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IMPLEMENTATION COMPLETION REPORT

CHINA

ERTAN HYDROELECTRIC PROJECT

(LOAN 3387-CHA)

May 15, 1997

Infrastructure Operations Division
China and Mongolia Department
East Asia and Pacific Regional Office

CURRENCY EQUIVALENTS

Currency Unit: Yuan (Y)

At Appraisal (April 1, 1991) $1=Y5.24

Exchange Rates During Project Years

Year	Ave.
1991	Y 5.36
1992	Y 5.49
1993	Y 5.75
1994	Y 8.60
1995	Y 8.30
1996	Y 8.30

WEIGHTS AND MEASURES

Metric System

FISCAL YEAR

January 1 to December 31

ABBREVIATION AND ACRONYMS

CHIDI	Chengdu Hydroelectric Investigation & Design Institute
DRB	Dispute Review Board
EA	Environmental Assessment
EEC	Ertan Engineering Corporation
EHDC	Ertan Hydroelectric Development Corporation
EMP	Environmental Management Plan
ERP	Environmental and Resettlement Panel
PPA	Power Purchase Agreement
GOC	Government of China
SBC	Special Board of Consultants
SDB	State Development Bank
SDIC	State Development Investment Corporation
SEPC	Sichuan Electric Power Company
SIC	Sichuan Investment Company
SPRO	Sichuan Provincial Resettlement Office
WHO	World Health Organization

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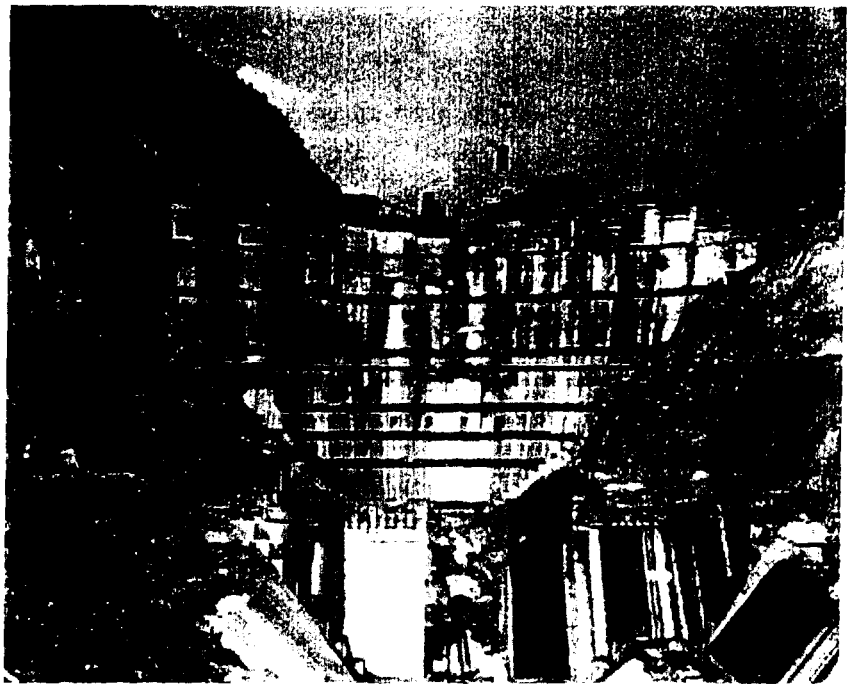

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PREFACE

This is the Implementation Completion Report (ICR) for the first phase of the Ertan Hydroelectric Project in China, for which two consecutive loans have been provided. The first loan (Loan 3387-CHA) in the amount of $380 million was approved on July 2, 1991 and made effective on September 6, 1991. To complete the construction of the project, a second loan (Loan 3933-CHA) in the amount of $400 million was subsequently approved on August 22, 1995 and made effective on January 17, 1996.

The first loan was closed on December 31, 1996, as originally scheduled. It was fully disbursed, and the last disbursement took place on December 17, 1996.

This ICR covers the implementation of the first phase of the project for the period up to September 1996. It was prepared by Junhui Wu with the assistance of Barry Trembath and Noureddine Berrah, Infrastructure Operations Division, China and Mongolia Department of the East Asia and Pacific Region, and reviewed by Mr. Richard Scurfield, Division Chief, and Mr. Yo Kimura, Project Advisor.

Preparation of this ICR was begun during the Bank's supervision mission in November 1996. It is based on the Staff Appraisal Report, the Loan and Project Agreements, Supervision Reports, correspondence between the Bank and the Borrower/ Beneficiary, and interviews with Bank and Borrower/Beneficiary staff involved in project implementation. The Borrower/Beneficiary contributed to the preparation of the ICR by preparing their own evaluation of the execution of the project, and by providing comments on the draft Bank ICR that were incorporated in the final version.

CHINA

ERTAN HYDROELECTRIC PROJECT

(LOAN 3387-CHA)

EVALUATION SUMMARY

Introduction and Project Objectives

1. The Ertan Hydroelectric Scheme is located on the lower reaches of the Yalong River in the southwestern province of Sichuan. Shortages of electricity in the province were, when the project was identified, and still are a major constraint to its economic development and to the improvement of the population's living standards.

2. The objectives of the Project were to: (a) provide additional generation capacity in Sichuan Province to alleviate the acute shortage of electricity; (b) assist in the transfer of modern power technology and efficient dam construction method; (c) contribute to further improvements in the analyses of environmental and ecological impacts of hydroelectric resource development; (d) enhance the institutional development of the beneficiary, Ertan Hydroelectric Development Corporation (EHDC), by strengthening its organization through a comprehensive management training program and introduction of economic efficiency and sound pricing principles; and (e) provide technical assistance in project design and implementation, and for the promotion of the optimal operation of the power system, prudent financial management, and manpower development.

3. The project consisted of: (a) preparatory works; (b) construction of a parabolic, double-curvature arch dam (240 m high) across the Yalong River together with an underground powerhouse complex, a log conveyance system, and appurtenant works and structures; (c) provision and installation of six 550-MW generating units and associated equipment; (d) resettlement of about 45,812 people affected by the project; (e) an environmental science station and management program; (f) consultancy services for engineering, procurement, construction management, and preparation of future power projects; (g) studies of power pricing and power plant and reservoir operation; and (h) strengthening EHDC's organization, technical assistance and staff training, together with related equipment and accessories.

4. The design of the project responded to the country's regional and sectoral objectives at the time of appraisal. The project objectives were consistent with the Government's strategy to accelerate the development of the large and economic hydroelectric potential and the Bank's country assistance goals regarding transfer of appropriate modern technology, staff training, and modern utility practice. Phasing of Bank support for the project, with Loan 3387-CHA ($380 million) followed by Loan

3933-CHA for $400 million, is considered appropriate given the project's long gestation period. It allowed the Bank to assist EHDC in better addressing environmental and resettlement issues and complying with environmental and resettlement guidelines issued after appraisal.

Implementation Experience and Results

5. The progress made toward achieving the primary objective of the project, i.e., to build a hydroelectric scheme of 3,300 MW, has been very satisfactory. All the key target dates of physical construction were met. The Yalong River was successfully diverted in November 1993. By the end of October 1996, excavation for the dam and the underground powerhouse complex were virtually completed. Concrete placement is generally on schedule despite delays at the earlier stage. The dam is approximately half complete in terms of both height and volume. Reservoir filling will start in Spring 1998 as scheduled. This laid a solid ground for timely completion of the second phase of the project.

6. The latest estimates of the project cost to completion (excluding interest during construction) are $941.87 million in foreign costs and Y 10,653.86 million in local costs, equivalent to a total of $2,282.41 million. In comparison with appraisal estimates, there is an overall cost overrun of about 21 percent when expressed in US dollars and 60 percent when expressed in local currency, in which the foreign cost overrun is about 5 percent. The cost overrun is largely due to (a) the higher-than-expected inflation in China (an inflation rate of 5 percent per year for 1993-2000 at appraisal compared to actual rates of 24 percent in 1993, 19.5 percent in 1994 and 14.9 percent in 1995), (b) the devaluation of US dollar against major European currencies during 1992-96, and (c) the devaluation of the local currency against the US dollar from an exchange rate of Y 5.24/$1 at the time of appraisal to Y 8.30/$1 in 1996.

7. If actual expenditures and latest estimates are de-escalated to the appraisal date, then overall costs are about 22 percent above those originally anticipated. This can be largely explained by the cost overrun in real terms of three components: (a) resettlement by 138 percent ($130.4 million equivalent), (b) engineering/contract administration/ technical assistance by 223 percent ($162.2 million equivalent), and (c) civil works for the dam by 7 percent ($42.1 million). Large resettlement cost overruns are partly attributable to the lesser preparation status of the resettlement component at the outset of the project,[1] and partly to the fact that increases of resettlement costs substantially exceed general inflation rates in times of dynamic economic growth. Significant cost increases had occurred in both local and foreign components of engineering/contract administration. The large overrun in local costs is attributable to the fact that wages and salaries in this area have risen much faster than the general inflation. In addition, in line with the corporatization of the power sector, all costs (direct and indirect) are now

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[1] The scope of resettlement changed over time from 30,000 persons to 45,812 persons.

charged to the project, in contrast to the earlier situation where significant proportions were off-budget. With regard to the foreign assistance in these areas, the budgeted level of effort, though it far exceeded anything previously used in China, still proved to be inadequate, and it is to EHDC's credit that they recognized this and increased expenditures in response to the need. The cost overrun in the civil works can be attributed to an inadequate contingency allowance to cover the claims resulting from unforeseen geological conditions. However, a 7 percent cost overrun for a civil contract of this magnitude is considered acceptable.

8. The project internal economic rate of return (IERR) has been recalculated using the most recent estimates of costs and benefits. The calculation is based on an economic cost 14 percent higher than the estimated economic cost at appraisal. However, in present value terms (both costs discounted to the same year at 12 percent), the revised cost is only 5 percent higher than the original estimates. The 5 percent cost increase would result in a reduced IERR from 14.90 percent (appraisal estimate) to 14.49 percent, if the benefits remain unchanged. However, given the profound changes in power pricing in China, benefits should also be revised. They are estimated based on a proxy of SEPC's (the buyer) willingness to pay for new generation at the plant gate (35.0 fen/kWh, 1996 price). This approach yielded an IERR of 16.11 percent, which is higher than the appraisal estimate (14.90 percent). This shows that the increased plant gate price (about 12 percent higher than the covenanted tariff in real terms) outweighs the cost overrun of the project. It should be noted that the above calculations have not taken into account the environmental benefits of the project. The project will avoid mining, transporting, and burning of some 10 million tons of raw coal a year in Sichuan Province, which has the highest level of air pollution in China. If environmental benefits, i.e., the avoided sulfur dioxide (SO_2), particulates (PM_{10}) and carbon dioxide (CO_2) emissions are considered, an IERR of 17.99 percent is obtained using the most conservative values of the externality cost of SO_2, particulates and the climate change. Finally, risk analyses have been performed using a probability approach to assess the impact of the perceived risk factors that affect the return of the project. Five broad categories of risk have been considered in the analysis, namely, demand risk, price risk, cost risk, operational performance risk and hydrological risk. The expected IERR, based on the weighted average of all simulated combinations is 15.81 percent, only about 0.3 percent lower than the base case value without consideration of project risks. This suggests that the uncertainty of the return of the project investment is much reduced at the completion of the first-phase construction and that the project's economic viability is robust.

9. Modern technology for construction of large-scale dams and powerhouses was successfully introduced through international consulting services and training. This is demonstrated by EHDC's capability in managing the critical path of a project of such magnitude and complexity and achieving timely implementation.

10. In the course of project implementation, the successful incorporation of EHDC as a limited liability company in accordance with China's new Company Law furthered power sector and enterprise reforms in the country. Improved corporate governance has

been achieved through the establishment of a Board of Directors. EHDC is now allowed to make important management and investment decisions on its own instead of seeking instructions from government agencies. The institutional capability of EHDC will be further strengthened following completion of the ongoing study on organizational restructuring and financial management. Implementation of the recommendations of the study will prepare EHDC to assume its role as the most important independent (nonutility) power producer in the province.

11. The resettlement task has been carried out successfully according to the resettlement implementation plan that was updated during preparation of the second project to incorporate lessons learned at that time from the first project. In total, 45,812 people needed to be resettled, in which 28,482 people live in rural areas. By the end of October 1996, 12,286 out of 28,482, or 43 percent of project-affected persons in rural areas were physically relocated. Resettlement activities have been intensified for the last two years and significant physical progress has been achieved in construction of the new town (housing 15,000 people), rural resettlement sites, and key infrastructure facilities, thus creating favorable conditions for completing all required resettlement work before the end of 1997. While urban resettlement in 1997 is well planned and organized, continuing resettlement efforts will concentrate on providing extensive assistance in relocating rural people, in particular, less able resettlers like the elderly.

12. The environment component has been proceeding satisfactorily following the environmental management plan (EMP). The environmental assessment (EA) and EMP were also revised for the second phase to comply with more stringent national EA procedures and Bank policies. Work under the first phase mainly comprised implementation of identified mitigation measures and establishment of environmental baselines for the reservoir and catchment area. The mitigation measures implemented include: (a) public health, schistosomiasis treatment and prevention, (b) construction worker health inspections, and (c) preservation of cultural relics. Through the comprehensive monitoring systems, a large amount of data has been collected covering meteorology, hydrology, water quality, sedimentation, and health. In addition, biodiversity investigations were conducted through field walks, sample surveys and interviews with the local peasants. These data will be used (a) to devise environmental mitigation measures as required and (b) to study the effects of large dams in the province to assist in the evaluation of future projects. The major tasks for the second phase will be to establish a conservation management zone around the periphery of the reservoir, building on the work completed during the first phase, and to promote and support catchment rehabilitation.

13. The achievements of the first phase can mainly be attributed to three factors: (a) the overall implementation organization was structured according to modern management practices; (b) the project executing agency, EHDC, was incorporated in the course of project implementation as a limited liability company with sole responsibility for construction and commercial operation of the Ertan scheme, and therefore had a strong sense of ownership; and (c) the efficient integration of the Advisory Group (which

comprises about 50 international experts specialized in different technical and managerial areas) into the project management team throughout the construction.

Summary of Findings, Future Operations, and Key Lessons Learned

14. The objectives of the project were consistent with those of the Chinese Government and the Bank. The progress made toward achieving all project objectives has been very satisfactory. The outcome is rated as highly satisfactory, and sustainability likely.

15. The project is now entering a new phase where construction priorities have gradually shifted from civil works to installation of electrical and mechanical equipment. Drawing lessons from other Bank-financed projects in China, the following measures have been taken to ensure a smooth implementation in the second phase: (a) conclusion of a single contract with one foreign firm assuming full responsibility for supply of both hydraulic turbines and generators. This would reduce interfacing problems and thereby reduce potential delays in equipment delivery, equipment defects and mismatching; (b) extension of consulting services provided by the Advisory Group into the second phase, with more emphasis on electrical and mechanical aspects; and (c) development of computerized project management systems that consist of a master schedule for civil works and erection of electrical and mechanical equipment, equipment and design drawing production and delivery control system and cost control system. The second-phase implementation will continue to be supervised and monitored in terms of physical construction, the environmental management program, resettlement action plan, institutional development and financial performance.

16. To prepare for future operation, EHDC has hired about 150 college graduates and sent them for one year of training in operating an existing large hydropower station. In addition, EHDC signed an agreement in 1996 with Gezhouba Hydropower Plant, which will assist EHDC in preparation, operation, and maintenance of the Ertan Hydropower Plant for the period 1996-2000. Preparation of performance indicators for future operation was discussed during the November 1996 supervision mission. Due to the need to incorporate the outcome of the optimization study (ongoing study) in the operation plan of the plant and reservoir, the operation plan including performance indicators will be prepared in 1997 when the study results become available and will be included in the ICR for the second project.

