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Report No. 18970

IMPLEMENTATION COMPLETION REPORT

CHINA

SECOND SHUIKOU HYDROELECTRIC PROJECT

(LOAN 3515-CHA)

February 17, 1999

Energy and Mining Development Sector Unit
East Asia and Pacific Regional Office

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CURRENCY EQUIVALENTS

Currency Unit: Yuan (Y)

At Appraisal of first loan (March 1986) \$1 = Y 3.7

At Appraisal of second loan (July 1991) \$1 = 5.35

Exchange Rates During Project Years

Year Avg.

1987	-	3.73	1993	-	5.81
1988	-	3.73	1994	-	8.46
1989	-	4.73	1995	-	8.33
1990	-	5.24	1996	-	8.30
1991	-	5.45	1997	-	8.30
1992	-	5.77	1998	-	8.30

FISCAL YEAR

January 1 - December 31

WEIGHTS AND MEASURES

Metric System

ABBREVIATIONS AND ACRONYMS

ECIDI	-	East China Investigation and Design Institute
FIDIC	-	Federation Instructionale des Ingenieurs Conseils
FPEPB	-	Fujian Provincial Electric Power Bureau
ICB	-	International Competitive Bidding
ICR	-	Implementation Completion Report
IERR	-	Internal Economic Rate of Return
MOE	-	Ministry of Energy
SAR	-	Staff Appraisal Report
SBC	-	Special Board of Consultants
SHPC	-	Shuikou Hydroelectric Project Corporation
SRRO	-	Shuikou Reservoir Resettlement Office

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CONTENTS

Preface	
Evaluation Summary.....	i

PART I: PROJECT IMPLEMENTATION ASSESSMENT

A. Project Objectives	1
B. Achievement of Project Objectives.....	3
C. Implementation Record and Major Factors Affecting the Project	4
D. Project Sustainability	15
E. Bank Performance	16
F. Borrower Performance.....	17
G. Assessment of Outcome.....	17
H. Future Operation	17
I. Key Lessons Learned.....	18

PART II: STATISTICAL TABLES

Table 1: Summary of Assessment.....	21
Table 2: Related Bank Loans	22
Table 3: Project Timetable	26
Table 4: Loan Disbursements: Cumulative Estimated and Actual	26
Table 5: Key Indicators for Project Implementation.....	27
Table 6: Key Indicators for Project Operation.....	28
Table 7: Studies Included in Project	29
Table 8a: Project Costs	31
Table 8b: Project Financing	32
Table 9: Economic Analysis of Power Plant.....	33
Table 10: Status of Legal Covenants	36
Table 11: Compliance with Operational Manual Statements	38
Table 12: Bank Resources: Staff Inputs.....	39
Table 13: Bank Resources: Missions	39
ANNEX 1: Projected and Actual Financial Statements of FPEPB	40
ANNEX 2: Implementation Review prepared by the Borrower	43
ANNEX 3: Aide-Memoire Extract for Completion Mission	58

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IMPLEMENTATION COMPLETION REPORT

CHINA

SHUIKOU HYDROELECTRIC PROJECT (LOAN 3515-CHA)

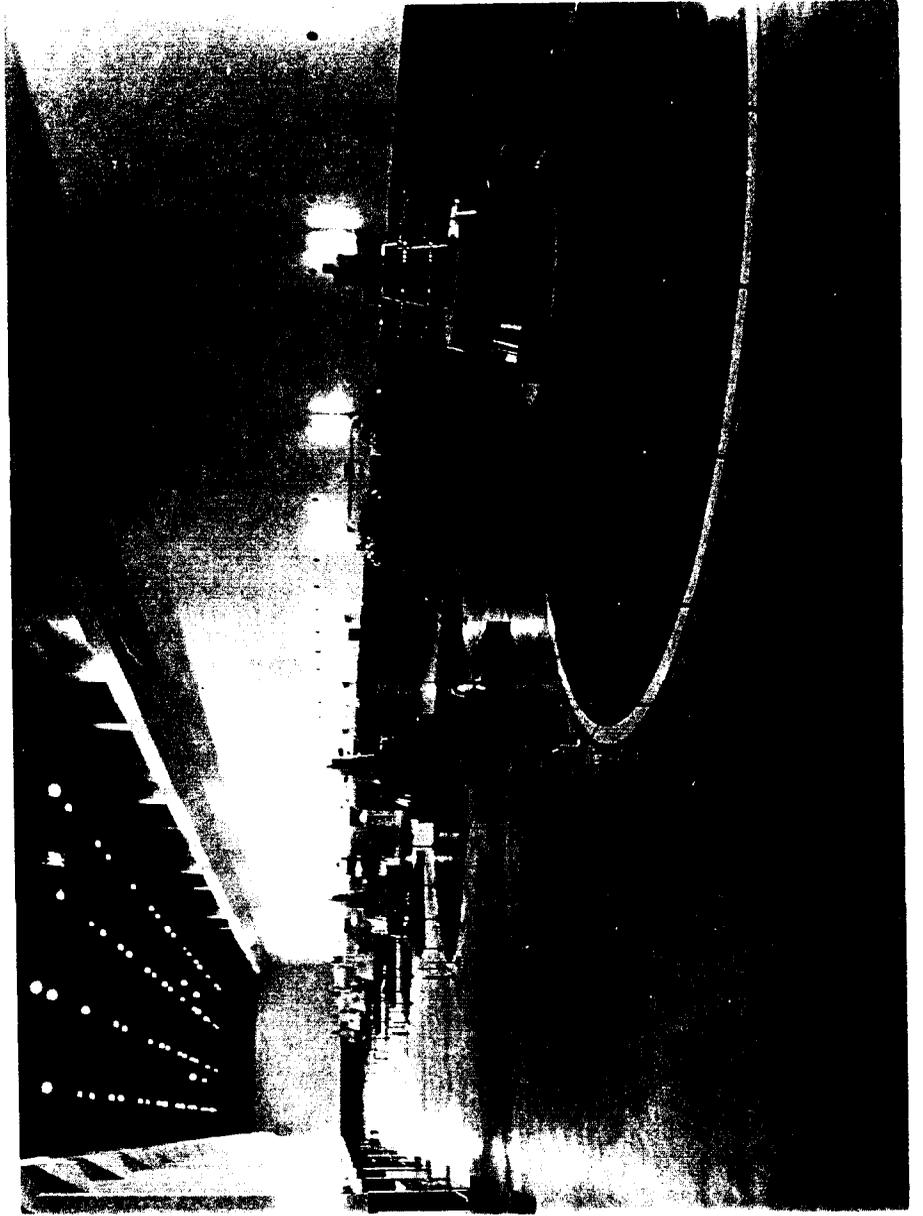
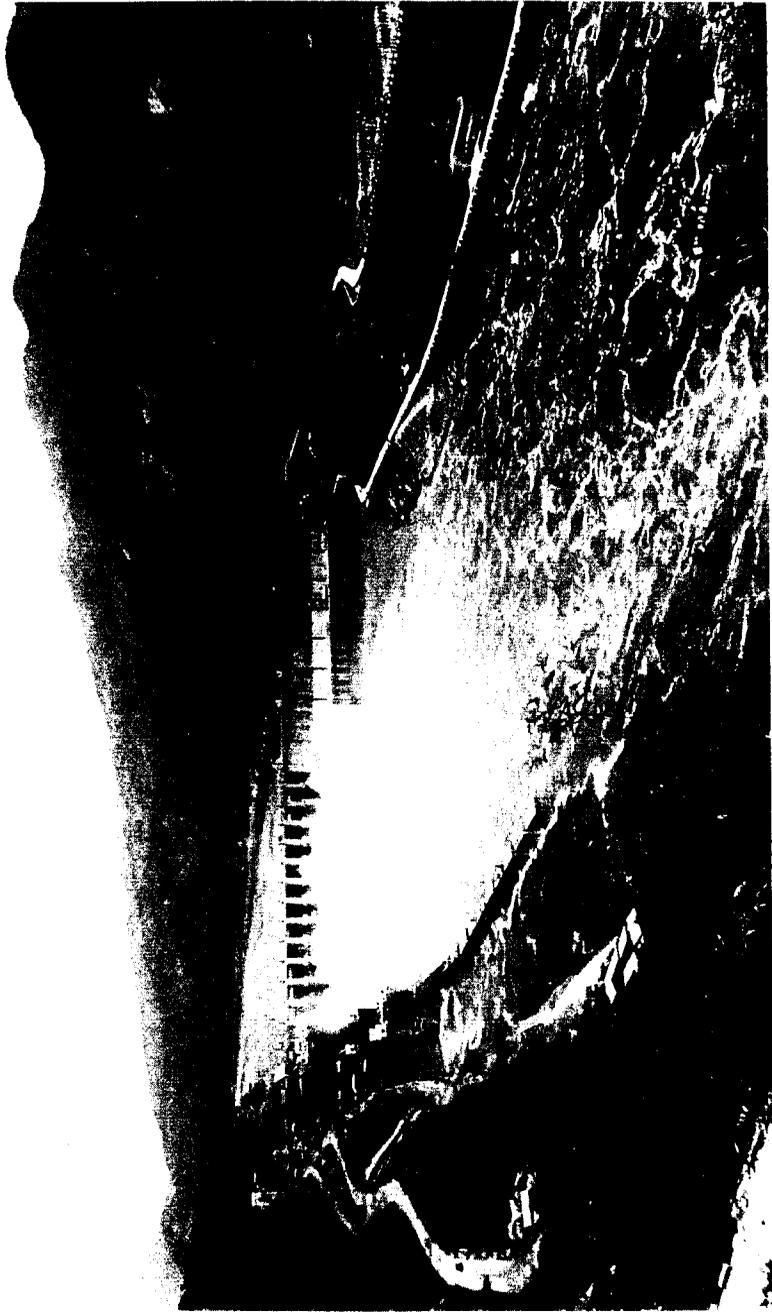
PREFACE

This is the Implementation Completion Report (ICR) for the Second Shuikou Hydroelectric Project in China for which Loan 3515-CHA in the amount of \$100 million was approved on September 1, 1992 and made effective on January 13, 1993. It was the second of two loans for the Shuikou dam and power plant, the first being Loan 2775-CHA, approved on January 15, 1987. This somewhat unusual approach was adopted because of the long implementation period and monolithic nature of the project facilities.

The loan was closed on June 30, 1998, 18 months beyond the date originally envisaged. Final disbursement was made on November 4, 1998 when the balance of the loan (\$14,380,659.51) was canceled. An ICR for the first loan was issued on June 28, 1996 (Report No. 15843). At the time of preparation of that ICR, construction of the hydroelectric project facilities and associated resettlement was nearing completion. This ICR updates the earlier one, particularly with regard to resettlement which is now complete, additional scope covered by the second loan, final project cost, economic performance and FPEPB financial performance.

The ICR was prepared by Barry Trembath, Energy and Mining Development Sector Unit of the East Asia and Pacific Region, and reviewed by Mr. Noureddine Berrah, Acting Unit Chief. The Borrower/Beneficiary provided comments, which are incorporated in the ICR, its own completion report, an executive summary of which is included as an annex to the ICR.

Preparation of this ICR was begun during a completion mission in October, 1997, during which the Beneficiary's draft completion report was received. Based on comments made in the mission aide memoire, a revised version was forwarded to the Bank on January 25, 1998. With the extension of the closing date until June 30, 1998, a further update was requested on certain items and these were received during a brief visit to Fujian in July, 1998. This ICR is based on these documents and discussions with Beneficiary staff and consultants, Staff Appraisal Reports for the first and second loans, the Loan and Project Agreements, Supervision Reports, correspondence between the Bank and the Borrower/Beneficiary, and internal Bank memoranda



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SECOND SHUIKOU HYDROELECTRIC PROJECT (LOAN 3515-CHA)

EVALUATION SUMMARY

Project Objectives

1. The objectives of the first phase project were to: (a) develop a major hydroelectric site to serve the Fujian and East China grids; (b) introduce the latest technology for dam and power station construction; (c) link the East China and Fujian power grids, (d) promote effective integrated operation of a major regional grid; (e) upgrade the capability of the FPEPB in financial management and management of large civil works contracts; and (f) enhance environmental and resettlement policies. The objectives of the second-phase project included the above, except that MOE and FPEPB had decided not to build the tie-line at that stage. Improving power pricing arrangements in the province was added as an additional objective. An addition to project objectives occurred in July, 1996 when the Board approved (on a no-objection basis) the addition of a new project component which provided for strengthening of transmission lines to the south. The full description and appraisal of this component is described in a Memorandum of the President dated July 10, 1996.

2. The second project first provided for the completion of the Shuikou Hydroelectric Dam and powerplant comprising: (a) a 101 m high concrete gravity dam, a spillway, a powerhouse, a navigation lock and appurtenant works at Shuikou on the Min River in Fujian Province; (b) seven generating units of 200 MW each and associated electrical and mechanical equipment; (c) switchyard and transmission to connect to the Fujian Provincial Grid; (d) resettlement of about 63,000 people in the reservoir area; (e) consulting services for design and construction management; and (f) studies and staff training. The second project also included: (a) construction of a supervisory control and data acquisition system (SCADA) system for the Fujian Province Grid; (b) completion of system planning and operation studies commenced under the first project, and (c) a new study to reevaluate the hydro-inventory of Fujian province; (d) implementation of an action plan for tariff reform; and (e) provision of technical assistance and training programs in financial management and project related technology and management. The new component, added in 1996, consisted of the following 500 kV transmission lines and substations: (a) a transmission line from Shuikou Power Plant to Guanqiao via Huian, a total line length of 206.5 km (111.5 km upgraded from 220 kV and 95 km of new line)

(b) a substation with main transformer capacity of 900 MVA at the Shuikou Power Plant; and (c) a substation with the main transformer capacity of 900 MVA at Guanqiao.

3. The objectives carried over from the first project continued to be realistic, relevant and important, and to reflect Government and Bank strategy for the sector. The additional objective of the second project, improving power pricing arrangements, was relevant and important in that it reflected the developing policy dialogue between the Bank and the Chinese Government. The objective, as stated, was realistic; however, the pace at which reform could be achieved, as spelled out in the implementation plan, proved to be overly optimistic.

Implementation Experience and Results

4. The project achieved its primary objective of developing a major hydroelectric site. The ex-post IERR (based on a minimum proxy of "willingness to pay") at 26 percent substantially exceeds the expectation of 19 percent. Modern technology for dam and power station construction was successfully introduced, enabling the project civil works to be completed generally on schedule, despite setbacks from force majeure events. The objective of promoting effective integrated operation of a major grid was achieved with the completion of studies and the carrying forward of their results into FPEPB operations and subsequent investments. The objective of upgrading local capabilities in management of large civil works contracts was convincingly demonstrated when the executing agency, FPEPB and its construction manager, Shuikou Hydroelectric Project Corporation (SHPC), played a major role in overcoming initial delays during project implementation, and filling the reservoir on schedule. The resettlement task fully achieved its objectives of relocating affected people in a timely manner and establishing new production systems to enable them to restore their livelihoods. By the end of 1996, average income level of the resettlers, after allowing for inflation had substantially surpassed the before moving level. On the physical side, both size and standard of housing had improved as had infrastructure and community facilities. The objective of reforming power pricing arrangements at the consumer level was achieved with the elimination of the multiple tier pricing system which was completed in October, 1997.

5. Key dates in relation to civil works were essentially met, and the reservoir impoundment started on April 2, 1993. Commissioning of generating units were delayed because of delays in supply of turbine and generator components. Initial delays were limited, varying from two to seven months for Units 1 to 4, but, casting defects resulted in delays increasing to an average of 12 months for Units 5 and 6 and 19 months for Unit 7. However, these delays had little negative impact on energy production since initial periods of delay generally covered dry season months and, in the case of later units, efficient operation of available generating capacity was successful in reducing spill to a minimum, thus utilizing almost all available flow to generate energy. At the same time, capacity additions kept pace with the demand for peaking capacity in the Fujian grid.

6. With regard to final costs in comparison with those estimated at the time of appraisal of the second loan, for the dam and power plant there was a cost overrun of 4.9 percent when expressed in US dollars and 27.3 percent when expressed in local currency. Differences in the overrun figures are due to the higher-than-expected inflation in China (67 percent between 1992 to 1996 compared with 21.5 percent estimated) and the devaluation of the local currency from an exchange rate of Y5.35 to the dollar at the time of appraisal to Y8.46 to the \$1 in 1994. The comparison of costs expressed in US dollars is considered to give a reasonable estimate of cost overrun excluding the effects of inflation and devaluation. There is therefore relatively good agreement between costs estimated at appraisal of the second loan and final costs. Final costs for other components were reasonably close to those estimated (and generally lower) except for the ship-lift, comprising a relatively small proportion of the Bank loan, where costs were considerably underestimated

7. The resettlement task was carried out according to plan with 67,239 persons in rural areas being physically relocated. In addition, some 17,215 urban residents in Nanping city, at the upstream end of the reservoir, were relocated as part of a project to re-develop the Min River foreshore and raise flood protection. In the rural areas, by the end of June 1997, 38,439 jobs had been created, exceeding the total requirement. An independent evaluation indicated that by the end of 1996, average income level of the resettlers, after allowing for inflation, had surpassed the before moving level by 44 percent. On the physical side, per capita housing space increased from 30.0m² to 37.9 m² and inundated infrastructure and community facilities had been fully replaced, generally to a higher standard

8. All elements are present to ensure sustainability of the project. Technically, the finished hydroelectric development is of good quality and the units have operated at a high availability over the initial operating period of up to five years. Financially, the pricing arrangements for the plant output are already demonstrating very satisfactory financial and economic returns. On the institutional side, the upgrading of local capabilities in design and management of hydroelectric construction has already been carried over to future operations. The resettlement and rehabilitation is sustainable since an economic base has been established that will provide households with a flow of annual revenues. The replacement of rice agriculture with orchards and newly developed sidelines and light industrial activities have the further potential to significantly improve standards of living on an ongoing basis.

Summary of Findings, Future Operations and Key Lessons Learned

9. The objectives of the project were consistent with those of the Chinese Government and the Bank and the project achieved its major objectives. The outcome is rated as highly satisfactory, and sustainability as likely.

