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Report No. 15483

PROJECT COMPLETION REPORT

PAKISTAN

**KOT ADDU COMBINED CYCLE POWER PROJECT
(LOAN 2698-PAK)**

March 29, 1996

**Energy and Project Finance Division
Country Department I
South Asia Region**

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CURRENCY EQUIVALENTS

Currency Unit	=	Pakistan Rupee (Rs)
Rupee 1	=	Paisa 100
Rupee 1	=	US\$0.0625
Rupees 1,000,000	=	US\$62,500
US\$1	=	Rs 16.0
US\$1,000,000	=	Rs 16,000,000

GOP AND WAPDA'S FISCAL YEAR

July 1 - June 30

MEASURES AND EQUIVALENTS

1 kilometer (km)	=	0.6214 miles (mi)
1 ton	=	1,000 kilograms (kg)
	=	2,205 pounds (lbs)
1 kilovolt (kV)	=	1,000 volts (V)
1 megawatt (MW)	=	1,000 kilowatts (kW)
1 megavolt-ampere (MVA)	=	1,000 kilovolt-amperes (kVA)
1 kilowatt hour (kWh)	=	1,000 watt-hours (Wh)
1 gigawatt hour (GWh)	=	1 million kilowatt hours (kWh)
1 kilocalorie (Kcal)	=	3.97 British Thermal Units (BTU)
1 ton of oil equivalent (toe)	=	10,200 Kcal/kg

ACRONYMS AND ABBREVIATIONS

ESL	-	Energy Sector Loans
GOP	-	Government of Pakistan
ERR	-	Economic Rate of Return
KESC	-	Karachi Electric Supply Corporation
PCR	-	Project Completion Report
WAPDA	-	Water and Power Development Authority

March 29, 1996

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

**SUBJECT: Project Completion Report on Pakistan
Kot Addu Combined Cycle Power Project (Loan 2698-PAK)**

Attached is the Project Completion Report (PCR) on the Kot Addu Combined Cycle Power Project (Loan 2698-PAK, approved in FY86) prepared by the South Asia Regional Office, with Part II prepared by the Borrower. The loan for an amount of US\$ 90 million was approved in May 1986, fully disbursed and closed in June 1993, two years behind schedule.

The objective of this tenth Bank operation in Pakistan's power sector was to help reduce the country's shortfall in generating capacity by improving the efficiency of WAPDA's (the state-owned water and power utility) Kot Addu thermal power station. The project thus comprised: (i) the installation of four heat recovery boilers and two steam turbo-generators (each of about 100 MW capacity); and (ii) the construction of related 220 kV transmission lines. The main project component (generation units), which was carried out on a turnkey basis, was completed about eight months behind schedule. Total project cost was about 20 percent lower-than-estimated (largely due to exchange rate adjustments).

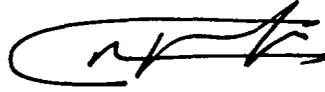
Initial operation of the project was marred by several major technical problems (water leakages from the boilers and damage to the turbines) which resulted from manufacturing defects and inadequate supervision by the project consultants. However, these problems have since been corrected by the contractor (under its warranty obligations) and the plant has now been operating for more than two years as specified. It is likely that these problems could have been resolved even more expeditiously if WAPDA's technical staff had been less busy on routine administrative tasks and if the Bank's supervision resources had been stretched less thin among several concomitant projects in the sector. The project also had an unanticipated negative environmental impact related to the disposal of furnace oil residue but this problem is expected to disappear once the plant is converted to natural gas firing in the near future.

In light of the plant's current satisfactory operation, project outcome is assessed as satisfactory and project sustainability is rated as likely on economic as well as physical and institutional grounds: the project's ERR has been recalculated at 18 percent (versus 15 percent at appraisal); WAPDA's ability to operate and maintain the plant is considered adequate; and its finances have remained generally satisfactory. Institutional development impact was rated as negligible since the project did not have any institutional objectives (these were and are being pursued under other operations). In spite of the above cited minor shortcoming, Bank performance is assessed as generally satisfactory. All of these ratings are the same as those in the PCR's.

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Key lessons learned from this project relate to the pitfalls of major technical design changes during project implementation (such as the change to furnace fuel oil firing) and the need for a power utility to streamline administrative procedures in order to utilize more effectively its technical manpower and resources.

The PCR is satisfactory: it is thorough in its analysis and provides appropriate background data. The project may be audited together with prior and subsequent loans made to Pakistan's power sector.

A handwritten signature in black ink, consisting of a large, stylized initial 'C' followed by several loops and a horizontal stroke.

Attachment

PROJECT COMPLETION REPORT**PAKISTAN****KOT ADDU COMBINED CYCLE POWER PROJECT
(LOAN 2698-PAK)****Table of Contents****PREFACE****EVALUATION SUMMARY**

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PROJECT COMPLETION REPORT

PAKISTAN

KOT ADDU COMBINED CYCLE POWER PROJECT **(LOAN 2698-PAK)**

Preface

This is the Project Completion Report (PCR) for the Kot Addu Combined Cycle Power Project, for which Loan 2698-PAK in the amount of US\$90 million was approved on May 22, 1986. The Loan Agreement was signed with the Water and Power Development Authority (WAPDA) on June 25, 1986, and the Loan was declared effective on November 22, 1986. The original loan closing date of June 30, 1991, was extended twice until June 30, 1993, by which time the loan was fully disbursed and the loan account closed.

The PCR was prepared by the Energy and Project Finance Division, Country Department I, South Asia Regional Office, and by WAPDA. The former prepared the Preface, Evaluation Summary and Parts I and III of the PCR, while WAPDA prepared Part II-A, and provided some of the supporting data. Part II-B includes a statement regarding the project provided from the consultant. Although invited to do so, the contractor did not provide comments on the report.

Preparation of Parts I and III of the PCR was based on information in the Staff Appraisal Report, the Loan and Guarantee Agreements, documents contained in Bank files and information provided by WAPDA. The preparation was also based on discussions with the officials of the Government of Pakistan and WAPDA during a completion mission to Pakistan in December 1993.

The generous assistance provided by those officials to the completion mission is gratefully acknowledged.

PROJECT COMPLETION REPORT

PAKISTAN

KOT ADDU COMBINED CYCLE POWER PROJECT

(LOAN 2698-PAK)

Evaluation Summary

Introduction

1. This project was the sixth Bank Group operation with the Water and Power Development Authority (WAPDA) for the country's power sector (para 2.4). It comprised a loan in the amount of US\$90 million to increase the capacity of a combustion turbine power plant (then under construction) at Kot Addu by installing four heat recovery boilers and two steam turbo-generators (each of about 100 MW capacity), and construction of 220-kV transmission lines from Kot Addu to Multan.

Objectives

2. The objectives were to improve the efficiency of Kot Addu power station by providing 50% more power and energy per unit of fuel consumed through the recovery of waste heat from the boilers, and thereby to assist in reducing the shortfall in generating capacity (para 3.1).

Implementation Experience

3. The main project component, comprising the boilers and turbo-generators, was implemented as a turnkey operation. Its commissioning was delayed by a few months partly because of a dispute between the contractor and the consultant/Borrower on the mode of operation of the plant, the former perceiving it as semi-automatic and the latter as fully automatic (para 5.3). The final project cost (excluding the cost of the transmission component which was implemented under the Fourth Power Project, Ln. 2499-PAK), in current Rupees was about 11% higher than the appraisal estimate, while in US\$ equivalent it was about 20% lower because of several devaluations of the Rupee against the dollar (para 5.8).

Results

4. The project was successful in meeting its objectives. Based on measurable costs and benefits, the ex-post economic rate of return is 18% compared to 15% estimated at appraisal (para 7.3). Between 1985 and 1993, WAPDA's generation and sales of energy more than doubled, representing an average annual growth rate of about 10% compared to the GDP growth rate of 5.6% during the same period, and the output from the Kot Addu power station contributed to about 8.5% of total generation (para 6.1).

5. Since its commissioning in 1991, the project has experienced several problems, the more serious ones being water leakage in waste heat boilers, and damage to the steam turbines during the guarantee period. Repairs and replacements have been carried out, and since then, the units have been in operation successfully. For most of the period, the plant is used for base load operation, and because of a shortage of generating capacity on the Borrower's system, the units have yet to be taken out of service for examination of the repairs.