17. Ertan is the first large-scale hydroelectric project in China implemented entirely with international contracting and construction management procedures. Many of the difficulties experienced in implementing the new system were due to the relative newness of economic and enterprise reforms in China. In retrospect, it is doubtful whether matters could have been handled differently. However, given the economic and enterprise reforms that have now occurred and the prospects for even broader reform, it is possible to formulate key lessons from project implementation that will benefit future projects in

the sector, including the second phase of the Ertan Project. The key lessons are summarized as follows:

- In implementing a project of the magnitude and complexity of Ertan, implementation will be greatly assisted if an implementing organization is in place at the outset of the project, which is commercially independent and has full decision-making authority and responsibility for its performance. Initial delays in project implementation, resulting in sizable contractors' claims for acceleration of works, largely resulted from EHDC's inability to make timely decisions. The incorporation of EHDC in 1995 as a limited liability company following the promulgation of the new Company Law led to major improvements in this regard, allowing EHDC to make quick decisions on its own instead of seeking instructions from government agencies. This single factor is largely responsible for the recovery from earlier difficulties to the currently successful implementation and probability of timely completion of the second project.

- Prior to the start of construction, construction management personnel should be trained in contract administration and modern project management techniques. This training should include fairly lengthy assignments on ongoing projects where these techniques are in use. China routinely undertakes such training of operating personnel prior to the commissioning of all large hydropower plants and this is very successful. Similar training of construction management personnel will increase their competence and improve response time through allowing increased delegation rather than involving senior management in matters of detail.

- Improved communication among various parties (owner, engineer, designer, advisors and contractors, etc.) should be actively pursued from the outset, to avoid misunderstandings that could cause delays and/or losses to the project. Communication difficulties were perhaps the most difficult to resolve in construction of the Ertan scheme. The issue is not simply translation between different languages, but of communicating ideas and concepts across international boundaries of training and culture.

- Development of project management systems should also commence before construction in order to manage the construction more efficiently. These should include contractual documentation management systems, a project master schedule, procurement and delivery schedule for employer-supplied equipment, a design drawing control system and cost control system. EHDC has now developed systems in most of these areas, which has resulted in less exposure of EHDC to claims resulting from delayed supply of information or equipment.

- In the future, consideration should also be given to reducing interfacing by procuring equipment in smaller numbers of larger packages. In retrospect, the division of civil activities among the two major contractors was not ideal, resulting in an increased number of interfaces that led to contractual difficulties.

- With regard to resettlement, the lessons learned are the necessity to advance the preparation of the resettlement implementation plan at the outset of the project, which will allow a better coordination of various resettlement activities and more detailed cost estimates to be carried out. In this project, the problems encountered in implementing the resettlement component at the early stage were largely due to a lack of a detailed resettlement implementation plan, which was only completed in 1995. In addition, in preparing the resettlement cost estimates, adequate contingency allowances should be made to cover the costs of compensation and the measures necessary to restore incomes.

CHINA

ERTAN HYDROELECTRIC PROJECT

(LOAN 3387-CHA)

PART I: PROJECT IMPLEMENTATION ASSESSMENT

A. Project Objectives and Description

1. The Ertan Hydroelectric Scheme is located on the lower reaches of the Yalong River in the southwestern province of Sichuan. When the project was identified, the shortage of electricity in the province was a major constraint to its economic development and improving the living standards of the population.

2. The Government of China (GOC) has given high priority to electric power development. Its strategy is to accelerate the pace of hydropower development, construct large-scale and high-efficiency coal-fired thermal power plants, interconnect power systems through high-voltage extension of transmission networks, and replace obsolete generating plants. These measures will lead to improved energy efficiency and conservation, and therefore mitigate the adverse environmental impact of electric power growth.

3. On the institutional front, GOC's commitment to economic reform has called for modernizing the power sector and making it more efficient. A number of actions were taken to introduce modern energy technologies and modern construction management methods, increase the autonomy of power supply entities, and rationalize power pricing.

4. The design of the Ertan Project responded to the country's regional and sectoral objectives by: (a) providing additional generation capacity in Sichuan Province to alleviate acute shortages of electricity; (b) assisting in the transfer of modern power technology and efficient dam construction methods; (c) contributing to further improvements in the analyses of environmental and ecological impacts of hydroelectric resource development; (d) enhancing the institutional development of the beneficiary, the Ertan Hydroelectric Development Corporation (EHDC), by strengthening its organization through a modern management training program and introduction of economic efficiency and sound pricing principles; and (e) providing technical assistance in project design and implementation, and for the promotion of the optimal operation of the power system, prudent financial management, and manpower development. In particular, the project was consistent with the GOC goal of accelerating development of the country's large and economic hydroelectric potential and the Bank's country assistance goals regarding transfer of appropriate modern technology, staff training, least-cost investment planning, and modern utility practice. Phasing of Bank support for the project, with Loan 3387-

CHA ($380 million) followed by Loan 3933-CHA for $400 million, is considered appropriate given the project's long gestation period. It allowed the Bank to assist EHDC in better addressing environmental and resettlement issues and complying with environmental and resettlement guidelines issued after appraisal.

5. The Ertan Hydroelectric Project consisted of :

(a) preparatory works;

(b) construction of a parabolic, double-curvature arch dam (240 m high) across the Yalong River, together with an underground powerhouse complex, a log conveyance system, and appurtenant works and structures;

(c) provision and installation of six 550-MW generating units and associated equipment;

(d) resettlement of about 45,812 people;

(e) an environmental science station and management program;

(f) consultant services for engineering, procurement, management of construction, and preparation of future power projects;

(g) studies of power pricing and power plant and reservoir operation; and

(h) strengthening EHDC's organization, technical assistance and staff training, together with related equipment and accessories.

6. In the course of project implementation, in February 1995, EHDC was incorporated as a limited liability company (known as Ertan Hydropower Development Limited Liability Company) in accordance with China's new Company Law. It has three shareholders: the State Development and Investment Corporation (SDIC), Sichuan Investment Company (SIC) and Sichuan Electric Power Company (SEPC). The Board of Directors consisting of 10 members was established at the same time, with its role being to represent the interests of the shareholders, appoint and dismiss the general manager and high-level staff, and supervise the management of the Company. Members of the Board of Directors are appointed by the shareholders. In May 1995, the Board of Directors appointed a new general manager and other high-level management staff of EHDC. In response to the need to prepare EHDC to assume the role as the most important independent power producer in the province for commercial operation of the Ertan scheme and for development of future projects on the Yalong River, the second project (Ertan II Hydroelectric Project) included a Reform Implementation Plan, supported by technical assistance and training to facilitate EHDC's transformation.

7. With regard to resettlement, there has been a change of scope in terms of the number of people to be affected. The first appraisal estimate was about 30,000 people,

based on 1984 census data. The Staff Appraisal Report (SAR) for the second project established that about 35,000 people would be relocated according to the revised plan based on a physical survey and demarcation of the reservoir boundary after the 1992 census. More recently, the scope of resettlement impacts was further revised by the Sichuan Provincial Resettlement Office (SPRO) to include those who will lose land only and do not require relocation, those who will be indirectly affected by sliding reservoir banks, and natural population growth until 1998. As a result, the total number of affected people increased to 45,812 persons, of which 28,412 live in rural areas. Meanwhile, the total budget of the plan was raised from Y 0.61 billion to about Y 2.0 billion and was approved by the central government in November 1996. The resettlement budget on a per person basis was more than doubled.

B. Achievement of Project Objectives

8. The progress toward achieving the primary objective of the project, i.e., to build a hydroelectric scheme of 3,300 MW, has been very satisfactory thus far. All the key target dates of physical construction were met. By the end of October 1996, the dam was approximately half complete in terms of height and volume. About 97 percent of the excavation work and 63 percent of the concrete work was complete for the underground powerhouse complex. The installation of electrical and mechanical equipment commenced as planned. This laid a solid ground for timely completion of the second phase of the project. The reestimated Internal Economic Rate of Return (IERR) is 14.26 percent using the most recent estimates of costs and benefits.

9. The modern technology for dam and power station construction was successfully introduced through: (a) the participation of the Advisory Group, which comprises 17 international experts on a permanent basis and about 30 on an ad-hoc basis specializing in different technical and managerial areas; (b) training courses conducted in management systems for hydropower construction and monitoring techniques for arch dams and underground works; and (c) project studies. This is demonstrated by EHDC's capability in managing the critical path of a project of this magnitude and complexity and achieving timely implementation.

10. EHDC was the first commercially independent power enterprise to be the beneficiary of a Bank-financed power project in China. The successful incorporation of EHDC furthered power sector and enterprise reforms in the country. EHDC's corporate governance has been improved by the establishment of a Board of Directors following its incorporation. This allows EHDC to make important management and investment decisions on its own instead of seeking instructions from government agencies. The institutional capability of EHDC has been improved during project implementation and will be further strengthened upon completion of the ongoing study on organizational restructuring and financial management.

11. The resettlement of the affected population is being carried out successfully according to the resettlement implementation plan. By the end of October 1996, 12,286

out of 28,482, or 43 percent of project-affected persons in rural areas were physically relocated. To date, Y 947 million has been spent on resettlement. Significant physical progress was achieved in construction of the new town, rural resettlement sites and associated facilities, thus creating favorable conditions for completing all required resettlement work before the end of 1997.

12. Progress toward improving analyses of environmental and ecological impacts of hydropower development was satisfactory. With assistance from a variety of international experts, EHDC has been monitoring meteorological, hydrological, water quality, sedimentation, and sanitation aspects of the project since 1993. Nine new meteorological stations have been built and functioning since April 1996 and will provide 2-3 years' data before the filling of the reservoir scheduled in spring 1998. Three major biodiversity surveys have been fielded so far to collect samples and specimens, which covered the whole catchment area. These data will be used (a) to devise environmental mitigation measures as required, and (b) to study the effects of a large dam to assist in the evaluation of future projects.

13. Financial performance was not reassessed at this stage because the project is still at the construction stage. It will be fully assessed in the ICR for the second-phase project (Ln. 3933-CHA).

C. Implementation Record and Major Factors Affecting the Project

Implementation Organization

14. EHDC is the executing agency for the project. It has assigned construction supervision and management responsibility to Ertan Engineering Corporation (EEC), which is a subsidiary of EHDC, specially set up for the project. Chengdu Hydroelectric Investigation and Design Institute (CHIDI) was contracted as the designer of the project. CHIDI is one of the most experienced design institutes in China and has been responsible for the design of several large hydroelectric projects. Since the start of project preparation, CHIDI and EEC have been assisted by an Advisory Group consisting of international consultants, as well as three expert panels: the Special Board of Consultants (SBC), the Environmental and Resettlement Panel (ERP), and a Dispute Review Board (DRB). The SBC and ERP are composed of prominent foreign and Chinese experts in their respective areas and have convened regularly to review and advise on important technical and management matters. With the progress of the project, a mechanical and electrical branch of SBC also met to review bid documents for the main equipment. The DRB was set up to facilitate prompt resolution of disputes relating to civil works contracts. The contractors and EHDC each selected a member of the DRB and the third member, the chairman of DRB, was selected by the two sides.

15. Resettlement of people and reconstruction of structures being displaced by the reservoir and the construction site areas are carried out by SPRO, which is a governmental body responsible for resettlement associated with large-scale hydropower projects. EHDC signed a contract for independent monitoring and evaluation of the

resettlement program in October 1994 with the Resettlement Engineering Development Center of Sichuan Province (REDC), which has a staff of 25 professionals.

Implementation Schedule

16. The implementation schedule established in the SAR of the first project required commencement of the main civil works on September 15, 1991, river closure by December 1993, commissioning of the first unit on July 1, 1998 and the last unit on April 1, 2000, and project completion by the end of the year 2000. Critical intermediate dates for commissioning of the first unit are completion of powerhouse draft tube liner of the first unit on October 1, 1996 and reservoir filling in spring 1998. It is a very demanding schedule to build this large and complex a hydroelectric scheme in only nine years instead of the originally planned 12 years, even for an experienced international contractor. The nine-year implementation schedule was slightly revised in the SAR of the second project by advancing the commissioning operation of the first unit by one month and the last unit by four months.

17. Despite some delays at various stages, but particularly at the beginning, project management with the support of all concerned parties has been able to recoup the delays and keep the construction on schedule (see Figure 1). The two major contractors of civil works (Lot I for the dam and plunge pools, and Lot II for the underground powerhouse complex) started work on September 15, 1991 as planned. The Yalong River was successfully diverted in November 1993, one month ahead of schedule. The dam foundation excavation was completed by January 1995. There was a five-month delay in starting dam concrete placement; however, the accumulated delays were substantially recovered in 1996. The monthly concrete production exceeded 200,000 m^3 in October 1996, of which 150,000 m^3 were placed in the dam. At the beginning of November 1996, the arch dam was about 150 meters above ground level (designed height 240 m).

18. For underground works, excavation was substantially completed in the powerhouse cavern, headrace tunnels, the main transformer chamber, tailrace surge chambers and tailrace tunnel No. 2. Excavation is continuing on tailrace tunnel No. 1. Power conduits and penstock tunnels were completed in advance of the date required. The draft tube liner of the first unit (Unit 6) was completed three months ahead of schedule. By the end of October 1996, embedding the steel lining of the draft tube for the second unit (Unit 5) was nearly completed and embedding the lining for the third unit (Unit 4) was ongoing. The erection bay was handed over for installation of electric and mechanical equipment by the milestone date (August 1, 1996). Regarding the construction of log-passing facilities, there were delays due to modification of the design and a landslide that occurred in June 1996. EHDC has recently negotiated an agreement with the Lot I contractor for partial completion of the log-passing structure by August 1997 and overall completion by the end of 1997. No major problems are foreseen in this work.

19. The contract for erection of electrical and mechanical equipment (Lot III) was awarded on February 29, 1996. Notice to proceed was issued on April 1, 1996. Construction at the gas-insulated switchgear (GIS) yard started on June 1, 1996. Soil conditions and requirements for additional excavation and rock support caused some initial delay. However, structural concrete work is now underway and progressing satisfactorily on an accelerated basis to overcome the time lost. By the end of October 1996, erection of discharge and stay rings for Unit 6 was completed and 75 percent of the spiral case segments were set and welding had begun.

20. Major factors causing the delays were:

(a) **Institutional Problems**. At the early stage of project implementation, EHDC's inability to make quick decisions to solve problems encountered during the construction was the major cause for initial delays. This was largely overcome after the incorporation of EHDC in 1995.

(b) **Unforeseen Geological Conditions, such as Rockbursts, Rock Movements and Cracking, and Landslides**. Two major rock bursts occurred in the powerhouse complex. There has been considerable additional support work carried out in critical areas. This was done without significantly affecting critical activities although a major claim is expected.

(c) **Problems Experienced in the Aggregate Production Plants**. This includes undersized and improperly selected equipment and lack of maintenance. In addition, the primary crusher had a major breakdown for two months in December 1995 and January 1996. This was overcome by the addition of supplementary equipment and improvement of maintenance, so that aggregate production is no longer a critical path item. Concrete production reached 200,000 m^3 per month in October 1996.

(d) **Late Delivery of Drawings by CHIDI**. This caused a significant delay and has become a major concern. Late delivery and defects of employer-supplied equipment and materials also caused delays. However, EHDC substantially increased communication in this area, and project delays and claims due to drawing delays are expected to decline. Other measures also being taken to ensure timely delivery of drawings and employer-supplied equipment and materials include development of computerized project management systems.

21. During the last few years, EHDC developed a number of computer databases to keep records of project activities. However, the databases were not interrelated and did not have the capability of scheduling and coordination. EHDC has undertaken to develop an integrated computerized project management system to identify the critical path items at any moment of construction and to coordinate all related activities. By the end of October 1996, the master schedule was developed in some detail and continued to be

elaborated in critical areas, particularly those that have numerous interfaces between contractors, equipment suppliers and/or designers. Systems for tracking the status of equipment production and delivery, including production and review of manufacturers' drawings, have also been largely developed, and continue to be refined.