10. The project commenced operation in August 1, 1993 with the commissioning of the first generating unit. In 1995, with only four units in operation for most of the year,

the output of the power plant was 4,763 GWh, which is only slightly below the design output in an average year with all units operating. In 1997, the first year with all units operating, generation was 6070 GWh, 23 percent above the design output. Total generation by the end of 1998 had generated revenue to the power plant approximately equal to the construction cost of the dam and powerhouse including interest during construction. The Shuikou power plant has already been accredited as fully meeting the standards established by the State Power Corporation, which cover safety, reliability and efficiency. Resettlement activities are continuing with future funding being largely provided by the reservoir development fund which will generate income based on energy production of about Y20 million per year

11. The key lessons to be learned from this project are:

- (a) The two stage loan arrangement achieved its objectives. The use of the Adjustable Program Loan, which has now been added to the Bank's product line, should be considered for similar future operations.
- (b) Shuikou resettlement was carried out successfully, which can be attributed to several factors, some of which are project specific and others which are more general and offer some opportunity for replication elsewhere. Among the factors which might be replicated elsewhere are: (a) the enlightened policies of central and provincial governments, supplemented by the preferential policies and incentives established by the provincial government in the reservoir area; (b) the strong institutional framework for resettlement; (c) the planning process which commenced well ahead of the project, in consultation with local government down to village level; (d) the open, fair, participatory and flexible approach adopted during implementation; (e) the flexibility shown by government agencies in adjusting resettlement budgets for inflation, more detailed planning and unforeseen circumstances, and the strong support of FPEPB in obtaining additional funding; and (f) the independent evaluation of resettlement, which provided early feedback on the successes and weaknesses of the resettlement process. Despite these successes, it is considered that there is room for improvement in the process which should be taken into account in future projects: (a) the resettlement office and relevant government departments should play an even greater role in supervision and technical assistance, particularly in income restoration activities; (b) resettlement planning should be even further advanced at appraisal stage and estimates of remaining land resources need to be more realistic; (c) implementation of resettlement should also be advanced as much as possible, particularly land development for agricultural activities; (d) the budget adjustment process should provide for automatic adjustment of inflation.

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SECOND SHUIKOU HYDROELECTRIC PROJECT
(LOAN 3515-CHA)

PART I: PROJECT IMPLEMENTATION ASSESSMENT

A. PROJECT OBJECTIVES

1. The objectives of the first phase project were to: (a) develop a major hydroelectric site to serve the Fujian and East China grids; (b) introduce the latest technology for dam and power station construction; (c) link the East China and Fujian power grids, (d) promote effective integrated operation of a major regional grid; (e) upgrade the capability of the FPEPB in financial management and management of large civil works contracts; and (f) enhance environmental and resettlement policies. The objectives of the second-phase project included the above, except that MOE and FPEPB had decided not to build the tie-line at that stage. Improving power pricing arrangements in the province was added as an additional objective.

2. The Phase 2 project first provided for the completion of the Shuikou Hydroelectric Scheme with the following components:

- (a) construction of a 101 m high concrete gravity dam, a spillway, a powerhouse, a navigation lock and appurtenant works at Shuikou on the Min River;
- (b) provision and installation of seven generating units of 200 MW each and associated electrical and mechanical equipment;
- (c) switchyard and transmission to connect the project to the FPG;
- (d) environmental management and resettlement of some 67,000 people in the reservoir area;
- (e) consulting services for design and construction management;

The second phase project also included:

- (a) construction of a supervisory control and data acquisition system (SCADA) system for the Fujian Province Grid:

- (b) completion of system planning and operation studies commenced under the first project, and a new study to reevaluate the hydro-inventory of Fujian province;
 - (c) implementation of an action plan for tariff reform; and
 - (d) provision of technical assistance and training programs in financial management and project related technology and management.
3. The development of Shuikou reservoir area with resettlement and rehabilitation of 67,000 people while not singled out as a specific development objective, was to be undertaken in the context of the Chinese legal framework for resettlement and Bank policies and procedures for involuntary resettlement (OMS 2.33 and OPN 10.08 for first loan and OD 4.30 for second loan), which called for the relocation of the reservoir population in a manner that would leave them after relocation as well off as before, possibly better. To this end, a detailed resettlement plan was prepared in 1984 for the resettlement and rehabilitation of 67,000 persons living in 89 villages, 16 townships, and four counties at a cost of Y410 million (1986 prices).
4. An addition to project objectives occurred on July, 24 1996 when the Board approved (on a no-objection basis) the addition a new project component which provided for strengthening of transmission lines to the south. The full description and appraisal of this component is described in a Memorandum of the President dated July 10, 1996. A summary of the background leading to this new component and its description, follow:
5. During appraisal of the second phase project, the Bank had agreed with the Borrower that, due to exceptional load growth in the Fujian grid, interconnection to the East China grid in the north to export Shuikou power was no longer viable since Fujian would be able to absorb the full output of the power plant. After appraisal of the second loan, the province experienced even more rapid economic development, with GDP growing at an average annual rate of 23.4 percent from 1992 to 1994 with corresponding annual increases in peak demand and generation of 19.7 percent and 17.5 percent respectively. Much of this growth was concentrated in the southeastern part of the province where foreign invested industries were concentrated, where annual growth rates for peak demand and energy reached 28.5 percent and 30 percent respectively. Thus, over a period of seven years the power flow pattern in the grid has changed from a predominantly south-north flow envisaged during the appraisal of the first project to a strong north-south flow. More power needed to be sent to the south from Shuikou and the three circuits of the 220 kV transmission line from Shuikou to Huian, constructed in parallel with the second phase project, would not be able to accommodate the required transfers.
6. Based on the above factors, the Borrower requested, and the Bank agreed, to use savings from the second loan to add a new component comprising:

- (a) Supply and erection of a 500 kV transmission line from Shuikou Power Plant to Guanqiao via Huian. The total line length would be 206.5 km, of which the existing 111.5 km of Shuikou-Huian double circuit line would be upgraded from 220 kV to 500 kV and a 95 km new line would be constructed from Huian to Guanqiao.
- (b) Construction of a 500 kV step-up substation with the main transformer capacity of 900 MVA at the Shuikou Power Plant switchyard using the reserved space.
- (c) Construction of a 500 kV substation with the main transformer capacity of 900 MVA at Guanqiao.

7. The objectives were clearly stated in the appraisal report and, in relation to the additional component, in the Memorandum of the President relating to that component. The objectives carried over from the first project continued to be realistic, relevant, important, and reflect Government and Bank strategy for the sector. The additional objective of the second project, improving power pricing arrangements, was relevant and important in that it reflected the developing policy dialogue between the Bank and the Chinese Government. The objective, as stated, was realistic; however, the pace at which reform could be achieved, as spelled out in the implementation plan, proved to be overly optimistic.

B. ACHIEVEMENT OF PROJECT OBJECTIVES

8. The project achieved its primary objective of developing a major hydroelectric site. Despite some delays in project implementation, the ex-post IERR (based on a minimum proxy of "willingness to pay") at 26 percent substantially exceeds the expectation of 19 percent mainly because: (a) demonstrated "willingness to pay" is greater than original estimates; and (b) power and energy is entirely absorbed by the Fujian grid, obviating the need to construct a long transmission line to connect to East China. By the end of 1998, two years after completion of commissioning of the power station, cumulative revenue earned by the power plant (as a profit center) approximated the cost of the dam, power plant and reservoir works including interest during construction.

9. The modern technology for dam and power station construction was successfully introduced. This enabled the project civil works to be completed generally on schedule, despite setbacks from force majeure events. The modern construction techniques pioneered at Shuikou are now being accepted as the norm for large projects in China, validating the "demonstration" strategy.

10. The objective of promoting effective integrated operation of a major grid has been achieved with the completion of studies and the carrying forward of their results into FPEPB operations and subsequent investments. While the Fujian grid is smaller than that

of East China-originally envisaged as the target of the studies, its projected size in the year 2000 (in terms of installed capacity) is in the same order as that of the East China Grid at the time of project appraisal.

11. The objective of upgrading local capabilities in management of large civil works contracts was convincingly demonstrated when the executing agency, FPEPB and its construction manager, Shuikou Hydroelectric Project Corporation (SHPC), played a major role in overcoming initial delays during project implementation, and filling the reservoir on schedule.

12. The resettlement task fully achieved its objectives of relocating all affected people in a timely manner and establishing new production systems to enable them to restore, and preferably improve their livelihoods. By the end of 1996, average income level of the resettlers, after allowing for inflation had already surpassed the before moving level by 44 percent, and this situation was expected to improve as more newly planted orchards come into production. On the physical side, both size and standard of housing had improved as had infrastructure and community facilities.

13. The objective of reforming power pricing arrangements at the consumer level was largely achieved with the elimination of the multiple tier pricing system which was completed in October, 1997. Adjustment to tariff structure to better reflect costs were made, but this was only partly successful because of the structure of surcharges added by local governments. However, it is worthy of note that, largely due to Bank focus in projects such as Shuikou, tariff structure reform has become a primary objective of central government agencies responsible for regulation of the sector. The principle of a unified tariff structure: "all consumers of a particular category connected to a particular grid paying the same price" is now incorporated in the Electricity Law. In addition, the government has now decreed that local surcharges, responsible for distortion of tariff level and structure, are illegal and should be eliminated throughout China. Implementation of both of these measures is underway and is expected to be completed by the end of 1999.

14. The objective of the new transmission component, to provide the capability to deliver more power to the fast growing areas in the south, was achieved with the commissioning of the new 500 kV substations and lines in March, 1998. The transmission lines operated at full capacity throughout the 1998 high flow season.

C. IMPLEMENTATION RECORD AND MAJOR FACTORS AFFECTING THE PROJECT

Implementation Organization

15. FPEPB was the executing agency for the project. For the Shuikou power plant a special organization, SHPC, was set up to manage construction of the project and exercise the functions of the engineer under the Federation Instructionale des Ingenieurs Conseils (FIDIC) Conditions of Contract. East China Investigation and Design Institute

(ECIDI) served as the designer. The contract for the main civil works was awarded to a Chinese-foreign construction joint venture while the contract for the installation of electro-mechanical equipment was awarded to an experienced national level construction bureau after local competitive bidding. Resettlement in the reservoir area was managed by the Shuikou Reservoir Resettlement Office (SRRO), a special unit established by the Fujian Provincial Government for this purpose. International consultants were employed to assist SHPC in all aspects of construction and contract management, and ECIDI in design management and the review of bid documents. A Special Board of Consultants (SBC) was also appointed to review and comment at various stages during design and construction on the major technical issues, scheduling, management, environment, and resettlement.

Dam and Power Plant Construction

Overall Progress in Comparison with Schedule in SAR

16. The implementation schedule established in the SAR provided for commencement of the main civil works in January 1987, commissioning of the first unit after 6½ years (June 1993) with the six subsequent units commissioned at four month intervals. The schedule was demanding, even by the standards of an experienced international contractor.

17. With the joint efforts of all concerned parties, many difficulties and problems were overcome, key dates in relation to civil works were essentially met, and the reservoir impoundment started on schedule on April 2, 1993. Generating unit commissionings were delayed because of delays in supply of turbine and generator components. Initial delays were limited, varying from two to seven months for Units 1 to 4, but casting defects in the very large turbine runner components resulted in delays increasing to an average of 12 months for Units 5 and 6 and 19 months for Unit 7. However, these delays had little negative impact on energy production since initial periods of delay generally covered dry season months and, in the case of later units, efficient operation of available generating capacity was successful in reducing spill to a minimum, thus utilizing almost all available energy. At the same time, peaking capacity additions kept pace with the demand growth of the Fujian grid

Main Civil Works Contract

18. A detailed review of the implementation of this contract is presented in the ICR for the first project, and it is not intended to repeat it here since the contract was essentially completed at the time of the first ICR. In summary, the contractor with the support of FPEPB, SHPC and MOE, overcame great difficulties to meet the target dates for commencement of reservoir impoundment on April 2, 1993. Remaining civil work after reservoir filling were power house second stage concreting and roof completion, and finishing and architectural work. These were duly completed and the Completion and Maintenance certificates were issued on May 25, 1996, and May 25, 1997 respectively.

Supply of the Generating Unit Equipment

19. After ICB, the contract for the first two generating units was awarded to a foreign/Chinese joint venture. This contract was financed by the Bank. The contract for the remaining five units, not financed by the Bank, was awarded to the Chinese partner of the joint venture. Subsequently, the Bank indicated no objection to an extension of the ICB contract, to cover specialized components (governors and excitors) for all seven units.

20. Contracts for all seven generating units were signed in August 1988. However, for reasons beyond the control of FPEPB or the contractor, as explained in the previous ICR, the issue of the Letter of Credit was not issued until the end of 1989, a delay of almost one year compared to the contract stipulations. The manufacturing schedule and equipment delivery schedule were correspondingly affected. The following table shows the contractual vs. actual equipment delivery for each of the seven units.

Equipment Delivery - Units 1 to 7

Item	Unit 1		Unit 2		Unit 3		Unit 4		Unit 5		Unit 6		Unit 7	
	Contract Date	Actual Date												
Embedded parts	05/91	01/92	08/91	06/92	05/93	06/93	07/93	08/93	11/93	03/94	05/94	08/94	07/94	10/95
Distributor system	08/91	05/92	12/91	09/92	10/93	05/94	01/94	09/94	06/94	04/95	10/94	06/95	02/95	4/96
Runner assemblies	05/91	12/91	12/91	12/91	10/93	02/94	01/94	07/94	05/94	05/95	09/94	08/95	04/95	8/96
Stator assemblies	12/91	06/92	03/92	02/93	08/93	01/94	11/93	04/94	03/94	10/94	07/94	02/95	04/95	4/96
Rotor assemblies	03/92	11/92	06/92	06/93	10/93	03/94	02/94	07/94	04/94	02/95	08/94	08/95	04/95	5/96
Main Shaft	12/91	11/92	06/92	05/93	12/93	04/94	02/94	07/94	06/94	05/95	10/94	08/95	04/95	8/96
Thrust head and support	09/92	01/93	09/92	07/93	10/93	04/94	02/94	07/94	06/94	05/95	10/94	08/95	04/95	8/96
Thrust bearings	09/92	09/92	09/92	09/92	12/93	05/94	03/94	09/94	06/94	06/95	10/94	09/95	04/95	8/96
Upper bracket	12/91	12/92	03/92	02/93	10/93	12/93	02/94	09/94	06/94	06/95	10/94	06/95	04/95	9/96

- Notes:
1. The equipment delivery of units 1 and 2 refer to the date stipulated in the international contract.
 2. The equipment delivery of units 3-7 refer to the date stipulated in the supplementary agreement of units 3-7.

Mechanical and Electrical Installation

21. The electrical and mechanical installation contract was signed in January 1991, and the contractor commenced mobilization on site in March 1991. The execution bay and bridge crane were handed over to him in December 1991 and the Unit 1 area was handed over in February 1992. According to the provisions of the contract, the installation duration for each unit was 18 months counted from the installation of stay ring to completion of 72-hour trial operation with units commissioned at four intervals. With contributions from other concerned parties, the installation contractor was able to reduce the effect of delayed equipment deliveries and expedite the installation work to catch up some of the time lost through delayed deliveries. The installation time and commissioning date of units 1 through 7 are shown in the following table, which shows that even for the first unit the erection period was three months less than the contract period, with progressive reduction in the erection period for subsequent units, reducing to 10.5 months--or 7.5 months less than the contract period--for the sixth unit, and only increasing slightly to 11.7 months for the seventh unit, despite the complexities of erection and second stage concreting in the fully enclosed powerhouse. The performance of the erection contractor in achieving these dates must be rated as outstanding.

Installation Progress for Shuikou Units 1 to 7

Item	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Installation duration (month)	15	13.5	12.5	11	12	10.5	11.7
Including: second stage conc. placing time (day)	107	90	87	80	98 (incl. holiday)	70	80
Operation date	08/01/93	02/08/94	09/02/94	12/28/94	11/06/95	12/28/95	12/05/96
Operation date established in SAR	05/31/93	09/30/93	01/31/94	05/31/94	09/30/94	01/31/95	05/31/95
Actual vs. Target (month delayed)	2	4	7	7	13	11	19

Spillway Gate Supply and Installation

22. This equipment was designed by ECIDI, and most components were supplied by local manufacturers, with only certain specialized components being imported. Erection was carried out by the main civil works contractor. While no difficulties were experienced in supply and installation, some difficulties were experienced in raising the

gates, arising from the previously untested design. Modifications to overcome the problems were designed, implemented on a pilot basis on one gate in the 1996-97 dry season, and when proven successful, applied to all gates in the next dry season.

Navigation Facilities

23. Navigation facilities included in the scope of the first project were a three flight ship-lock to accommodate two 500 ton ships and a raft lift to accommodate a 10.5m x 64m x 1m timber and bamboo raft. The transportation capacity of the ship-lock was estimated at 3.2 million tons per year, while that of the raft-lift was 1.6 million m³ per year. By the time of the appraisal of the second loan in mid-1991, FPEPB had decided to upgrade these facilities to convert the raft lift to a vertical ship-lift which could also accommodate two 500 ton ships at the same time. The ship-lift was therefore included in the additional scope of the second project.

24. *Ship-Lock.* As detailed in the previous ICR, during filling of the lock in October, 1994, some cracking was observed in bottom slabs and walls of the lock chambers, and commissioning and trial operations were suspended. An eight member expert panel recommended comprehensive treatment measures, which were subsequently implemented, being completed in September 1995. Based on initial operating experience, it was then decided to replace domestic hydraulic equipment and electric control elements with imported equipment to ensure reliable and stable operation of the ship-lock in the long-term. This was carried out in the following dry season, and was completed in November, 1996.

25. While the reinforcing measures generally solved the structural and leakage problems, FPEPB, anxious to ensure long term stability and trouble-free operation, commissioned another design review. Emanating from this review were recommendations for further reinforcement measures and these were implemented in the following dry season. Operation is now fully satisfactory.

26. *Ship-Lift.* From the outset, it was planned that, as far as possible, the ship-lift would be constructed using local resources, and that Bank finance would only be used for components that needed to be imported. The amount of the Bank loan projected to be expended on this component was only \$5.9 million or 5.9 percent of the loan amount. In addition, FPEPB had agreed with central government agencies that an additional unquantifiable benefit of constructing the Shuikou ship-lift would be to provide prototype experience for the much larger ship-lift planned for the Three Gorges Project. Taking these factors into account, the Bank did not fully appraise this part of the project.

27. The construction of the ship-lift was delayed substantially in comparison to the schedule presented in the SAR for the second loan. This schedule showed erection completed by the end of 1995, whereas it was not completed until mid-1998. Therefore the planned one year testing and trial operation period will not be completed until mid-1999. About half the delay was in the design and procurement process with the remainder occurring during the construction process. The initial delay can generally be

attributed to the fact that the level of design of this project component was only at a preliminary stage at project appraisal, and that the precedents available for design of a facility of this size were very limited. Therefore, the design development was slow and subject to extensive review by local and international experts. Moreover, early in the detailed design process, it was decided to build a large integrated physical model to test and validate various aspects of the mechanical, electrical and electronic design. This model was built in Nanjing over the period September 1993 to March 1994, and tested over the next seven months. The delays during the construction were due to much more difficult construction processes than originally anticipated.

28. The civil contract for the ship-lift was awarded to Minjiang Construction Company, and the Twelfth Construction Bureau, Chinese members of the joint venture that constructed the dam and power station civil works. The main item of note in the civil work construction was the necessity to maintain vertical tolerance in the 73 m high towers of less than 12 mm. This objective was achieved and earned a special award from the State Power Corporation.