Sustainability

6. The project has played a vital role of providing base load energy in the Borrower's power generation system, and has thereby contributed to the reduction in the load shedding on the system. So long as the technical problems do not resurface (para 6.4), and once the power station's environmental problems arising from the use of furnace oil, and the disposal of the residue (para 5.14), are resolved, the project will continue to have a beneficial impact for several years. The Borrower's financial performance during the project period was generally satisfactory, its internally generated funds contributing around 40% of its annual capital expenditure (para 6.7). The accounts receivable, however, continued to be on the high side because of the large amounts due from the government departments and agencies. Drastic measures, such as direct deductions of payment, due to WAPDA from budgetary releases to the government departments and agencies, are being undertaken to reduce the level of these receivables. As a result, in June 1995, some Rs 30.0 billion was deducted and adjusted against WAPDA's debt service to the Government. The Government and the Borrower are committed to ensuring the financial viability of the utility, as manifested by the adequate tariff increases, and the resulting satisfactory financial performance (para 6.5). In the institutional areas, the utility is generally well-managed and technically competent. It is therefore concluded that the project is sustainable.

Findings and Lessons Learned

7. Apart from delays in start-up and implementation, the project experienced a number of technical problems (water leakages from the waste heat recovery boilers, and damage to the steam turbines), which required repair, modification and replacement of some of the equipment (para 6.4). These damages resulted from major errors and/or omissions by the manufacturer during fabrication and erection, as well as inadequate supervision by the consultants. However, the consultant did manage to get the damage successfully rectified by the contractor within his contractual obligations (guarantee). The power plant is now operating as specified without major problems. The performance of both the supplier and the consultants during the execution of this project cannot thus be termed as satisfactory.^{1/} Some of the other problems experienced during this project (e.g., the dispute and delays over the fully automatic versus partially automatic mode of operation) could also have been resolved earlier than they actually were.

8. The chances of such events affecting project implementation could have been reduced if WAPDA's technical staff assigned to the project had been able to perform their anticipated functions in a timely manner, e.g., design review, construction supervision and monitoring. The fact that these officials had to devote considerable time to routine administrative matters highlights the need for WAPDA to streamline its administrative procedures so as to more effectively utilize its technical manpower and resources (para 9.1). In any event, the role of the consultants was to compensate for these shortcomings.

9. The project also highlights an issue arising from design changes during implementation. While for this project the conversion to fuel oil firing probably saved on the direct cost of generation, it has left the unanticipated problem of disposal of the waste sludge, traffic congestion arising from large volumes of truck traffic to and from the plant site, and significantly higher maintenance costs for the plant as a whole. As these design changes were mid-stream events, they probably did not receive the level of scrutiny normally associated with project appraisal; as a result, the full costs of these modifications were probably not appreciated or accounted for while approving these design changes. Clearly, both the Bank and the Borrower should review and agree on major modifications of the design only after all the associated costs (and benefits) have been identified and evaluated (para 5.14). Some of these problems could have been identified or anticipated (and remedial measures agreed between the Borrower and the

^{1/} Reference Part II-B.

Bank) through more intensive and focussed supervision by both the Borrower and the Bank (paras 9.1 and 8.1-8.3).

10. Under subsequent operations a number of actions have been taken by the Government and the Bank to address the critical issues identified during the implementation of the project, in particular those relating to the Borrower's participation and role during the preparation and implementation of projects, and shortfalls in budgetary allocation. Specifically, agreements have been reached on (a) the preparation and annual review of a Core Investment Program of priority projects which would be protected from budgetary shortfalls; and (b) a National Procurement Reform Program, including the adoption of model bidding documents, based on the Bank's Standard Bidding Documents for goods, works and consultants, which is designed to address some of the procurement issues that have repeatedly arisen during the implementation of Bank funded projects.

PROJECT COMPLETION REPORT

PAKISTAN

KOT ADDU COMBINED CYCLE POWER PROJECT (LOAN 2698-PAK)

PART I - PROJECT REVIEW FROM BANK'S PERSPECTIVE

1. Project Identity

Project Name:	Kot Addu Combined Cycle Power Project
Loan No:	2698-PAK
RVP Unit:	SA1
Country:	Pakistan
Sector/Subsector:	Energy/Power

2. Background

2.1 Responsibility for public electricity supply in Pakistan is assigned to the Water and Power Development Authority (WAPDA), a semi-autonomous agency established in 1958. WAPDA operates throughout the entire country with the exception of the Karachi area, which is served by Karachi Electricity Supply Corporation (KESC). WAPDA is organized into two largely independent "wings," one for power activities and the other for water activities. "WAPDA" is used in this report solely to refer to the Power Wing which is responsible for planning, construction and operation of power generation, transmission and distribution facilities throughout the country with the exception of the area served by KESC (para 2.4).

2.2 In 1985, WAPDA's facilities included (a) installed generating capacity of just over 4,000 MW (63% hydro and mainly in the northern part of the country, and 37% thermal and mainly in the south); (b) some 19,000 km of transmission lines at various voltages including 850 km at 500-kV; (c) 457 grid substations with about 14,000 MVA of transformer capacity; and (d) a distribution network (some of which was about 50 years old) amounting to some 145,000 km, at 11-kV and 440/220 Volts. The energy generated in FY85 was nearly 19,000 GWh of which about 73% was billed to some 4.5 million customers. The per capita energy consumption was only 155 kWh, which was lower than that in other countries in the region at a similar level of development.

2.3 Through the early 1970s, WAPDA investments, with international donor support, were channelled largely towards increasing generation facilities. However, for most of the period including the present, the increase in installed generating capacity had been inadequate to meet the rapidly increasing power demand, and had resulted in considerable load shedding, particularly during the dry season. Furthermore, the system losses through the late 1970s had been very high (around 35%). This is partly attributed to the old and overloaded distribution system, and to inadequate, ad hoc investment in sub-transmission and distribution systems. These systems transmitted power over long distances at rather low voltages, and had inadequate step-down substations to reduce the length of primary feeders.

2.4 Between 1955 and 1967, the Bank financed four KESC operations for development of generating facilities. Thereafter, the Bank became involved in the Government of Pakistan's (GOP) program for strengthening the power transmission and distribution networks. A list of related Bank loans and credits to WAPDA are detailed in Part III, Table 1. The first operation in 1970 provided financing of US\$23.1 million to WAPDA. In 1976, US\$50.0 million was provided for the second project;

US\$45.0 million in 1979 for a third; US\$100.0 million in 1985 for a fourth; and US\$100.0 million for a fifth project in 1985. The Kot Addu Combined Cycle Power Project was the sixth operation approved in 1986 for US\$90.0 million; and in 1987, US\$70.0 million was approved for a seventh investment operation to WAPDA. In addition, in July 1985, the Bank provided funding to support GOP's reform program, and to assist in the implementation of the core investment program for the sector, covering FY83-88 of the least cost national plan through an Energy Sector Loan (ESL, Ln. 2552-PAK); a follow-on project was approved in 1989 (ESL II, Ln. 3107-PAK) covering the timeframe between FY89-93 to continue the policy reform program initiated under the first ESL (para 5.7). These projects have all closed.

2.5 Subsequent Bank lending to WAPDA for ongoing projects include an eighth loan in 1989 for US\$162.0 million for the expansion and reinforcement of the 500-kV transmission grid; and a combined loan and credit of US\$160.0 million also in 1989 for rural electrification. In 1990, a related loan of US\$190.0 million (Ln. 3252-PAK) was approved for, inter alia, construction of a pipeline for supplying natural gas to the Kot Addu power station (para 5.7). The most recent loan was approved in June 1994 for US\$230.0 million for a Power Sector Development Project which, inter alia, provides for the reorganization and corporatization of WAPDA (para 5.15).

2.6 The Kot Addu Combined Cycle Power Project, which forms the subject of this PCR, was the sixth Bank operation with WAPDA which was approved in 1986. Construction of the Kot Addu power plant was initiated in the mid-1980s, as a set of four combustion turbines of 100 MW each (which were commissioned in FY87) based on high speed diesel oil, with provisions for additional capacity to be installed over time. Currently, the plant includes:

- (a) an additional block of four combustion turbines (400 MW) which was completed in 1989;
- (b) the two combined cycle units (224 MW) installed under the Bank project;
- (c) two combined cycle units (200 MW), commissioned during 1995; and
- (d) an integrated block (396 MW), comprising two combustion turbines which were completed in mid-1994 and a combined cycle unit, expected to be commissioned in August 1996.

Upon completion of the ongoing schemes, total generating capacity at the site would thus amount to about 1600 MW. The plant had originally been designed to use high speed diesel oil as fuel; however, in view of the high cost, the units were designed to also use furnace oil, or a mix of crude (80%) and high speed diesel oil (20%).

2.7 While the project was primarily expected to provide peaking capacity at Multan, close to the load centers, the forecast energy requirement indicated that these units would be operated during off-peak periods also, at least during the first 10 years. Accordingly, priority was accorded to the conversion of the combustion turbines to combined cycle operation, to allow WAPDA to utilize the waste heat from the turbines, and provide for additional peaking capacity. The Bank agreed to finance the cost of conversion to combined cycle for the first block (4 X 100 MW) of the combustion turbines.