Project Costs

22. The estimated cost of the project at appraisal (excluding interest during construction) was $896.4 million in foreign costs and Y 5,679.2 million in local costs, equivalent to a total of $1,885.5 million. The latest estimates of the project cost to completion were $941.87 million in foreign costs and Y 10,653.86 million in local costs, equivalent to a total of $2,282.41 million (see Table 8). In total, there is a cost overrun of about 21 percent when expressed in US dollars and 60 percent when expressed in local currency. The cost overrun is largely due to: (a) the higher-than-expected inflation in China (an inflation rate of 5 percent per year for 1993-2000 was projected at appraisal compared to actual rates of 24 percent in 1993, 19.5 percent in 1994 and 14.9 percent in 1995, see Annex 5); (b) devaluation of the US dollar against major European currencies during 1992-96, which resulted in exchange losses of $63.34 million; and (c) the devaluation of the local currency from an exchange rate of Y 5.24/$1 at the time of appraisal to Y 8.30/$1 in 1996. The foreign cost overrun is about 5 percent (equivalent to $ 45.5 million) when expressed in US dollars, which can be attributed to: (a) the procurement of power transformers changed from local to foreign suppliers ($17.9 million); (b) increased person-months for engineering and contract management ($21.8 million); and (c) a combination of exchange losses and deduction of duties and taxation. With regard to local costs, significant cost variations were found in the following components:

	SAR estimate (including contingencies) (Y million)	Actual/latest estimate (including contingencies) (Y million)	Increase (%)
Resettlement & land acquisition	635.8	2,259.49	255.0
Arch dam (Lot 1), local portion	1,828.01	2,552.02	39.6
Engineering /contract admin./ technical assistance, local portion	366.9	1,800.28	390.7

23. Analyses of base cost estimates indicated that costs for resettlement and engineering/contract administration/technical assistance were largely underestimated. The scope of resettlement changed from 30,000 persons to 45,812 persons over the time, and the resettlement cost on a per person basis more than doubled. Regarding the cost of engineering/contract administration/technical assistance, for the local portion, there is a significant real increase of person-month rates (almost quadrupled in five years). For the foreign portion, there is an increased scope for consulting services for construction management, totaling about 600 person-months (see para. 26).

24. To verify the adequacy of various contingencies, detailed analyses have been carried out for the two major civil contracts, i.e., Lot I (dam) and Lot II (underground powerhouse). In terms of physical contingencies including changes in bill of quantities, variation orders and claims, it was found that the original estimate of 10 percent for Lot I is inadequate in comparison with the actual increase of about 16 percent and that the original estimate of 20 percent for Lot II is close to the actual increase of about 22 percent. The difference in contingency allowances arises from the difference in the type of work. Allowance of 20 percent and 10 percent is generally considered appropriate for underground and surface work respectively. However, in retrospect, quantities and costs for Lot I were also subject to considerable variations due to geological conditions. Unforeseen geological conditions are a large factor in claims for extension of time, which were eventually resolved through approval of additional costs for acceleration.

25. With respect to price contingencies, it was found that the price contingency for foreign currency adequately covered actual inflation except for foreign exchange losses resulting from the devaluation of US dollars against major European currencies. The exchange losses were, however, largely offset by deduction of duties and taxes. The price contingency for local currency was significantly lower than the actual inflation level.

26. In order to exclude the effects of inflation and devaluation, a more accurate cost analysis has been carried out by de-escalating both foreign and local costs to the appraisal date, using respective foreign and local inflation rates, combining the two at the appraisal exchange rate, and comparing the resultant value with the appraisal estimates (including physical contingencies). This analysis indicates a total cost overrun of about 22 percent, which can be largely explained by the cost overrun of three components: (a) resettlement by 138 percent ($130.4 million equivalent), (b) engineering/contract administration/ technical assistance by 223 percent ($162.2 million equivalent), and (c) the Lot I contract by 7 percent ($42.1 million). The large resettlement cost overrun has been the norm for hydroelectric projects in China. They are partly attributable to the lesser preparation status of the resettlement component at the outset of the project, and partly to the fact that increases of resettlement costs substantially exceed general inflation rates in times of dynamic economic growth. Significant increases occurred in both foreign and local components of engineering/contract administration. With regard to the foreign assistance in these areas, the budgeted level of effort far exceeded anything previously used in China. In any event, it proved to be inadequate, and it is to EHDC's credit that they recognized this and increased expenditures in response to the need. The large overruns in local costs is attributable to the fact that wages and salaries in this area have risen much faster than the general inflation. In addition, in line with the corporatization of the power sector, all costs (direct and indirect) are charged to the project, in contrast to the earlier situation where significant proportions were off budget. The cost overrun in the civil works can be attributed to unforeseen factors not taken into account in the contingency allowance as explained above.

27. An arrangement has been made to enhance the cost control in executing the second phase. A cost control system is being developed, which would provide periodic

updates of current committed costs and expected costs to completion in the two currencies of US Dollars and Renminbi. This system will be fully in place by the end of May 1997. The agreed budget for Phase II advisory services includes provisions for a cost engineer to initiate the cost control system and support it for a period of 18 months so that it will be fully established and can be continued by others.

Procurement and Disbursement

28. The project included 38 major procurement contracts, of which 9 entailed international competitive bidding (ICB). The total amount of the procurement contracts including the second phase was $2,350.3 million equivalent, of which $1,655.8 million equivalent was under ICB packages. All procurement activities for the project were performed in accordance with the Bank's procurement guidelines and were generally carried out satisfactorily. Involvement of foreign engineering consultants in the procurement process and the use of Model Bidding Documents contributed to efficient procurement. Disbursements were made ahead of the original estimates. The last disbursement was made on December 17, 1996.

29. Procurement was largely carried out as scheduled. The two major civil works contracts were signed six days before the loan effective date, using retroactive financing. This allowed timely commencement of civil works. Delays occurred in two major procurement items, i.e., a seven-month delay for main transformers and a one-year delay for gates and hoists. However, delivery of these items was not on the critical path of construction. By the end of 1996, all major contracts were awarded, requiring no major procurement tasks for the rest of the project period.

30. The major civil works contracts (Lots I and II) were awarded to two joint ventures respectively, each consisting of a number of foreign and domestic contractors. Both contracts were signed on August 31, 1991. Lot 1 consists mainly of the dam and plunge pool. Lot II is for the underground powerhouse, two spillway tunnels, a log-passing tunnel, and two diversion tunnels. In retrospect, the division of civil works among two major contractors was not ideal, resulting in an increased number of interfaces that led to contractual difficulties. The contract for Lot III, installation of electrical and mechanical equipment was awarded on February 29, 1996 to a joint venture of three local contractors and a local equipment supplier.

31. For supply of electrical and mechanical equipment, a single contract was concluded on March 28, 1994 with a foreign manufacturer for supply of both hydraulic turbines (6 sets) and generators (6 sets). Although four out of the six turbines and generators will be supplied by the local manufacturers through subcontracting, the foreign manufacturer will assume the full responsibility for the supply of all the contracted equipment. This would greatly reduce the interfacing problem and ensure timely delivery and quality of equipment. As the project is entering the phase of installation of electrical and mechanical equipment, EHDC is planning to meet with the foreign manufacturer to insist that they step up their control and supervision in all supplier factories.

32. For procurement of the main civil works, the DRB was set up to facilitate prompt resolution of disputes. Up to the end of 1996, 23 claims and disputes were handled. This has so far greatly accelerated the construction pace. However, dissatisfaction exists with recent DRB recommendations, which was not found adequately justified.

Consulting Services, Training and Studies

33. Due to the magnitude and complexity of the project, international consulting firms have been engaged throughout the project period to assist EHDC and CHIDI in construction management and design including contract administration, cost control, scheduling, construction inspection and quality assurance, design engineering services, and construction site administration. About 1,000 person-months of consulting services were contracted for the first phase of the project. These services were financed through grants, the Bank Group-supported Technical Cooperation Credit (TCC) and Loan 3387-CHA. The advisory services were performed satisfactorily and made a significant contribution to efficient project management.

34. The advisory service has been retained for the second phase of the project and the agreement was signed in December 1995. In total, 544 person-months were budgeted for the period from July 1995 to 1999. The budget covers the services of (a) the core advisory group providing general support and consultation on contractual matters, (b) the DRB, (c) specialists in civil, underground, mechanical and electrical engineering, (d) establishment of a cost control system, and (e) startup coordination during the commissioning stage. The projected level of input and the anticipated staffing mix is considered appropriate.

35. Project training concentrated on modern management of hydropower construction and decision-making techniques, particularly in project economics and investment planning, preparation of reconnaissance and feasibility studies, construction management, hydrology forecasting and measurements, monitoring procedures, resolution of claims and disputes, tariff and power pricing, financial management, environmental protection, human resettlement matters, safety and inspection of hydroworks, log transport facilities, and personnel management. Training was conducted both abroad and in China. Some domestic training was carried out by the Sino-Norwegian Training Center, sponsored by EHDC and a Norwegian group and supported by Norwegian grants. Other training was provided by a number of reputable Chinese universities and research institutes. In total, 228 persons received domestic training for 607 person-months. The international training, including visits to Canada, France, Norway and the United States, covered the subjects of monitoring techniques for arch dams and underground works, engineering management, environment and resettlement.

36. Three studies were envisaged in the SAR, namely, power pricing, optimization of plant and reservoir operations, and preparation of future power projects. Despite some delays in starting these studies, they were all carried out satisfactorily. The power pricing study was completed in April 1996. The optimization study and preparation of future

power projects study are expected to be completed in 1997. The results of the pricing study and optimization study have provided a sound basis for setting the price formula and dispatching provisions of a power purchase agreement (PPA). The PPA will be signed in June 1997, under which EHDC would sell electricity generated from the Ertan scheme to the Sichuan provincial grid. Since EHDC was incorporated as a generation company in 1994, the implementation of retail tariff reforms is no longer relevant and is carried forward by another Bank-financed project, i.e., the Sichuan Power Transmission Project. The results of the study for preparation of future power projects were approved by the Chinese authorities, and an investment is planned for a hydroelectric project (Guandi) to be built on Yalong River as part of the cascade development plan (see Table 7).

Resettlement

37. Resettlement was carried out satisfactorily according to the resettlement implementation plan, which was updated during preparation of the second project to incorporate lessons learned from the first project. In the initial period, only a small number of people who lived in the construction site were relocated. Most of them moved their houses to the higher elevation locations not far from their original homes. Resettlement activities have been intensified for the last two years with increased resettlement spending (Y 316 million for 1995 and Y 600 million for 1996). By the end of October 1996, 12,286 out of 28,482, or 43 percent of project-affected persons in rural areas were physically relocated, 397,603 m^2 of new houses were built and 14,501 out of 27421 mu, or 53 percent of farmland, was developed. Significant physical progress has been achieved in various aspects of the resettlement implementation, ranging from construction of Yanbian New Town (housing 15,000 people), the Hongge rural resettlement site (housing 7,000 people), the reservoir boundary road, and key irrigation facilities, thus creating favorable conditions for completing all required resettlement work before the end of 1997. While urban resettlement in 1997 is well planned and organized, continuing resettlement efforts will concentrate on providing extensive assistance in relocating rural people including transporting construction materials to the site, technical advice on house construction, and helping to build houses for less able resettlers, e.g., the elderly.

38. The major factor that affected the progress of resettlement was the delayed approval of the resettlement budget, which was only granted in November 1996 by the central government. Meanwhile, resettlement had to proceed without an approved budget. This slowed down the overall resettlement pace in 1995 and 1996 and a number of resettlement projects lagged behind their implementation schedule. The other factor that affected resettlement implementation was the lack of coordination mechanisms at the early stage to link the allocation of the budget to each county with the quality and pace of their resettlement implementation. Several rural settlements were built without proper design and planning, and lack of user participation. SPRO has recently revised its work plan and prepared a detailed timetable for each affected village, with milestone dates for each implementation phase, and its supervision and coordination activities will be

intensified in future implementation. In order to strengthen the training center of SPRO for population resettlement and environmental impact, a grant provided by the Institutional Development Fund (IDF) has been approved in association with the second loan. It was agreed that the first training activity will be focused on providing training for county-level resettlement staff of the Ertan project. The training will be held in Ertan during the first half of 1997.

39. Monitoring and evaluation of resettlement has been carried out by REDC. Key staff members of REDC participated in the workshop for resettlement monitoring and evaluation sponsored by the Bank and ODA in October 1994. Since then, resettlement monitoring and evaluation reports were produced regularly by REDC based on the results of their field surveys. The fourth and latest report covers the period up to April 1996. These reports provided a detailed review of the resettlement status, and more importantly, a detailed description of the changes of livelihood among resettlers.

40. The environment component has been proceeding satisfactorily following the environment management plan (EMP). The environmental assessment (EA) was revised for the second phase to comply with more stringent national EA procedures and Bank policies. The work carried out covered (a) public health and schistosomiasis treatment, (b) construction worker health inspections, (c) biodiversity surveys, and (d) preservation of cultural relics. Monitoring activities have so far focused on establishing environmental baselines of the reservoir and catchment area, which includes biodiversity studies in the reservoir area and monitoring systems in particular meteorological observatories. EHDC has maintained a team of more than 200 staff members engaged in environment-related activities.

41. Historically, four townships under the jurisdiction of Yanbian County in the location of the Ertan reservoir area had been an epidemic schistosomiasis area. The disease had generally disappeared but was recurrent on a small scale. A control and surveillance program was carried out with the assistance of the World Health Organization (WHO). An agreement for schistosomiasis prevention was signed with the Public Health Bureau of Yanbian County in February 1996 and Y 750,000 were spent on the program. The prevention program includes treatments for human and animal diseases, eradication of italics snails that are the intermediate host of schistosomiasis, and management of excrement. Public awareness has been greatly increased since then. However, recent investigation indicated that the snail eradication program has not been totally effective to date. There is a need to revise the scope of the current control program, and work in this regard is proceeding. Major preventive measures are planned to be implemented before impoundment begins and to be continued thereafter.

42. With regard to preservation of cultural relics, the task is undertaken by Panzhihua Resettlement Bureau, which concluded a contract with the Provincial Cultural Relics Management Department. Preliminary investigation of cultural relics in the reservoir area was completed in 1995. The work of unearthing the cultural relics will be completed by the end of 1997.

43. Preparation for the biodiversity investigation started in March 1995. The agreement on biodiversity studies in the Ertan Reservoir Area was signed with the Rare Fauna and Flora Research Institute of Sichuan Teachers' College in September 1995. Foreign experts were engaged for both the bird and fish surveys. Investigations were carried out through field walks, sample surveys, monitoring and interviews with the local peasants. Terrestrial biodiversity subjects investigated were comprehensive and included vegetation, birds, mammals, reptiles and amphibians. The aquatic biodiversity survey covered a large number of sites.

44. The monitoring systems started to function at different dates according to the object of monitoring. Water quality monitoring has been carried out since 1993, sedimentation and wastewater, noise and air quality, aquatic resources since 1994, land use and earthquake since 1995, water level/precipitation since 1996. Nine new meteorological monitoring stations have been built and functioning since April 1996 and staffed with professional meteorologists to provide 2-3 years' data before the reservoir impoundment. These data will be used (a) to devise environmental mitigation measures if required and (b) to study the effects of large dams in the province to assist in the evaluation of future projects.

45. Establishment of a conservation management zone around the periphery of the reservoir has been proceeding as planned. Large-scale mapping was delegated to the Forestry Department to allow them to carry out detailed planning of a 100 m wide buffer zone, the management of which will be covered by the EHDC budget. Construction of a perireservoir highway, which is a component of the resettlement plan, has caused some destruction of vegetation. EHDC has entrusted the construction company to take effective water and soil conservation measures to minimize the adverse impact of road construction. In the wider catchment area, the major issue identified in executing the EMP is human activity causing environmental degradation, due largely to inappropriate land use and insidious forest clearance. EHDC is taking measures to promote and support the catchment rehabilitation including a preliminary plan to develop part of the catchment area into a National Park. The Bank has cautioned that this will need careful planning to allow achievement of both tourism and conservation objectives. In addition, a workshop focusing on watershed issues for the five counties affected by the reservoir will be convened in Chengdu in 1997 by the SPRO Training Center.

Economic Rate of Return

46. At appraisal, the internal economic rate of return (IERR) was estimated at about 15.0 percent, based on the shadow-priced investment and O&M costs and the covenanted tariff level. The IERR was reestimated using the most recent estimates of costs (including sunk costs) and benefits. The calculation is based on an economic cost 14 percent higher than the estimated economic cost at appraisal. However, in present value terms (both costs discounted to the same year at 12 percent), the revised cost is only 5.2 percent higher than the original estimates. The 5.2 percent cost increase would result in a reduced IERR from 14.90 percent (appraisal estimate) to 14.49 percent, if the benefits

remain unchanged (see Case 2). In spite of the cost increase, the return of the project is still higher than the opportunity cost (12 percent) of capital investment in China.