29. Local equipment design and supply was awarded as a single responsibility contract to a joint venture led by Wuhan Ship Building Corporation, and this was later extended to cover installation. As far as it is known, this is the first example in China of a single responsibility contract for complex equipment of this type. The specifications and tolerances demanded of the equipment suppliers were also very challenging. Major achievements included the river transportation (towed by tugs) of the chamber (123 m long x 18.6 m wide x 7.6 m high a 1400 t); and the machining of the upstream and downstream working gates, the 3.5 m lifting drum to close tolerances, and the 2.8 m dia. hard surface gears for the retarding device.

Resettlement

30. The resettlement task was carried out according to plan with 67,239 persons in rural areas being physically relocated. In addition, some 17,215 urban residents in Nanping city, at the upstream end of the reservoir, were relocated as part of a project to re-develop the Min River foreshore and raise flood protection standards. This project was catalyzed by the projected modest increase in flood levels in the area due to the Shuikou project. The Nanping City resettlement was not included in the original resettlement plan since: it was regarded as a separate, parallel activity with scope extending considerably beyond simple resettlement; was managed by a different agency; and it did not require any income restoration activities, only reconstruction of infrastructure and housing. However, the Shuikou project contributed compensation funds to the overall re-development budget.

31. Early on in project supervision, the Bank promoted the initiation of an Independent Evaluation of Resettlement. This evaluation by ECIDI took place over a five year period (1992 to 1996) and involved samples of 524 households and 35 villages. The annual reports of the evaluation proved particularly valuable in providing FPEPB;

SRRO and the Bank with regular feedback as to achievements and outstanding problems. The Independent Evaluation is the first of its kind in China and provides a thorough case study.

32. In the rural areas, by the end of June 1997, 38,439 jobs had been created, exceeding the total requirement. Of these, 52 percent involved non-farm or non-land-based activities. By the end of 1995 (the last year of the independent evaluation), average income level of the resettlers, after allowing for inflation, had surpassed the before moving level by 14.5 percent, and a later "town level" survey indicated that, by the end of 1996, this had further increased to 44 percent. On the physical side, per capita housing space increased from 30.0m² to 37.9 m² and inundated infrastructure and community facilities had been fully replaced, generally to a higher standard. To date Y1,220 million of the finally approved budget of Y1423.6 million had been spent on resettlement and rehabilitation. The original budget was Y410 million (1984).

33. For reasons given above, no detailed follow-up evaluation was carried out in relation to the Nanping City urban redevelopment, but from inspection of the redeveloped area and interviews with relocated people, its success is evident.

Environment

34. An environmental management plan prepared for the appraisal of the second loan grouped activities into four categories: environmental protection, environmental monitoring, special studies and instrumentation, equipment and training.

35. The three major items under environmental protection were relocation of water supply intakes, reconstruction of navigation facilities, and afforestation of construction site areas. Water supply intakes needed to be relocated to avoid possible fouling from downstream waste water outfalls after reservoir filling. This was accomplished well before reservoir filling. Existing navigation facilities were also reconstructed and considerably upgraded, in line with the anticipated use of the reservoir for navigation. The new works covered 26 wharves of various sizes, three navigation administration buildings, navigation channel reconstruction to accommodate 2 x 500 ton barge fleet, re-establishment of navigation markers to Grade I of the National Standards on Inland Navigation. An afforestation plan of the areas around the construction site was drafted in 1994, commenced execution in 1996, and was completed in 1998. (full details in the FPEPB Executive Summary).

36. Environmental monitoring focused on three areas: water quality monitoring particularly in the areas of pollution inflows near Nanping City, hydrological monitoring in the catchment and sediment deposition in the reservoir. Water quality monitoring to date has indicated no deterioration in river water quality through Nanping City. This is attributed to a strengthening of pollution control measures in Nanping City which has resulted in a substantial improvement in quality of effluents discharged into the river and the restriction of new industries to those which do not generate pollutants. In addition, because of the small volume of the reservoir in relation to average flow, velocities

through the reservoir are relatively high even in the dry season. This results in efficient flushing and dilution of pollution loads. The originally envisaged hydrological monitoring has been expanded to include a comprehensive flood warning system, with real time transmission of readings from precipitation and streamflow gauges to the Shuikou power station, where projected flood hydrographs are automatically computed. The system played an important role in flood mitigation during a large flood which occurred on June 23, 1998. The peak inflow discharge to the Shuikou reservoir was 37,800 m³/s, which has a return period of greater than 100 years. Based on projections from the flood warning system, the reservoir was drawn down in advance of the flood, providing flood storage which was able to mitigate the flood, reducing peak outflow discharge to 33,600 m³/s. FPEPB reported that without this mitigation, Fuzhou city would have been submerged. The first survey of sediment deposition in the reservoir since its filling was carried out in 1995. This indicated no significant deposition and a periodic flushing of sediments. The next survey will be carried out in 2000.

37. The special study consisted of the development of a mathematical model to enable a study of the assimilation capacity of the stretch of the river bordering Nanping City after reservoir filling. This study was completed before reservoir filling, and predicted adequate capacity to assimilate the biological load from Nanping effluents, which has been borne out by monitoring results reported above. A small unit consisting of two to three people has been established in the Shuikou Power Plant to be responsible for environmental and hydrological monitoring and the flood prediction system. These staff have received specialized training in each aspect.

Other Components

Power Grid Automation

38. The Energy Management System (termed SCADA in the SAR) was successfully installed, and initial operation commenced in September, 1996 with passing of site acceptance tests of a number of functions. However, full functionality and acceptance testing was not completed until November, 1998, when software defects in three functions were corrected and final acceptance tests were passed¹. The effect of the Automatic Generation Control function is particularly evident from records, which show that, over the period July 1997 to June 1998, system frequency was automatically controlled within a range of 50 +/- 0.1 Hz for 99.56 % of time, and within +/- 0.2 % for 99.997 % of time.

¹ Supervisory Control and Data Acquisition (SCADA), State Estimate (SE), Security Analysis (SA), Operator Training Simulation (OTS) were accepted in September, 1996. Automatic Generation Control (AGC) /Economic Dispatch (ED) were accepted in May, 1997. Optimum Power Flow (OPF), Short Term Load Forecast (SLF) and Unit Commitment (UC) were accepted in November, 1998)

Digital Microwave System

39. The first stage contract, covering 20 stations, was signed in September, 1994, and this was extended to cover an additional 11 stations in May, 1995. Installation commenced in October, 1996 and was completed in January, 1997. While the system has been in trial operation since September, 1997, operation has not been trouble free. The manufacturer has accepted responsibility for the defects in the system and based on a September, 1998 agreement, is actively pursuing a plan to remedy the defects.

New 500 kV transmission Component

40. The new component was approved by the Board on July 24, 1996, and bidding for equipment commenced the following month. Civil work construction commenced on October 31, 1996, and was basically completed by the end of 1997. Equipment installation in the substations commenced in September, 1997 and was generally complete by January, 1998. Erection of the new section of transmission lines was completed in November, 1997, and, during the dry season from October, 1997 to January, 1998 the Shuikou Huaian circuits were upgraded to 500 kV. The transmission lines and substations were successfully commissioned in March, 1998. The new lines demonstrated their usefulness in the 1998 wet season, when they generally operated at full load

Procurement

41. Full details of the procurement process for the Shuikou dam and power plant are presented in the ICR for the first loan and will not be repeated here. The conclusion was that procurement had generally been carried out efficiently, but that qualification criteria for both contractors and suppliers should have been more rigorous. Procurement activities throughout the duration of the second loan were related to the new components: the ship-lift, the EMS and associated microwave communication system, and the new 500 kV transmission component.

42. Overall there were 34 ICB contracts for this additional scope, five of which were actually extensions of existing contracts carried out with Bank no-objection.

43. There was only one procurement incident of note, relating to the purchase of the energy management system. The formula combining performance and price was mis-stated in the bid documents resulting in anomalies in the evaluation process. In addition, it became clear during the evaluation, that performance should have been given a greater weight in the evaluation. FPEPB and the Bank agreed to re-bidding, which was successfully carried out in a short time. For recent contracts in China for equipment of this type, the draft standard bidding documents for procurement of information systems have been successfully used. Borrowers have found that the two stage bidding process and the greater weight given to performance in evaluation have facilitated the evaluation process and resulted in an evaluation more in accord with their own judgement.

Consulting Services

44. For the first project, four main contracts were awarded for foreign consulting services, one relating to design and construction supervision of the Shuikou Dam and power plant and three relating to studies to upgrade FPEPB institutional capability. Contracts with individual consultants were also signed, mainly in relation to the SBC.

45. The execution of the consulting contract for the dam and hydropower plant was fully detailed in the ICR for the first project, since the contract had been concluded at that time. The overall conclusion was that the consulting services were successfully carried out. Since the quantity and nature of services were specified by FPEPB in consultation with the recipients of the assistance, ECIDI and SHPC, they enjoyed a high degree of "ownership" by them. Technologies transferred to ECIDI and SHPC were highly valued by them, and this has led to their replication in other projects under their control.

46. The studies commenced under the first loan were completed under the second loan. The scope of one of the studies (referred to as Study A) was extended under the second project. In addition, three additional studies of limited scope were carried out. These dealt with hydro inventory evaluation, consumer tariff structure, and planning and commercial management. In addition, FPEPB implemented the full series of training programs as envisaged in the minutes of negotiations. All studies were successfully completed, and most have yielded results which have been carried forward into FPEPB operations and subsequent investments (see Table 7).

Project Costs

47. Cost estimates in the body of the SAR for the second loan refer to the costs to complete the Shuikou dam and power plant rather than overall costs. It is considered that overall costs provide a more meaningful comparison. Therefore for the dam and power plant, comparisons are made with the first table of Annex 5.6 of the SAR which shows overall costs of the dam and power plant. Separate comparisons are then made for other components. The estimated cost of the dam and power plant at the time of appraisal of the second loan (excluding interest during construction) was \$214.22 million in foreign costs and Y2108.33 million in local costs, equivalent to a total of \$657.49 million (Y3,189.20 million). The final cost was \$181.81 million in foreign costs and Y3,913.90 million in local costs, equivalent to a total of \$823.17 million (Y5,114.91 million) (see Table 8a-1 for details). Considering overall costs (foreign plus local), there is an apparent cost overrun of about 25 percent when expressed in US dollars and 60 percent when expressed in local currency. However, it should be noted that there is a significant discrepancy in scope of the appraisal estimate and final cost, in that figures for preparatory works provided to the appraisal team evidently did not include the entire scope of preliminary works. Neglected items included contractors and supervisors camps and mobilization and construction power. All of these costs expenditures had actually occurred by the time of appraisal, and their exclusion from the estimate is probably a reflection of Chinese accounting practices at the time, if not being the intention to charge

them to the project. All such expenditures have been included in the final cost compiled by FPEPB, since this now forms the basis for calculating the price of power delivered to the grid. If the original estimates are corrected to show actual preparatory works costs, the estimated total cost increases to \$784.46 million (Y4017.19 million). Cost overruns then reduce to 4.9 percent in dollar terms and 27.3 percent in local currency. The difference in the two figures for cost overrun is due to the higher-than-expected-inflation in China (67 percent between 1992 to 1996 compared with 21.5 percent estimated) and the devaluation of the local currency from an exchange rate of Y5.43 to the dollar at the time of appraisal to Y8.46 to the \$1 in 1994 (with a slight recovery to 8.30 thereafter). The comparison of costs expressed in US dollars is considered to give a reasonable estimate of cost overrun excluding the effects of inflation and devaluation. After adjusting for the missing preparatory works in the initial estimate, there is therefore relatively good agreement between costs estimated at appraisal of the second loan and final costs. Final costs for other components, shown in Table 8A-1, were reasonably close to those estimated except for the ship-lift, comprising a relatively small proportion of the Bank loan, where costs were considerably underestimated, which is attributed to the factors outlined in para 23.

Economic Performance

48. For the appraisal of the first loan an analysis was carried out to demonstrate that Shuikou was part of the least-cost expansion plan for the East China Grid. For the appraisal of the second loan a less rigorous approach was used to demonstrate that Shuikou remained a competitive method of generation expansion. This was done by comparing Shuikou with coal-fired power plants of equivalent capacity. The analysis indicated an equalizing discount rate of 18.0 percent. A similar analysis was carried out ex-ante, which yielded an equalizing discount rate of 47.1 percent. The levelized cost of Shuikou is calculated at 21.00 fen/kWh (1997 prices, 12 percent discount rate), in comparison with 49.0 fen/kWh for the coal alternative, strongly demonstrating that even with modest cost overruns and completion delays, Shuikou is very economical in comparison to thermal alternatives.

49. At appraisal, the IERR was calculated by valuing the output of Shuikou at the covenanted tariff and a demonstrated willingness to pay based on the selling price to the grid of a newly commissioned thermal power plant. This analysis yielded IERRs of 13.5 and 19.1 percent for the respective cases. The "willingness to pay" type of analysis was repeated ex-ante using prices of energy sold to the grid in 1997, plus power development surcharges applied at provincial and local levels (averaging 8.26 fen). If the average selling price is used, IERR is 19.6 percent. If the price at which Shuikou power is sold to the grid is substituted for the average, the IERR increases to 20.5 percent. If the highest price at which any power is sold to the grid (from the new Songyu thermal plant) is substituted for the average, IERR increases to 25.8 percent (comparable to the 19.1 percent estimated at appraisal).

FPEPB Financial Performance

50. Comparative financial statements containing the projected and actual amount for the period 1991 to 1997 are summarized in Annex 1. FPEPB fixed assets in 1997 amounted to Y16,783 million, only slightly higher than the estimated Y13,259 million, despite Shuikou project cost overruns and a 1993 asset revaluation applying to all power companies in China which added Y1,200 million. On the other hand, FPEPB has spent less on new generation preferring to leave this to non-utility power producers. FPEPB borrowing was in proportion to capital expenditures so that it maintained a balanced financial structure. The debt/ (debt+equity ratio) closely followed projections peaking at 73.4 percent in 1993 (below the covenanted 75 percent from 1992 to 1996) before falling to 61.2 percent in 1997, well below the covenanted 70 percent.

51. Over the seven years, from 1991 to 1997, energy sales have increased by a factor of 2.05, an average increase of 10.7 percent per annum, reflecting the fast economic growth in Fujian Province. The average tariff has been adjusted from 17.2 fen/kWh in 1991 to 38.4 fen/kWh in 1997 (excluding surcharges),-an increase in constant terms of 12.0 percent per annum, and 5.8 percent per annum in US\$ terms. Actual operating revenues in 1997 amounted to Y7.73 billion, about 4.6 times those of 1991 and 63 percent higher than projected at appraisal. Along with the increase in revenues, operating costs also rose rapidly, largely contributed by much higher than expected power purchase costs. This results from changes in the power sector structure, whereby most new plants are constructed by semi-independent joint investment partnerships which sell power to the FPEPB grid. FPEPB role has thus largely changed to that of a purchasing and transmission agency. This is also reflected in an increase in operating ratio to 86 percent in 1997 in comparison with a projected 76 percent.

52. Over the course of project implementation, the debt service ratio has been satisfactorily kept at higher than 1.3 before 1995 and 1.5 thereafter. The self-financing covenant was complied with in all years except 1994 when the ratio achieved was 16.5 percent in comparison with the covenanted 25 percent. This can be attributed to several factors: (a) a change in the taxation system in 1994 which resulted in much higher transfers to the government, concurrently with a government imposed tariff freeze for macroeconomic purposes; and (b) peak expenditure on Shuikou concurrently with delayed commissioning of some generators due to casting defects. In 1995 the self-financing ratio rose to 32.3 percent, and was maintained above the covenanted value of 30 percent (applying after 1995) in 1996 and 1997. Overall therefore, it can be concluded that FPEPB financial performance has been satisfactory.

D. PROJECT SUSTAINABILITY

53. All elements are present to ensure sustainability of the project. Technically, the finished hydroelectric development is of good quality and the units have operated at a high availability over the initial operating period of up to five years. Efficient and economic operation is expected based on FPEPB past record of hydroelectric plant operation and the arrangements for the current project, as set out in the Operational Plan.

Financially, the pricing arrangements for the plant output are already demonstrating very satisfactory financial and economic returns. On the institutional side, the upgrading of local capabilities in design and management of hydroelectric construction has already been carried over to future operations. ECIDI has provided consulting services to local entities in preparing projects for international bidding. These include at least three Bank financed projects. SHPC is carrying out construction management capabilities to the Asian Development Bank (ADB) financed Mienhuatan Project. The institutional development objectives in relation to FPEPB itself have been built on and further developed under the ADB Mienhuatan Project.

54. The resettlement and rehabilitation is sustainable since an economic base has been established that will provide households with a flow of annual revenues. Income targets have been fully met on an average basis and the five percent poverty level among resettled households is in line with non-resettled households. The replacement of rice agriculture with orchards and newly developed sidelines and light industrial activities have the potential to significantly improve standards of living on an ongoing basis.

E. BANK PERFORMANCE

55. Preparation of the second project commenced with an Initial Executive Project Summary followed by a pre-appraisal in April, 1990. Main issues at that stage were project management, whether or not the tie-line to the East China grid should be implemented, and power pricing which was flagged as an appropriate policy component of the project. Appraisal was carried out in June/July, 1991. While the appraisal was generally straightforward, the mission reported that it was unable to complete the appraisal in respect to the tie line to East China. FPEPB planned to delete the tie-line, but the mission considered that adequate justification had not been provided. Further studies were agreed during the mission and a follow up meeting to review the studies was carried out in September/October, 1991. Based on the studies and discussions during the mission, the Bank accepted the position of the Chinese side in deleting the tie-line and the appraisal was declared completed (since FPEPB growth forecasts have now been validated, the decision was the correct one). Negotiations occurred in July, 1992 and Board presentation on September 1, 1992. Processing of the project was relatively slow but this was geared to the anticipated need for additional funds beyond those provided by the first loan. Despite the protracted preparation period, processing was quite efficient in the use of resources with only 82 staff weeks being employed during the entire preparation period.

56. During implementation, the Bank supervised the project regularly, averaging about twice per year. After commencement of filling of the reservoir in April, 1993 emphasis of supervision was on the ship-lift, resettlement and the tariff action plan. With regard to the ship-lift, as noted earlier initial designs at appraisal were only at the conceptual level and ECIDI, the designer, was unsure how to proceed in many areas. Bank missions catalyzed the employment of specialist assistance which provided the necessary momentum to proceed. In addition, Bank advice significantly influenced the

innovative procurement arrangements for non-Bank financed contracts which proved to be very successful. With regard to resettlement, Bank missions had a major influence in obtaining approvals for budget increases, maintaining focus on the rehabilitation aspect of resettlement after completion of physical relocation and in the initiation of, and progressive improvement of, independent evaluation reports. With regard to the tariff action plan, Bank missions persevered in continually reminding FPEPB and provincial government agencies of their obligations under the project agreement, worked with Asian Development Bank to combine leverage provided by their Mianhuatan Project and the proposed new 500 kV transmission component, to ultimately achieve the objective of tariff unification. The Bank also contributed to the expeditious preparation and implementation of the new transmission component. The request to finance the additional component was received on March 11, 1996. The appraisal was carried out from March 20 to 26, 1996. The Memorandum of President was prepared and submitted to the regional vice president on July, 9, 1996, and approved by the Board on a no objection basis on July 24, 1996. First bid documents were submitted for Bank review on July 8, 1996, the first contract was signed on October 31, 1996 and by January 14, 1997, 14 of the 15 contracts had been signed.