2.8 The most appropriate fuel for combustion turbines and combined cycle projects is natural gas; however, in view of the constrained availability of natural gas, no allocation of gas was originally made for the power plant. Additional natural gas reserves were, however, discovered in 1990 (mainly at the Qadirpur field, which is being developed with funding from the Bank under the 1992 Domestic Energy Resources Development Project, Ln.3500-PAK). The Government has therefore approved an

allocation of 190 MMCFD of natural gas for the Kot Addu power station from the gas transmission system, and about 45 MMCFD from the Dhodak field; this allocation is expected to be adequate for meeting most of the plant's fuel requirements. Following this allocation, the Sui Northern Gas Pipelines Limited (SNGPL) has installed gas pipelines linking the power plant with SNGPL's main gas transmission pipeline, and the Dhodak field; conversion facilities for the power station to utilize natural gas have also been installed by WAPDA, with funding through the Bank's Second Energy Sector Loan (Ln. 3107-PAK, para 5.7).

2.9 There were no major issues or major technical risks associated with the project. However, the payment of outstanding bills due to WAPDA from the government departments and agencies (a covenant under the fourth project) had not been made in a timely manner, adversely affecting WAPDA's cash flow. Negotiations for the project took place during March 24-26, 1986. Appointment of consultants to assist with the project design, implementation, etc., and payment to WAPDA of 80% of the aggregate amount of all outstanding bills for the supply of electricity from government departments and agencies was determined as conditions for Board presentation. A signed contract for construction of a fuel pipeline between Mahmood Kot and Kot Addu, and approval by ECNEC^{1/} in the PC-1 document with respect to the project were made conditions for Loan Effectiveness. In order to avoid slippage of the project from the scheduled Board presentation date, payment of outstanding bills was subsequently made a condition of Loan Effectiveness. The loan was approved by the Bank on May 22, 1986, signed on June 25, 1986, and declared effective on November 22, 1986. The original Loan Closing Date was June 30, 1991; however, it actually closed on June 30, 1993 after two extensions.

3. Project Objectives and Description

3.1 Project Objectives. The objectives were to improve the efficiency of Kot Addu power station by providing 50% more power per unit of fuel consumed, and to assist in reducing the forecast shortfall in generating capacity by adding 200 MW in a relatively short time.

3.2 Project Description. The project, as approved by the Board, comprised:

- (a) installation of four heat recovery boilers (to be connected to two 125 MW and two 100 MW combustion turbines then under construction), and of two turbo-generators of about 100 MW each, together with the associated transformers and auxiliaries;
- (b) construction of 104 km of 220-kV transmission lines from Kot Addu to Multan, and addition of connecting bays at substation; and
- (c) consulting services for preparation of equipment specifications, bidding documents, finalization of designs, and supervision of erection and testing of the units.

4. Project Design and Organization

4.1 Unlike previous Bank operations with WAPDA, where the loans and credits were made for the construction of transmission lines and substations, the purpose of this project was mainly for increasing power plant output. WAPDA had already acquired substantial experience in the design and construction of transmission system, and in the installation and operation of conventional thermal power

^{1/} ECNEC = Executive Committee of the National Economic Council.

plants. As the combined cycle plant was rather new to WAPDA, consultants were employed for the entire activities, from preparation of specifications to finalization of design (proposed by the manufacturer), and to supervision of manufacture, erection, testing and commissioning of the units.

5. Project Implementation

5.1 Project Start-up and Implementation Schedule. The start-up of project implementation was slightly behind the original schedule because of delays in Loan Effectiveness, and the ensuing delays in the appointment of consultants for preparation of bidding documents. The process of consultant selection was somewhat marred by an objection from another consultant firm, which felt that it did not receive adequate merit for its experience during the evaluation process conducted by WAPDA. Because of the high cost of diesel fuel, the combustion turbines were modified to use furnace oil as well. This modification required installing extra monitoring and diagnostic equipment.

5.2 As had been envisaged at the time of appraisal, the scope of the work on the combined cycle was to supply and erect on a turnkey basis four heat recovery boilers, two steam turbo-generators and the associated equipment. Bidding documents for procurement of the combined cycle work were reviewed by the Bank with the assistance of a consultancy firm. The selection of the main contractor responsible for the turnkey contract was also challenged by a consortium, which claimed that one of the competing firms (associated with a boiler manufacturer and with a turbo-generator manufacturer), among other things, did not have adequate experience in combined cycle power projects.

5.3 Implementation of the main project component was conducted satisfactorily. The most significant event, however, according to the main contractor, was the lack of progress with the commissioning of the plant after the erection work had been completed. The contractor claimed that the contractual requirement for the combined cycle operation mode was partly manual operation, but the consultant insisted on behalf of the Borrower that the specification and the contractual obligation of the contractor required the fully automatic operation mode. The contractor also claimed that delivery of project plant and machinery was substantially delayed at Customs because of the bureaucratic procedures and the Borrower's shortage of local funds to pay Customs duties. Under Part II-A, the Borrower accepts that his technical staff spent their time in dealing with GOP bureaucratic procedures rather than on the technical activities, including supervision of the project.

5.4 Unit No. 1 was commissioned on January 1, 1991, and unit No. 2 in March 1991, six and eight and nine months behind the appraisal schedule respectively.

5.5 The transmission component was implemented by WAPDA under the Fourth Power Project (Ln. 2499-PAK). Correspondence in Bank files indicates that, for the purposes of bidding, the transmission component was supervised as part of the project. However, no disbursements were made from the loan amount under Category 2 for which US\$4.7 million had been allocated. The transmission line was funded under the Fourth Power Project being implemented concurrently by WAPDA with Bank's assistance, and the allocated US\$4.7 million was used to fund the power station.

5.6 Project Revision. There were no significant revisions to the project, except the financing of the transmission line under Ln. 2499-PAK (para 5.5). In 1990, however, following the confirmation of additional domestic gas reserves and slower take-up by other users, it was decided to convert the combustion turbine units to use domestic natural gas instead of imported diesel fuel (para 5.14).

5.7 Around that time, as a means of providing additional assistance to GOP to mitigate the effect of the Gulf crisis in 1991, the Bank approved an increase in cost-sharing arrangements for projects it was

financing. Furthermore, instead of making supplemental loans for individual operations, it was decided to group the supplemental loans. An amount of US\$12 million, covering the cost of equipment (for conversion to natural gas firing) to be installed at the Kot Addu plant was included in the ESL II Supplemental Loan approved on June 20, 1991. Under a separate Bank operation^{2/}, Sui Northern Gas Pipeline Ltd has constructed a pipeline between Multan and Kot Addu, for supplying natural gas to the Kot Addu power station.

5.8 Project Costs. The final project cost was Rs 3,121.8 million which is 11% higher than the appraised cost estimate of Rs 2,804.6 million. The cost, in US\$ equivalent, is US\$140.3 million, which is about 20% lower than the corresponding estimate of US\$175.2 million, and this reflects the effect of several devaluations of the Rupee against the US\$, from Rs 16 in 1986 to Rs 30 in 1993, and a conceptual design (proposed by the consultant) that allowed the procurement of standardized turbines. The total cost of the project, including interest during construction was Rs 3,345 million (US\$149.7 million equivalent).

5.9 Extension of Closing Date. The original closing date for the loan was June 30, 1991. Although the project was commissioned only eight months after the appraisal estimate (para 5.4), the closing date was extended twice, first to June 30, 1992 to take into account the slight delay in commissioning date, and then to June 30, 1993, in order to effect retention payments which had to be postponed because of problems with the turbine units secured during the guarantee period (para 6.4d).

5.10 Procurement. Retroactive financing of about US\$0.5 million to cover expenditures after December 1, 1985 and before the loan was made effective, was authorized so that advance procurement might be undertaken. All contracts estimated to cost over US\$1 million required prior Bank review of bidding documents and evaluation reports. Considerable time and effort from Bank staff was required during project implementation because the bidding documents, prepared by the Borrower, required extensive modifications. The Bank engaged an independent consultant to review the specifications for the turnkey contract (para 8.4).

5.11 Disbursements. Actual disbursements in the earlier years of project implementation period were far slower than projected, reflecting the delays in getting the project off the ground. By June 1989, i.e., three years after the Loan Agreement was signed, only about 27% (vs. 60% estimated) of the loan amount had been disbursed. However, the pace of disbursements picked up, and by the original closing date, over 80% of the loan had been disbursed. The last disbursement was on February 1, 1993, by which date the loan amount was fully disbursed.

5.12 Environmental Aspects. In two important respects, the project adopted measures favorable to the environment. First, at an existing plant, heat from the exhaust gases was recovered. Secondly, the route for the transmission line was selected to minimize transgression into the populated areas. Therefore, the project, by itself, did not have any adverse effect on the environment. Although not a part of the current project, the power plant is also being converted to natural gas firing, which is expected to further reduce emissions from the power plant.