47. However, given the profound changes in power pricing in China, the benefits also should be revised. They are estimated based on a proxy of SEPC's (the buyer) willingness to pay for new generation at the plant gate. The highest price that SEPC is current paying is 44.9 fen/kWh for purchase of power from a new coal-fired, fluidized-bed combustion thermal power plant. However, this price is considered rather high because of the new technology involved in the power plant. A better proxy of SEPC's willingness to pay is the average value (35.0 fen/kWh, 1996 price) for purchase power from new conventional coal-fired plants. This approach yielded an IERR of 16.11 percent. This shows that the increased plant-gate price (about 12 percent higher than the covenanted tariff in real terms) outweighs the cost overrun of the project.

48. A comparison of IERRs under different assumptions is shown below:

Case	Economic Costs	Benefits	IERR (%)
1	Appraisal Present value (1991) Y 5,568 million, 1991 price	Appraisal (covenanted tariff at plant gate, 16 fen/kWh, 1991 price)	14.90
2	Reestimated Present value (1991) Y 5,860 million, 1991 price	The same as appraisal	14.47
3	Reestimated Present value (1991) Y 5,860 million, 1991 price	Reestimated (proxy of SEPC's willingness to pay for new generation, 18 fen/kWh, 1991 price)	16.11

49. Finally, if the full cost of the transmission cost is added to the project cost, the IERR would be reduced to 13.2 percent. This minimum IERR to be expected from the project is still higher than the test discount rate of 12 percent. It should be noted that this very conservative estimate does not take into account that a large part of the power will be produced during peak hours and has therefore a higher value to the system. A more accurate estimate will be carried out following completion of the reservoir optimization study.

50. It should also be noted that none of the above calculations has taken into account the environmental benefits of the project. The project will avoid mining, transporting, and burning of some 10 million tons of raw coal a year in Sichuan Province, which has the highest level of air pollution in China. According to the detailed simulation of two

systems (with and without) carried out during the preparation for the second phase, in the without-Ertan project case, SO_2 emissions in the province would increase 10,200 tons per year for the period 1998-99, 236,500 tons for 2000-04, 198,300 tons for 2005-09, and 252,500 tons for 2010 and beyond. It is estimated that annual emission of about 6,000 tons of fine particulates (PM_{10}) will be avoided as a result of Ertan hydropower generation. The externality cost of SO_2 and particulates emission is in the range of $400-$5,000 and $20-$90 per ton, respectively.[1] If the lowest value of the control cost is used as a proxy of the externality value to estimate the minimum environmental benefits of the project, the IERR will be increased to 17.39 percent. Furthermore, hydropower generation from the Ertan Scheme will avoid emission of about 5 million tons of CO_2 each year. If this is credited to the project, an IERR of 17.99 percent will be obtained using a lower-range value of climate change externality cost[2] and an IERR of 18.71 percent using a higher-range value (see Annex 6).

Project Risks

51. To complement the above deterministic analysis, risk analyses have been performed using a probabilistic approach to assess the impact of the perceived risk factors that affect the return of the project. Five broad categories of risk have been considered in the analysis:

(a) **Demand Risk**. Demand risk is related to lower load growth than expected and/or breach of contract by the purchaser. Demand risk is not perceived as a major risk factor in the short term with energy shortages prevailing in the Sichuan Provincial Power Grid. However, a low-load growth and/or an important reduction in electricity offtake could jeopardize the economic viability of the project.

(b) **Price Risk**. Price risk is related to the willingness and ability of the power purchaser to pay and/or changes in pricing policy. This risk is normally mitigated or managed through long-term contractual arrangements and/or the financial covenants of the project. However, experience shows that the seller could still be confronted with unexpected price changes.

(c) **Cost Risk**. This risk is significantly reduced at this stage of the project with all the major contracts signed and major excavation works completed. However, delays of construction due to interfacing problems between different equipment suppliers and unforeseen site conditions may still cause cost overrun.

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[1] Source of information: *Economic Analysis of Environmental Impacts* by J.A. Dixon, L.F. Scura, R.A. Carpenter and P.B. Sherman, published in association with the Asian Development Bank (ADB) and the World Bank, 1994.

[2] Source of information: *Economic Evaluation of Environmental Impacts, A Workbook*, published by ADB in March 1996.

(d) **Operational Performance Risk**. Poor operational performance could be caused by: (i) low quality of generating equipment and facilities, and (ii) inadequate maintenance and poor management.

(e) **Hydrological Risk**. The uncertainty of hydrology was captured in the basic simulation model analyses of the hydropower system energy yield. The financial implications of the higher and/or lower-than-expected output has been investigated in the risk analysis.

52. Based on the foregoing considerations and extensive sensitivity analyses, four variables have been selected as the crucial *risk variables* because of their significant impact on the project economic viability. Annex 6.3 presents the selected variables, the assumed value ranges and the probability distributions attached to them based on past Bank experience in power projects in general and China in particular.

53. The risk analysis was carried out with the Risk Master computer software, which uses the Monte Carlo simulation[3] technique (see Annex 6.3). The expected IERR, based on the weighted average of all simulated combinations (1,000 simulations), is 15.81 percent (with a standard deviation of 1.4 percent), only about 0.3 percent lower than the base case value without consideration of project risks. This suggests that the uncertainty of the return of the project investment is much reduced at the completion of the first-phase construction. The minimum and maximum IERR, under the considered uncertainties, are respectively 11.58 and 19.29 percent. The probability of a negative outcome (negative net present value) is zero. And finally, the probability for the IERR to be below the considered discount rate (12 percent) is negligible. All the above analyses clearly show that the project is robust under future uncertainties.

Financial Performance

54. Financial performance was not reassessed at this stage since the project will not generate income until 1998. The actual FY91-95 financial statements attached at Annex 1, Tables 2 and 3, were prepared following the new accounting regulations effective July 1, 1993. The estimated financial statements given in the SAR are not included in this ICR because they were prepared based on the old Chinese accounting system and therefore do not correspond to the actual statements.

D. PROJECT SUSTAINABILITY

55. The project is sustainable because all necessary conditions were or are likely to be achieved: (a) the construction of the first phase was on time; (b) the project implementation organization was structured following modern management practice and

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[3] Monte Carlo simulation works by generating a series of random numbers following the distribution of probability of each risk variable. For each simulation that represents a combination of different state of four variables, IERR is calculated and recorded. The results of 1,000 simulations are averaged.

has had a proven record of working efficiently in the last five years; (c) the institutional capability of EHDC has been strengthened in the course of implementation; (d) efficient procurement arrangements for the supply of electrical and mechanical equipment led to reduced interfacing problems; and (e) transfer of modern management technology will continue in the second phase through continued involvement of international consulting services.

56. As an essential external element, the demand for electricity remains high as power shortages continue to be acute and economic growth has been sustained at a high level. On the commercial side, in July 1995, EHDC signed an agreement with SEPC for sales/ purchases of power generated from the Ertan scheme to the provincial grid. Despite the fact that the agreement is not a full PPA, it laid down the pricing principles that will allow EHDC to cover all operating costs, full repayment of loan principal and interest, and an agreed profit margin. By June 1997, EHDC and SEPC will sign a full PPA for selling Ertan power to the grid. The results of the power pricing study and the optimization study of the plant and reservoir operation will provide a rational basis for negotiating a PPA that would ensure financial viability of EHDC as well as efficient use of the resources in the province.

57. The resettlement objective, i.e., to provide the affected people with a better standard of living than before the project, can be achieved because of a very comprehensive resettlement plan and matching budget in place, construction of the new sites as scheduled, and an effective monitoring system with participation of an independent agency. With respect to environmental sustainability, the Ertan project has relatively benign environmental impacts when compared to thermal alternatives. Through continued monitoring, additional mitigation measures can be devised and implemented as necessary.

E. Bank Performance

58. Bank performance from project preparation to implementation was highly satisfactory. At the early stage, the Bank supported the establishment of EHDC as commercially independent entity responsible for construction of the project, instead of as a provincial power utility as was the practice at that time in China. Later on, the Bank supported the reorganization of EHDC as a limited liability company in line with China's enterprise reform policy.

59. Drawing lessons from other projects regarding the interfacing problems caused by an excessive number of contract packages and the benefits of having international experts involved in the construction management, the Bank played an instrumental role in structuring the procurement arrangements for goods and services. This included (a) conclusion of a single contract with one foreign firm assuming full responsibility for supply of both hydraulic turbines and generators, and (b) extension of consulting services provided by the Advisory Group into the second phase. The first would reduce interfacing problems and thereby reduce potential delays in equipment delivery,

equipment defects and mismatching. The latter would enhance the project management of the second phase by continued transfer of modern management practices.

60. In order to meet the implementation schedule, the Bank arranged the second loan in a timely manner to allow for the continuation of construction. Seeing that lack of funds had postponed preparation of a 500 kV transmission line project (which was not part of the project and was originally planned to be financed locally) to send electricity generated from Ertan to the provincial grid, the Bank provided Loan 3848-CHA to finance the Sichuan Transmission Project.

61. The Bank regularly supervised the project and attached high priority to implementation issues related to resettlement and environmental aspects. The Bank advised high-level government officials on delayed approval of the resettlement implementation plan (budget) when it had become a major cause of delayed resettlement. This accelerated the approval process. During the recent supervision missions, the Bank identified environmental problems owing to tree cutting by local farmers and advised EHDC to take actions for catchment rehabilitation and development.

F. Borrower Performance

62. EHDC has successfully implemented the first phase of the project. Its primary achievement was to meet all the milestone dates of the physical construction. Its institutional capability has been strengthened in the course of transforming itself to a limited liability company, which contributed to further the power sector and enterprise reforms in China. To become better prepared to undertake its future operational and commercial functions, EHDC promptly arranged inception of the study of organizational restructuring and financial management systems in the second phase at the suggestion of the Bank. Throughout the implementation of the project, the performance of EHDC was highly satisfactory.

63. EHDC has been open to new technologies and construction management techniques and willing to adopt the best practice in terms of organization and project management systems. The successful integration of the Advisory Group into the management team was largely responsible for efficient management of construction. When delays occurred at various stages of construction, EHDC was able to promptly identify the problems on the critical path and take measures to solve them. Recently, EHDC has reached a settlement (with a value of about $65 million) with the Lot 1 contractor for all claims for time extension up until May 31, 1996 in order to reestablish the original contract completion dates.

64. EHDC has a strong sense of project ownership and this was reflected in the fact that for at least the past two years, EHDC, with the support of its Board of Directors, covered investment expenditures of about $110 million for both resettlement and environment, in the absence of an approved budget from the central government (the budget was only granted in November 1996). This prevented serious delays in executing resettlement and environment programs.

G. Assessment of Outcome

65. Progress toward achievement of all project objectives was substantial and laid a solid ground for timely completion of the second project. The project outcome is rated as highly satisfactory. Sustainability is likely. Bank performance is rated highly satisfactory during project identification, preparation assistance and supervision, and satisfactory for appraisal. Borrower performance is rated highly satisfactory for project implementation and covenant compliance and satisfactory for project preparation.

H. Future Operation

66. The Ertan project is still under construction. Its second-phase implementation in terms of physical construction, environment management program, resettlement action plan, institutional development and financial performance will continue to be monitored according to key (implementation) monitoring indicators set out in the SAR for the second project (see Annex 4).

67. To prepare for future operation, 29 graduates from colleges and/or professional schools were hired in 1995 and sent to Geheyan Hydropower Station for one year of training. In 1996, 120 more graduates were employed as part of the future operation staff. EHDC has also employed five experienced technical persons from other power stations in China. They will serve as the operating backbone in the future. In addition, EHDC signed an agreement in 1996 with Gezhouba Hydropower Plant, which will assist EHDC in preparation, operation, and maintenance of the Ertan Hydropower Plant for the period 1996-2000.

68. Preparation of performance indicators for future operation was discussed during the November 1996 supervision mission. Due to the need to incorporate the outcome of the optimization study (ongoing study) in the operation plan of the plant and reservoir, the operation plan including performance indicators will be prepared in 1997 when the study results become available and will be included in the ICR for the second project.

I. Key Lessons Learned

69. Ertan is the first large-scale hydroelectric project in China to use only international contracting and construction management procedures. Many of the difficulties experienced in implementing the new system were caused by the relative newness of economic and enterprise reform in China. In retrospect, it is doubtful that matters could have been handled differently. However, given the economic and enterprise reforms that have now occurred and the prospects for even broader reform, it is possible to formulate key lessons from project implementation that will benefit future projects and the second phase of the Ertan Project. The key lessons are summarized as follows:

(a) In implementing a project of the magnitude and complexity of Ertan, implementation will be greatly assisted if there is an implementing

organization in place at the outset of the project, which is commercially independent and has full decision-making authority and responsibility for its performance. Initial delays in project implementation, resulting in sizable contractors' claims for acceleration, largely resulted from EHDC's inability to make timely decisions. The incorporation of EHDC in 1995 (four years after the commencement of construction) as a limited liability company led to major improvements in this regard, allowing EHDC to make quick decisions on its own instead of seeking instructions from government agencies. This single factor is largely responsible for the recovery from earlier difficulties, to the currently successful implementation and probability of timely completion of the second project.

(b) Prior to the start of construction, construction management personnel should be trained in contract administration and modern project management techniques. This training should include deputation for substantial periods to ongoing projects where these techniques are in use. China routinely undertakes similar training of operating personnel prior to the commissioning of all large hydropower plants and this is very successful. Similar training of construction management personnel will increase their competence and improve response time through allowing increased delegation rather than involving senior management in matters of detail.

(c) Improved communication among various parties (owner, engineer, designer, advisors and contractors, etc.) should be actively pursued from the outset, to avoid misunderstandings which could cause delays and/or losses to the project. Communication difficulties were perhaps the most difficult to resolve in construction of the Ertan scheme. This issue is not simply of translation between different languages, but of communicating ideas and concepts across international boundaries of training and culture.

(d) Development of project management systems should also commence before construction in order to manage construction more efficiently. These should include contractual documentation management systems, a project master schedule, a procurement and delivery schedule for employer-supplied equipment, a design drawing control system and cost control system. EHDC has now developed systems in most of these areas, which has resulted in less exposure of EHDC to claims resulting from delayed supply of information or equipment.

(e) In the future, consideration should also be given to reducing interfacing by procuring equipment in smaller numbers of larger packages. In retrospect, the division of civil works activities among two major contractors was not

ideal, resulting in an increased number of interfaces that led to contractual difficulties.

(f) With regard to resettlement, the lessons learned are the necessity to advance the preparation of the resettlement implementation plan at the outset of the project, which will allow a better coordination of various resettlement activities and more detailed cost estimates to be carried out. In this project, the problems encountered in implementing the resettlement component at the early stage were largely due to a lack of a detailed resettlement implementation plan, which was only completed in 1995. In addition, in preparing the resettlement cost estimates, adequate contingency allowances should be made to cover the costs of compensation and the measures necessary to restore incomes.

PART II: STATISTICAL TABLES

TABLE 1: SUMMARY OF ASSESSMENT

A. Achievement of Objectives	Substantial	Partial	Negligible	Not Applicable
Macroeconomic policies				x
Sector policies	x			
Financial objectives	x			
Institutional development	x			
Physical objectives	x			
Poverty reduction				x
Gender issues				x
Other social objectives	x			
Environmental objectives	x			
Public sector management				x
Private sector development				x

B. Project Sustainability	Likely	Unlikely	Uncertain
	x		

C. Bank Performance	Highly Satisfactory	Satisfactory	Deficient
Identification	x		
Preparation assistance	x		
Appraisal		x	
Supervision	x		

D. Borrower Performance	Highly Satisfactory	Satisfactory	Deficient
Preparation		x	
Implementation	x		
Covenant compliance	x		
Operation (if applicable)			

E. 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 telecontrol 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 & Ln. 3515-CHA Shuikou Hydroelectric Projects I & II	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. ICR for first project issued 4/28/96.
	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	12/31/97.

Table 2: (Cont'd)

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 six 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. Closing dates 12/31/96 & 12/31/2001.
Cr. 2305-CHA & Ln. 3412-CHA Daguangba Multi-purpose 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	Implementation under way. Closing date 12/31/97.
Ln. 3433-CHA Yanshi Thermal Power Project	To install 2 300-MW generating units and five 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	Implementation under way. Closing date 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.