57. In the ICR for the first loan, Bank performance was rated Highly Satisfactory. It is considered that this performance has been maintained throughout the course of the second project, and the same rating is therefore applied.

F. BORROWER PERFORMANCE

58. In the ICR for the first loan, all organizations associated with the construction of the Shuikou dam and hydroelectric power were rated as highly satisfactory. Successful completion of the project, including the resettlement program, all additional components, studies and reforms leads to reaffirmation of this rating.

G. ASSESSMENT OF OUTCOME

59. The project outcome is rated as highly satisfactory. All of the development objectives were achieved. The economic rate of return has increased in comparison with appraisal estimates. Sustainability is highly likely, and both Borrower and Bank performances are rated as highly satisfactory.

H. FUTURE OPERATION

60. The project commenced operation in August 1, 1993 with the commissioning of the first generating unit. The commissioning of the seventh and final unit occurred on December 5, 1996. In 1995, with only four units in operation for most of the year, due to favorable hydrology, the output of the power plant was 4,763 GWh, which is only slightly below the design output in an average year with all units operating, i.e. 4,950 GWh. In 1997, the first year with all units operating, generation was 6070 GWh aided by favorable hydrology. Total generation by the end of 1998 was 24,453 GWh which has

generated revenue approximately equal to the construction cost of the dam and powerhouse including interest during construction.

61. With regard to performance indicators for the power plant, the State Power Corporation already sets benchmarks for numerous parameters which collectively measure safety, reliability and efficiency of operation of hydroelectric power plants. Some of the main parameters are listed in Table 6. In addition, a different set of criteria relate to factors such as cleanliness, aesthetics and working environment which, if met, qualify the power plant for "civilized" status. When both of these standards are met the power plant is accredited as having met the dual standards. A "first class" standard is also specified involving more rigorous performance indicators for some operating efficiency factors. The Shuikou power plant has already been accredited as meeting the dual standards. In addition, it meets "first class" standard for all parameters except employees per MW. To date, only three hydroelectric power plants in China meet the "first class" standard, two of which have very large installed capacity facilitating their compliance with the employee per MW standard.

62. Trial operation of the ship-lock was commenced on December 26, 1995, and it was put into public trial operation on February 10, 1996. Up until the end of 1998, 30,819 boats had passed through the lock in 3,731 passes. Total tonnage passed was 1,160,600 tons or 1,442 tons on average. Typically, the lock can pass 12 boats at one time. Annual volumes have increased from an initial 120,000 tons per year to about 700,000 tons per year in 1998, still well below the 3.2 million ton estimated capacity of the facility, but tonnages are projected to continue to increase as the availability and reliability of the lock becomes more widely known, and boat sizes increase to the size that can now navigate the river and reservoir.

63. The FPEPB Operation Plan summarizes the arrangements made for future operations of the power plant in terms of organization and staffing of the operating unit, training technical and financial staff, operating procedures, regular maintenance program, power dispatch, methodology for efficient utilization of water, dam safety procedures, the flood and environmental monitoring. With regard to resettlement, after depletion of the remaining budget, the reservoir development fund will generate income based on energy production of about Y20 million per year. This should sustain the workplan of the SRRO. With regard to environmental operations, a small unit has been established in the Shuikou Power Plant to be responsible for environmental and hydrological monitoring and operation and maintenance of the flood warning system, ensuring the continuation of these activities.

I. KEY LESSONS LEARNED

64. In the ICR for the first loan, the importance of rigorous prequalification processes for contractors and suppliers was highlighted, and this remains as an overall lesson from the two projects.

65. The two stage loan arrangement achieved its objectives in reducing the early repayment burden before power plant commissioning and reducing commitment charges. It was also appropriate in the context of the fast growing Fujian system, in that it allowed reevaluation of project scope at mid-term. As a result of this, the transmission line to East China was deleted, the navigation facilities were upgraded by the addition of a shiplift, a grid control component was added based on the outcome of studies carried out in the first stage, and the financial and institutional objectives were strengthened. However, two disadvantages of this approach were: the lack of Bank commitment to the second phase, creating difficulties in opening letters of credit for equipment, and the considerable expenditure by both the Borrower and Bank in processing the second loan. The use of the Adjustable Program Loan, which has now been added to the Bank's product line, should be considered for similar future operations. This would provide the same advantages with regard to commitment charges and repayment profile, flexibility, and processing costs, although it would not address the letter of credit issue.

66. Shuikou resettlement was carried out successfully. An OED evaluation, Recent Experience with Involuntary Resettlement - China: Shuikou and Yantan (Report No. 17539), June 2, 1998 concurs with this assessment. A detailed report on Shuikou resettlement is being finalized. Conclusions are summarized as follows:

67. The success of the resettlement can be attributed to several factors, some of which are project specific and others which are more general and offer some opportunity for replication elsewhere. Among the factors specific to Shuikou are its location close to the dynamic coastal economy creating opportunities for non land-based resettlement. These were enhanced by the eventual construction of the highway paralleling the reservoir, improving access of the resettlement communities to Fuzhou City and the coastal areas. The topography at Shuikou was also conducive to a "moving back" resettlement plan, enabling minimal disruption to communities. Among the factors which might be replicated elsewhere are:

- (a) The enlightened policies of central and provincial governments which established the principles of restoration of living standard and development based resettlement, supplemented by the preferential policies and incentives established by the provincial government in the reservoir area.
- (b) The institutional framework for resettlement, based on the local government administrative system. This consisted of a dedicated provincial resettlement office staffed by professionals, and counterpart offices at county, township and village levels. These were supported by functional departments at the various levels. This decentralized approach provided the necessary oversight and technical support while facilitating participation, and flexibility in planning and implementation.

- (c) The planning process which commenced well ahead of the project, developing an overall framework for the resettlement process in consultation with local government down to village level. As well as infrastructure and housing, this considered income restoration options based on natural resources available at various sites.
- (d) The open, fair, participatory and flexible approach adopted during implementation, adjusting plans based on actual resource availability, current market conditions and wishes of the resettlers.
- (e) The flexibility shown by government agencies in adjusting resettlement budgets for inflation, more detailed planning and unforeseen circumstances, and the strong support of FPEPB in obtaining additional funding.
- (f) The independent evaluation of resettlement, which provided early feedback on the successes and weaknesses of the resettlement process.

Despite these successes, it is considered that there is room for improvement in the process which should be taken into account in future projects.

- (g) The disadvantage of the decentralized resettlement planning and implementation process is its dependence on the quality of leadership and technical competence at lower levels of government. It appears that the resettlement office and relevant government departments should play an even greater role in supervision and technical assistance, particularly in income restoration activities.
- (a) Resettlement planning should be even further advanced at appraisal stage, to allow more detailed cost estimates to be carried out. Detailed cost estimates of measures to reestablish income need to be compared with compensation costs that finance these measures. Estimates of remaining land resources need to be more realistic, taking adequate account of quality of available unused land, losses to infrastructure and to slippages of land into the reservoir.
- (b) Implementation of resettlement should also be advanced as much as possible, particularly land development for agricultural activities, to reduce or even eliminate the time lag between reservoir filling and re-establishment of income.
- (c) The budget adjustment process was protracted, and did result in delays at critical stages. Automatic adjustment for inflation would make the process less reliant on periodic reviews.

PART II: STATISTICAL TABLES

TABLE 1: SUMMARY OF ASSESSMENT

Achievement of Objectives				
	Substantial	Partial	Negligible	Not Applicable
Macroeconomics policies				X
Sector policies		X		
Financial objectives	X			
Institutional development	X			
Physical objectives	X			
Poverty reduction				X
Gender concerns				X
Other social objectives				X
Environmental objectives	X			
Public sector management	X			
Private sector development				X
Project Sustainability				
	Likely	Unlikely		Uncertain
	X			
Bank Performance				
	Highly Satisfactory	Satisfactory		Deficient
Identification	X			
Preparation assistance	X			
Appraisal	X			
Supervision	X			
Borrower Performance				
	Highly Satisfactory	Satisfactory		Deficient
Preparation	X			
Implementation	X			
Covenant compliance	X			
Assessment of Outcome				
	Highly Satisfactory	Satisfactory	Unsatisfactory	Highly Unsatisfactory
	X			

TABLE 2: RELATED BANK LOANS

Loan Title	Purpose	Year of Approval	Status
Ln. 2382-CHA Lubuge Hydroelectric Project	To construct a rockfill dam, a spillway, an underground powerhouse, to install 4 generating units of 150 MW each, 3 single circuits of 220 kV transmission lines; to provide consultant services and a training program.	02/21/84	Loan was closed on 06/30/92.
Ln. 2493-CHA Second Power Project	To construct a 500 kV transmission line from Xuzhou to Shanghai and 5 associated substations totaling 3,500 MVA in capacity, to install tele-control and telecommunications equipment for load dispatching, and to provide training for 400 kV transmission lines and substations.	02/19/85	Loan was closed on 06/30/92.
Ln. 2706-CHA & Ln. 2955-CHA Beilungang Thermal Power Projects I and II	To construct a coal-fired thermal power project with two units of 600 MW and two single circuit of 500 kV transmission lines, and to carry out a tariff study, a study on ZPEPB reorganization and management improvement and a study for improvement of distribution networks for the cities of Ningbo and Hangzhou.	05/29/86 & 06/14/88	First loan closed 06/30/94. Second loan closed 06/30/95.
Ln. 2707-CHA Yantan Hydroelectric Project	To construct a 110 m high concrete gravity dam, a spillway, a powerhouse, and a shiplift; to install 4 generating units of 275 MW each, 2 single circuits of 500 kV transmission lines and 3 associated substations; and to carry out a training program.	05/29/86	Loan was closed on 06/30/94.
Ln. 2775-CHA & Shuikou Hydroelectric Project	To construct a 101 m high concrete gravity dam, a spillway, a powerhouse and a navigation lock; to install 7 generating units of 200 MW each; to carry out a resettlement program in the reservoir.	01/06/87	Closed 6/30/93.
Ln. 3515-CHA Second Shuikou Hydroelectric Project	To complete the ongoing Shuikou dam and hydroelectric power plan, upgrade the control and data acquisition system of the Fujian grid, carry out an action plan for tariff reform, and a training program for planning and financial management.	09/01/92	Closed 6/30/98. Current ICR..

Loan Title	Purpose	Year of Approval	Status
Ln. 3387-CHA & Ln. 3933-CHA Ertan Hydroelectric Projects I & II	To construct a 240 m high arch dam with an underground powerhouse, to install 6 550-MW generating units and associated equipment; to carry out an environmental management program, studies of power pricing and reservoir operation, and a training program.	07/02/91 & 08/22/95	Implementation under way. First loan closed 12/31/96. Closing date second loan 12/31/2001
Cr. 2305-CHA & Ln. 3412-CHA Daguangba Multipurpose Project	To construct a 56 m high gravity dam and an underground powerhouse with 4 x 60 MW generating units; to erect a 36 km long double-circuit 220 kV transmission line and to build canals to irrigate 12,700 ha of land.	10/31/91	Closed 12/31/98. ICR in preparation
Ln. 3433-CHA Yanshi Thermal Power Project	To install 2 300-MW generating units and 5 220-kV transmission lines and associated substations; to carry out a tariff study, a tariff action plan, and a training program for upgrading the technical, financial and management skills for HPEPB staff.	01/14/92	Closed 12/31/97.
Ln. 3462-CHA Zouxian Thermal Power Project	To install 2 additional 600 MW generating units; to construct 500 kV and 220 kV transmission lines and substations; and to carry out an air quality control study, a power tariff study, an action plan for tariff adjustment, and a training program for the technical, financial, and management staff of SPEPB.	04/12/92	Implementation under way. Closing date 06/30/99.
Ln. 3606-CHA Tianhuangping Hydroelectric Project	To construct a pumped-storage hydroelectric power plant with six 300 MW reversible pump-turbine units, together with upper and lower reservoirs, a water conveyance system, an underground powerhouse; to erect 250 km long 500 kV transmission lines; to carry out studies of optimal power plant operation and its output pricing; and to strengthen the beneficiary's organization through technical assistance and training.	05/18/93	Implementation under way. Closing date 12/31/2001.

Loan Title	Purpose	Year of Approval	Status
Ln. 3718-CHA Yangzhou Thermal Power Project	To construct a coal-fired thermal power plant with two 600 MW generating units; to erect two 500 kV transmission lines (30 km long); to extend technical assistance for the development and implementation of improved accounting and financial management information systems; and undertake management development and staff training.	03/22/94	Implementation under way. Closing date 12/31/2000.
Ln. 3848-CHA Sichuan Transmission Project	To construct a new 500 kV transmission network consisting of 2,260 km of transmission lines and 5,250 MVA of substations; provide technical assistance for implementation of sector reform plan, organizational improvements and financial management systems.	02/28/95	Implementation commenced. Closing date 12/31/2001.
Ln. 3846-CHA Zhejiang Power Development Project	To construct Beilungang Phase II power plant consisting of three 600 MW coal-fired units; to construct 400 circuit-km of 500 kV transmission lines, 2,250 MVA of 500 kV substations and reinforce distribution networks in Hangzhou and Ningbo; to extend technical assistance to assist the power company in commercialization and corporatization, establish computerized financial management information system, improve transmission and distribution planning and upgrade environmental monitoring.	02/28/95	Implementation commenced. Closing date 12/31/2002.
Ln. 3980-CHA Henan (Qinbei) Thermal Power Project	To construct two 600 MW coal-fired thermal power units; to erect two 165 km 500 kV transmission lines; to assist HPEPB in engineering, procurement and construction supervision; and to extend technical assistance to support the implementation of the power sector reform action plan.	2/27/96	Canceled 12/12/97 without disbursement.
Ln. 41720-CHA Tuoketuo Thermal Power Project	To construct the first two coal-fired 600 MW units in Inner Mongolia Autonomous Region; to implement a desertification control and dryland management program; to assist TEPGC with the introduction; of modern accounting and financial management	05/27/97	Implementation underway. Closing date 7/31/2004.

systems, environmental management, operation and maintenance of the power plant and involvement of private investors in existing and new power projects in Inner Mongolia.

To construct two 220 kV indoor substations in Beijing; to add a 250 MVA transformer to Wangfujing substation in Beijing; and to assist NCPGC to implement accounting and financial management systems.

Ln. 41970-CHA
Waigaoqiao Thermal
power Project

To construct two 900-1000 MW coal-fired supercritical units; to install FGD facilities at Shidongkou Power Plant to offset SO₂ emissions from the project; to construct two 500 kV transmission lines; to assist SMEPC to implement modern accounting and financial management systems, promote efficient management and power sector reforms including financial and corporate restructuring of the generation company.

06/24/97 Implementation
underway. Closing
date 1/31/2006.

TABLE 3: PROJECT TIMETABLE

Steps in project cycle	Date planned	Date actual/latest estimate
Preappraisal		04/90
Appraisal	02/86	07/91
Negotiations	11/86	07/92
Board presentation		09/01/92
Signing		10/20/92
Effectiveness		01/13/93
Project Completion	12/31/96	06/30/98
Loan closing	12/31/91	06/30/98

TABLE 4: LOAN DISBURSEMENTS: CUMULATIVE ESTIMATED AND ACTUAL

	FY93	FY94	FY95	FY96	FY97	FY98
Appraisal estimate	32.0	85.3	98.6	99.8	100.0	100.0
Actual	27.6	32.8	49.1	61.3	84.8	85.63
Actual as % of estimate						
Date of final disbursement: Nov 4, 1998.						

Note: Disbursement schedule was slower than anticipated at appraisal mainly because of the Borrower's decision to use the Bank loan for the direct foreign exchange costs only rather than 70 percent of total costs as provided in the Loan Agreement. This resulted in a delayed commencement of disbursements (first loan took longer to be exhausted) and then a slower rate of disbursements. Savings of some \$40 million were realized. Disbursements in the last one and a half years are related to the new transmission component approved in August 1996 utilizing these savings.

TABLE 5: KEY INDICATORS FOR PROJECT IMPLEMENTATION
(Refer to Equipment Delivery Table in Text)

TABLE 6: KEY INDICATORS FOR PROJECT OPERATION
Shuikou Dam and Power Plant

Index	Unit	Actual Completion to 12/31/97	Target Value Dual Standard	Target Value First Class Standard ¹
1. Continuous Safe Operation ¹	Days	1228	Three 100 day periods	Three 100 day periods
2. Human accidents at year end	No	0	0	0
3. Dam Safety Evaluation		Regular Dam ²	Regular Dam	Regular Dam
4. Annual Energy Output	GWh	6009	4,950	4,950
5. Station Services as % of generation	%	0.14	0.15	0.15
6. Average Availability	Hours/year	8047	7,888	7963
7. Perfect Operation of Main Equipment	% of year	100	100	100
8. Perfect Operation of Flood Forecasting System	%	97.86	95	95
9. Accuracy of Forecast of Largest Flood	%	98.6 (peak) 97.7 (vol.)	92	92
10. Average accuracy of Flood Forecast	%	94.9 (peak) 95.2 (vol.)	85	85
11. Labor Productivity	%	178.04	110	110

¹ In addition to meeting targets listed, first class performance standard requires following:

- (a) Computerized MIS system for.
- (b) Computerized SCADA and EMS for plant.
- (c) Automatic hydrological forecasting system in place.
- (d) No leakage from equipment.
- (e) Plant labor force less than 0.15 persons/MW.

² Routine safety evaluation every year. Reviewed by panel every five years. Compliance with all criteria required.

TABLE 7: STUDIES INCLUDED IN PROJECT

Study	Purpose as defined at appraisal/redefined	Status	Impact of study
Hydro Inventory Study	To identify hydro schemes to provide seasonal energy storage.	Completed 1994	Potential energy storage scheme identified.
Gas Turbine Study	Examine the feasibility of oil fired gas turbines to provide reserve capacity and back-up to seasonal hydropower.	Completed 1994	Gas turbines found to be promising. 100 MW installed.
Generation Planning Study	Not contemplated at appraisal. Objective was to transfer and modify planning software installed under first project to planning department and assist them to develop long-term generation planning capabilities, and a least cost plan incorporating results of two above studies.	Completed 1996	Least cost generation plan to 2010 developed by planning department. Includes balanced mix of nuclear, 600 and 300 MW coal, hydro and gas turbines.
Tariff Study	To transfer to FPEPB modern methods of power tariff design and to look into practical problems raised by transition from current pricing arrangements.	Initial report submitted by BERI May 1994. Reviewed by EDF and commented on in conjunction with training program June 1995. November 1996 further meetings with FPEPB of which final revisions to Study Report and Reform Plan agreed.	Technology transfer objective achieved. FPEPB and Provincial Pricing now have good knowledge of principles of tariff structure. Some improvements implemented. More contemplated.
Planning and Commercial Management Study	Transfer technology in demand forecasting and demand analysis. Modernize operations, hardware and software of Business Management Dept. in relation to statistics, tariff management etc.	Contract signed June 1994. Interim and final reports submitted December 1994 and September 1995.	FPEPB trained in use of EDF software packages. Software transferred to FPEPB and data for Fujian grid input. Software in use.