5.13 The power station, however, has faced a major environmental problem, arising from the use of furnace oil as fuel for some of the gas turbine units. WAPDA has had little control over the wide fluctuation in the quality of the furnace oil it receives from the supplier, i.e., the state-owned oil company. The oil needs to be treated and cleaned before it is fired in the gas turbine combustion chamber. The treatment and cleaning process leaves a relatively large amount of residual sludge (or

^{2/} The Corporate Restructuring and System Expansion Project (Ln. 3252-PAK).

slurry) for disposal. Attempts to get rid of the residue by burning it in an oil fired steam boiler (at a plant in Multan some 120 km away) were not successful because of the problem of transporting it and, more importantly, because the residue is not easily combustible in the boiler. Alternative measures such as the use of coagulants or centrifuges or both to remove the undesirable constituents from the sludge in such a way that they could be easily disposed of, have not been successful. Out of the twenty fuel storage tanks in the power station, eight are used for storing diesel oil, four for storage of untreated furnace oil, four for storing treated oil, and the last four for storing the sludge.

5.14 According to the Borrower, furnace oil was chosen as fuel for the gas turbines because it is less expensive than the alternative fuels, i.e., diesel oil, and consequently the unit cost of energy generated was expected to be much lower than that from the use of diesel oil. While the Bank was not asked to evaluate this modification in the design, factors that were apparently not fully anticipated or fully taken into account in the Government's approval of the change in project design to allow for furnace oil firing were: (a) the more elaborate (and expensive) cleaning and pre-combustion treatment needed for the furnace oil; (b) more frequent need to clean the combustion chamber and the turbine nozzles which necessitates it to be out of service more frequently, thereby reducing the availability of the units for energy generation; and (c) most importantly, the cost of sludge disposal and, over the long term, the cost of the failure to dispose of the waste economically. The problems arising from the use of furnace oil at the power station are, however, expected to be resolved in the very near future, once the conversion to natural gas firing is completed.

5.15 WAPDA established an Environmental Management Cell to develop, with initial assistance from foreign experts, in-house expertise in dealing with environmental issues, particularly in view of the large investments planned. As part of the program for strengthening WAPDA's environmental management under that project, WAPDA would be provided with guidance from power plant managers or from relevant sources where a similar problem of sludge disposal has been resolved. Furthermore, within the ongoing divestiture of the power station, it is expected that the environmental issues will be addressed.

5.16 Compliance with Loan Covenants. The key covenants introduced in the Loan Agreement and the extent to which they were complied with are listed in Table 6, Part III. The Borrower complied with the vital financial covenant [5.02(a)] which required an annual internal contribution of 40% towards an "averaged" capital expenditure.

6. Project Results

Project Objectives and Impact

6.1 The project achieved its objectives of providing 50% more power/energy per unit of fuel consumed from the Kot Addu power units, and of reducing the shortfall in energy generation and peak demand. During the last three years, generation from the power station reached a level of about 8.5% of WAPDA's total generation. It also contributed, in the form of additional generation through waste heat recovery, to improvement in WAPDA's overall operational performance which, in the last several years, has been satisfactory. The following are some indicators of the improvement in overall operational performance: between 1985 and 1993, WAPDA's generation and sales of energy more than doubled, representing an average annual growth rate of about 10% compared to the GDP growth rate of 5.6% during the same period. Gross assets in operation and total fixed assets (in historical costs) nearly quadrupled, installed generating capacity nearly doubled, the length of its transmission lines and the number of grid stations increased by about 30%, and the transformer capacity nearly doubled. The number of electrified villages more than doubled, the number of connections nearly doubled, and per

capita consumption increased by about 80%. More importantly, the industrial sector's consumption has more than doubled, reflecting sustained, high growth in industrial output and investment; these developments also have secondary benefits, such as increased employment and exports.

6.2 The total system losses, even though reduced from 25% in 1985 to around 21% since 1991, are still on the high side, and the problem is addressed under follow-on Bank operations as well as from operations financed by other donor agencies. WAPDA has been promoting or inducing the industrial consumers to invest in capacitors and thereby raise the power factor, which would improve the system efficiency and reduce the overload on the system.

6.3 WAPDA's overall performance over the project period compared to the appraisal estimate has also been generally satisfactory. Annual generation and sales of energy during the most recent years exceeded the appraisal estimate by about 10%. The actual computed maximum (or peak) demand during the last three years has been lower than that projected, but the unmet demand (or load shedding) has also been lower. Table 5 of Part III provides a comparison between the appraisal estimate and actual performance on key operating indicators.

Operational Performance

6.4 Even though the project used well-established technology, it experienced several technical problems as discussed below:

- (a) Water Leakage in Waste Heat Boiler. After about 3,000 hours of operation of the units, heavy water leakage was observed through the cracks in the elbows (of the tubes) of the Low Pressure Evaporator. The release of water/steam caused damage to the external surfaces of the adjacent tubes. The unit was taken out of service and damaged parts and surfaces were either repaired or replaced. Since then the unit has been on load, but because of shortage of system generating capacity, it has yet to be taken out of service for inspection of the repaired and replaced parts. The Bank has expressed its concern that this must be undertaken. (Details of the damage and the alleged causes are provided in Annex 1).
- (b) Start-up By-Pass Control Valve. This valve is occasionally found to stick in full open position during the start-up of the turbine, thereby frustrating the process of putting the unit on load. The start-up process needs to be shut down to await the return of the valve to the closed position (which may take hours) before the start-up process can be resumed. Rectification of this valve was completed by the contractor in July 1994.
- (c) Damage to Gear Boxes of Fans for the two Cooling Towers. Some gear boxes had to be changed (two were completely replaced during the guarantee period) as a consequence of damage to the bearings of the low speed shaft. This is attributed to lack of air circulation in the confined space (particularly during the summer when the ambient temperature hovers around 50 degrees C), and resulting in overheating of lubricating oil. During the PCR mission visit (which was in winter), six of the twelve fans were not functioning, awaiting repairs and replacement. The completion mission was informed that the design of the gear boxes was being modified to include a small fan mounted on the shaft to improve air circulation. Rectification of this damage was completed in 1994.
- (d) Damage to the Steam Turbines. The rotors and other parts of the two turbines were found to have suffered serious damage when they were opened for inspection just before the end of the guarantee period. According to a report carried out by a consultant, the problem

emerged largely due to a machining error (or omission) during fabrication of the components, and was compounded by poor supervision during site erection; adequate or design clearances were not maintained between the turbine casings and their clamping sleeves (at the turbine casing foundation bolts). This restricted the vital movement arising from thermal expansion of the casing which takes place when the unit is being put into operation, and led to blades and other parts of the two rotors fouling axially with their respective casings. Additionally, the rotor of No. 2 turbine unit, which had manifested unduly high level of vibrations during its commissioning, is understood to have been erected with inadequate radial clearance between the top half of the casing and the rotor. Repairs and modifications appropriate to the reported damage have been carried out. They include: machining the clamping sleeves to maintain adequate clearances; removal, repair and or replacement of all high pressure blades of No. 1 rotor; and realigning the radial position (i.e., lowering the horizontal axis) of No. 2 rotor. Since the repairs were carried out, the turbine units have been on load for over two years. According to the Borrower, the units have not manifested a repetition of the problems.

Financial Performance

6.5 To ensure that adequate funds are available for the implementation of WAPDA's investment program, WAPDA has agreed under ongoing operations with the Bank on an Internal Cash Generation (ICG) covenant, which requires WAPDA to generate annually from internal sources at least 40% of its capital expenditures, averaged over the previous, current and ensuing year, taking into account changes in working capital. WAPDA is also required to consult with the Bank before incurring new debt should it be unable to maintain a debt service coverage of at least 1.5 times. WAPDA's tariffs are set to ensure that these two financial objectives are met. By and large, WAPDA has achieved these financial performance targets satisfactorily since FY85.