Table 2: (Cont'd)

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.	02/27/96	Implementation commenced.. Closing date 12/31/2002.

TABLE 3: PROJECT TIMETABLE

Steps in project cycle	Date planned	Date Actual/latest estimate
Identification/Preparation		07/03/87
Appraisal	12/89	11/26/89
Negotiations		03/25/91
Board presentation	07/91	07/02/91
Signing	07/91	07/11/91
Effectiveness	09/91	09/06/91
Project completion /a	12/31/2000	12/31/2000
Loan closing	12/31/96	12/31/96

/a Including Phases I and II.

TABLE 4: LOAN DISBURSEMENTS: CUMULATIVE ESTIMATED AND ACTUAL

	FY92	FY93	FY94	FY95	FY96	FY97
Appraisal estimate	110.0	213.0	286.0	380.0		
Actual	139.1	243.5	294.4	371.1	377.0	380.0
Actual as % of estimate	126.5	114.5	102.9	97.7		

Date of final disbursement
December 17, 1996

TABLE 5: KEY INDICATORS FOR PROJECT IMPLEMENTATION

(Refer to Figure 1)

Note: Key monitoring indicators for implementation of the second-phase project are attached in Annex 4.

TABLE 6: KEY INDICATORS FOR PROJECT OPERATION

(Not Applicable at this stage but will be included for Phase II)

TABLE 7: STUDIES INCLUDED IN THE PROJECT

Study	Purpose	Status	Impact of Study
Power pricing study	To provide a basis for price determination in PPA and promote tariff reforms in the Sichuan grid	Contract signed in July 1994 Final report completed April 1996	Study results on the Ertan power sale price will be used to establish the price formula in negotiating the PPA between EHDC and SEPC. PPA will be signed in June 1997 Since EHDC was incorporated as a generating company in 1995, retail tariff reform in the provincial grid is no longer relevant to EHDC. The study results of retail tariff structure and level have been followed up through another Bank financed project in the province—Sichuan Transmission Project (Ln.3848-CHA) for implementation of sector reform plan.
Optimization of reservoir operations	To examine the technical and economic aspects of operating the Ertan Hydroelectric Station and its storage reservoir and to establish rules and procedures for their optimum exploitation	Contract signed in November 1995 Expected completion date May 1997	The study results will be incorporated in the price formula and dispatch arrangements in PPA to achieve the objectives of (a) minimizing thermal generation in the Sichuan grid and (b) maximizing the profit of EHDC under the terms and conditions of PPA The study results will be used to formulate an operating plan (including rule curves)of the plant and the reservoir Techniques and software for power system operation optimization has been transferred to HDC staff members along with the progress of the study.
Preparation of future power projects	To help prepare EHDC's future projects	Contract signed in October 1993 The study includes preparation of • Prefeasibility study for Tongzhiling Hydroelectric Project (completed in 1994) • Yalong River Cascade Development Plan (completed in 1995) • Prefeasibility study for Guandi Hydroelectric Project (completed in December 1995) • Feasibility study of Guandi Hydroelectric Project (ongoing) Expected completion date December 1997.	The study effectively helped prepare future projects to be undertaken by EHDC on the Yalong river: • One of the study results "Yalong River Cascade Development Plan" was approved by Chinese authorities in 1995, in which 5 projects were identified, with Guandi Hydroelectric Project to be the next to be built. • A prefeasibility study and site selection report for Guandi Hydroelectric Project was approved in March 1996.

TABLE 8A-1: PROJECT COSTS

	Appraisal estimate ($ M)			Actual/latest ($ M)*		
	Local	Foreign	Total	Local	Foreign	Total
Preparatory works	102.4	0.0	102.4	79.27		79.27
Resettlement	82.3	0.0	82.3	227.95		227.95
Land acquisition	7.1	0.0	7.1	10.15		10.15
Arch dam (lot no. 1)	217.8	284.3	502.2	315.76	375.94	691.70
Powerhouse (lot no. 2)	159.8	212.4	372.3	216.03	308.32	524.35
E&M equipment /a	108.7	148.7	257.4	141.77	200.32	342.09
Engineering/Contract admin. /b	52.3	19.4	71.7	221.16	40.12	261.28
Training & Studies	1.2	1.8	3.0	4.18	1.54	5.72
Environmental protection	1.6	0.3	1.9	4.10		4.10
Total Base Cost	**733.1**	**667.0**	**1,400.1**	**1,220.37**	**926.24**	**2,146.61**
Contingencies:						
Physical	80.8	83.2	164.0	25.16	11.24	36.40
Price	107.9	120.8	228.7	21.31	4.38	25.70
Taxes and duties	67.3	25.5	92.8	73.70		73.70
Total Project Cost	**989.1**	**896.4**	**1,885.5**	**1,340.54**	**941.87**	**2,281.41**
Interest during construction (IDC)	342.9	258.7	601.6	552.30	233.60	785.90
Total Financing Required	**1,332.0**	**1,155.1**	**2,487.1**	**1,892.84**	**1,175.47**	**3,068.31**

/a Including transformers and gates/hoists, etc.
/b Including technical assistance

TABLE 8A-2: PROJECT COSTS

	Appraisal estimate (Y million)			Actual/latest (Y million)		
	Local	Foreign	Total	Local	Foreign	Total
Preparatory works	439.1	0.0	439.1	468.40		468.40
Resettlement	429.4	0.0	429.4	1,797.08		1,797.08
Land acquisition	26..9	0.0	26.9	67.11		67.11
Arch dam (lot no. 1)	1,140.3	1,488.8	2,629.0	2,461.42	2,725.04	5,186.46
Powerhouse (lot no. 2)	836.7	1,112.0	1,948.7	1,604.23	2,194.51	3,798.74
E&M equipment /a	568.9	778.9	1347.8	1,176.70	1,662.66	2,839.36
Engineering & Contract administration	256.9	98.3	355.3	1,643.77	310.87	1,954.64
Training & Studies	6.1	9.5	15.6	30.8	12.78	43.58
Environmental protection	8.3	1.5	9.9	33.8		33.8
Total Base Cost	**3,712.5**	**3,488.9**	**7,201.4**	**9,283.31**	**6,905.87**	**16,189.18**
Contingencies:						
Physical	423.0	435.3	858.3	208.84	93.32	302.16
Price	1,191.2	1,320.3	2,511.5	549.71	53.77	603.47
Taxes and duties	352.5	133.2	485.7	612.00		612.00
Total Project Cost	**5,679.2**	**5,377.7**	**11,056.9**	**10,653.86**	**7,052.95**	**17,706.81**
Interest during construction (IDC)	1,794.9	1,354.5	3,149.4	4,540.90	1,881.20	6,422.10
Total Financing Required	**7,474.1**	**6,732.2**	**14,206.3**	**15,194.76**	**8,934.15**	**24,128.91**

/a Including transformers and gates/hoists, etc.

TABLE 8B: PROJECT FINANCING
($ million equivalent)

	Appraisal estimate ($ M)			Actual/latest ($ M)		
	Local	Foreign	Total	Local	Foreign	Total
IBRD	-	380.0	380.0	0.00	780.00	780.00
IDA (TCC)	-	3.3	3.3	0.00	2.58	2.58
US Exim Bank Credit	-	30.0	30.0	0.00	0.00	0.00
Guarantee financing	0.00	0.00	0.00	0.00	150.00	150.00
Norwegian Grant	-	5.0	5.0	0.00	5.00	5.00
GOC (through SEIC)	666.0	129.4	795.4	803.34	0.00	803.34
Sichuan (through ETIC)	666.0	129.4	795.4	803.34	0.00	803.34
SDIC Equity	0.00	0.00	0.00	238.92	0.00	238.92
SIC Equity	0.00	0.00	0.00	238.92	0.00	238.92
SEPC	0.00	0.00	0.00	19.91	0.00	19.91
Other financing	-	478.00	478.00	0.00	26.30	26.30
Total	**1,332.00**	**1,155.10**	**2,487.10**	**2,104.43**	**963.88**	**3,068.31**

TABLE 9: REESTIMATED ECONOMIC COSTS AND BENEFITS
(1996 Constant Million Yuan)

Year	Generation Capital Cost	Fuel Cost	O&M Cost	Total Cost	Benefit GWh	M Yuan	Net Benefit
1991	1,128.33	0.00	0.00	1,128.33	0.00	0.00	-1,128.33
1992	3,193.95	0.00	0.00	3,193.95	0.00	0.00	-3,193.95
1993	1,472.89	0.00	0.00	1,472.89	0.00	0.00	-1,472.89
1994	1,510.31	0.00	0.00	1,510.31	0.00	0.00	-1,510.31
1995	1,786.43	0.00	0.00	1,786.43	0.00	0.00	-1,786.43
1996	3,791.49	0.00	0.00	3,791.49	0.00	0.00	-3,791.49
1997	4,486.28	0.00	0.00	4,486.28	0.00	0.00	-4,486.28
1998	1,472.59	0.00	188.42	1,661.01	1,198.00	419.30	-1,241.71
1999	523.79	0.00	193.66	717.45	10,032.00	3,511.20	2,793.75
2000	128.58	0.00	194.95	323.53	15,273.00	5,345.55	5,022.02
2001	0.00	0.00	194.95	194.95	15,878.00	5,557.30	5,362.35
2002	0.00	0.00	194.95	194.95	16,094.00	5,632.90	5,437.95
2003	0.00	0.00	194.95	194.95	15,897.00	5,563.95	5,369.00
2004	0.00	0.00	194.95	194.95	15,885.70	5,560.00	5,365.05
2005	0.00	0.00	194.95	194.95	16,071.00	5,624.85	5,429.90
2006	0.00	0.00	194.95	194.95	15,990.90	5,596.82	5,401.87
2007	0.00	0.00	194.95	194.95	16,531.00	5,785.85	5,590.90
2008	0.00	0.00	194.95	194.95	16,574.10	5,800.94	5,605.99
2009	0.00	0.00	194.95	194.95	16,124.60	5,643.61	5,448.66
2010	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2011	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2012	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2013	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2014	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2015	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2016	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2017	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2018	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2019	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2020	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2021	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2022	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2023	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2024	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2025	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2026	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
2027	0.00	0.00	194.95	194.95	17,559.60	6,145.86	5,950.91
Total	**19,494.64**	**0.00**	**5,840.58**	**25,335.22**	**487,622.10**	**170,667.74**	**145,332.51**
Present Value /a	11,350.80	0.00	707.24	12,058.03	51,368.40	17,978.94	5,920.91
Internal Economic Rate of Return (IERR)							16.11%

Assumptions:

Official exchange rate (Y/$)	8.3
Shadow exchange rate (Y/$)	8.3
Standard Conversion Factor	1.0
Willingness to pay (Y/kWh)	0.35
Discount rate	0.12

/a Discounted to year 1991.

TABLE 10: STATUS OF LEGAL COVENANTS

Agreement	Section	Covenant type	Present status	Original fulfillment date	Revised fulfillment date	Description of covenant	Comments
Loan	3.01(b)	3	C			Relend the proceeds of the loan through Sichuan to EHDC, under terms and conditions satisfactory to the Bank	
	3.04	2	CP		06/30/97	Take all steps necessary to enable EHDC and SCEPA to enter into the purchases agreement no later than June 30, 1996.	Memorandum of Understanding covenanted identifying the principles that will govern the process agreement has been signed by EHDC and SCEPA. New covenanted date for signing of the Power Purchase Agreement under Ertan II by 6/97
	3.05	5	CP			(i) Furnish or cause to be furnished to the Bank a plan for completion of the 500 kV line connecting Ertan Hydroelectric station with the power transmission system in Sichuan; (ii) implement such plan not later than June 1998.	Bank involved in the construction of the 500 kV transmission line under the Sichuan Power Transmission Project (Loan 3848)
	3.6	7	C			Carry out, or cause to be carried out, the resettlement of the people affected by the project, in accordance with the plan agreement with the Bank	Satisfactory progress
	3.04(b)	10	NYD			Propose to the Bank the components for inspection, not less than one year prior to expected completion	
	4.01	1	NYD	06/30/97		(a) Maintain records and accounts adequate to reflect its operating and financial condition; (b) have its records, accounts and financial statements for each fiscal year audited; furnish to the Bank not later than six months after the end of each year	None
	4.02	2	NYD			Produce net operating income equivalent to not less than (a) 201 in 1999, (b) 151 in 2000, and (c) 351 percent of its average annual investment program	The self-financing ratio covenant replaced with a rate of return on revalued assets under the Ertan II Project (Loan 3933)
	4.03	2	NYD		12/31/99	Ensure that interval cash generation for each fiscal year during the term of the debt to be incurred shall be at least (i) 1.3 times in 1999, and (ii) 1.5 times thereafter	
	4.04	2	C			Not incur any debt, if after the incurrence of such debt the ratio of debt to equity shall be greater that (i) 82 to 18 for each year from 1991 through 1997; (ii) 80 to 20 for each of 1998 and 1999, and (iii) 70 to 30 thereafter.	Debt/equity ratios slightly changed under Ertan II: (i) 85/15 in 1995-97; (ii) 80/20 in 1998-2000 and 70/30 thereafter.

Table 10 (Cont'd)

Agree-ment	Section	Cove-nant type	Present status	Original fulfillment date	Revised fulfillment date	Description of covenant	Comments
	Schedule	10	C			1. Maintain the Project Management Unit with staffing and responsibilities satisfactory to the Bank	
	Schedule	10	NYD		06/30/97	2. Carry out, no later than June 30, 1993, the studies related to the project in accordance with the terms of reference and a schedule agreed with the Bank	Bank agreed to delay studies. Tariff study completed and contract for optimal operation of the reservoir signed and initiated studies will continue under phase II Loan.
	Schedule	10	C			3. Carry out the training and the project in accordance with a program agreed with the Bank.	Implementation on schedule
	Schedule	10	C			4. Carry out an environmental management program as agreed with the Bank	Progress satisfactory

Covenant Class:
1 = Accounts/audits
2 = Financial performance/revenue generation from beneficiaries
3 = Flow and utilization of project funds
4 = Counterpart funding
5 = Management aspects of the project or executing agency
6 = Environmental covenants
7 = Involuntary resettlement
8 = Indigenous people
9 = Monitoring, review, and reporting
10 = Project implementation not covered by categories 1-9
11 = Sectoral or cross-sectoral budgetary or other resources allocation
12 = Sectoral or cross-sectoral policy/ regulatory/institutional action
13 = Other

Status:
C = covenant complied with
CD = complied with after delay
CP = complied with partially

TABLE 11: COMPLIANCE WITH OPERATIONAL MANUAL STATEMENT

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	OD not in force at the time of first project, but fully reflected in second project.
3. OD 4.01 - Environmental Assessment	OD not in force at the time of first project, but fully reflected in second project.
4. OD 4.02 - Environmental Action Plans	OD not in force at the time of first project, but fully reflected in second project.
5. OD 4.30 - Involuntary Resettlement	Fully Complied