Training Programs	Not defined at appraisal. Several topics identified and recorded in minutes of negotiations.	Overseas study tours and training programs covering 168 persons completed. Topics covered construction management, contract management, financial and commercial management, project cost control, tariff and power planning studies, management delegation of operation for hydraulic power station, management delegation of equipment automation for hydraulic power station, dam safety management for hydraulic power station, reservoir operation and its management, delegation for operation and management of large scale ship lock and shiplift, operation and management of electric power system, environment management delegation.
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TABLE 8A: PROJECT COSTS

Item	Appraisal estimate (\$ M)			Actual/latest (\$ M)		
	Local	Foreign	Total	Local	Foreign	Total
Preparatory works ¹	38.2	0.0	38.2	163.7	1.5	165.2
Resettlement	197.2	10.0	207.2	204.1	7.8	211.9
Civil works	73.4	144.3	217.7	112.3	118.4	230.7
Metal works	10.0	8.2	18.2	16.3	7.2	23.5
Electrical and mechanical equip.	39.4	87.2	126.6	93.6	37.1	130.8
Transshipment of Cargo ²	0.0	0.0	0.0	15.4	0.0	15.4
Engineering and construction supervision	24.7	8.9	33.6	17.1	1.2	18.3
Administration	11.6	0.0	11.6	23.2	6.3	29.5
Technical Assistance and training ³	1.0	3.3	4.3	10.9	2.3	13.2
<u>Total Cost incl. Contingencies Shuikou Dam and Power Plant</u>	<u>443.3</u>	<u>214.2</u>	<u>657.5</u>	<u>656.8</u>	<u>181.8</u>	<u>838.6</u>
Shiplift	13.3	19.1	32.4	69.4	5.9	75.3
Grid Automation ⁴	0.0	5.8	5.8	6.0	6.8	12.8
New 500 kV Component ⁵	43.5	40.0	83.5	61.9	31.3	93.2
<u>Total Project Cost</u>	<u>500.1</u>	<u>279.1</u>	<u>779.2</u>	<u>794.2</u>	<u>225.8</u>	<u>1020.0</u>
Interest during construction ⁶	83.2	148.8	232.0	191.6	71.8	263.3
<u>Total Financing Required</u>	<u>583.3</u>	<u>427.9</u>	<u>1011.2</u>	<u>985.8</u>	<u>297.6</u>	<u>1283.3</u>

¹ Appraisal estimate did not include several items that were previously not charged to the project under old accounting system. These are now included. Neither appraisal estimate nor actual includes railway relocation costs of \$125.3 million, since this component was considered separately at time of appraisal of first project and found to be economically justified in its own right.

² Mainly required because of delay in completion of shiplock due to floods in construction phase.

³ Operator training not included in appraisal estimates.

⁴ Local costs for grid automation not included in SAR.

⁵ Appraisal estimates are those included in MOP for new component.

⁶ IDC estimates for demand power plant from SAR for first project, since SAR for second project only included IDC during implementation of project, covered by second loan. Figures for IDC vary from first ICR because of different cut-off dates.

TABLE 8B: PROJECT FINANCING

Item	Appraisal estimate (\$ M)			Actual/latest (\$ M)		
	Local	Foreign	Total	Local	Foreign	Total
IBRD ¹		240.0	240.0		225.6	225.6
Local bank	534.1	148.8	682.9	923.9	72.0	995.9
Provincial Power Construction Fund	49.2			61.9	0.0	61.9
Foreign Exchange loans to be arranged		40.0	260.0	0.0	0.0	0.0
Total	<u>583.3</u>	<u>427.9</u>	<u>1011.2</u>	<u>985.8</u>	<u>297.6</u>	<u>1283.4</u>

¹ Includes \$140.0 million from Loan 2775-CHA.

TABLE 9: ECONOMIC ANALYSIS OF POWER PLANT

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995		
SHUIKOU													
POWER ABSORPTION BY GRID (MW)									200	600	800		
ENERGY ABSORPTION BY GRID (GWh)	0	0	0	0	0	0	0	0	564	2960	4770		
ECONOMIC CAPITAL COST (million Y, 1997 CONSTANT)/a	36.97	128.02	313.85	490.00	489.02	624.41	971.55	633.02	716.42	950.26	399.14		
OPERATING COST (million Y)								0	11.43	34.28	45.71		
TOTAL COST (million Y)	\$3,432.67	(cost-NPV)	36.97	128.02	313.85	490.00	489.02	624.41	971.55	633.02	727.85	984.54	444.85
AIC OF Shuikou(Yuan/kWH)	\$16,127.21	(energy-NPV)	0.21										
COAL ALTERNATIVE													
EQUIVALENT COAL CAPACITY (MW)									235.72	707.15	942.87		
EQUIVALENT COAL ENERGY (GWh)	0	0	0	0	0	0	0	0	597.84	3137.6	5056.2		
INSTALLATION SCHEDULE (MW)									300	600	300		
CUMULATIVE CAPACITY (MW)									300	900	1200		
COAL UNIT 1					192.81	578.43	771.24	385.62					
COAL UNIT 2						192.81	578.43	771.24	385.62				
COAL UNIT 3						192.81	578.43	771.24	385.62				
COAL UNIT 4							192.81	578.43	771.24	385.62			
COAL UNIT 5								192.81	578.43	771.24	385.62		
COAL UNIT 6									192.81	578.43	771.24		
CAPITAL COST (million Y)					192.81	964.05	2120.91	2795.745	2410.125	1542.48	578.43		
FUEL COST (million Y)									86.81	455.58	734.16		
OPERATING AND MAINTENANCE (million Y)									57.84	173.53	231.37		
TOTAL COST (million Y)	\$8,421.37	(cost-NPV)	0.00	0.00	0.00	0.00	192.81	964.05	2120.91	2795.75	2554.77	2171.59	1543.96
AIC OF COAL ALT. (Y/KWH)	\$17,094.84	(energy-NPV)	0.49										
COST DIFFERENCE (COAL - HYDRO)	-36.97394	-128.0231	-313.8501	-490.0011	-296.2061	339.63713	1149.3589	2162.72	1826.9232	1187.0446	1099.1138		
EQUALIZING DISCOUNT RATE	47.09%												
NPV OF SHUIKOU PROJECT COSTS	3432.67												
NPV OF THERMAL ALTERNATIVE	8421.37												
NPV OF THERMAL/NPV OF HYDRO	2.45												
IRR CALCULATIONS													
BENEFIT (FPEPB 1997 AVERAGE PURCHASE PRICE)	0	0	0	0	0	0	0	0	221.8776	1164.464	1876.518		
BENEFIT - COST	-36.97	-128.02	-313.85	-490.00	-489.02	-624.41	-971.55	-633.02	-505.97	179.92	1431.67		
IRR BASED ON FPEPB AVERAGE PURCHASE PRICE	19.62%												
BENEFIT (SHUIKOU SELLING PRICE TO THE GRID)	0	0	0	0	0	0	0	0	236.4288	1240.832	1999.584		
BENEFIT - COST	-36.97	-128.02	-313.85	-490.00	-489.02	-624.41	-971.55	-633.02	-491.42	256.29	1554.74		
IRR BASED ON SHUIKOU SELLING PRICE TO GRID	20.52%												
BENEFIT (SONGYU SELLING PRICE TO GRID)	0	0	0	0	0	0	0	0	334.2264	1754.096	2826.702		
BENEFIT - COST	-36.97	-128.02	-313.85	-490.00	-489.02	-624.41	-971.55	-633.02	-393.62	769.55	2381.85		
IRR BASED ON SONGYU SELLING PRICE TO GRID)	25.79%												

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
SHUIKOU											
POWER ABSORPTION BY GRID (MW)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
ENERGY ABSORPTION BY GRID (GWh)	4498	6070	4950	4950	4950	4950	4950	4950	4950	4950	4950
ECONOMIC CAPITAL COST (million Y, 1997 CONSTANT)/a	533.35	216.02	110.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPERATING COST (million Y)	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
TOTAL COST (million Y)	\$3,432.67 (cost-NPV)	613.34	296.02	190.97	80.00	80.00	80.00	80.00	80.00	80.00	80.00
AIC OF Shuikou(Yuan/kWH)	\$16,127.21 (energy-NPV)										
COAL ALTERNATIVE											
EQUIVALENT COAL CAPACITY (MW)	1650.02	1650.02									
EQUIVALENT COAL ENERGY (GWh)	4767.88	6434.2	5247	5247	5247	5247	5247	5247	5247	5247	5247
INSTALLATION SCHEDULE (MW)	450										
CUMULATIVE CAPACITY (MW)	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650	1650
COAL UNIT 1											
COAL UNIT 2											
COAL UNIT 3											
COAL UNIT 4											
COAL UNIT 5											
COAL UNIT 6											
CAPITAL COST (million Y)	0	0	0								
FUEL COST (million Y)	692.30	934.25	761.86	761.86	761.86	761.86	761.86	761.86	761.86	761.86	761.86
OPERATING AND MAINTENANCE (million Y)	318.14	318.14	318.14	318.14	318.14	318.14	318.14	318.14	318.14	318.14	318.14
TOTAL COST (million Y)	\$8,421.37 (cost-NPV)	1010.43	1252.38	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00	1080.00
AIC OF COAL ALT. (Y/KWH)	\$17,094.84 (energy-NPV)										
COST DIFFERENCE (COAL - HYDRO)	397.09029	956.36353	889.03054	1000.0049	1000.0049	1000.0049	1000.0049	1000.0049	1000.0049	1000.0049	1000.0049
EQUALIZING DISCOUNT RATE											
NPV OF SHUIKOU PROJECT COSTS											
NPV OF THERMAL ALTERNATIVE											
NPV OF THERMAL/NPV OF HYDRO											
IRR CALCULATIONS											
BENEFIT (FPEPB 1997 AVERAGE PURCHASE PRICE)	1769.5132	2387.938	1947.33	1947.33	1947.33	1947.33	1947.33	1947.33	1947.33	1947.33	1947.33
BENEFIT - COST	1156.17	2091.92	1756.36	1867.33	1867.33	1867.33	1867.33	1867.33	1867.33	1867.33	1867.33
IRR BASED ON FPEPB AVERAGE PURCHASE PRICE											
BENEFIT (SHUIKOU SELLING PRICE TO THE GRID)	1885.5616	2544.544	2075.04	2075.04	2075.04	2075.04	2075.04	2075.04	2075.04	2075.04	2075.04
BENEFIT - COST	1272.22	2248.53	1884.07	1995.04	1995.04	1995.04	1995.04	1995.04	1995.04	1995.04	1995.04
IRR BASED ON SHUIKOU SELLING PRICE TO GRID											
BENEFIT (SONGYU SELLING PRICE TO GRID)	2665.5148	3597.082	2933.37	2933.37	2933.37	2933.37	2933.37	2933.37	2933.37	2933.37	2933.37
BENEFIT - COST	2052.17	3301.06	2742.40	2853.37	2853.37	2853.37	2853.37	2853.37	2853.37	2853.37	2853.37
IRR BASED ON SONGYU SELLING PRICE TO GRID)											

ASUMPTIONS

COAL PLANT (ECONOMIC COSTS)					SHUIKOU	
CAPACITY COST (Y/KWH GEN)	6427				OPERATING AND MAIN. HYDRO (Y/KW)	57.14
FUEL CONSUMPTION (G/KWH GEN)	330				DESIGN LIFE HYDRO (YEARS)	50
COAL COST (Y/TON STD)/b	440				AUXILARY POWER USE (%)	0.1
FUEL COST PER KWH GEN	0.1452				FORCED OUTAGE (%)	0.5
DISBURSEMENT RATE COAL PLANTS	0.1	0.3	0.4	0.2	ANNUAL OVERHAUL (DAYS)	41
	192.81					
ECONOMIC LIFE (YEARS)	30				SELLING PRICES OF GENERATING PLANT TO GRID	
AUXILARY POWER USE%	6				(INCLUDING VAT) PLUS SURCHARGES OF Y0.0826) Y	
FORCED OUTAGE%	10				FPEPB 1997 AVERAGE	0.39
ANNUAL OVERHAUL (DAYS)	42				SHUIKOU	0.42
					SONGYU	0.59

a/ Costs for Shuikou do not include railway relocation costs which appraised separately in original appraisal. Economic costs calculated annually by (i) multiplying the local cost with standard conversion factor, (ii) converting at the official exchange rate to US\$, (iii) adding to foreign cost; (iv) converting to 1997 constant prices by using MUV index; and (v) reconverting to Yuan using the 1997 exchange rate.

b/ Coal price based on FOB Qinhuangdao (US\$35.4/ton, 5500 kcal/kg). Shadow freightage of Y48.0/ton (from Qinhuangdao to Fujian) was added to price, and two percent transportation losses were assumed. Calculated price was therefore Y349/ton which is Y444/ton of standard coal.

TABLE 10: STATUS OF LEGAL COVENANTS

Agreement	Section	Covenant Class	Present status	Original fulfillment date	Revised fulfillment date	Description of covenant	Comments
Loan	3.01(b)	3	C			Relend the proceeds of the loan to FPEBP, on terms and conditions satisfactory to the Bank.	
	3.04	7	C			In collaboration with carry out FPEBP resettlement program, undertake an independent evaluation of resettlement (IER), monitor the IER reports, take action to accelerate the reestablishment of income and welfare in identified problem areas.	
	3.05	6	C			In collaboration with FPEBP, carry out an environmental action plan, acceptable to the Bank.	
Project	4.01	1	C			Have project records and accounts for each fiscal year audited. Furnish to the Bank, not later than six months after the end of the fiscal year, the audited report.	
	Schedule 2, Para 1	10	C			Prepare, prior to completion of the dam, a program of annual maintenance of the project works, satisfactory to the Bank, undertake periodic inspections of the dam and associated works using independent experts whose qualifications and experience are acceptable to the Bank, and to implement their recommendations.	
	Schedule 2, Para 2	12	CD			FPEPB shall implement a plan for power tariff structure improvements acceptable to the Bank, in a manner satisfactory to the Bank, including the completion of the first phase by December 31, 1993.	
	Schedule 2, Para 3	10	C			FPEPB shall carry out a transmission expansion program which includes integration of facilities under Part A of the Project and the Fujian Province Grid in accordance with a schedule satisfactory to the Bank.	
	Schedule 3, Para 4	10	C			FPEPB shall carry out hydro-inventory reevaluation with timing, specialist assistance and terms of reference satisfactory to the Bank.	
	Schedule 3, Para 5	7	C			In collaboration with FPEBP carry out resettlement program, undertake an independent evaluation of resettlement (IER), monitor the IER reports, take action to accelerate the reestablishment of income and welfare in identified problem areas.	
	Schedule 3, Para 6	6	C			FPEPB shall, in collaboration with the Borrower, undertake an environmental action plan, acceptable to the Bank, in a	

			manner satisfactory to the Bank.
4.01(b)	2	C	Have records, accounts and financial statements for each fiscal year audited. Furnish audited financial statements to the Bank not later than six months after the end of each fiscal year,
4.01(c)	1	C	Maintain and have audited, accounts for SOEs. Submit audit report together with audited financial statements of FPEPB.
4.02	2	C	Not incur additional debt unless a reasonable forecast shows internal cash generation would provide a debt service coverage ratio of no less than 1.3 times before 1995, and 1.5 times thereafter.
4.03	2	C	Maintain a debt/equity ratio of no more than 75/25 in 1992-96 and 70/30 thereafter.
4.04	2	C	Take all measures, including but not limited to tariff adjustments, to ensure that its internal cash generation is sufficient to maintain a self-financing ratio of no less than 22 percent in 1992/93, 25 percent in 1994/95, and 30 percent thereafter.