6.6 Past and Present Financial Performance. Part III, Table 5 provides a comparison between appraisal estimates and actual performance for selected financial indicators during FY85-93, while Table 1 below provides a summary of WAPDA's financial performance during FY90-95:

Table 1: WAPDA'S FINANCIAL RESULTS, FY90-FY95

KEY FINANCIAL INDICATORS	FY90	FY91	FY92	FY93	FY94	FY95 UNAUD
kWh Generated (Millions)	31427	34345	38067	40791	42396	45917
kWh Sold (Millions)	24121	26584	29267	31272	32131	35081
Average Revenue/kWh Sold (R.)	1.06	1.16	1.27	1.26	1.41	1.75
Increase in Average Revenue (%)	11.9	10.2	11.9	5.0	12.4	13.9
Operating Revenue (Rs./kWh Sold)	1.09	1.19	1.33	1.39	1.55	1.77
Operating Expenses (Rs./kWh Sold)	.61	.70	.82	.92	1.08	1.14
Net Operating Income (Rs./kWh Sold)	.48	.51	.53	.51	.50	.63
Investment Program (Rs. Million)	16764	16030	24804	22310	25591	26395
Internal Cash Gen. (%) 3 Yr. Avg.	40.7	47.3	50.0	44.0	28.0	39.9
Rate of return on Avg. Net Fixed Assets (%) ²	20.8	19.0	19.2	18.6	16.4	19.0
Debt Service Coverage Ratio	1.8	1.5	1.6	1.4	0.9	1.5
Debt Equity Ratio	58:42	57:43	56:44	57:43	56:44	57:43

²On historical cost basis.

6.7 WAPDA's overall financial performance during the period has been satisfactory. Its self-financing performance has been sufficient (exceeding 40%) in all the years, except in FY94 due mainly to WAPDA's retirement of its Second bond issue of Rs 5.6 billion which it was unable to roll-over because of unfavorable market conditions. A substantial tariff increase in November 1994 (averaging 24%) led to an improvement of WAPDA's financial performance, enabling it to meet the financial covenants during FY95. Thus, WAPDA is expected to earn a satisfactory rate of return on net fixed assets during FY95 of about 19.0%. Average revenue has steadily increased from Rs 1.06/kWh in FY90 to Rs 1.75/kWh in FY95. Operating revenues increased from Rs 1.09/kWh in FY90 to Rs 1.77/kWh in FY95 representing an average annual increase of 10.8%, while operating costs increased at an average rate of 13.3% during the same period. The faster increase in operating expenses is due to a lower recovery of fuel costs in FY94 and FY95 and higher fuel costs resulting from an increase in thermal generation to compensate for the low hydro generation during these two years. With average inflation rates running a about 10 - 12% during the period, WAPDA has been achieving rates of return well above inflation, based on assets valued at historical book values, the normal practice of public sector agencies in Pakistan.

6.8 While WAPDA's debt-equity ratio has been satisfactory at about 57:43, WAPDA has had to resort to substantial short-term borrowings in recent years, in part due to its high levels of receivables, especially from government agencies and departments, and the difficulty in mobilizing long-term financing due to the general tightness in credit markets. WAPDA also faced increasing difficulties in its bond issues due to the removal of GOP guarantees. In future, there is a need to monitor WAPDA's debt-servicing capacity in order to avoid expensive short-term borrowing.

6.9 Accounts Receivable. The level of WAPDA's overall accounts receivable has been increasing over the past three years, from 22% of sales in FY92 to 26% in FY95. As of February 1995,

total receivables amounted to Rs 14.8 billion representing about 3.8 months average sales. While receivables from private sector consumers, amounting to about Rs 9.7 billion, represent 2.6 months average sales, those from government departments and agencies, amounting to Rs 5.1 billion were equivalent of 6.3 months sales. Under the ongoing Bank loans, GOP agreed to ensure that all federal and provincial government departments and agencies would settle all bills for the supply of electricity within three months. To ensure this, the Cabinet has taken several important decisions providing for: (a) recovery of arrears through budgetary releases and deductions at source; (b) withholding of payments due by WAPDA to those government agencies in arrears; (c) disconnection of defaulters; and (d) monthly reporting of status of arrears to the Economic Coordination Committee. These decisions are now being implemented by WAPDA. As a result, the government adjusted about Rs 3.0 billion of receivables from government departments and agencies against amounts payable by WAPDA to the government in FY95. Thus, government receivables are now about 2.6 months of billing.

Institutional Performance

6.10 Management, Professionals and Other Staff. In general, WAPDA's managerial and professional staff is well qualified and competent. The professional staff have particular expertise in the technical areas, e.g., design of transmission (up to 220-kV) and distribution systems, operation and maintenance of generation plants, transmission lines and substations and other equipment. The institution, which in the past has been somewhat over-staffed at the lower levels (particularly in the distribution department which, it is estimated, accounts for over 70% of the total employees), has however made some improvement over the years. This is manifested by the increase in the conventional efficiency ratio of number of consumers per employee (and also of kWh sold per employee) which has increased from 42 in 1985 to 53 in 1993. To promote staff development and enhance professionalism, WAPDA has an ongoing training program to update staff skills.

6.11 Financial and Accounting Aspects. Following the recommendations from a study by consultants in 1982, WAPDA adopted a decentralized accrual-based accounting system. It has some 400 accounting units distributed over the entire country. The department has difficulty in attracting trained accounting personnel in the distribution areas. This shortcoming, together with the manual system of maintaining accounts in those areas cause delays in the submission of information for management, and in the preparation of accounts. Under the Bank financed Rural Electrification Project,^{3/} WAPDA availed the assistance of an international utility consulting firm to provide training to accounting staff, and to design and implement an automated accounting and financial management information system. The design has now been completed and is being implemented.

6.12 Internal Audit. As required under the Loan Agreement, WAPDA engaged a consortium of foreign consultants and seconded two of its staff (one a former WAPDA Chief Auditor and the other a deputy Chief Auditor) to design a modern system of internal auditing. The consultants submitted a reorganization plan, the salient features of which were: (a) upgrading the position of Chief Auditor to that of General Manager; (b) establishing new Sections for System Control and Data Processing and for training coordination; (c) Special Audit; and (d) upgrading of Regional Audit Offices, and Policy Procedures. Following WAPDA management approval of the consultant's reorganization plan, the consultants carried out a review of audit procedures and developed manuals for the implementation and functioning of the Internal Audit which have been reviewed and found satisfactory by the Bank. Most of the proposals and recommendations in the manuals have been approved by WAPDA management, and have been implemented.

^{3/} Ln. 3148/Cr. 2078-PAK, approved in 1989 with an original closing date of December 1995, and extended to June 30, 1997.

6.13 **External Audit.** The Auditor General of Pakistan (AGP) is responsible for auditing WAPDA's annual accounts. So far, the audited accounts have consistently taken a few months longer than the target (six months from year end) stipulated in the loan covenant, because of delays in the flow of information and the lack of an effective internal audit system. The delays are expected to be gradually eliminated after the completion of the automation of the accounting system and with the reorganization which has taken place in the internal audit. The observations made by AGP on WAPDA's financial statements included deficiencies such as lack of reconciliation of material account balances, and lack of supporting detail to certify revenue accounts.

6.14 **Training.** While no specific provision for training was made under the Project, WAPDA has a comprehensive training program, with 11 training establishments located in eight cities, to meet the needs of managerial, professional, technical and accounting staff. Between 1986 to 1992, the establishments have collectively provided training to some 76,000 staff, from officers in grades 17-20, supervisors in grades 11-16, and staff in grades 5-10. In addition, staff have received training overseas.

6.15 The completion mission understood from managers and senior staff of the training department, that several of their establishments need to be better equipped, in terms of improved practical training facilities (tools, equipment and plant), libraries, laboratory equipment, and audio and visual equipment. It would also appear that staff training needs more attention and commitment from the management. In order to emphasize this aspect, it was felt by the training department managers that there was need to make completion of relevant training courses one of the requirements for promotion to a higher grade.

7. **Sustainability and Economic Rate of Return**

7.1 **Sustainability.** The project was, at the time of its appraisal, and continues to be a part of the least cost development program. Provided the technical and the environmental problems have been satisfactorily resolved, the project is and will remain a vital part of WAPDA's generation system, with its availability for base load operation, as well as for peak load operation at a short notice.

7.2 GOP and WAPDA recognize the need for the utility to remain financially viable, and to make a reasonable contribution to its capital expenditure. These are manifested by GOP commitment to the cash generation covenant, and by the increases in WAPDA tariffs and fuel adjustment charges, which have been generally adequate and timely. The tariffs and fuel adjustment charges collectively are now tending towards long run marginal costs. A significant activity where the performance has been less than satisfactory is the continuing high level of accounts receivable, contributed largely by the amounts owed to the utility by some of the government departments and agencies. This problem has now been addressed satisfactorily (para 6.9). Overall, however, it could be concluded that the project is sustainable.

7.3 **Economic Rate of Return (ERR).** Based on measurable costs and benefits, the ex-post ERR is 18% compared to 15% estimated at appraisal. The measurable costs are the capital expenditure on the combined cycle equipment, the transmission system and the operations and maintenance cost. The benefits are the revenues from incremental sales attributable to the generation from the project.