TABLE 12: BANK RESOURCES: STAFF INPUTS

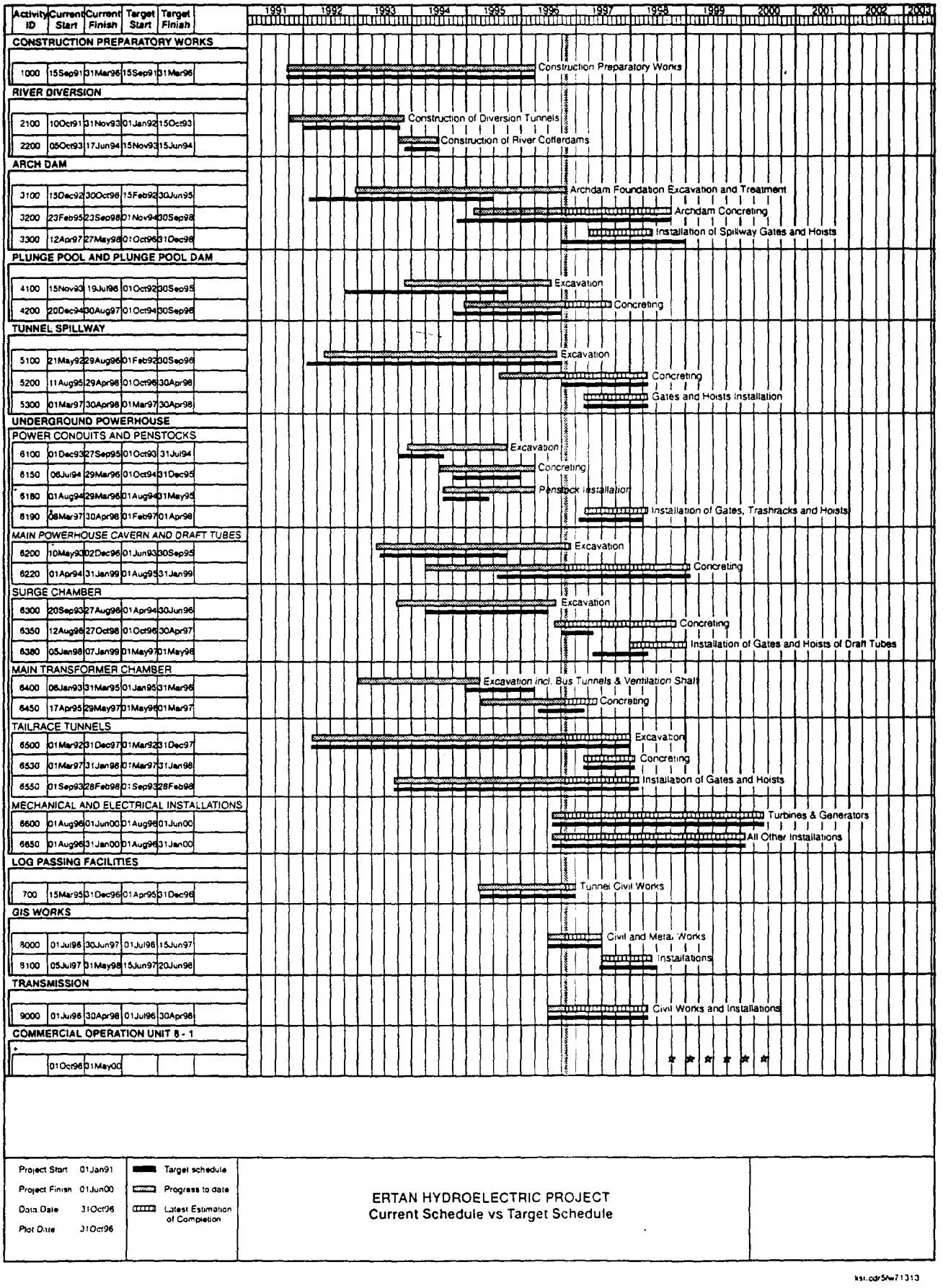
Stage of project cycle	Planned		Revised		Actual	
	Weeks	$'000	Weeks	$'000	Weeks	$'000
Preparation to appraisal					141.5	397.9
Appraisal					32.5	98.2
Negotiations through Board approval					39.5	125.4
Supervision					46.1	121.0
Completion					4.3	11.1
Total					263.9	753.6

TABLE 13: BANK RESOURCES: MISSIONS

Stage of project cycle		Month/ year	No. Of persons	Days in field	Specialized staff skills represented /a	Performance rating: Imple-mentation status	Performance rating: Devel-opment objectives	Type of problems
Through appraisal		02/91	5	5	E,FA,FA,R,EN			
Appraisal through Board approval								
Board approval through effectiveness								
Supervision	1	08/92	2	3	E,E			
	2	07/93	1	4	E.			
	3	04/94	2	4	Ec,Ec			Tariff Study delayed
	4	07/94	1	13	E	1		
	5	10/95	4	11	E, En. R, En	1		
	6	06/96	3	4	E, En. R.	1		Resettlement budget approval delayed
	7	11/96	4	5	E, E, R, Ec	1		
Completion \b								

/a E: Engineer, Ec: Economist, En: Environmental Consultant, FA: Financial Analyst, R: Resettlement Specialist
/b Combined with the 7th supervision mission.

Figure 1: Actual Progress vs. Target Schedule



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ANNEX 1: EHDC FINANCIAL STATEMENTS

TABLE 1: INCOME STATEMENT

The project is under construction and will not generate any income until late 1998.

ACTUAL FINANCIAL STATEMENTS OF EHDC (1991-95)

TABLE 2: BALANCE SHEET
(Y million)

Year Ended December 31	1991	1992	1993	1994	1995
ASSETS					
Current Assets					
Cash	45.45	51.26	104.25	95.52	91.41
Inventories	0.00	0.00	1.41	3.32	7.11
Other Current Assets	37.46	132.91	106.03	138.90	7.84
Receivable	0.00	0.00	0.00	0.00	0.00
Total Current Assets	**82.91**	**184.17**	**211.69**	**237.74**	**106.36**
Fixed Assets					
Plant in Service	2.58	23.29	24.06	30.87	37.72
Less: Accumulated Depreciation	(0.25)	(0.58)	(2.50)	(4.64)	(6.76)
Net Plant in Service	2.33	22.71	21.56	26.23	30.96
Construction WIP	1,370.47	2,420.17	3,726.40	6,065.70	8,587.45
Total Fixed Assets	**1,372.80**	**2,442.88**	**3,747.96**	**6,091.93**	**8,618.41**
Special Funds	0.00	0.00	0.00	0.00	0.00
TOTAL ASSETS	**1,455.71**	**2,627.05**	**3,959.65**	**6,329.67**	**8,724.77**
LIABILITIES & EQUITY					
Current Liabilities	0.00	0.00	0.00	0.00	0.00
Accounts Payable	70.95	163.34	121.56	127.26	122.54
Tax Payable	0.00	0.00	0.00	0.00	0.00
Short-term Loan	0.00	0.00	50.00	25.00	199.15
Total Current Liabilities	**70.95**	**163.34**	**171.56**	**152.26**	**321.69**
Working Capital	0.00	0.00	0.00	0.00	0.00
Long term Liabilities	1,086.94	1,903.23	2,893.23	5,606.05	6,935.90
Government Funds	0.00	0.00	0.00	0.00	0.00
Special Funds	0.28	0.82	0.00	0.00	0.00
Hydropower Development Funds	0.00	0.00	0.00	0.00	0.00
Fixed Capital	2.33	22.71	0.00	0.00	0.00
Capital Surplus	295.21	533.37	885.09	560.00	1,450.00
Retained Capital	0.00	3.58	9.02	12.36	17.18
TOTAL LIABILITIES & EQUITY	**1,455.71**	**2,627.05**	**3,959.65**	**6,329.67**	**8,724.77**
Debt/ (Debt and Equity) Ratio (%)	78.49	77.25	84.98	90.73	82.54

ACTUAL FINANCIAL STATEMENT OF EHDC (1991-95)

TABLE 3: FUNDS FLOW STATEMENT
(Y million)

Year End December 31	1991	1992	1993	1994	1995
SOURCE OF FUNDS					
Profit for the Year					
Depreciation	0.25	0.33	1.92	2.14	2.12
Maintenance	0.03	0.00	0.00	0.00	0.00
Internally Generate	0.00	0.00	0.00	0.00	0.00
Subtotal	**0.28**	**0.33**	**1.92**	**2.14**	**2.12**
Other Sources					
Long-term Debt Increased	1,086.94	816.29	990.75	2,711.07	1,330.85
Withdraw of long-term Investment	0.00	0.00	0.00	0.00	0.00
Fixed/Intangible Assets Sales Proceed	0.00	0.00	0.00	0.00	0.00
Subtotal	**1,086.94**	**816.29**	**990.75**	**2,711.07**	**1,330.85**
Net increase on Capital Raised	297.54	258.54	329.01	(325.09)	890.00
Net increase on Capital reserve	0.00	3.58	5.44	3.34	4.82
TOTAL SOURCE OF FUNDS	**1,384.76**	**1,078.74**	**1,327.12**	**2,391.46**	**2,227.79**
APPLICATIONS OF FUNDS					
Distribution of Profit					
Income Tax Payable	0.00	0.00	0.00	0.00	0.00
Drawing for Profit Surplus	0.00	0.00	0.00	0.00	0.00
Dividend Payable	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00
Adjustment for Profit previous year	0.00	0.00	0.00	0.00	0.00
OTHER APPLICATIONS					
Increase on Fixed Assets	2.58	20.71	0.77	6.81	6.85
Increase on Work in Progress	1,370.22	1,049.16	1,307.05	2,339.30	2,521.75
Repayment of Long-term Debt	0.00	0.00	0.00	0.00	0.00
Increase in Long-term Investment	0.00	0.00	0.00	0.00	0.00
Others	0.00	0.00	0.00	0.00	0.00
Subtotal	**1,327.80**	**1,069.87**	**1,307.82**	**2,346.11**	**2,528.60**
TOTAL VALUE OF APPLICATION	**1,372.80**	**1,069.87**	**1,307.82**	**2,346.11**	**2,528.60**
Net Increase on Cash	11.96	8.87	19.30	45.35	(300.81)

ANNEX 2: EXECUTIVE SUMMARY OF EHDC'S OWN EVALUATION

1. The principal objective of the Ertan Hydroelectric Project is to provide inexpensive, clean, and dependable electrical power to Sichuan Province, the most populous province in China.

2. Ertan is located in the southern part of Sichuan on the Yalong River, about 50 kilometers north of Panzhihua City. The Project comprises the construction of a double-curvature, 240-meter high concrete arch dam; an underground powerhouse with six generating units and a total installed capacity of 3,300 MW; the associated power intake, spillway, tailrace tunnels, accesses, and other appurtenant works; and a log-passing facility. The overall scope of the project also includes land acquisition and resettlement of the population that will be displaced by the reservoir, environmental studies and procedures to minimize any adverse effects of the dam, and the design and construction management services necessary to initiate and oversee the work.

3. Construction began in 1991, and, at present (Fall 1996), the Ertan Project appears well on the way toward completion according to the originally forecast schedule. Excavation is essentially complete. The first dam concrete was placed in February 1995, and the dam is now about half complete in terms of height and volume. Placing concrete in the Plunge Pool and Plunge Pool Dam began in late 1995, and is approximately 40 percent complete. Progress on the Power Intake structure, the log-passing facility, and the Tunnel Spillway is also at commensurate levels.

4. The underground works are also progressing well. Nearly all the required excavation is complete, and about 65 percent of the concrete has been placed. Most of the work associated with the erection bay, power conduits, penstock tunnels, and spillway tunnels is complete. Installation of the steel draft tube liners, excavation and lining of the Tailrace Tunnels, and other work in the Powerhouse is ongoing. Erection of the turbines and generators began in August 1996.

5. Most of the major electrical and mechanical equipment, and other equipment, has been purchased. Equipment delivery has begun.

6. All necessary land has been acquired, and construction of the resettlement areas is progressing well. The environmental mitigation program has also been timely and successful.

7. All elements are present, therefore, to suggest the project will be completed as foreseen. The quality of the work performed has generally met or exceeded the requirements, indicating that the finished product will operate as planned.

8. This Implementation Completion Report provides a series of Financial Tables that summarize the status of the cost aspects, actual and forecast through completion, of the Ertan Hydroelectric Project at the end of the period encompassed by the Phase One Loan.

9. As of mid-1996, well past the halfway point of the project, the key lessons learned to date may be summarized as follows:

- A basic requirement for implementing such a large project is early establishment of the organizational structure that will manage the work, and definition of the relationships and dependencies of all parties involved.

- Timely action is essential. To the contractors, "Time Is Money." This attitude demands decisions be made quickly, at the working front if possible. Therefore, responsible persons with clearly defined tasks and limits of authority must be available. Decisions must be taken at appropriate levels, and responsibility must be delegated.

- Large international contractors are expert at building dams, and also at preparing claims and identifying alleged problems to justify these claims. Management must, therefore, avoid any action that may be construed as an obstruction to the progress of the work.

- A trained core staff of personnel, at various levels, conversant in the ways of modern contract administration and project management techniques, is essential.

- Initially, true communication proved to be very difficult. This was not just a matter of translation, but of really communicating ideas and thoughts across international boundaries of training and culture. Suspicion and mistrust among the parties amplified these difficulties at that time. Once an atmosphere of confidence was established, this situation was generally alleviated.

- The hardware and software systems that will be used to manage the project must be in place before construction actually begins. Moreover, these systems must be practical, flexible, and address the actual needs of the project as it develops.

- The manner in which individual portions of the work are contracted has an effect on how the work will be performed, and the level of effort required to manage it. When the work is divided into many discrete portions and awarded

to different parties, scheduling and coordination become more confused and complicated.

- It is very difficult to both maximize progress and minimize costs. Increasing production seems to inevitably lead to increased costs.

10. The process of learning is ongoing. From the foregoing, Ertan must be considered as a building block for the future. The persons involved with Ertan will be able to use the experience they have gained to instruct others. The "ripple effect" of the experiences gained at Ertan should be far-reaching. It is this gained, and shared, experience, more than any specific lessons that may have been learned, which will greatly influence and facilitate the management of future projects.

11. There are three general parameters for judging the success of a project such as Ertan: quality of the completed work, cost of the work (compared with the original estimates), and progress of the work (compared with the original completion schedule). According to these general parameters, the progress at Ertan to date must be considered a success.

ANNEX 3: EXTRACT OF COMPLETION MISSION AIDE MEMOIRE

(November 5, 1996)

1. This is an extract from the aide memoire of the completion mission for the Ertan Hydroelectric Project. Since the same mission also supervised the ongoing Ertan II Hydroelectric Project, those parts not relevant to the first project have been deleted.

2. A World Bank mission comprising Messrs./Mmes. Scurfield, Berrah, Trembath, Sun, Wu, Zhu and Zhao visited Ertan over the period November 5 to 9 to prepare for the ICR for the first project and to supervise the Phase II project. The mission would like to thank all parties participating in the mission for their excellent cooperation and cordial hospitality. The main findings of the mission and agreements reached are summarized in this aide memoire.

Construction Progress and Status

3. A good summary of progress is provided in EHDC's draft Project Completion Report for the first project. It is gratifying to note that the project is generally on schedule, and on-time impoundment and commissioning of the first unit is becoming a strong probability. EHDC is even hopeful that commissioning of the second generating unit (Unit No. 5) will be ahead of schedule.

Contractual Issues

4. The most significant event since the last mission was that EHDC reached a settlement with the Lot I contractor on his claim for acceleration. The settlement is comprehensive, settling all claims for extension of time up until May 31, 1996, and reestablishing the original contract completion dates. The package is valued at approximately $65 million. Although the amount involved is large, the mission supports and congratulates EHDC in resolving this major set of disputes. There are a few remaining disputes with the Lot II contractor, where the contractor has indicated his intent to proceed to arbitration in dissatisfaction of DRB recommendations.

Project Management Systems

5. Good progress has been made in development of project management systems in all areas. The master schedule has now been developed in some detail and continues to be elaborated in critical areas, particularly those that have numerous interfaces between contractors, equipment suppliers and/or designers. Systems for tracking production and delivery status of equipment, including production and review of manufacturers'

drawings have also been largely developed, and continue to be refined, particularly in relation to tracking progress of equipment manufacture in addition to actual delivery date. Design drawings from CHIDI have posed a problem until recently, but EHDC has substantially increased communication in this area, and EHDC are cautiously optimistic that the scope for project delays or claims due to drawing delays has been greatly reduced.

6. EHDC have also begun to develop a cost control system that would provide periodic updates (at least have yearly) of current committed costs and expected costs to completion (versus time) in the two currencies of account US dollars and Renminbi. *This system will be fully in place by the end of May 1997.*

Resettlement

7. With increasing intensity of using resettlement funding (Y 600 million for 1996), considerable physical progress has been achieved in Yanbian County, Hongge Resettlement Site, Reservoir Highway, and key irrigation facilities. Conditions are now favorable for completing all required resettlement works before the end of 1997.

8. The long-awaited resettlement budget was finally approved by the central government in November 1996. Based on this approved budget, SPRO is planning to issue final compensation policies and standards for Ertan reservoir resettlement, which will provide the basis for the final stage of resettlement implementation in 1997.

