphtha, with a low sulfur content, so as not to present increased environmental emission. The combustion turbine burners are specifically designed to minimize NO_x emission. Gas samples are regularly analyzed to ensure that emissions are within permissible limits. In the event NO_x emission should go beyond permissible limits, there is provision for water or steam injection in the machine to reduce the production of NO_x. The plants, in addition, are equipped with sound attenuating devices. Plant equipment are designed to a maximum permissible noise level of 90 dB. Owing to the relatively small size of the steam units and the installation of cooling towers for condenser cooling, the water requirement for each station is minimal (less than 1 cubic meter per second). Effluent water quality is monitored on a regular basis and waste water treatment plants have been installed to neutralize the waste water streams. Green belts have been developed around the power plants. Safety regulations for the power stations are enforced; NTPC's site record in this respect for its power plants has been satisfactory. Acquisition of land for the right-of-way for transmission lines did not pose any significant environmental problems. The transmission lines have been designed to keep radio interference within acceptable limits. GOI environmental standards and regulations are strictly enforced and monitored on a regular basis.

10. The implementation of the project at Anta required the acquisition of about 391 acres (158 hectares) of land, out of which 368 acres (149 ha) belonged to private owners, cultivated by some 154 families. None of the families were physically displaced as a result of land acquisition. Loss of land by the owners was compensated, including by cash payments in accordance with GOI regulations in force in the late 1980s. 28 of the Project Affected Persons (PAP) found permanent jobs at the plant, 6 were given maintenance contracts, and 2 were allotted shops. Community development schemes comprising, inter alia, repairing of pump sets for drinking water, building of approach roads to the railway station, extension to school buildings, etc., were implemented.

11. For Auraiya, 512 acres (207 ha) of land was acquired, out of which 298 acres (121 ha) was owned by private owners. PAPs numbered a total of 287; however, only 4 families were actually displaced. Alternative plots of land were given to these families. The rest of the PAPs received compensation for the loss of their land. 49 of the PAPs found jobs in NTPC, 6 were given maintenance contracts, and a number of community development schemes were implemented. Seven hand pumps were installed to augment drinking water supply, about 500 m of black top road was constructed, street lighting was provided over a length of 2.5 km.

12. For the Kawas project, 568 acres (230 ha) of land was acquired of which 227 acres (92 ha) was private land. There were 51 PAPs in all, all of whom have been compensated. 28 PAPs have been given employment in NTPC. Improving the lot of the PAPs in the surrounding villages has been taken up by NTPC as the next phase of their community development operation.

13. NTPC operates in several states and to ensure a common approach, it formalized in 1993 its own comprehensive R&R policy for PAPs. This policy is consistent with the Bank's operational directives and applies to all NTPC operations. The basic objective of the policy is to ensure that after a reasonable transition period, the PAPs improve or at least regain their previous standard of living. Included in the policy are a number of options, such as, land for land, training to upgrade skills, allotment of shops with seed money as loan, self-employment with seed money as grant, as well as jobs with NTPC in the unskilled and semi-skilled categories. The policy also provides for the rehabilitation of PAPs of existing NTPC projects, if required, who have not been able to regain or improve their past standard of living.

14. With the adoption of a formalized and comprehensive R&R policy, NTPC has decided to reappraise the already implemented resettlement action plans in respect of the PAPs of the Combined Cycle Project. This is being done through the Community Development Group created in 1993, under the Personnel and Administration Division. The institutional strengthening of NTPC and manpower development to effectively deal with R&R issues forms an integral part of this plan. In all three project sites, NTPC has provided developed housing plots to those PAPs who lost their homestead and has been making efforts to economically rehabilitate them by providing them with regular employment with NTPC, work with contractors, allotment of shops, award of small contracts, etc. In most cases, NTPC has upgraded community facilities in the resettlement villages and "adopted"

villages in the vicinity of its power projects to improve their economic well being. As part of its R&R policy, NTPC is also carrying out socioeconomic surveys to ascertain the present economic status of PAPs. The TOR for this survey was agreed with the Bank and funding is being provided under the National Power Generation Project (Loan 3632-IN). Based upon the findings, NTPC would: (i) focus on developing or enhancing community facilities for the benefit of the said PAPs; (ii) provide training and other assistance to help upgrade their skills and improve opportunities for employment; (iii) use its good offices to enhance improvements through Government assisted programs. The community facilities would include: establishment of primary schools, medical dispensaries, drinking water wells, roadways, area street lighting, etc. The surveys in respect of Anta, Auraiya and Kawas were completed in December 1994, and submitted to the Bank for review. Specific Remedial Action Plans in accordance with the said R&R Policy are being prepared.

IMAGING

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