7.4 The above ERR does not take into account the following benefits, some of which are not readily quantifiable: improvement in the quality of life and the standard of living through the use of electricity; development of the local manufacturing, supply and contracting industry; and the increase in commercial activities and the employment opportunities which these, in turn, created. Alternatively, the ERR derived by using only WAPDA's existing tariff as a proxy for project benefits understates the

economic value of electricity, which in Pakistan is deemed to be considerably higher. Given the shortage of electricity, many industrial and commercial consumers have installed their own standby generation facilities. The above ERR thus does not account for the consumers' surplus, based on the consumers' willingness to pay for electricity.

8. Bank Performance

8.1 The Bank carried out nine supervision missions with adequate frequency and reasonable continuity in staff (Part II, Table 7). Mission staff, however, had a large agenda which included supervision, preparation and appraisal of other projects. As a result, the time available to such missions for focussed supervision and intensive discussions with the Borrower on critical implementation issues was limited. Discussions with WAPDA staff also suggests that Bank supervision missions, pressed as they were with a number of activities related to other projects as well, did not have much time to visit the project site more often and to meet with WAPDA officials in the field, and provide them with the detailed assistance they might have needed.

8.2 As is usually the case, Bank supervision was concentrated mainly on the procurement issues, and this project had its fair share of such issues and problems, including objections from a consulting firm (on the Borrower's evaluation process for selection of consultants) and from a contractor (on the pre-qualifications of the eventual main turnkey contractor).

8.3 Design and construction of combined cycle power plants generally follows established technology and manufacturing practice. It was known that the Borrower was not adequately conversant with the erection and operation of such plants. Therefore, the Borrower has indicated in Part II-A that it would have benefitted from Bank support in the form of an expert in the erection and operation of such plants. Nevertheless, it is clear that the Borrower has the primary responsibility for managing the contract, while the consultant/engineer has the specific responsibility to ensure that the works are carried out in accordance with specifications.

8.4 The project supervision staff used the services of an independent consultant to review the specifications for the turnkey contract. However, despite the availability of this expert, the issue between semi-automation and full automation mode of the plant was not identified or resolved at an earlier stage.

8.5 As in the case of the Fourth Project (Ln. 2499-PAK), WAPDA did not record, in its final accounts, expenditures on this project separately from the expenditures on the overall investment program for thermal generation. However, project accounts were maintained separately for the project as part of the detailed accounts, and have been routinely audited by the Auditor General of Pakistan.

9. Borrower Performance

9.1 WAPDA's technical staff assigned for design review, construction supervision, etc., were instead bogged down with such activities as resolving administrative bottlenecks, dealing with customs for clearance of goods, and preparing budgets. These activities diverted the staff from contributing towards construction supervision, and deprived them of a valuable opportunity to develop their technical skills and know-how in this area of technology.

9.2 The Borrower's financial performance was satisfactory during the project period, and has met the key performance criteria stipulated in the Loan Agreement. In fact, a 40% contribution towards capital expenditure is quite an achievement, considering the level of investment which resulted in nearly

quadrupling the gross assets in operation in less than ten years. WAPDA's performance in bill collection, however, has fallen short of the target, largely because of large receivables from government departments and agencies. Given the economic, social and political environment which prevailed during the project implementation period, it is unlikely that WAPDA, on its own, could have effected a substantial improvement on its accounts receivable through timely collection, particularly from certain government departments and agencies, including the defense establishment.

9.3 In most operational areas such as energy generated and distributed, the number of customers, and the number of villages electrified, the utility has performed creditably. The system losses have steadily decreased from 25% in 1985 to about 21.5% since 1993, and the manpower utilization ratio (an efficiency criterion) has improved, with the number of consumers per employee having increased from 33 in 1985 to 52 in 1993.

10. Performance of Consultants and Contractors

10.1 Consultants. The Borrower has expressed dissatisfaction with the consultant's performance in connection with: (a) the preparation of technical specifications for the bidding document, which were not precise on the degree of automation of plant operation and which were presumably perceived by the Borrower/the consultant as full automation and by the contractor as semi-automation; and (b) poor supervision during the erection of the steam turbines.

10.2 Contractors. The damage to the two steam turbines was clearly due to a machining error (more precisely, an omission) during its manufacture, which was compounded by the failure to notice the error during erection of the plant, and to the error in the radial alignment in the case of No. 2 unit. The problem with the start-up valve, which on occasion delayed the unit from being put on load, did not reflect satisfactorily on either the supplier or on the contractor responsible for erection of the plant. The project did, however, provide useful experience to local firms who were responsible for tubes and welding of the u-bends.

10.3 The consultants and contractors were invited to respond the comments included in the report. The comments of the consultant are shown in Part II-B. No response was received from the contractor.

11. Project Relationship

11.1 Bank staff (including the Resident Mission) maintained a very good working relationship with GOP and WAPDA staff. While this understanding facilitated the implementation of the project in general, experience under this project suggests the need for more closer interaction at the administrative and technical levels.

12. Project Documentation

12.1 The Loan and Guarantee Agreements for the project were quite adequate and appropriate for the monitoring of the project objectives in the key organizational and financial areas. In retrospect, it may have been useful for the Loan Agreement to have included the requirement for a reduction in accounts receivable. The Staff Appraisal Report provided a useful framework for WAPDA to monitor project implementation. Information contained in the project file, including supervision reports prepared recording the findings of progress reports prepared by the Borrower were also adequate.

KOT ADDU COMBINED CYCLE PROJECT
(LOAN 2698-PAK)

PROJECT COMPLETION REPORT

Part II-A - PROJECT REVIEW FROM THE BORROWER'S PERSPECTIVE^{4/}

A. Evaluation of Bank's Performance and Lessons Learned

The Bank's performance, in general, was satisfactory. There was no delay in disbursement of any payment to the contractor. Bank personnel, who visited the site were recognized professionals. The project involved heat recovery steam generators and steam turbines, therefore, it would have been ideal if mission included some experts in this field. This could help WAPDA in keeping a check on the performance of contractor and consultant as well.

Major Lessons Learnt

- I. Overall communication between the Bank and WAPDA, including record of commitments and draw down of loan proceeds is not well documented. Even in WAPDA, no year wise and overall ledger is maintained indicating invoice number, disbursement number, amount of disbursement, date of disbursement, currency exchange rate and total cost of the project at the end of the project. Neither such requirement was emphasized by the mission visiting for evaluation of project performance, in any of their correspondence. Record should be computerized at WAPDA's end also and WAPDA accounting staff be trained for keeping Loan documents in order and up-dated.
- II. Bank should provide services of experts before bidding for review of technical specifications. The technical specifications on operating philosophy as regards to degree of automation were not clear. WAPDA had no previous experience of combined cycle and relied only upon consultants. The dispute on this issue delayed the project considerably which could be avoided.

B. Evaluation of Borrower's Own Performance and Lessons Learnt

Indeed there was augmentation of further 200 MW in power generating capacity of WAPDA. WAPDA engineers were trained and local companies gained experience in manufacturing of boilers and erection work. The technical specifications as regards to degree of automation were not spelled out clearly resulting in delay of the project. Disputes with local authorities at the time of custom clearance hindered the progress.

Lessons Learnt

WAPDA engineers deputed to work on project did not contribute in monitoring of project erection works, design review etc. They were all busy in resolving administrative bugs with customs, budget preparation, preparing number of progress reports etc. There should be independent group of WAPDA engineers who should perform only technical work and remain associated with

^{4/} Part II-A is the Borrower's product and its contents are not attributable to the Bank. A copy of the telex dated December 23, 1993 is in the project file.

consultant/contractor like shadow. This will help WAPDA to keep check on consultant's performance also. WAPDA can give special allowance to said group of members as an incentive.

It was concluded from the failures of cooling tower gear boxes, boiler tubes (LP area), steam turbine blade rubbing that consultants even did not possess sufficient experience. Cooling tower problems could be foreseen at the time of design review stage. WAPDA suffered a lot.

The Bank could also engage experts for evaluation of the problems. The consultants role should be more effective and not just a post office between contractor and client.

C. Assess the effectiveness of the relationship between the Bank and the Borrower during the evaluation and implementation of the project

The relationship between Bank and Borrower was good. At least, there was no disbursement problem which was Bank's major responsibility. There was not much expected from the Bank as regards to their help in technical matters. Therefore there is no complaint. But after completion of the project, it is strongly felt that Bank should have more effective role in this area also.

D. Evaluate the performance of co-financiers and assess the effectiveness of their relationship with the Borrower during the evaluation and implementation of the project

There was no cofinancier.