Environmental Component

9. The mission was able to follow up on the recommendations of the June mission and have brief discussions concerning the report of the Environmental panel of Experts dated October 25, 1996. However, since this report was only received by EHDC on November 6, and had not been translated, a full discussion was not possible.

10. However, the Panel report and the aide memoire of the last mission identify a number of issues of continuing concern, including:

11. Schistosomiasis. The Panel's considers that schistosomiasis risks are increasing rather than decreasing, concluding that snail eradication program has not been effective to date. The mission requested that EHDC consult with their schistosomiasis advisors and seriously address the detailed recommendations of the Panel, particularly the need for revising the scope of the current control program.

- **Biodiversity**. This continues to be a major concern of both the Panel and the Bank's environmental specialist. It is noted that considered that an additional survey in the fall would be valuable. The mission strongly supports their recommendations for an additional survey.

- **Boundary Road and Buffer Zone**. The Environmental Assessment approval considered that the proposed buffer zone was beyond what could reasonably be required of a project entity. This is in contrast to the statements in the Panel report that the 100 m elevation buffer zone is required by national legislation. EHDC clarified that the 100 m requirement applies to rivers but not reservoirs. While the reservoir boundary road is acknowledged to be necessary to replace the previous road link following the river, the mission endorsed the Panel recommendation that EHDC give increasing attention to environmental mitigation measures in road construction, particularly in relation to slope protection and spoil disposal.

Tariff, Optimal Operation Studies and Power Sales Agreement

11. Based on the aide memoire of the last mission and correspondence since then, the mission was expecting to have comprehensive discussions on this aspect. Unfortunately, however, relevant parties such as SEPC, BERI and SMEC consultants dealing with the optimal operation study were not present and only abbreviated discussions were possible. *The mission strongly recommended that EHDC commission a further study aimed at producing draft provisions relating to pricing and dispatch arrangements for Ertan.* This should be aimed at bringing together all of the other work on optimal operations and pricing that has already been carried out. EHDC agreed to carry out the study and proposed that it be carried out as an extension of existing studies, possible through joint venture of existing consultants, rather than involved one more set of consultants. The mission indicated no objection to this arrangement. The scope of the optimal operations study would be extended to include the commercial issues related to power sales and the preparation of power sales agreements meeting the principles agreed with the Bank during negotiations of the Phase II loan. It would also take into account the results of all studies carried out to date including those carried out by EDF and BERI under the first loan.

Implementation Completion Report (ICR) for Ertan I

12. In connection with preparation of ICR for the first loan (Ln. 3387-CHA), EHDC submitted to the mission a draft version of their own evaluation report of project implementation. The report was well prepared and provided a detailed account of the project implementation to date. The mission held two special sessions with EHDC to review and discuss the evaluation report. One session was focused on the key lessons learned and the other on modifications and complementary analyses required in order to finalize the evaluation report and to assist the Bank in preparation of its own ICR.

Key Lessons

13. Ertan is the first large-scale hydroelectric project in China to adopt entirely international contracting and construction management procedures. Many of the difficulties experienced in implementing the new system are founded in the immature

status of economic and enterprise reform, and even in retrospect it is difficult to see how things could have been done differently. However, given the economic and enterprise reforms that have now occurred and the prospects for even broader reform, it is possible to formulate key lessons from project implementation that will not only benefit future projects but also the implementation of the second phase of Ertan Project. The mission's version of these lessons, which are based on those set out by EHDC in its completion report, as elaborated during discussion and which also incorporate the mission's opinion in some areas are summarized as follows:

- In implementing a project of the magnitude and complexity such as Ertan implementation will be greatly assisted if there is an implementing organization in place at the outset of the project that is commercially independent and has full decision-making authority and responsibility for its performance. Initial delays in project implementation, resulting in sizable claims for acceleration largely resulted from EHDC's inability to respond to the need for decisions. The incorporation of EHDC in 1995 (four years after the commencement of construction) as a limited liability company resulted in major improvements in this regard, allowing EHDC to make quick decisions on its own instead of seeking instructions from the government agencies. This single factor is largely responsible for the recovery from earlier difficulties to the stage where the project is being successfully implemented and on-time completion is increasingly probable.

- Prior to the start of construction, construction management personnel should be trained in contract administration and modern project management techniques. This training should include deputation for substantial periods to ongoing projects where these techniques are in use. China routinely undertakes similar training of operating personnel prior to the commissioning of all large hydropower plants and this is very successful. Similar training of construction management personnel will increase their competence and improve response time through allowing increased delegation rather than involving senior management in matters of detail.

- Improved communication among various parties (owner, engineer, designer, advisors and contractors, etc.) should be actively pursued from the outset, to avoid misunderstandings that could cause delays and/or losses to the project. Communication difficulties were perhaps the most difficult to resolve in construction of the Ertan scheme. It is not just a matter of translation between different languages, but of communicating ideas and thoughts across international boundaries of training and culture.

- Development of project management systems should also commence before construction in order to manage the construction more efficiently. These should include contractual documentation management systems, project master schedule, procurement and delivery schedule for Employer-supplied

equipment, design drawing control system and cost control system. EHDC has now developed systems in most of these areas, which seems is resulting in less exposure of EHDC to claims resulting from delayed supply of information or equipment.

- In the future, consideration should also be given to reducing interfacing by procuring equipment in smaller numbers of larger packages. In retrospect, the division of civil activities among the two major contractors was not ideal, resulting in an increased number of interfaces, which led to contractual difficulties.

14. With regard to resettlement, lessons learned are as follows: the need to strengthen the resettlement organization at the provincial level to provide necessary leadership, technical assistance and monitoring of resettlement activities at the local levels, as shared by other power projects in China.

Further Work Scope and Schedule

15. It was agreed that EHDC would carry out some revisions and complementary tasks to finalize its own evaluation report and to assist the Bank in preparation of its ICR. These are detailed hereafter. EHDC agreed to submit the additional information by the end of December 1996.

16. The project cost estimate (Table 8a-1 and 8a-2) should be revised based on standard Bank methodology. For costs incurred to date, the base cost should include expenses relating to both physical and price contingency. Only for future estimates, should these contingencies be presented separately. The latest Bank published MUV index and local currency inflation index (provided by the mission) should be used for price escalation projections. Foreign and local currency components should be presented separately and when combined, converting from Renminbi to US dollars, or vice versa, the applicable exchange rate in the year of disbursement should be used. For consistency with previous Bank estimates, the exchange rate for the future should include devaluation of the Renminbi to maintain current purchasing power parity.

17. A full analysis of cost variations should be conducted for Lot I and II, covering bill of quantity adjustments, variation orders, price variations, exchange rate variations (between US dollars and contract currencies), claims, and variation of taxes and duties. The foreign currency portion and local currency portion should be treated separately. For items where there are significant changes to the BOQ, physical quantities and brief explanation of the reasons for the changes should be shown in the notes.

18. To exclude the effects of inflation and devaluation, a complementary analysis of project cost variations should be carried out by de-escalating both foreign and local costs to the appraisal date using respective foreign and local inflation rates and combining the two at the appraisal exchange rate.

19. Yearly streams of costs (1991-2000) should also be presented, for local and foreign expenditure including expenditures for physical contingencies, but excluding expenditures from price contingency and tax and duties. These streams will be used to recalculate the EIRR of the project.

20. A table should be prepared to show the total contract amounts of electrical and mechanical equipment (both foreign and local contracts) and the equipment erection contract (Lot III). Major contracts should be itemized. Financing table (Table 8b) should be revised using the applicable exchange rates.

ANNEX 4: KEY MONITORING INDICATORS

Indicators	Target Dates
A. Physical Construction	
Construction Progress	
Diversion Tunnel Closure	December 1, 1993
Completion of Powerhouse Draft Tube Liners	
Unit 6	October 1, 1996
Unit 1	June, 1, 1998
Commercial Operation	
Unit 6	October 1, 1998
Unit 1	June 1, 2000
Procurement Progress	1995-1996
500 kV Dry Cable	
Generator Circuit Breakers	
500 kV GIS	
Main Transformers	
Gates, Hoists, Cranes	
Overall Cost Control	1995-2000
B. Environmental Management Program	
Mitigation Program	1991-1997
Environmental Monitoring System	1994-1996
Environmental Monitoring during Construction	1993-2000
Staff Training and Study Tour	1991-1998
Scientific Research	1995-1998
Environmental Evaluation Panel	1994-1998
C. Resettlement Action Plan	
Liangshan County (resettlement of 1,705 inhabitants)	1995
Yanbian County (resettlement of 19,574 inhabitants)	1995-1997
Miyi County (resettlement of 3,406 inhabitants)	1995-1997
Relocation of 12 Small Plants	1995-1997
Road Construction	1995-1997
Telecommunication, Power Transmission Line	1995-1997
Fish Farm	

Indicators	Target Dates
D. Institutional Development	
Corporatization	
Incorporate EHDC as a Limited Liability Company	1995
Establish a Board of Director	1995
Commercialization	
Study of Organizational Restructuring and Financial Management System	1995-1996
Implementation of the New Organization Structure and Financial Management System	1997
Power Sales	
Bulk Sales Study	1995
Memorandum of Understanding with SEPC	1995
Reservoir Optimization Study	June 30, 1995
Signing of the Power Sales Agreement with SEPC	June 30, 1997
Training Program	
Senior Management	1995-1997
Technical and Business Staff	1995-1997
Financial Staff	1995-1997
Environmental and Resettlement	1996-1997
Power Station	1996-1997

E. Financial Indicators (in %)

	1998	1999	2000	2001	2002	2003	2000
Rate of Return on Revalued Assets	0.8	20.0	17.0	17.5	16.3	15.0	15.0
Long-term Debt (LT Debt and Equity)	79.0	77.0	71.0	63.0	56.0	52.0	47.0
Debt Service Coverage	1.5	1.5	1.6	1.5	1.5	1.5	1.5

ANNEX 5: INFLATION AND EXCHANGE RATES

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
INFLATION RATES										
Annual Rates										
At Appraisal										
Local	10.0	8.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Foreign	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Actual/Latest Estimates										
Local /a	6.2	6.8	24.0	19.5	14.9	6.5	6.2	5.8	5.5	5.5
Foreign /b	2.1	4.3	-0.3	3.6	8.3	-2.5	1.7	2.2	2.6	2.8
Inflation Allowance /c										
At Appraisal										
Local	5.0	14.4	21.8	27.9	34.3	41.0	48.0	55.4	63.2	71.3
Foreign	1.7	5.2	8.7	12.4	16.3	20.2	24.3	28.5	32.9	37.4
Actual/Latest Estimates										
Local	3.1	9.8	27.0	54.4	80.6	99.4	112.0	124.7	137.4	150.5
Foreign	1.1	4.3	6.3	8.1	14.6	17.6	17.1	19.4	22.3	25.6
Exchange Rates (Yuan/$)										
Rates used at Appraisal	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24
Actual/Latest Estimates /d	5.36	5.49	5.75	8.60	8.30	8.30	8.30	8.30	8.30	8.30

Sources of information:

/a Percentage change from previous year. 1991-94, *Industry Producer's Price Index*, China Statistics; 1995-2000, *China Price Contingencies Updates*, EA2CO, the World Bank, December 20, 1996.

/b Percentage change from previous year. 1991-2000, *Index of Unit Value of Manufactured Exports (MUV)*, the World Bank, November 1996.

/c Compounded inflation rates.

/d Nominal official exchange rate (annual average). 1991-94, *The Chinese Economy—Fighting Inflation, Deepening Reforms*, A World Bank Country Study, 1995-2000, project staff appraisal reports.

ANNEX 6.1: REESTIMATED ECONOMIC COSTS AND BENEFITS (INCORPORATING ENVIRONMENTAL BENEFITS OF AVOIDED SO_2 AND PARTICULATES EMISSIONS)

(1996 Constant Million Yuan)

Year	Total Cost /a	Benefit GWh	Benefit M Yuan	Avoided SO_2 Emission ton	Avoided SO_2 Emission M Yuan	Avoided PM_{10} Emission ton	Avoided PM_{10} Emission M Yuan	Total Benefit	Net Benefit
1991	1,128.33	0.00	0.00					0.00	-1,128.33
1992	3,193.95	0.00	0.00					0.00	-3,193.95
1993	1,472.89	0.00	0.00					0.00	-1,472.89
1994	1,510.31	0.00	0.00					0.00	-1,510.31
1995	1,786.43	0.00	0.00					0.00	-1,786.43
1996	3,791.49	0.00	0.00					0.00	-3,791.49
1997	4,486.28	0.00	0.00					0.00	-4,486.28
1998	1,661.01	1,198.00	419.30	1,020.00	3.39	438.69	0.07	422.76	-1,238.25
1999	717.45	10,032.00	3,511.20	10,200.00	33.86	3,673.59	0.61	3,545.67	2,828.22
2000	323.52	15,273.00	5,345.55	236,500.00	785.18	5,592.78	0.93	6,131.66	5,808.13
2001	194.94	15,878.00	5,557.30	236,500.00	785.18	5,814.33	0.97	6,343.45	6,148.50
2002	194.94	16,094.00	5,632.90	236,500.00	785.18	5,893.42	0.98	6,419.06	6,224.11
2003	194.94	15,897.00	5,563.95	236,500.00	785.18	5,821.28	0.97	6,350.10	6,155.15
2004	194.94	15,885.70	5,560.00	236,500.00	785.18	5,817.14	0.97	6,346.14	6,151.19
2005	194.94	16,071.00	5,624.85	198,300.00	658.36	5,885.00	0.98	6,284.18	6,089.24
2006	194.94	15,990.90	5,596.82	198,300.00	658.36	5,855.67	0.97	6,256.14	6,061.20
2007	194.94	16,531.00	5,785.85	198,300.00	658.36	6,053.45	1.00	6,445.21	6,250.26
2008	194.94	16,574.10	5,800.94	198,300.00	658.36	6,069.23	1.01	6,460.30	6,265.35
2009	194.94	16,124.60	5,643.61	198,300.00	658.36	5,904.63	0.98	6,302.95	6,108.00
2010	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2011	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2012	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2013	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2014	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2015	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2016	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2017	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2018	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2019	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2020	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2021	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2022	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2023	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2024	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2025	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2026	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
2027	194.94	17,559.60	6,145.86	252,500.00	838.30	6,430.11	1.07	6,985.23	6,790.28
Total	**25,335.22**	**487,622.10**	**170,667.74**	**6,730,220.00**	**22,344.33**	**178,561.12**	**29.64**	**193,041.71**	**167,706.48**
Present Value /b	12,058.03	51,368.40	17,978.94	1,481,879.39	4,919.84	41,583.95	6.90	20,207.55	8,149.51
Internal Economic Rate of Return (IERR)									17.39%

Assumptions:

Official exchange rate (Y/S)	8.3	Y/ton SO_2:	3,320
Shadow exchange rate (Y/$)	8.3	Y/ton PM_{10}:	166
Shadow conversion factor	1.0		
Willingness to pay (Y/kWh)	0.35		
Discount rate	0.12		

Sources of information: "Economic Analysis of Environmental Impacts" by J.A. Dixon, and L.F. Scura, published in association with the Asian Development Bank and the World Bank, 1994.

/a Including Capital Investment & O&M costs.
/b Discounted to year 1991.