TABLE 11: COMPLIANCE WITH OPERATIONAL MANUAL STATEMENTS

The project was carried out in full compliance with the following Operational Directives:

Statement Number and Title	Describe and comment on lack of compliance
1. OMS 3.80 - Dam Safety	Fully Complied.
2. OD 4.00B - Environmental Policy for Dam and Reservoir Projects	Fully Complied.
3. OD 4.01 - Environmental Assessment	Fully Complied
4. OD 4.02 - Environmental Action Plans	Fully Complied
5. OD 4.30 - Involuntary Resettlement	Fully Complied

TABLE 12: BANK RESOURCES: STAFF INPUTS

Stage of project cycle	Planned		Revised		Actual	
	Weeks	\$'000	Weeks	\$'000	Weeks	\$'000
Preparation to appraisal					31.7	75.6
Appraisal					41.3	108.9
Negotiations through Board approval					8.8	23.9
Supervision					38.4	94.5
Completion					3.5	12.3
<u>Total</u>					<u>123.7</u>	<u>315.2</u>

TABLE 13: BANK RESOURCES: MISSIONS

Stage of project cycle	Month/year	No. Of persons	Days in field	Specialized staff skills represented /a	Performance rating		Type of problems	
					Implementation status	Development objectives		
Through appraisal	04/90	2	3	EC,EC				
	10/90	3		E,EC,FA,EC,R				
	07/91	4	9	E,EC,FA,R				
	10/91	2	6	E,EC				
Appraisal through Board approval								
Board approval through effectiveness	10/92	2	5	E,R	1	1		
Supervision	1	05/93	2	7	E,R	S	S	
	2	02/94	3	7	E,R,R,EC,EC	S	S	(Missions in 02/94 and 06/94. F590 updated 08/94)
	3	10/94	1	5	E	HS	S	
	4	04/95	3	4	E,FA,R	HS	S	
	5	11/95	3	3	E,R,R			(F590 not prepared)
	6	04/96	4	5	E,FA,R	HS	HS	
	7	03/97	2	5	E,R	HS	HS	
Completion	10/97	3	10	E,R,R	HS	HS		
	07/98	2	3	E,R				

/a E: Hydroelectric Engineer, Ec: Economist, FA: Financial Analyst, R: Resettlement Specialist,

Projected and Actual Financial Statements of FPEPB (1991-1997)

Table 1: INCOME STATEMENT

(Y million)

Year Ended December 31	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual												
Operating Revenues																				
Sales Increase (%)	14.5	21.1	13.2	11.1	13.3	17.9	13.3	18.9	13.4	15.1	9.8	10.7	9.9	3.5	10.0		9.9		10.1	
Energy Sales (GWh)	9,272	9,803	10,499	10,892	11,899	12,840	13,485	15,274	15,294	17,578	16,794	19,461	18,465	20,147	20,312		22,321		24,576	
Average Price (fen/kWh)	16.5	17.2	17.7	17.2	21.0	21.8	22.4	26.1	24.41	30.3	25.3	34.1	25.8	38.4	25.9		26.7		29.25	
Total Operating Revenues	1,530	1,686	1,861	1,873	2,495	2,799	3,015	3,987	3,733	5,326	4,247	6,636	4,755	7,729	5,265	0	5,966	0	7,188	0
Operating Costs																				
Fuel	190	262	273	260	294	377	335	378	394	334	524	387	696	222	875		927		1,152	
Purchased Power	770	945	918	931	947	1,556	976	1,688	1,006	2,042	1,038	2,899	1,070	3,335	1,192		1,904		2,278	
Operation & Maintenance	129	63	143	85	196	155	287	207	364	255	407	355	465	404	506		531		591	
Administration	47	12	57	39	68	86	80	166	96		111		128		147		170		197	
Sales Tax /a	155	150	193	197	316	157	416	616	557	831	656	1,039	753	1,214	831		829		1,002	
Depreciation	93	83	102	143	108	175	168	332	282	518	370	584	407	737	464		492		504	
Overhaul	0	63	0	73	0	104	0	180	0	266		254		284						
Other Expenses	0	13	0	23	0	0	0	0	0	235		279		458						
Less Fuzhou Thermal Revenue	(11)	0	(14)	0	(15)	0	(16)	0	(16)	0	(17)		(18)		(21)		(34)		(42)	
Total Operating Cost	1,373	1,591	1,672	1,751	1,914	2,610	2,246	3,567	2,683	4,481	3,089	5,797	3,501	6,654	3,994	0	4,819	0	5,682	0
Operating Income	157	95	189	122	581	189	769	420	1,050	845	1,158	839	1,254	1,075	1,271	0	1,147	0	1,506	0
Interest Charged to Operation	39	33	42	31	101	7	211	182	461	528	466	518	547	653	516		472		542	
Other Income (Losses)	10	12	10	(4)	10	27	10	17	11	15	11	42	12	(37)	12		13		13	
Net Income Before Income Tax	128	74	157	87	490	209	568	255	600	332	703	363	719	385	767	0	688	0	977	0
Income Tax	55	36	64	42	229	17	246	83	182	109	194	113	175	122	158		125		201	
Net Income	73	38	93	45	261	192	322	172	418	223	509	250	544	263	609	0	563	0	776	0
Distribution of Net Income																				
Remittance to Government	22	0	28	0	77	0	95	0	89	0	86		61		37		30		57	
Transferred to Government Fun	16	0	25	0	59	0	104	0	256	0	340		388		463		432		582	
Employee Benefits Special Fund	13		17		47		58		76		93		98		110		101		140	
Retained Earnings	23	0	24	0	79	0	65	0	0	0										
Operation Ratio(%)	90	94	90	93	77	93	74	89	72	84	73	87	74	86	76		81		79	
Rate Base	2132	2229	2255	2406	3097	2866	5435	5315	8096	8683	9568	10905	10523	12368	11300		11386		11,776	
Rate of Return on																				
Average Net Fixed Assets in Se	7.36	4.27	8.40	5.09	18.77	6.60	14.15	7.89	12.97	9.73	12.10	7.70	11.91	8.69						

/a Actual Values from 1994 onwards represent value added tax

Projected and Actual Financial Statements of FPEPB (1991-1997)

Table 2: BALANCE SHEET
(Y million)

As of December 31	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
ASSETS																				
Current Assets																				
Cash	217	210	304	697	400	929	509	1,456	560	1,952	626	3,242	705	2,290	800		911		1012	
Inventories	80	68	84	410	88	365	93	472	98	576	102	97	108	121	113		119		125	
Accounts Receivable	75	108	92	122	123	337	149	528	184	277	210	277	235	2,209	260		294		355	
Other Current Assets	0	0	0	0	0	9	0	17	0	550	0	1,978		42						
Total Current Assets	372	386	480	1,229	611	1,640	751	2,473	842	3,355	938	5,594	1,048	4,662	1,173	0	1,324	0	1,492	0
Long-term Investment	0	0	0	0	0	127	0	157	0	243		362		454						
Fixed Assets																				
Plant in Service	2,907	3,110	3,094	3,240	4,799	4,630	8,047	9,103	10,571	12,369	11,641	14,790	13,259	16,783	14,066		14,388		15842	
Less: Accumulated Depreciation	(694)	(706)	(796)	(831)	(904)	(1,306)	(1,072)	(1,797)	(1,353)	(2,309)	(1,723)	(3,041)	(2,131)	(3,796)	(2,595)		(3,087)		(3591)	
Net Plant in Service	2,213	2,404	2,298	2,409	3,895	3,324	6,975	7,306	9,217	10,060	9,918	11,749	11,128	12,987	11,471	0	11,301	0	12,251	0
Construction WIP	3,268	3,490	4,288	4,126	4,314	5,927	2,620	3,323	1,400	2,503	1,479	2,191	842	2,231	1,173		2,413		2445	
Total Fixed Assets	5,481	5,894	6,586	6,535	8,209	9,251	9,595	10,629	10,617	12,563	11,397	13,940	11,970	15,218	12,644	0	13,714	0	14,696	0
Special Fund Assets	209	204	233	354	224	0	249	0	295	0	305		344		408		472		519	
Deferred and Intangible Assets	0	0	0	0	0	94	0	30	0	473		370		131						
Total Assets	6,062	6,484	7,299	8,118	9,044	11,112	10,595	13,289	11,754	16,634	12,640	20,266	13,362	20,465	14,225	0	15,510	0	16,707	0
LIABILITIES & EQUITY																				
Current Liabilities																				
Accounts Payable	136	131	167	282	173	28	179	260	186	334	191	695	197	645	205		231		257	
Due to Government	25	19	26	58	27	32	28	26	29	43	30	146	32	112	33		34		36	
Short-term Loan	0	9	0	0	0	0	0	3	0	3		65		108						
Other Current Liabilities	0	0	0	0	0	807	0	660	0	888		1,624		1,637						
Total Current Liabilities	161	159	193	340	200	867	207	949	215	1,268	221	2,530	229	2,502	238	0	265	0	293	0
Construction Appropriate	75	272	75	316	75	0	75	0	75	0	75		75		75		75		75	
Working Capital Funds	47	34	47	53	47	0	47	0	47	0	47		47		47		47		47	
Long-term Debt	4,011	4,214	4,921	5,319	6,294	7,287	7,407	8,705	7,998	10,063	8,235	10,681	8,251	10,022	8,348		8,813		8994	
Government Funds	1,325	1,318	1,520	1,528	1,770	0	2,044	0	2,474	0	3,017		3,574		4,150		4,756		5557	
Special Funds	419	487	495	562	533	0	624	0	752	0	853		993		1,173		1,361		1549	
International Borrowing	23		48		127		192		192		192		192		192		192		192	
Capital	0	0	0	0	0	1,796	0	3,000	0	3,399		3,473		3,655						
Capital Surplus	0	0	0	0	0	1,023	0	385	0	1,430		2,687		3,078						
Retained Earnings	0	0	0	0	0	141	0	250	0	474		895		1,208						
Total Liabilities & Equity	6,061	6,484	7,299	8,118	9,046	11,114	10,596	13,289	11,753	16,634	12,640	20,266	13,361	20,465	14,223	0	15,509	0	16,707	0
Debt as % of Debt and Equity	68.3	67.4	69.7	69.7	72.2	73.4	72.6	72.6	70.5	68.1	67.3	65.2	63.8	61.2	60.5		58.6		55.4	
Current Ratio	2.3	2.4	2.5	3.6	3.1	1.9	3.6	2.6	3.9	2.6	4.2	2.2	4.6	1.9	4.9		5.0		5.1	

Projected and Actual Financial Statements of FPEPB (1991-1997)
Table 3: FUNDS FLOW STATEMENT
(Y million)

Year Ended December 31	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000	
	Projected	Actual	Projected	Actual	Projected	Actual														
SOURCES OF FUNDS																				
Internal Cash Generation																				
Net Income Plus Interest Expe	113	74	136	136	364	196	532	348	882	751	981	881	1,094	916	1,126		1,035		1322	
Depreciation & Amortization	93	83	102	143	108	180	168	407	282	604	370	721	407	1,034	464		492		504	
Maintenance	3	63	13	73	9	0	19	0	29	0	36	0	37	44			46		47	
Distribution Expansion Specia	95	73	120	100	92	269	105	284	119	303	99	300	110	450	122		133		149	
Other Resources	175	247	226	302	244	0	268	0	294	57	322	210	332	410	316		403		451	
Total Internal Source	479	540	597	754	817	645	1,092	1,039	1,606	1,715	1,808	2,112	1,980	2,810	2,072	0	2,109	0	2,473	0
Borrowings																				
Proposed IBRD Loan-Phase I	85	85		163		75		0		0		0		0		0				
Proposed IBRD Loan-Phase II	0	0	243	0	326	92	151	131	39	17	0	157	0	165						
Other Shuikou Project loan	643	0	545	0	463	0	249	0	67	0	0	0	0							
Other Loans/b	45	907	272	1,200	771	1,611	994	1,507	1,014	1,952	925	1,904	750	1,790	872		1,240		1107	
Total Borrowings	773	992	1,060	1,363	1,560	1,778	1,394	1,638	1,120	1,969	925	2,061	750	1,955	872	0	1,240	0	1,107	0
Government Funds - Grants	0	70	0	7	0	0	0	0	0	0										
Total Sources of Fun	1,252	1,602	1,657	2,124	2,377	2,423	2,486	2,677	2,726	3,684	2,733	4,173	2,730	4,765	2,944	0	3,349	0	3,580	0
APPLICATIONS OF FUNDS																				
Capital Expenditure																				
Proposed Shuikou Project	586	610	601	710	622	835	316	1,212	106	711	0	827	0	582						
Other Construction	45	697	260	56	718	1,157	870	158	971	1,222	848	1,298	722	1,670	802	3,000	1,089		985	
Renovations/Distribution Expa	67	0	68	0	79	0	97	0	125	0	147		176		224		272		298	
	81		103		82		89		103		87		94		106		114		128	
Interest During Construction	142	0	199	0	220	0	208	0	44	0	77		28		70		151		122	
Total Capital Expenditures	921	1,307	1,231	766	1,721	1,992	1,580	1,370	1,349	1,933	1,159	2,125	1,020	2,252	1,202	3,000	1,626	0	1,533	0
Operational Requirements																				
Changes in Working Capital	7	78	(10)	173	30	(31)	24	223	33	90	26	(313)	24	48	23		14		41	
Changes in Special Funds Asse	0	82	0	63	0	0	0	0	0	0	0	0	0	0	0		0		0	
Loan Repayment(Debt Service)	140	166	193	228	288	119	493	525	990	1,040	1,154	1,443	1,280	1,885	1,291		1,247		1469	
Remittances to Government	21	0	27	(6)	76	0	94	0	88	0	81	0	60		36		28		55	
Special Fund Expenditures	113	172	129	413	164	0	188	0	216	0	246		269		298		322		379	
Increase in Long-term Investm	0	0	0	0	0	112	0	32	0	124		119		92						
Total Operational Requirements	281	498	339	871	558	200	799	780	1,327	1,254	1,507	1,249	1,633	2,025	1,648	0	1,611	0	1,944	0
Total Applications of Funds	1,202	1,805	1,570	1,637	2,279	2,192	2,379	2,150	2,676	3,187	2,666	3,374	2,653	4,277	2,850	3,000	3,237	0	3,477	0
In(de)creases in Cash	50	(203)	87	487	98	231	107	527	50	497	67	799	77	488	94	(3,000)	112	0	103	0
ebt Service Coverage (times)/d	2.7	2.4	2.4	3.3	2.5	5.4	2.0	2.0	1.5	1.6	1.4	1.5	1.4	1.5	1.5		1.5		1.6	
3-Year capital expenditure	717.3	973.3	1,291.0	1,355.0	1,510.7	1,376.0	1,550.0	1,765.0	1,362.7	1,809.3	1,176.0	2,103.3	1,127.0	2,459.0	1,282.7		1,453.7		1,579.5	
Self-financing Ratio(%)/c	43.4	22.0	30.0	21.8	28.0	40.5	31.0	16.5	20.5	32.3	25.6	46.7	30.8	35.7	33.1		34.3		33.5	

/b Actual for Other Loans includes Other Shuikou and Other Loans

/c Due to change in accounting procedures, distribution special funds are included in internal cash generation since 1992. Also changes projected self financing.

/d Projections slightly different to SAR because of use of three year average capital expenditure

IMPLEMENTATION REVIEW
FOR
SHUIKOU HYDROELECTRIC PROJECT
FUJIAN, CHINA
(LOAN No.: 3515-CHA)

FUJIAN PROVINCIAL ELECTRIC POWER BUREAU

JANUARY 1999

**IMPLEMENTATION REVIEW FOR
SHUIKOU HYDROELECTRIC PROJECT
FUJIAN, P.R. CHINA
PROJECT IMPLEMENTATION**

Foreword

1. The Shuikou Hydroelectric Project is the largest hydro project in East China with a total installed capacity of 7 x 200 MW, a dependable output of 260 MW and an average annual generation of 4,950 GWh. It is a large multipurpose project planned mainly for power generation, but for navigation as well. It is a key project in the national 7th and 8th Five-Year-Plan, and it is a pilot project for managerial system reform in the field of large-scale hydroelectric project construction. The project is partially funded with World Bank loans in two phases.

- (a) Phase I: Loan amount of US\$140 million with an original closing date of December 31, 1991, an extended closing date of June 30, 1992, and final closing date of June 30, 1993.
- (b) Phase II: Loan amount of US\$100 million with an effective date of October 20, 1992, and planned closing date of December 31, 1996.

2. ICB procedure was introduced in the construction of main civil works and procurement of imported electromechanical equipment. The competitive bidding system was also adopted for all temporary work and local procurement items.

Review Implementation of Main Works

Organization

3. FPEPB is the owner and proprietor of the project. Representing the owner, SHPC implements overall management of project construction and also exercises the functions of the construction unit and engineer. East China Investigation and Design Institute (ECIDI) serves as the designer. The contracts for main civil works and for the installation of electromechanical equipment have been awarded to a construction joint venture (Chinese/Japanese) and the Fourth Hydroelectric Construction Bureau of China respectively through competitive bidding procedures. Resettlement in the reservoir area is implemented by SRO under the Fujian Provincial Government. The Morrisson Knudsen Engineering Co. (MKE) of the USA was hired to provide consultancy services for SHPC in the aspects of construction and contract, management and for ECIDI in the reviewing of bidding documents and design management. In the meantime, a Special Board of Consultants (SBC) was appointed to review and comment on the major

technical issues, project management, environment, and resettlement during the design and construction of the project at various stages.

Construction Schedule

4. The construction period for the project from commencement of the project in March 1987 to commercial operation of the first unit on August 6, 1993 was only about six years and five months, which was about two months behind the original implementation schedule in the SAR. However, the milestone dates for various stages of the project had been realized timely. The main river was closed on September 25, 1989. During 1990, excavation of the dam and powerhouse foundations were started and completed, the placement of concrete was entered into peak production and a record of 123,000 m³/month was created. In 1991, the annual concrete placement reached 1.15 million m³ and the transition from Stage II to Stage III was carried out. In 1992, the project withstood successfully an early flood and overcame all the difficulties caused by the extraordinary flood (50 years in return) on July 7, 1990, and was kept ongoing to form a basis for the first unit operation in 1993. The peak labor forces during construction of the project did not exceed 4,000. Overall construction quality was verified in the first rank among the under construction of five large hydroelectric projects scaled over 1,000 MW in the national quality evaluation for priority projects organized by Ministry of Energy (MOE). The requirement of 'high speed, quality and efficiency' was realized in the project. By the end of 1996, all seven generating units were put into operation, and by the end of 1998 accumulated electricity generation was 24,453 GWh. All of these achievements received benefit from taking the advantage of using World Bank loan actively to introduce the experience and practice of international project management and to import advanced, foreign technology and equipment, as well as from national reform and opening policy, and joint efforts as team work from all parties involved.

Electric and Mechanic Works

Supply of the Units Equipment

5. The signature of procurement contracts for the seven units of main equipment and their accessories was made in August 1988. However, since the payment for equipment delivery spanned over Phase I loan while the Phase II loan was not available at the time, it created a big trouble and time consuming to issue the LC though every effort was involved. The LC was not available until the end of 1989, which was delayed for nearly one year compared to the contract stipulations. The manufacturing schedule and equipment delivery schedule was affected. Because the manufacturers proceeding capability was limited and many manufacturing contracts were signed as well as Shuikou's seven turbines are among the largest Kaplan turbines in operation today with big size and complex manufacturing technology, the actual delivery intervals for each unit was longer than four months as established in the contract and the casting defect of the runners for the later units made the part delivery delayed for one year.

E/M Installation

6. The E/M installation contract was signed in January 1991, and the contractor mobilized to site in March 1991. As the Statements in the contract document, the installation duration for each unit was 16 months counted from the installation of stay ring to completion of 72-hour trial operation with units commissioned at four months intervals. The installation duration for Unit #1 to #6 are 15, 13.5, 12.5, 11, 12, 10.5 months respectively.

Construction Situation of the Navigation Facilities

7. The stage 11 excavation for the shiplock and the shiplift bottom slab foundation started after the closure of the channel on 20 November 1991. The construction of shiplock was affected by the extraordinary 50-year flood on July 7, 1992 about six months. The lock should be put into operation by July 1993. However, water filling and trial operation of shiplock was started in September 1994. Unfortunately, some cracks occurred in each bottom slab of the lock chambers, lock walls and the watering galleries during the trial operations. The commissioning and trial operation of lock was suspended. A meeting presented by an panel consisting 8 local experts invited by the Ministry of Power was held to review the design and the construction of shiplock in February 1995. Some comprehensive treatment measures such as cracks grouting, leakage drainage and strengthening the chamber 1# and 2# walls and bottom slabs by using prestressed anchorage were proposed. In May 1995, the defect treatment and strengthening works were started and finished in September 1995. In October, the independent and combined tests of E/M equipment and hydraulic facilities were finished. Then watering up the lock and started trial operation again in November and the internal trail navigational operation was carried out in December. On February 10, 1996 public trial started with traffic twice a day. The Owner decided to purchase the hydraulic and control facilities made in Rexroth, Germany to replace the existing ones which were unreliable in quality and unstable in operation, the replacement was executed in November 1996 so the navigation operation stopped. In February 1997, the navigation recovered with the replacement completion, the shiplock equipment operated well. By the end of 1998, 30,819 boats had passed through the lock in 3731 passes, totaling 1,160,600.