KOT ADDU COMBINED CYCLE PROJECT
(LOAN 2698-PAK)

PROJECT COMPLETION REPORT

Part II-B - PROJECT REVIEW FROM THE CONSULTANTS' PERSPECTIVE^{1/}

1. The project objectives were achieved. The additional power generating capacity is in operation and the project was implemented within the estimated budget (including interest during construction).
2. The project could not be implemented within the planned time schedule. The main reasons for this were delays in the planning process, administrative problems (mainly customs problems), disputes about the specifications and rectification of design problems and defects in equipment
3. The conceptual design proposed by the consultants was very creative and proved to be of very substantial benefit to the borrower. This was particularly true of the connection of different GT's (Unit 1 + 3, 2 + 4) to 2 steam turbines of identical design. This was as unusual as it was successful. It reduced the investment costs as well as the maintenance costs by avoiding different spare parts, etc.
4. Lessons learned by the Consultant:
 - 4.1 Major design changes shortly before issuance of the tender documents should be avoided. Consistent specifications are very important. Additional efforts in manmonths as well as in respect to the time schedule should pay off. Otherwise delays and increased efforts during implementation are almost certain to occur, if the contractor is allowed to allege contradictory statements in the specifications.
 - 4.2 If the consultants are made responsible for design mistakes caused by the contractor (as in this project), it is recommendable that the consultant be utilized as engineer and allowed to influence the detailed design by a multi-lot-approach. In such case the engineer will be able by stimulating competition to take advantage of further price savings in the procurement of equipment and to prevent design mistakes. Given the limited role of a consultant, mistakes made by a contractor can sometimes only be corrected ex post by the consultant.
 - 4.3 Site supervision has to be intensified even if the contractor erecting the plant is a world leader in his field.

^{1/} Part II-B is the Consultant's product and its contents are not attributable to the Bank. A copy of a letter dated June 12, 1995 is in the project file.

KOT ADDU COMBINED CYCLE POWER PROJECT
LOAN 2698-PAK

PROJECT COMPLETION REPORT

PART III - STATISTICAL INFORMATION

1. Related Bank Loans and Credits

Cr./Ln. No. and Title	Purpose	Yr. of Apprv.	Status	Comments
A. Preceding Operations				
Cr. 213-PAK WAPDA Power Project (WAPDA I)	Upgrading capacity of Transmission Network	1970	Closed (12/31/78)	Completed with delay of five yrs.
Ln. 1208-PAK Second WAPDA Power Project (WAPDA II)	Finance part of 500-kV Trans. System, connecting hydro in north and thermal gen. in south	1976	Closed (9/30/82)	Successfully completed, with 1 year delay.
Cr. 968-PAK Third WAPDA Power Project (WAPDA III)	Finance 4-year tranche of program for dev. of secondary transmission	1979	Closed (12/31/85)	Successfully completed but with 3 year delay.
Ln. 2499-PAK Fourth WAPDA Power Project (WAPDA IV)	Finance 4-year tranche of program for development of secondary transmission.	1985	Closed (12/31/92)	Successfully completed, but with 3 year delay. PCR dated 6/21/95.
Ln. 2556-PAK Fifth WAPDA Power Project (WAPDA V)	Assist WAPDA in reinforcement of EHV power transmission network reducing transmission losses	1985	Closed (12/31/93)	Completed but with a delay of 3 years.
Ln. 2698-PAK Kot Addu Combined Cycle Power Project (WAPDA VI)	Installation of 200 MW additional generating capacity at Kot Addu Power Station.	1986	Closed (6/30/93)	Subject of this PCR.
Ln. 2792-PAK Power Plant Efficiency Improvement Project (WAPDA VII)	Finance program for rehabilitation of 7 power plants and addition of combined cycle generation at 2 power plants.	1987	Closed (6/30/94)	ICR under preparation.
B. Following Operations				
Ln. 3147-PAK Transmission Extension and Reinforcement Project (WAPDA VIII)	Installation of 2 single circuit 500-kV transmission lines between Hub Power Complex and Jamshoro; installation of a third single circuit 500-kV line between Guddu and Multan and a second single-circuit 500-kV line between Multan and Lahore via Gatti; extension and reinforcement of existing 500-kV substations at Lahore, Gatti, Multan and Guddu.	1989	Ongoing	Original Closing date 12/95; extended to 12/96.

Cr./Ln. No. and Title	Purpose	Yr. of Apprv.	Status	Comments
Ln. 3148/Cr. 2078-PAK Rural Electrification Project (WAPDA IX)	Extending the supply of electricity to new villages and settlements; connecting to the grid settlements of electrified villages; expanding consumer connections; reinforcing and rehabilitating existing distribution network; extending electricity supply to tubewells; mapping of all villages and settlements; and installing load management schemes.	1989	Ongoing after substantial delays in start-up.	Original Closing Date 12/95; extended to 6/97.
Ln. 3764-PAK Power Sector Development Project (WAPDA X)	Restructuring and privatization component to implement a Strategic Plan including reorganization and corporatization of WAPDA; investment component to implement a timeslice (1995-1998) of WAPDA's investment program.	1994	Ongoing	Closing Date 6/99
C. Related Loans				
Ln. 2552-PAK Energy Sector Loan	Finance GOP's program for policy reform and inst. development during Sixth Five Yr. Plan (FY83-88).	1985	Closed (12/31/88)	Successfully completed.
Ln. 3107-PAK Second Energy Sector Loan	Finance GOP's program for policy reform and inst. development during Seventh Five Yr. Plan (FY89-93)	1989 & 1991	Closed (12/31/94)	ICR under preparation
Ln. 3252-PAK Corporate Restructuring and System Expansion Project	Finance program for restr./privatization of SNGPL, and expansion of its transmission and distribution network capacity by about 50%. Under the project, SNGPL constructed a pipeline between Multan and Kot-Addu for supplying natural gas to the power station	1990 & 1991	Ongoing	Being Implemented

2. Project Timetable

<u>Activity</u>	<u>Date Planned</u>	<u>Actual Date</u>
Appraisal	-	September 1985
Negotiations	March 1986	March 24-26, 1986
Board Approval	May 1986	May 22, 1986
Loan Signature	-	June 25, 1986
Loan Effectiveness	September 1986	November 22, 1986
Loan Closing	June 30, 1991	June 30, 1993
Last Disbursement	October 30, 1991	February 1, 1993

3. Loan Disbursements

Cumulative Estimated and Actual Disbursements
(US\$ Million)

<u>FY</u>	<u>Estimated</u>	<u>Actual</u>	<u>Actual as % of estimated</u>
1987	3.2	.1	3
1988	19.2	2.4	13
1989	54.2	24.4	45
1990	80.0	65.3	82
1991	90.0	72.6	81
1992	—	82.5	92
1993	—	90.0	100

4. Project Costs and Financing

A. Project Costs

	<u>SAR Est</u>	<u>Actual</u>	<u>Increase/ Decrease</u>	<u>SAR Est</u>	<u>Actual</u>	<u>Increase/ Decrease</u>
	Million Rs			US\$ Million		
A. <u>Power Station</u>						
Civil Works	290.1	68.5		18.1	3.0	
Elec./Mech. Equipment	1804.5	2354.4		112.8	105.1	
Erection	416.5	319.0		26.0	14.1	
Engineering and Admin.	118.5	204.0		7.4	9.0	
SUB TOTAL A:	<u>2629.6</u>	<u>2945.9</u>	<u>12%</u>	<u>164.3</u>	<u>131.2</u>	<u>(-20%)</u>
B. <u>220-Kv Line</u>						
Civil Works	2.0			.1		
Elec./Mech. Equipment	111.1	175.9		6.9	9.1	
Erection	54.6			3.4		
Eng. and Admin.	7.4			0.5		
SUB TOTAL B:	<u>175.0</u>	<u>175.9</u>		<u>10.9</u>	<u>9.1</u>	
GRAND TOTAL (A and B)	2804.6	3121.8		175.2	140.3	
C. <u>Interest During Construction</u>	199.0	213.2		12.4	9.4	
<u>TOTAL FINANCING REQUIRED:</u>	<u>3003.6</u>	<u>3335.0</u>		<u>187.6</u>	<u>149.7</u>	

B. Project Financing
(US\$ Million)

	<u>SAR Est.</u>	<u>Actual</u>
IBRD Loan 2698-PAK	90.0	90.0
IBRD Loan 3107-PAK	0.0	4.0
WAPDA	75.1	55.7
GOP	2.7	-
<u>TOTAL</u>	<u>187.8</u>	<u>149.7</u>