ANNEX 6.2: REESTIMATED ECONOMIC COSTS AND BENEFITS (INCORPORATING ENVIRONMENTAL BENEFITS OF AVOIDED SO_2, PARTICULATES AND CO_2 EMISSIONS)

(1996 Constant Million Yuan)

Year	Total Cost /a	Benefits GWh	Benefits M Yuan	Avoided SO_2 Emission ton	Avoided SO_2 Emission M Yuan	Avoided PM_{10} Emission ton	Avoided PM_{10} Emission M Yuan	Avoided CO_2 Emission ton	Avoided CO_2 Emission M Yuan	Total Benefits	Net Benefit
1991	1,128.33	0.00	0.00							0.00	-1,128.33
1992	3,193.95	0.00	0.00							0.00	-3,193.95
1993	1,472.89	0.00	0.00							0.00	-1,472.89
1994	1,510.31	0.00	0.00							0.00	-1,510.31
1995	1,786.43	0.00	0.00							0.00	-1,786.43
1996	3,791.49	0.00	0.00							0.00	-3,791.49
1997	4,486.28	0.00	0.00							0.00	-4,486.28
1998	1,661.01	1,198.00	419.30	1,020	3.39	438.69	0.07	22,210.00	1.58	424.34	-1,236.68
1999	717.45	10,032.00	3,511.20	10,200	33.86	3,673.59	0.61	222,100.00	15.78	3,561.45	2844.00
2000	323.53	15,273.00	5,345.55	236,500.0	785.18	5,592.78	0.93	5,155,200.00	366.27	6,497.93	6174.40
2001	194.95	15,878.00	5,557.30	236,500.0	785.18	5,814.33	0.97	5,155,200.00	403.06	6,746.51	6551.56
2002	194.95	16,094.00	5,632.90	236,500.0	785.18	5,893.42	0.98	5,155,200.00	403.06	6,822.12	6627.18
2003	194.95	15,897.00	5,563.95	236,500.0	785.18	5,821.28	0.97	5,155,200.00	403.06	6,753.16	6558.21
2004	194.95	15,885.70	5,560.00	236,500.0	785.18	5,817.14	0.97	5,155,200.00	403.06	6,749.21	6554.26
2005	194.95	16,071.00	5,624.85	198,300.0	658.36	5,885.00	0.98	4,322,400.00	337.95	6,622.13	6427.19
2006	194.95	15,990.90	5,596.82	198,300.0	658.36	5,855.67	0.97	4,322,400.00	337.95	6,594.09	6399.15
2007	194.95	16,531.00	5,785.85	198,300.0	658.36	6,053.45	1.00	4,322,400.00	337.95	6,783.16	6588.22
2008	194.95	16,574.10	5,800.94	198,300.0	658.36	6,069.23	1.01	4,322,400.00	337.95	6,798.25	6603.30
2009	194.95	16,124.60	5,643.61	198,300.0	658.36	5,904.63	0.98	4,322,400.00	337.95	6,640.90	6445.95
2010	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	430.34	7,415.57	7220.62
2011	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2012	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2013	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2014	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2015	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2016	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2017	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2018	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2019	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2020	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	443.14	7,428.36	7233.42
2021	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
2022	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
2023	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
2024	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
2025	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
2026	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
2027	194.95	17,559.60	6,145.86	252,500.0	838.30	6,430.11	1.07	5,504,100.00	442.68	7,427.91	7232.96
Total	**25,335.22**	**487,622.10**	**170,667.74**	**6730,220.00**	**22,344.33**	**178,561.12**	**29.64**	**146,706,110.00**	**11,641.08**	**204,687.79**	**179,352.56**
Present Value b/	12,058.03	51,368.40	17,978.94	1,481,879.39	4,919.84	41,583.95	6.90	32,301,678.60	2,518.66	21,346.86	9,288.83
Internal Economic Rate of Return (IERR)											17.99%/c

Assumptions:

Official exchange rate (Y/S)	8.30
Shadow exchange rate (Y/$)	8.30
Standard Conversion Factor	1.00
Willingness to pay (Y/kWh)	0.35
Discount rate	0.12

Y/ton PM_{10}		166	
Y/ton SO_2		3,320	
Y/ton CO_2	High	Low	
1991-2000	159.86	71.05	
2001-2010	175.88	78.19	
2011-2020	181.27	80.51	
2021-2030	181.02	80.43	

Sources of information:
"Economic Analysis of Environmental Impacts", by J.A. Dixon, and L.F. Scura, published in association with the Asian Development Bank (ADB) and the World Bank, 1994
"Economic Evaluation of Environmental Impacts Workbook" Published by ADB, March 1996.

/a Including Capital Investment & O&M costs.
/b Discounted to year 1991.
/c Based on low values of climate change damage.

ANNEX 6.3: PROJECT RISK ANALYSIS

Selected Risk Variables and Assumed Probability Distributions.

No.	Variable	Probability Distribution		Probability
1	Output	discrete	decrease by 20% decrease by 10% assumed value /a increase by 10%	10% 20% 50% 20%
2	Investment cost	discrete	decrease by 5% Assumed value /a increase by 5%	5% 80% 15%
3	Construction Lead Time	discrete	assumed value /a delay by 1 year	80% 20%
4	Contractual Price	discrete	decrease by 10% assumed value /a increase by 10% increase by 20%	10% 50% 30% 10%

/a Assumed values refer to those adopted in the deterministic economic analysis.

The risk analysis was carried out with the Risk Master computer software which uses Monte Carlo simulation[1] technique. The spreadsheet employed for the risk analysis is based on the base case cost/benefit analysis (see Table 9). The correlation between risk variables is explicitly considered prior to the simulation to avoid generation of unrealistic project scenarios. For instance, variations of output and cost are correlated with the construction lead time.

The results, based on 1,000 simulations, are summarized in the table below and the figures.

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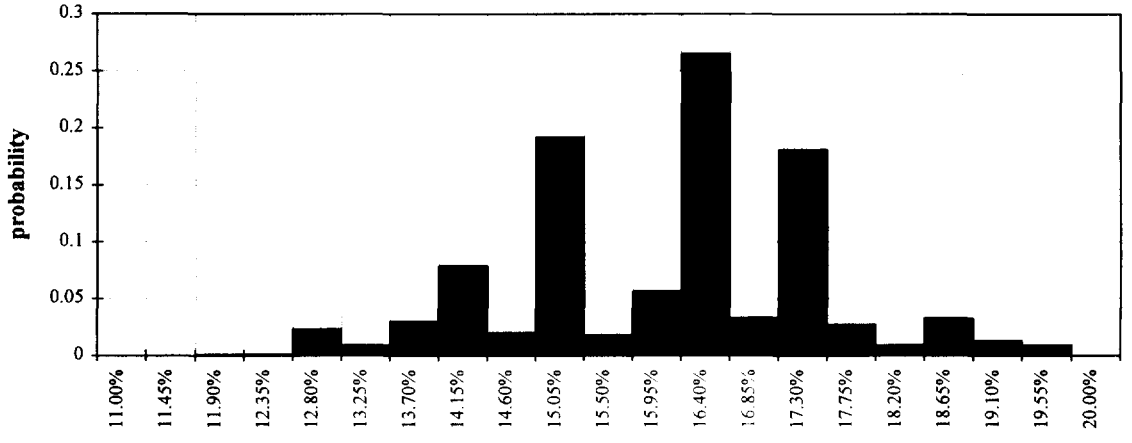
[1] Monte Carlo simulation works by generating a series of random numbers following the distribution of probability of each risk variable. For each simulation that represents a combination of different state of five variables, IERR is calculated and recorded. The results of 1,000 simulations are averaged.

ANNEX 6.3

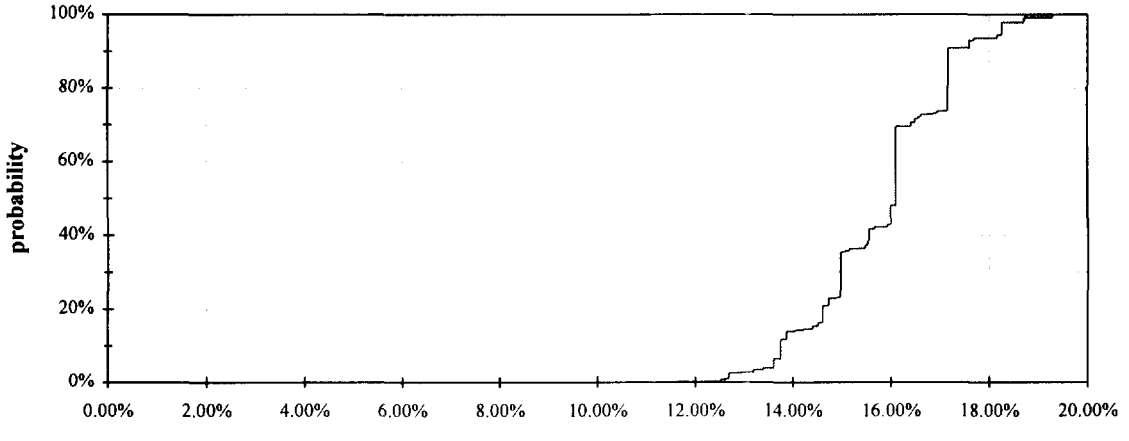
Expected IERR and Variance

Expected IERR	15.81%
Standard deviation	1.40%
Minimum	11.58%
Maximum	19.29%
Coefficient of variation	0.088
Probability of negative outcome	0.00%

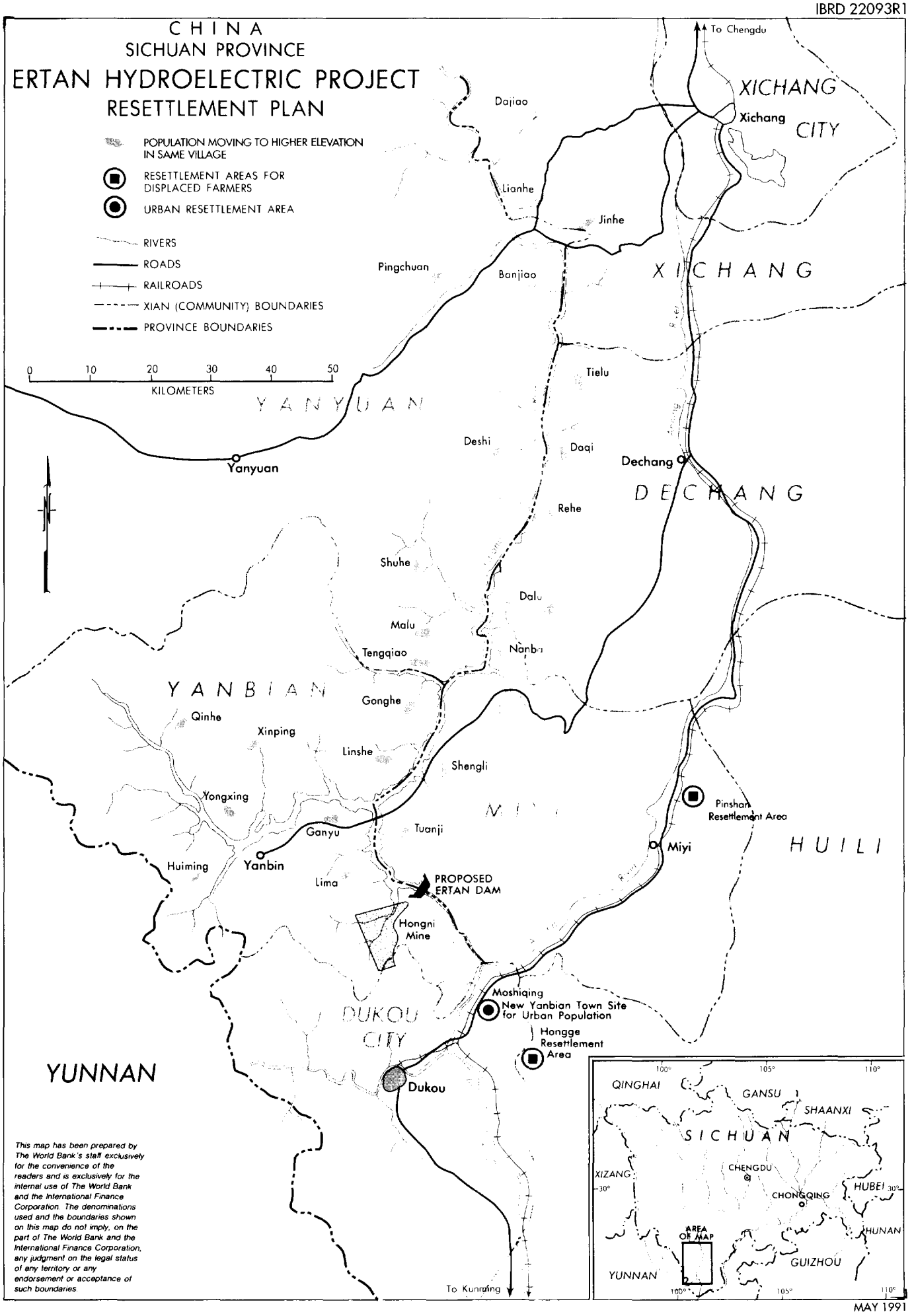
Probability Distribution of IERR



Cumulative Probability of IERR



CHINA
SICHUAN PROVINCE
ERTAN HYDROELECTRIC PROJECT
RESETTLEMENT PLAN



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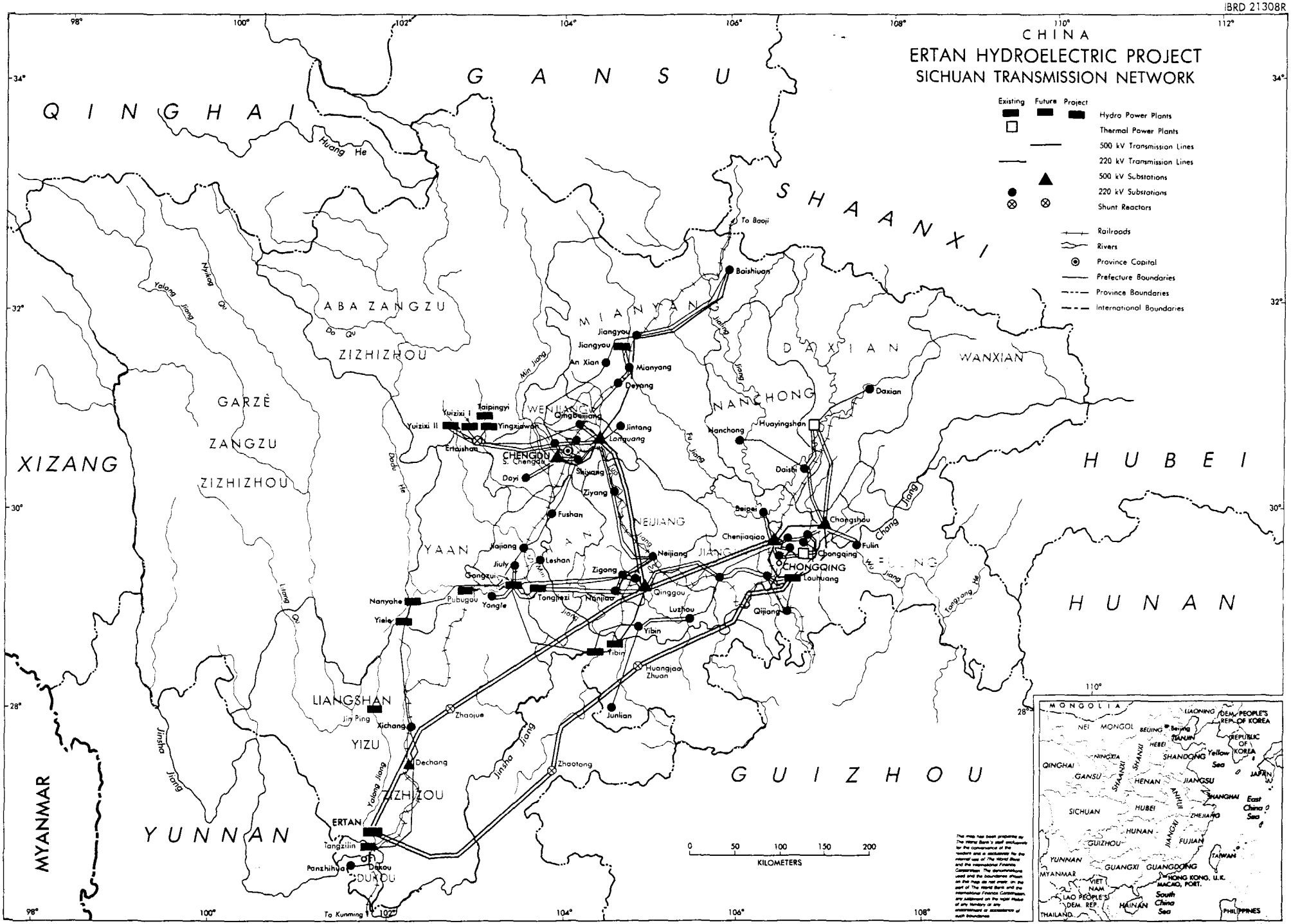
CHINA
ERTAN HYDROELECTRIC PROJECT
SICHUAN TRANSMISSION NETWORK



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