8. The conditions of the lock wall and bottom slabs have been improved by anchoring consolidation cracks, its hidden troubles have not been solved completely, however. In order to ensure the shiplock operation safely in a long term, the Owner decided to have the shiplock further reinforced. In July 1997, a scheme for reinforcing the shiplock for the second time was reviewed by the Programming & Designing Institute subordinated to the Ministry of Power. It was decided that the wall of lock chamber 1# would be heightened to E/L 74m, with a pull rod of steel structure installed to on the top to pull the walls of two sides. This consolidation scheme will be carried out between September 1997 and the end of April 1998.

Shiplift Construction

Civil Works Contracts

9. The contract of the civil works of shiplift was awarded to Mingjian Construction Bureau and the Twelfth Construction Bureau in early December 1994 through the domestic Competitive bidding, the following milestone should be reached by the Contractors in accordance with the schedule:

- (a) Completed foundation excavation before April 30, 1995.
- (b) Remove the downstream cofferdam before September 31, 1995,
- (c) Complete concrete placement to the tower below EL 74m before July 31, 1996.
- (d) Complete the construction of the pillars and beams on the operation house layer and the crane beam before September 30, 1996.
- (e) Complete the construction of the generator layer and control chamber before October 31, 1996.

10. According to the precision requirement of the shiplift structure, the contractors face an unprecedented challenge that he must ensure that the deviation should not be over 12mm on the up-and-down surfaces of two 73m towers. The quality of concrete placement to the shiplift not only met the requirements of specification, but won acclaim of the higher authorities and the units of the same trade thanks to importing the new technology of slide support circles while shifting form works and also the constructor conscientious construction altitude.

11. The construction of the shiplift civil works, however, was behind the schedule for nearly one year for multiple reasons. By the end of August 1997, the shiplift structure has been basically constructed, except for the pillars and beams frame on two sides of the operating room which as postponed to finish at the end of September due to the delayed installation of the upstream working gate. The architecture and decoration of shiplift are being undertaken at present. The civil works for the shiplift were generally complete by end of 1997.

12. The most critical rings for the schedule of the civil work of the shiplift were the cofferdam removal after the flood season 1996 allowing the chamber entering into the chamber room and rebuilding it to EL14 in order to place second stage concrete of the downstream headlock and install the maintenance gate before the flood coming at the end of March 1997. The schedule became tighter as the chamber transportation delayed a month due to the rebuilding of the Ming-River Bridge in Fuzhou. Under the Engineer careful management and the cooperation and hard work of the contractors, the work was done on the schedule.

Contracts on Shiplift Facilities Supply

13. The local manufacturing contracts for the shiplift have been awarded to a joint venture (Wuhan shipbuilding Corporation-Mining Machinery Company of CITIC) ON January 13, 1995. Wuhan Ship Building Corporation, the sponsor of the joint venture, is responsible for the manufacturing of metal structure, main lifting facilities (except for the retarding device), electric equipments and computer supervising system and for the test and adjustment of the equipments.

14. Heavy Machinery corporation of CITIC, the partner, is responsible for manufacturing the hoist retarding device of the main lifting equipments, counter weight device and bridge crane of main operating room.

15. The shiplift of the Shuikou Project is the biggest vertical one in China at present, there are no experiences to learn from outside for its design and manufacturing. The technical specification and manufacturing requirements for each facility were listed as the most difficult ones of the same trade. Some technology are the first used in manufacturing. Such as the transportation of the chamber, but (hermetically)-sealed device in big size, big square stainless steel plates, machine work of up-and-down streams, working gates, high accuracy lifting roll in diameter of 3.5m and the 2.8m hard surface gears machining for retarding device.

16. Each constructor paid great attention to the shiplift project, the Owner held five designing liaison meetings to jointly review the design and solve the key technical problems with the Engineer, Designer and the manufacturer. Expert consultant groups have been organized to solve the manufacturing problems respectively in Wuhan Shipbuilding Corporation and Mining Machinery Corporation. In order to make definition of the reliability, a group of tests have been made in Wuhan Shipping Company, such as the Finite Element Model Test for the Chamber, Butt Hermetically-Sealed Device, Electric-driven Test, Stressed Stability Deformation of the Pulley, Operation Reliability of the Brake etc. The Mining Machinery Corp. of CITIC made a research to the technology and design of big gear retarded device, and imported a carbonized furnace in the diameter of 3.5m to meet the requirement of gear thermal treatment. By August, 1997, most equipment had been delivered to the site. An integral unit test and adjustment test for the main lifting device was carried out the following month.

International Procurement for the Key Equipment and Materials of the Shiplift

17. The procurement for the key equipment and materials was carried out through ICB, or direct procurement, the procurement contracts have been well executed, and all the equipment was delivered to the site or to the workshop of Wuhan Shipbuilding Corporation in a timely manner.

Contract of Shiplift Installation

18. On February 7, 1996, the contract for the shiplift installation was awarded to the Wuhan Shipbuilding Corporation through negotiation, the contractor mobilized into the site on June 5, 1996 and began his installation operation. By the end August 1998, installation was basically completed

19. The test and trial operation will be completed by the end of 1999 based on the adjusted schedule.

500 kV Transmission Line and Switchyard Construction

Construction

20. Quanzhou 500 kV substation has a total ground space of 104,385m². The construction was commenced on October 31, 1996, and was completed in mid-1997. The Shuikou step-up substation was constructed on the site preserved for the original 500 kV step-up substation for Shuikou Hydropower Plant. Because of the narrow area, the side slopes of the substation were rather difficult to be treated. Further, the construction blasting was restricted by the surroundings and the supply of the construction drawings was lagged behind, so the construction of the Civil Works was commenced just in December 1996. Civil works were basically complete by end of 1997.

Line Works

21. According to the final preliminary design, the Shuikou-Quanzhou transmission line is 203,639 km long in total, which trends through Minqing County, Yongtai County, Xianyou County, Quanzhou City and Nan n City.

22. The transmission line of this project is consisted of two portions, the newly constructed portion and the upgrade portion. The newly constructed portion extends from the Shuikou step-up substation to the 7# tower of the existing 220 kV Shuikou-Hui n II and III circuits, which has a total length of 5.35 km and nine steel towers.

Bidding and Procurement of the Equipment and Materials

Bidding and Procurement of the Equipment

23. With the strong supports of the relevant departments of the State of the World Bank, the bidding of the equipment and materials of this project were carried out rather smoothly. Thirteen contracts were signed within six months of Board approval of the new component. Equipment delivery was generally completed in the ensuing 12 months, before the loan closing date. However, because of delay in award of two small contracts, related to central government approvals, the closing date was extended by a further six months which also provided the opportunity to purchase additional equipment utilizing savings.

Erection and Equipment Installation

Transformer Substations

24. From September 1997 to January 1998, the electrical equipment of the substations was installed. From February 1998-March 1998, the equipment was debugged and commissioned.

Transmission Lines

25. By the end of 1997, the erection of the transmission lines in the newly constructed sections was completed, inspected and accepted. In the dry season of October 1997-January 1998, the Shuikou-Hui n II and III circuits was transformed and upgraded. From February 1998-to April, the system was debugged, tested and commissioned.

Power Grid Automation

26. SCADA, SE, SA and OTS systems were put into operation after passing site acceptance test (SAT) in September 1996. AGC/ED functions passed its SAT in May 1997 as scheduled. AGC automatically control the active power output of unit #1, #3, #5, #6, #7 in Shuikou hydro power plant and maintains power grid frequency in the 50 +/- 0.1 HZ. AGC continuously since June 20, 1997. Quality rate of frequency is 99.56 percent. AGC make Fujian finish manual control frequency history and increased power energy quality.

27. For the remaining three functions, SLF, OPF, and UC, SAT tests were delayed due to software defects. They finally passed SAT in November 1998.

Microwave Digital System

28. We signed the first stage contract on September 9, 1994, the project covers SanMing-Fuzhou-ZhangZhou District, altogether 20 stations. The second stage contract was signed on May 8, 1995. This stage project contains SanMing-LongYan-ZhangZhou District and XiaMen-SongYu Subtrunk, up to 11 station. Due to the delaying providing products of Siemens part, the installation of the project was started till October 5, 1996, under the well cooperation between two parts, we had finished the equipment installation before January 23, 1997, and the whole circuit line was put in to running, replaced the original analog microwave equipment. For the reason of lacking providing equipment by Siemens part, some project problems still remained, of which includes: the supervisory and control system has not been put into full running, function of remote operation of PCM30H equipment has not fulfilled, the receiver level between Shuikou-MingQing two stations is too low, the influence of power broken on normal working of PCM30H equipment was huge, etc. Aiming at solving all above problems, both parts agreed to have a cooperation meeting on April 17, 1997 in Fuzhou City, the meeting made it definitely about the items of lacked equipment, date of providing equipment, time of solving remaining problems, time of trial operation of system, and fine of against

contract, etc. With the effort of both parts, the project has been put into trial operation in September 1997. However, it was not finally accepted until December 1998.

29. With full operation of the system, it will improve greatly the quality of electric power telecommunication transmission network, make the transmission trunk digitally, expand the capacity of transmission, establish a stable foundation for fulfilling IDN and ISDN in future.

30. It will also provide excellent channels for electric power dispatch, hydroelectric power dispatch, telecommunication dispatch, relay protection, AGC, the Safety Automation equipment and manage switching networks for production and enterprise manage networks, etc. ensure the safety in production of electric power networks, raise the system benefit, and it would finally hasten to modernize the management of Fujian electric power enterprise.

Resettlement works:

Progress

31. According to the requirements of the civil works progress, an overall resettlement works was commenced in the end of 1987. The works were divided into three stages: Stage I before March 1990, 32,000 people were resettled; Stage II before March 1992, 20,000 were resettled and Stage III before March, 1993, the rest of the resettlers were arranged to move to the reservoir area. The main progress was summarized as follows:

- (a) The resettlement organizations at provincial, prefectural and county levels were established in the second half year of 1986, and the propaganda and mobilization for resettlement were started.
- (b) In 1987, site investigation, planning and design were made for the concentrated resettlement area.
- (c) The period for rebuilding is between 1988 and 1991. The land leveling, housing bases, water and electricity supply and access road were constructed sequentially for the Stage I and part of Stage II resettlement places. The housing bases of 1,620,000 M² were distributed on the township and village basis. The house building and resettlement work were performed in great swing. Many difficulties were encountered due to the tight schedule and financial shortage. In order to meet the requirements of river transition from Stage II to Stage III, the operations of house reconstruction, resettlement and land leveling were carried out parallel as well as the Stage I resettlement standards were changed from twenty years round to ten years round. Ground leveling for stage II and III resettlement started.

- (d) After 1992 the resettlement compensation was raised and the resettled work for Stage 11 and III were executed smoothly by taking the experience in Stage I resettlement work. At the same time, the perfection work of the new resettlement places and the protection of the reservoir banks were carried out. Some of resettlement places were integrally inspected and accepted. With the joint efforts and full support from various parties and resettlers, the overall resettlement work was finished half a year ahead so as to ensure the requirements for timely reservoir impoundment and power generation be met.
- (e) By the end of 1998, of the total resettlement budget which was finally approved by the State of 1,423.16 million Yuan, 1,220.16 million Yuan has been spent. The overall resettlement work has been basically finished. The main remaining works are giving aid to the production and development in the reservoir area and speeding up the investment to the beneficial items; specially supporting the resettlers who are still below the poverty line; and particularly planning and properly managing the reservoir maintenance and construction fund.

Production Development in the Resettlement Area

32. Since 1988, The resettlers has been led to develop the production system while the resettlement physical works such as housing reconstruction and resettlement of people were undertaken. From the second half of 1991 to 1992, the attention was paid on the establishment of production development shifting from mobilization to the full swing execution. In 1993, the production development was deepened further. In 1994, the resettlers experienced a change from their house building to the production development, from which they have increased their income.

33. In general, a great achievement was made in the resettlement work of Shuikou Project. The resettlers have worked and made a new life in their reclaimed land and production system. Most of the resettlers have restored or exceeded their living standards comparing with that before the resettlement. The production development has shown its initial results, with the increasing of employment and economic opportunity, the adjusting of industrial structures, and the perfecting of the infrastructure which has taken on an alive new appearance in the resettlement area. The construction of Shuikou Hydroelectric Project has not widened the gap between the rich and the poor resettlers in the reservoir area, and the production and livelihood in the reservoir area has shown that the developing future is hopeful. The resettlement project of Shuikou reservoir is a successful example.

Independent Resettlement Monitoring

34. This work is carried out under the care of the World bank experts. Since 1990 when the outlines of independent resettlement were put forward, the trace survey ahs been performed with the support and collaboration of the Project Employer, the

provincial resettlement office for Shuikou Project, the resettlement offices of Nanping, Gutian, Youxi, and Minqing counties, and the evaluators. An official independent monitoring report is submitted to the World Bank each year ever since. The scheduled independent monitoring set in the program was finished in 1997, and the last independent monitoring report was submitted to the Bank.

Environmental Aspects

35. The Environmental Management Program of Shuikou Hydropower Project was completed and submitted to the World Bank in August 1991. The program covers the aspects such as environmental monitoring of the watershed above the dam, measurement of siltation in the reservoir, monitoring of the water quality, automatic hydrological forecast, navigation, fishery in reservoir bays, prevention of soil erosion in the reservoir peripheries, independent resettlement monitoring, afforestation in the project site, and staff training in environmental monitoring.

36. During the World Bank appraisal of the project for the second phase loan, a report on implementation of the program was submitted to the World Bank mission. The program implementation and achievements of the recent years are briefly summarized herein.

Water Quality

37. According to "Regulations of Grounding Water Observation in Fujian Province", a total of five sections were set by the authority of Ningping City in Mingjian River, Jianxi River and XiXi River to observe and analyze the water quality. By analyzing the water quality index in the end section the reservoir before and after the reservoir impoundment in 1993, it showed that the water quality index changes slightly between 1990 and 1995, which indicates that the water quality before and after the reservoir impoundment does not change evidently and the water in the reservoir has a strong migrating diffusion and dilution capability.

Environmental Monitoring of Watershed above Dam

38. The hydrology, meteorology and water quality in the watershed above the dam are measured, as routine by relevant departments using the basic monitoring network (or monitoring points), sorted and maintained according to the trade specifications. Such data can be available from the relevant departments following the procedures stipulated by the State Government.

Measurement of Siltation in Reservoir

39. Measurement of siltation in the reservoir is conducted as advised by the World Bank experts. The measurement is conducted after the flood season and once in a year from 1989 through 1993. In the reservoir are arranged 22 measuring sections. The measuring procedures and results have been reported to the World Bank mission.

Analysis on the measuring results show that the variation in siltation in the reservoir is not big, which is in coincidence with the feature of the less-laden Minjiang River.

Prevention of Soil Erosion in Reservoir Area

40. The soil erosion in the resettlement host areas has been harnessed after several years effort. Many engineering measures have been adopted, including protection dikes (or protection slopes) for the towns such as Xiadao, Taiping and Yuoxikou and Nanping City. A water and soil conservation system has been formed in the reservoir peripheries by biological means with afforestation as main measure. In 1996, a total of 14,977 mu of land was planted with trees. As a result, the slopes (banks) in the reservoir peripheries are basically stabilized.

Independent Resettlement Monitoring

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Automatic Hydrological Forecast

42. The overall plan for automatic hydrological forecasting was drawn up in September 1992, and was examined and approved at the meeting held by the Water Resources and Hydropower Planning and Design General Institute in Fuzhou in November the same year. The forecasting system has been operating normally in its service from May 1993. The system played an important role in reservoir regulation, particularly in the flooding period from July 2-13 of 1997.

Navigation

43. The affected navigation facilities in the reservoir areas (including wharves, navigation signs and ferries) have all been relocated, rebuilt or expanded as planned. The shiplock incorporated into the dam has already been in service and the shiplift will be put into operation in 1999.

Fishery in Reservoir Bays

44. The fishery industry in the reservoir has been rapidly developed recent years. In 1996, 78.63 mu of water surface was used for fishery in net cages, 2098 mu for fisher in pools and 9399 mu for fishery by nets, and 1455 mu for cultivating pearl mussels and

turtles. Ten tons of eels were produced. By that year, the fishery plan for the reservoir was basically realized, and little change has taken place in the following two years.

45. The reforestation in construction area of main work includes the construction site recovery, embankment access to Anrenxi and spoil area and service roads, etc. The total area is about 210,000 M2 with 11.8 km long. The reforestation planning was started in 1994. Trees planting started at the beginning of 1996 and was completed in 1998, by which time the following was achieved:

Completion Quantity and Investment for the Reforestation of Shuikou Project

Stage	Date	Square (m ²)	Arbors	Bushes	Climbing	Flowery Trees and Grass	Investment (Ten Thousands Yuan)
I	86.2~89.12	41,000	2,960	17,340	20,500	43,770	138.9
II	95.8~96.6	106,400	16,870	118,360	45,520	82,350	578.7
III	96.10~97.6	100,050	3,110	107,680	87,350	51,900	465.0
IV	97.8~98.7	79,450	1,690	144,800	135,280	16,450	507.2
Total		326,900	24,630	388,280	288,650	194,470	1689.8

OPERATION PLAN OF SHUIKOU POWER PLANT

Dam and Powerhouse Works

Operation Condition of Shuikou Hydroelectric Power Plant

46. Organization Structure and Staff Member for Shuikou Hydroelectric Power Plant (SHPP) were founded and settled in May 1992 under the approval of the Fujian Provincial Electric Power Bureau (the owner of the project). SHPP adopts the three-layer management structures, namely, administration by the top, the division, and groups or teams.

47. One director, two vice-directors, and one chief engineer are appointed to executed the managements of the operation and administration. In the management system, he fixes the following departments: Administration Office, Finance Department, Labor and Staff Management Department, Safety Supervision Department, Audit Office. Also, the following ones are set in the execution system: Power Generation Department, Hydraulic-Project Department, Maintenance and Overhaul Department and Navigation Department. The fixed number of works is 360, exclusive of workers work on overhaul and navigation. 53.1 percent of the staff members have been educated in colleges and

technology academies, others have been educated in special technical schools. Among them 88 people are already on their profession titles of high or middle levels.

Economic and Technical Indication and Safety Operation

48. The accumulative generation output from August 1993 to end of June 1997 reached to 16,350 GWh, in which:

- (a) In 1993, generation production, 564 GWh, operation hours 3123.
 - (b) In 1994, generation production, 2960 GWh, operation hours 6549.
 - (c) In 1995, generation production, 4770 GWh, operation hours 5966.
 - (d) In 1996, generation production, 4498 GWh, operation hours 3687 (it was dry year in 1996. The river water was just 86 percent of the normal year.
 - (e) In 1997, generation production 6009 GWh, operation hours 6652.
- In 1998, generation production 7500 GWh, operation hours 6862.

49. It was accounted that the unit cost of the generation was 101.26 Yuan RMB/MWh by reducing the production cost.

50. SHP pays a great attention to the safety operation, they established a three-level network to ensure the safety operation system and set up a chain of regulations in operation and safety management, executes safety operation responsibilities in different levels, make clear the relationship between production and management, institute management system for the defect treatment, equipment overhaul and grading etc. All of these measures have been strictly checked. By taking these measures, the equipment operate healthy. At present, the main equipment and flood-prevention facility are 100 percent in good operation condition. The record of safety operation reached to 1228 days.