5. **Project Results**

A. Direct Benefits^{1/}

Key Economic Indicators

	FY85 Act	FY87 Act	FY93 SAR	FY93 Act	% Increase (FY85-FY93)
Inst. Capacity (MW)	4,339	5,349	9,416	7,882	82%
Max. Demand (MW)	3,791	4,325	7,872	7,522	98%
Max. Load Shed (MW)	-	-	-	-	-
Generation (GWH)	18,777	23,630	36,775	40,783	117%
Energy Sales (GWH)	13,756	17,745	28,317	31,338	128%
Losses, incl. Aux.	27%	25%	23%	23%	-
Trans. Lines (km)	19,347	21,426	-	24,648	27%
Grid Substns (no.)	457	518	-	597	31%
Transformer Cap. (MVA)	14,258	18,551	-	26,651	87%
Consumers (million)					
Residential	3.50	4.11	-	6.62	89%
Industrial	0.13	0.14	-	0.17	32%
Commercial	0.77	0.90	-	1.22	58%
Bulk Supply (000)	1.50	2.80	-	2.40	60%
Others					
TOTAL	4.52	5.27	-	8.18	81%
Villages Electrified	19,269	25,251	-	45,608	137%
Consumption (GWH)					
Residential	3,880	5,357	7,078	11,242	190%
Industrial	5,061	6,436	10,993	10,925	116%
Commercial	769	991	1,557	1,307	70%
Bulk Supply	1,115	1,361	2,463	2,022	81%
Others	2,931	3,600	6,226	5,842	99%
TOTAL	13,756	17,745	28,317	31,338	128%
Per Capita Cons.(kwh)	155	188	-	277	79%

**Key Financial Indicators
(Rs million)**

	FY85 Act	FY87 Act	FY90 Est	FY90 Act	FY91 Est	FY91 Act	FY93 Est	FY93 Act	FY93-FY85 % Increase
Gross Oper. Assets	35,019	54,723	87,771	91,731	103,912	103,286	149,731	127,126	263%
Elec. Sales (GWH)	13,756	17,745	21,418	24,121	24,036	26,584	28,622	31,272	127%
Av. Tariff (p/kwh)	63.8	70.9	148.8	107.8	160.5	116.5	203.5	126.2	98%
Fuel Surcharge	1,500	2,517	7,232	7,405	9,130	9,130	14,474	12,262	-
TOTAL Op. Revenues	8,986	12,921	32,225	26,408	38,969	31,605	58,702	40,123	347%
Fuel Cost	2,404	3,714	11,126	6,768	14,047	9,150	22,103	11,771	-
TOTAL (Cash) Op. Exp.	5,224	7,099	19,602	12,009	24,503	15,198	36,173	23,440	349%
Op. Ratio (inc. Dep.)	0.71	0.68	0.70	0.56	0.71	0.59	0.69	0.69	-
Debt Serv. Coverage	1.7	1.5	1.9	1.9	1.8	1.5	1.7	1.4	-
Contrib. to Invest.	47%	35%	40%	41%	40%	46%	40%	42%	-
Debt/Equity Ratio	50/50	56/44	58/42	58/42	59/41	57/43	59/41	58/43	-
Rate of Return %	10.6	11.5	15.3	20.8	14.6	17.6	15.98	14.6	-

^{1/}Based on comparisons with appraisal estimates.

B. Economic Impact

Internal Rate of Return

FYear	Infl. Deflator	Annual Invest. (Rp mil)	Effec. Invest. (Rp mil)	Annual O & M (Rp mil)	T & D Costs (Rp mil)	Generation (GWH)	Energy Sales (GWH)	Av. Rev. per KWH (paia)	Benefit (Rp mil)	Net Benef (or Costs)	Const. Prices	
1985	1.000											
1986	1.049							74.4	0	0	ERR	
1987	1.136	1.00	7	6				69.6	0	(6)	(6)	
1988	1.247	1.10	81	69				82.9	0	(69)	(63)	
1989	1.352	1.19	567	482				94.4	0	(482)	(405)	
1990	1.468	1.29	486	413				105.7	0	(413)	(319)	
1991	1.644	1.45	224	190	50	27	199	154	116.5	179	(88)	(61)
1992	1.764	1.55	355	302	90	58	400	308	126.8	390	(60)	(39)
1993	1.928	1.70	350	297	100	98	678	520	126.2	656	160	95
1994	2.150	1.89	57	48	100	126	750	590	142.0	838	564	298
1995		1.89			100	127	750	598	142.0	849	621	328
1996		1.89			100	129	750	605	142.0	859	631	333
1997								611			631	333
1998								611			631	333
1999								611			631	333
2000								611			631	333
2001								611			631	333
2002								611			631	333
2003								611			631	333

ASSUMPTIONS

1. Investment Costs include cost of Transmission Line (estimated at Rs180 million) but not the Fuel Pipe Line
2. Customs Duty and other charges estimated @ 15% of the investment are deducted to arrive at effective investment
3. System losses are estimated at 15% of generation
4. Transmission and Distribution (T & D) Costs are estimated at 15% of sales revenue
5. Average annual revenue per KWh sold is used to calculate revenues from project
6. Revenue is used as a proxy for benefits.

IRR = 18%

C. Study

<u>Purpose</u>	<u>Status</u>	<u>Impact</u>
Feasibility and engineering study of the second phase of the power station complex at Jamshoro (Loan Agreement, Section 4.05).	Completed.	Consultants prepared detailed engineering specifications and bidding documents.

6. Status of Covenants

Key Covenants and Status of Compliance

<u>Section of LA/GA</u>	<u>Covenant</u>	<u>Status</u>
4.05 (a) (LA)	Carry out feasibility and Eng., study, prepare specs for second phase of Jamshoro by 06/87	Complied
4.05 (b) (LA)	Engage consultants for above study	Complied
5.01 (b) (LA)	Audited accounts within 6 months of end of fiscal year	Complied with delay
5.02 (a) (LA)	40% internal cash generation for capital expenditure program from FY88	Complied
5.03 (a) (LA)	Debt Service coverage of 1.5 times	Complied
3.02 (GA)	GOP to cause government agencies and departments to pay electricity bills within 3 months	Not Complied

LA = Loan Agreement

GA = Guarantee Agreement

7. Use of Staff Resources

A. Inputs

Staff Weeks

Through Appraisal	15.2
Appraisal through Board Approval	28.0
Board Approval through Effectiveness . .	2.2
Supervision	<u>80.1</u>
Total	<u>125.5</u>

B. Supervision Missions

No.	Mission Dates	Number of Persons	Days in the Field (a)	Specialization (b)	Overall Status (c)	Development Objectives (c)
1.	March 9-23, 1987	3	14	E, F	1	1
2.	August 8-24, 1987	2	16	E, F	1	1
3.	Nov. 27-Dec.20, 1987	5	23	E, F	N/R	N/R
4.	July 16-30, 1988	4	14	E, F	1	1
5.	Feb. 6-March 4, 1989	4	22	E, F	1	1
6.	Nov. 5-26, 1990	1	21	E	N/R	N/R
7.	Apr. 22-May 21, 1991	3	28	E, F	1	1
8.	June 21-July 10, 1992	3	19	E, F	1	1
9.	Feb. 16-March 10, 1993	2	22	E, Ec	2	1

a/ Days in field represent work undertaken as a combined effort on all ongoing power projects.

b/ Engineer (E); Financial Analyst (F); Economist (Ec).

c/ Minor or no problem (1); Moderate Problems (2); Major problems (3).

Completion Mission - December 1993

PROJECT COMPLETION REPORT

PAKISTAN

KOT ADDU COMBINED CYCLE POWER PROJECT
(LOAN 2698-PAK)

WATER LEAKAGE IN WASTE HEAT BOILERS

After about 3,000 hours of operation of the units, heavy water leakage was observed through the cracks in the elbows (of the tubes) of the Low Pressure Evaporator. The release of water/steam caused damage to the external surfaces of the adjacent tubes.

An investigation was carried out by a firm of consultants engaged by the insurance company. They carried out visual, metallographical, microfractographical examinations and non-destructive testing of the damaged elbows. Even though cracks were found in and on the circumferential welds, and in the base metal of the elbows, the report from the consultants attributed the damage, not to defective material or defective welding of the joints, but to intergranular stress corrosion cracking from soda lye which is released and becomes active particularly during the "start-up" process. The main recommendations from the consultants were to increase the flow of water circulation in the tubes, and to restrict the phosphate content in the water to less than 6 mg/l. The other recommendations included stress-relieving the elbows and welds, and installing soot blowers.

The unit has been on load since it was repaired. Because of the shortage of generating capacity, the Borrower has not been able to take the unit out of service for inspection or examination of the repair.

The fact remains that the damage was caused solely to the tubes of the Low Pressure Evaporator which have a relatively low pressure, and consequently are subjected to a relatively low stress level. Contrary to normal expectations, the above mentioned report found no problem or defect with the tube material or with workmanship, including welding of the elbow joints. Because of shortage of generating capacity in the country, it is not practical to take the unit out of service at a short notice, should the leakage problem recur. Therefore, the PCR mission agreed with the Borrower's view to seek a second opinion by an independent expert on both the cause of the damage and the appropriateness of the repair.

Repair or replacement was undertaken by the contractor during August/September 1993 for one unit, and March 1994 for the second unit. No leakage has been encountered since that time.

IMAGING

Report No: 15483
Type: PCR