Maintenance and Management to the E/M Equipment and Hydraulic Building

51. SHPP puts in the first place of his equipment maintenance, does his best to ensure equipment the health and safety operation and pays a great attention to training his workers in technical fields. SHPP holds the comprehensive training of E/M system phase by phase to his workers on post which win initial success. 350 technical workers have been trained in technical skill accumulatively, and 56 people attended the college correspondence course in spare time. Computer supervision and control system has been used in Units 1#, 2#, 3#. The central dispatch has controlled the generation of Unit 5# through auto-control system. And it was scheduled to put all the unit supervision system into operation in September. Television and computer supervision system have been erected to supervise the operation of 220 kV switchyard, which lays a foundation to realize the aim of concentrated control and small number of people needed on duties.

52. Before the flood season of this year, SHPC had completed renovating the tainter gate 4# of the dam, so the condition of the gate has improved a little. Since the renovation, the regiment auto-forecasting system was built and put into operation in May 1995. The 267.90 km² of river valley is under the supervision of the forecasting system (including two control stations in the established of the forecasting system (including two control stations in the established Shaxikon system, eight relay stations and 41 telemetering stations.) This system has forecasted the annual flood peak and flood quantity in the error under two percent and four percent respectively, and the average value of flood peak and quantity in the error under 11 percent and 14 percent respectively.

53. According to the statistic, the accuracy on forecasting flood in foreseen period are as follows: annual maximum flood peak 98.6 percent (>90 percent check figure), annual maximum flood volume 97.7 percent (>90 percent check figure), each flood peak within the year, 94.9 percent (>80 percent check figure), each flood volume measured within the year, 95.2 percent (>80 percent check figure), time difference between flood peak measure and actual, 2.9 hours, and 100 percent of the forecasting communication system are going smoothly.

CHINA

SHUIKOU HYDROELECTRIC PROJECT

(LN. 2775)

AIDE MEMOIRE EXTRACT

54. A World Bank mission comprising Barry Trembath, Martin ter Woort and Zhu Youxuan visited Fujian over the period October 3 to October 12, 1997 to carry out a final supervision of the project and to prepare for the Implementation Completion Report (ICR). On the Bank's side, the mission was accompanied by Gordon Appleby from the Bank Economic Development Institute (EDI). The mission commenced in Fuzhou with a review of documentation provided by FPEPB, proceeded to Wuyi Mountain where discussions were held over a two day period, and thence to Nanping at the upper end of the Shuikou reservoir. From there, the mission carried out two days of inspections and interviews in the reservoir resettlement areas finishing with a visit to the Shuikou Dam and Power Station. The mission then returned to Fuzhou for the aide memoire compilation and wrap-up meetings. The mission would like to thank FPEPB for the excellent arrangements for the mission and the personnel from FPEPB, SHPC, SHPP, SRRO and ECIDI and local government for the participation essential to the mission's success. It is also appropriate on this mission, marking the completion of the implementation phase of the Bank's two loans, extending over a 12 year period to offer the Bank's congratulations to all involved parties on the success of the two projects and to record the appreciation for the close cooperation, cordiality and hospitality which has been extended to all Bank missions over the course of project implementation. This aide memoire records the main findings of the mission and the agreements reached during its course.

Construction Status

55. **Shuikou Power Plant.** Since the last mission finishing and clean-up works have been completed, and the scrupulously clean power plant and ancillary areas indeed present an impressive spectacle which is also very pleasing to the eye.

56. **Dam.** Finishing works on the dam are generally complete. The only area or remaining work is in relation to the tainter gates where some operational difficulties have been experienced as reported during the last mission. Modifications were designed and one gate was modified before the last wet season and operations during the season demonstrated that the modifications satisfactorily addressed the problems. Now that the wet season has ended, all gates will be similarly modified before the end of 1997.

57. **Shiplock.** Since the last mission, the shiplock has generally operated satisfactorily. By the end of August, 1997 some 15,252 vessels totaling 516,776 tons had been passed. Availability has reached about 80 percent. However, there are still some doubts on the structural integrity of the walls of the upper chamber even after modifications carried out in late 1995. FPEPB commissioned special studies from Qinghua and Hohai Universities which indicated that safety factors lower than desirable considering the dynamic nature of the loading. For this reason, strengthening measures have been designed which will be implemented in the first quarter of 1998. It is unfortunate that the lock will need to be taken out of operation during that period presenting substantial interference to the fast growing water transport industry. *The mission urged FPEPB to take all measures necessary to minimize the outage period.*

58. **Shiplift.** The civil works are virtually complete with only architectural and decoration work remaining. Equipment installation is also well underway. In building the shiplift towers, the contractor faced an unprecedented challenge in needing to maintain a 12 mm out of plane tolerance over the 73m height of the towers. The contractor achieved this gaining congratulations from central government authorities. However, the construction was somewhat delayed which, together with late delivery of equipment has resulted in a projected slippage (in relation to the schedule produced in 1995) of about six months. First operation is now expected by mid-1998 with trial operation and testing extending over the remainder of the year. All imported equipment financed from the Bank loan has been delivered and paid for.

Resettlement

SRRO (Shuikou Reservoir Resettlement Office of Fujian Province)

59. SRRO staff reported that to the end of 1996 total resettlement expenditures amounted to Y1092 million. During 1996, expenditures were about Y35 million, mostly spent on bank stabilization works and production development. It is anticipated that in 1997 a further Y35 million will be spent. On March 22, 1996, the central government issued Circular No. 526 which allowed for the setting up of a reservoir development fund (or later-stage support fund), utilizing 0.5 fen (0.005 yuan) per kWh of output for 10 years, starting in 1996. This has been adopted for the Shuikou reservoir (replacing the Fujian Province temporary provision of 1995 which allowed a rate of 0.4 fen/kWh). At an average annual output of 4,950 GWh, the Shuikou project would generate Y24.75 million annually to be used for ongoing reservoir development purposes. SRRO proposes to use these funds for (i) new household enterprises; (ii) revolving loans for existing enterprises; (iii) participation in new village enterprises; and (iv) income support for vulnerable households. SRRO will remain in existence devoting their attention to the funding of future development in the Shuikou reservoir area although it will also become involved in other provincial resettlement projects. Actual programs will be implemented at the county, town and village levels. The preferential policies of the province were reviewed in 1995 and seven policies were extended to the year 2004, including lower electricity tariffs.

60. Production development and job creation continue at Shuikou: by mid-1997 some 38439 jobs had been provided (for a resettler population of 67239 persons, or 57 percent). These jobs are in agriculture (18664), livestock (2231), enterprises (5797), third industry (5210), and other categories (6541). Close to half the labor force is now engaged in non-agricultural activities and as ECIDI has reported, more than half the area's income is derived from these non-agricultural activities. SRRO reported that as of mid-1997, some 259 enterprises were in operation, out of a total of 347 relocated or started since the beginning of resettlement. The reasons for the 88 fewer enterprises in operation include: (i) some no longer required (e.g. brick-making plants closed now that the housing has been constructed), (ii) some paper making plants closed for environmental reasons, 3) some merged with other enterprises, and (iv) there were bankruptcies. SRRO will be updating the inventory of active enterprises, using county data. This information is required for the completion report and should therefore be made available to the Bank before the end of 1997.

ECIDI - Independent Evaluation of Resettlement.

61. Discussions were held with ECIDI staff on the results of the 1996 field survey work undertaken; this field work was the last phase of the 5-year program which consisted of collection of baseline data and four subsequent annual updates. The 1996 field work collected 1995 data from 35 villages and 524 households. The evaluation base is now complete, showing before moving data and comparable information for 1992, 1993, 1994, and 1995. On an overall basis, the average person income more than doubled, from Y780 before moving, to Y 1640 in 1995. On an inflation-adjusted basis, the increase in real per person income averages about 15 percent over the period. There are now only 20 households (out of 524) that have a per person income below Y600; these are mostly households with only one person earning an income. At the same time, there are 40 households (out of 524) that have a per person income exceeding Y2500. While reservoir incomes are still below the provincial rural average by about ten percent, the difference is getting smaller; ECIDI expects that on average, resettler incomes will surpass rural provincial incomes by the year 2000, if the present trend continues.

62. With the issuance of Report No. 9 (received by the Bank on October 3, 1997), ECIDI has come to the end of the 5-year evaluation contract with FPEPB. While it will still prepare a summary report by mid-1998, the results of the evaluation are now available, showing that by any measure the reservoir population was better off in 1995 than before. The evaluation has proven to be a valuable exercise that was able to demonstrate in clear and quantitative terms the progress made over the 5-year period, allowing SRRO and the local governments to continue their efforts when field data showed that income re-establishment work was not yet completed. ECIDI has suggested that developmental planning should continue at the town and village levels, especially for those with below average performance so far. The finalization of the FPEPB/ECIDI evaluation contract should include making available to FPEPB all the field data and computations so that it will be possible for other parties (such as academics) to build on

this evaluation in the future and allow them to identify individual households for follow-up visits.

63. The mission, with the assistance of FPEPB, SRRO ECIDI and local leaders carried out a three-day reservoir area inspection tour, visiting enterprises and households. The overall conclusion is that the economy of the area and of its households has developed well and is continuing to grow. Particularly, the completion of the new Highway 316 from Nanping to Fuzhou is assisting the area greatly in taking advantage of developmental opportunities. This transportation link will better connect the between-lying area to the Fuzhou and Nanping economies, substantially benefiting this area in the years ahead. It was also noted that reservoir navigation has expanded and is providing a major service to the region aided by the Shuikou Dam shiplock now in operation.

64. The mission also took the opportunity to review with ECIDI and SRRO the draft completion report on resettlement prepared by the Bank. This report will eventually be published (at least internally within the Bank and possibly externally) and should demonstrate that Shuikou is an outstanding example of the preparation and implementation of a resettlement project in China. In order to finalize the report, it is necessary for SRRO to provide up-to-date information as requested, before the end of October 1997.

Operations of the Shuikou Power Plant

65. By the end of June 1997, the Shuikou power plant had generated 16350 GWh, 564 GWh in 1993, 2,960 GWh in 1994, 4,770 GWh in 1995 and 4,498 GWh in 1996 and 3558 GWh up until the end of June, 1997. Both the 1995 and 1996 figures are close to the design average energy generation of 4950 GWh and the projected figure of 5,400 GWh for 1997 will substantially exceed it. The 1995 figure was achieved with only five units generating throughout the high flow season because of favorable hydrology. The 1996 figure was achieved with only six units installed during the wet season and average flow throughout the year being only 83 percent of normal (37.5 billion m³ in comparison with 54.5 billion m³). The expectation therefore is that actual average energy generation will exceed that projected at the design. This can be attributed to higher equipment efficiencies than originally projected, and efficient operations, generally maintaining water level in the reservoir as high as possible to maximize head, while using flood warning systems to anticipate high flows and to reduce reservoir level in preparation for them. In this respect, the accuracy of the flood warning system is particularly impressive.

66. The mission received the Chinese version of a table comparing certain key performance indicators with national and international standards. *It requested that an English version of this table be included in the revised ICR together with descriptions and formulae defining the parameters. A breakdown of the station operating cost was also requested.*

Grid Automation Components

67. The *Energy Management System (EMS)* contract, with Siemens Empros (USA) is generally completed. Field testing was completed on September 12, 1996 and the final payment was made on that date. The equipment is generally in operation. However, there are a few functions which are not entirely satisfactory which could benefit from a follow-up trip by the supplier. He is reluctant to do this because of the very low price quoted for these functions. The mission advised FPEPB personnel that the Bank would have no objection to them agreeing with the manufacturer that they pay for a follow-up visit which could be financed from the Bank loan. However, the visit should be completed and an invoice presented before the closing date of the loan..

68. With regard to the *Microwave Communication* contract with Siemens Itatel (Italy), equipment was delivered before the end of 1996, and installed in January, 1997. The trial operation did not fully meet specifications, with software requiring some refinement and some components missing. The manufacturer sent personnel to correct deficiencies but some remain. In a recent meeting in Fuzhou, the contract manager agreed with FPEPB the outstanding problems and agreed to correct them expeditiously. FPEPB is still withholding 10 percent retention on this contract which appears to be justified. However, it will be necessary to convert the retention into a Bank guarantee if the problems are not corrected before the closing date.

Shuikou Quanzhou 500 kV Transmission Component (Loan Amendment)

69. **ICB Equipment.** The 500 kV component was appraised during the April, 1996 mission, and amendment proposals were approved by the Board in July 1996. Bidding documents were basically completed in June, 1996 and 14 of the 16 contracts signed by the end of January, 1997. For various reasons, award of two smaller contracts for energy metering and 220 kV power cables connecting the 220 kV and 500 kV switchyards at Shuikou were delayed but these were eventually signed in September, 1997. Contract additions for four contracts were also agreed by the Bank and these have also been signed. Delivery of all equipment is scheduled to occur before the end of 1997 except for the two small contracts mentioned above, with a total value of about \$2.0 million, where deliveries are scheduled to occur in January and early-February.

70. **Substations.** For both Quanzhou and Shuikou substations, civil works are virtually complete and installation contractors have mobilized to prepare for equipment installation. Equipment installation is expected to be completed in January 1998. Testing and commissioning will be carried out in February and March, 1998. Although there have been some equipment delivery delays this is generally in accordance with the schedule reported to the last mission.

71. **Transmission Lines.** The transmission lines includes upgraded and newly built sections. The newly built section consists of 113.35 km with 234 towers. Concrete foundations have now been completed and steel towers erected. However, due to delays

in delivery of OPGW equipment only 45 km of line have been tensioned which is slightly behind schedule. Re-stringing of the section to be upgraded will be carried out during October, 1997 to January, 1998, during the period of low flow in the Min River, when the output of the Shuikou power plant can be limited to the capacity of the remaining transmission lines without resulting in spill.

Technical Assistance and Training Components

72. All studies and training programs have now been satisfactorily completed. The mission requested that the completion report include a brief write-up on the studies carried out under the second project in the completion report. These include the commercial management and planning study carried out by EDF, the extension of Study A by Monenco (which should also report on the preparatory stages: the hydro inventory update and gas turbine study).

FPEPB Financial Status

73. Latest audited financial reports cover the period up until December 31, 1996. During this period FPEPB's electricity sales were 19,461 GWh, compared with 17,578 GWh in 1995, a 10.7 percent increase. The average sales tariff was 34.1 fen/kWh (including VAT), 3.8 fen or 11 percent more than in 1995. Operating revenues and net income before taxes were Y6,636 million and Y363 million, representing increases of 24.5 percent and 9.3 percent respectively. Total assets increased 21.8 percent to Y20,266 million with the commissioning of further units of Shuikou power plant. Financial covenants under the second loan were met with debt service ratio of 1.5 (compared with 1.5 covenanted), debt equity ratio 1.5:1.0 (compared with 3.0:1.0 covenanted) and self-financing ratio 42.5 percent (in comparison with 30 percent covenanted). The satisfactory 1996 results were achieved despite the fact that it was a year of unfavorable hydrology, with flows at Shuikou being only 83 percent of average. In 1997, flows have been higher than average and substantial improvement can be expected. It can be concluded that FPEPB's financial performance continues to be satisfactory.

FPEPB Tariff Reform

74. (Progress since the last mission to be completed.) The mission requested that a summary of tariff reform activities during the second project (including the tariff study) be included in FPEPB's completion report.

Closing Date

75. The closing date for the second loan is December 31, 1997. However, as reported above there are two small contracts for which payment will not become due until February, 1998. The mission agreed to raise with Bank management the possibility of a three month extension of the closing date and advise FPEPB accordingly. However, a commitment has been made to produce the Bank's ICR during the current fiscal year

ending June, 1998, so that three months is the maximum extension that might be anticipated. The mission will advise the Bank's position by the end of October. If an extension is not forthcoming, it will be necessary to investigate the possibility of a contract amendment to provide for advance payment in exchange for a Bank guarantee.

Completion Reports

76. The Mission received a draft completion report from FPEPB (including SHPC) together with an updated comprehensive resettlement report from SRRO, the latest evaluation report from ECIDI, and a completion report from MKE. These reports considerably facilitated the completion mission. Discussions over the course of the mission focused on these reports. Some areas where additions have been requested have been mentioned above. These and other areas where elaborations or additions have been requested are attached as an annex to this aide memoire. the mission requested that the revised report be sent to Washington by end-November, 1997.

Use of Savings

77. During the course of the mission, various parties (including SHPP and the system dispatch department) requested that the Bank finance small additional expenditures for spare parts, equipment upgrades etc. The mission indicated no objection to this in principle, and the procurement rules under the project allow for fast procurement of such equipment. However, it is emphasized that payments should become due by the closing date discussed in the previous paragraph.

FPEPB Completion Report Requested Additions/Elaborations

Environment Report

1. It was requested that the Environment annex prepared for the completion of the first loan be updated and reissued. This should cover water quality results since the previous issue and ongoing implementation of the EMP.

Resettlement Report

2. Tables for completion were provided to FPEPB

Main Report

3. Additional Information was requested in the areas of technical assistance, power station performance indicators, power station operating cost breakdown and tariff reform as indicated in the body of the aide memoire.

Cost Estimates

4. To allow direct comparison between actual costs and those projected in the first and second appraisal reports, the following elaborations were requested.
5. Tables similar to those provided for the first ICR, giving expenditures by year with separate tables for local and foreign currency should be provided for the following components:
 - (a) The *original project scope* covered by the first Shuikou loan. The actual costs should exclude the 500 kV transmission line to East China since this was deleted. MKE charges should be counted as Engineering (not technical assistance). Foreign expenditures for resettlement should be included under this heading rather than Metalworks. It would be reasonable to include studies and training for both phases under technical assistance since Phase expenditures were relatively small and not counted as additional scope in the SAR for the second loan. Expenditures which were intentionally excluded from the costs in the first SAR (such as the railway) should be excluded (but noted in footnotes).
 - (b) *Additional Scope* as indicated in second ICR should separately cover all shiplift costs, and grid automation (including communications).

- (c) *Shuikou Quanzhou Transmission* as covered by loan amendment submitted to Board. This should also include local costs since these were included in the submission to the Board.

Energy Prices for Economic Analysis

6. For examining various measures of willingness to pay, the following information was requested:

- (a) FPEPB average selling tariff 1997 (including VAT).
- (b) An estimate of average surcharge beyond the FPEPB tariff, whether imposed by FPEPB, national, provincial or local governments. Adding this to the FPEPB tariff should give average value paid by final consumers.
- (c) FPEPB purchase cost for Shuikou power (at powerhouse (busbars or transformers)).
- (d) FPEPB average purchase cost (from power plants or other systems)
- (e) Largest purchase cost paid or projected to be paid to any power plant (in 1997 prices). Explain which one.

FPEPB transmission losses (percent). Difference between power sold and power purchased from power plants.