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PROJECT PERFORMANCE AUDIT REPORT

CHINA: SECOND POWER PROJECT
(Loan 671-CHA)

December 30, 1976

Operations Evaluation Department

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US\$1.00 = NT\$ 40.0	1969	100
US\$1.00 = NT\$ 40.0	1970	104
US\$1.00 = NT\$ 40.0	1971	106
US\$1.00 = NT\$ 40.0	1972	110
US\$1.00 = NT\$ 38.2	1973	119
US\$1.00 = NT\$ 38.0	1974	175
US\$1.00 = NT\$ 38.0	1975	184

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PROJECT PERFORMANCE AUDIT REPORT

CHINA: SECOND POWER PROJECT
(Loan 671-CHA)

Preface

This memorandum presents the results of a performance audit on Loan 671-CHA made to Taiwan Power Company for the country's second power project. The loan for US\$44.5 million was signed in May 1970 and closed in December 1975. The audit is based on information contained in the attached Project Completion Report (PCR) prepared by the East Asia and Pacific Regional Office; a review of Bank files and project documents; and discussions with Bank staff.

The memorandum expands on aspects of the project experience which deserve special emphasis.

PROJECT PERFORMANCE AUDIT BASIC DATA SHEET

CHINA: SECOND POWER PROJECT

(Loan 671-CHA)

(Amounts in US\$ mln)

As of Sept.30, 1976

	<u>Original</u>	<u>Disbursed</u>	<u>Cancelled</u>	<u>Repaid</u>	<u>Outstanding</u>
Loan 671-CHA	44.5	44.0	0.5	2.4	41.6

Project Data

	<u>Original Plan</u>	<u>Revision</u>	<u>Actual or Est. Actual</u>
Conception in Bank	-	-	6/69
Board Approval			4/21/70
Loan Agreement			5/16/70
Effectiveness	8/17/70	9/17/70	9/ 8/70
Physical Completion ^{a/}	3/74		10/73
Loan Closing	12/31/74		12/31/75
Total Costs <u>b/</u>	70.8		59.1
(Incremental) Internal Rate of Return <u>c/</u>	17%		13%

Mission Data

	<u>Month, Year</u>	<u>No. of weeks</u>	<u>No. of Persons</u>	<u>Manweeks</u>	<u>Date of Report</u>
Identification	-	-	-	-	-
Preparation	-	-	-	-	-
Preappraisal	(10/69	2½	3	7½	(3/25/70
Appraisal	(2/70	<u>1</u>	2	<u>2</u>	(
Subtotal		3½		9½	
Supervision I *	4/71	½	1	½	5/5/71
Supervision II *	3/72	½	1	½	4/3/72
Supervision III*	11/72	½	1	½	12/15/72
Supervision IV *	6/73	<u>1</u>	<u>1</u>	<u>1</u>	10/ 5/73
Subtotal		2½		2½	

Follow-on Project

Loan 749-CHA of US\$55.0 mln, signed in June 1971 for Third Power Project.

a/ & c/ Original and actual are not comparable.

b/ Actual excludes Transmission component, estimated at appraisal to cost US\$11.0 million plus interest during construction.

* Includes supervision of other Bank assisted projects.

PROJECT PERFORMANCE AUDIT REPORT

CHINA: SECOND POWER PROJECT
(Loan 671-CHA)

Highlights

This is a case of a successful project, completed within the appraisal cost estimate and, by and large, within the original schedule - a reflection of the technical and managerial competence of the borrower.

The following points may be of particular interest:

Procurement under Bank guidelines (para. 6).

Additional benefits from selection of a well-proven machine (para. 7 and PCR para. 16).

PROJECT PERFORMANCE AUDIT MEMORANDUM

CHINA: SECOND POWER PROJECT
(Loan 671-CHA)

1. This was the second Bank loan for a power project in the country^{1/}. It was intended to cover the project's foreign exchange cost amounting to about 63% of the estimated total cost of US\$70.8 million equivalent, including interest during construction (IDC). The project, part of Taipower's long-term development program comprised: a) installation of one 375 MW thermal unit (unit No. 4) at Talin station - at an estimated total cost of US\$45.3 + IDC; b) installation of two 90 MW hydroelectric units (units Nos. 3 and 4) at Lower Tachien hydroelectric station, at an estimated total cost of US\$9.8 million + IDC; and c) installation of the second circuit of the 345 KV double circuit transmission line, and of sub-station facilities, at an estimated total cost of US\$11.0 million + IDC. The project also included improvements to Taipower's long-term development planning, accounting systems and financial planning, and training of Taipower's staff with the help of engineering and management consultants for a total cost of US\$0.4 million.

2. Talin No. 4, 375 MW unit was completed exactly as planned within the appraisal cost estimate in current terms (about 15% cost underrun in real terms, Table A and Annex), and about 3 months earlier than scheduled (PCR para. 1). Lower Tachien units Nos. 3 and 4 were completed, also exactly as planned, for a cost underrun of about 7% in current terms (about 20% in real terms, Table A and Annex), and about 6 months behind the original schedule but without any detrimental effect on the system (PCR paras. 21 and 34).

3. The transmission and substation component of the project was subsequently integrated with its counterpart from the first power project. Soon after the loan was made, for political reasons^{2/}, Taipower arranged to have the transmission element financed from other sources, and to use the proceeds intended for this element, to finance the cost of the enlarged substation facilities. Details of the actual costs of transmission and substation components are not yet available. The audit therefore does not cover that part of the project.

4. Gilbert Associates, the management consultants, helped in long-term financial planning and accounting systems, and reviewed and made recommendations on the depreciation rates on the fixed plant. EBASCO, the engineering consultants, helped in load forecasting and developing a long-range power program, and in determining systems reserve capacity requirements. Lahmeyer International GmbH and Motor Columbus, the engineering consultants, helped in planning peaking power projects. The performance of the three consultants was satisfactory.

^{1/} The third loan for power project (Loan 749-CHA for US\$55.0 million) was made in 1971. Audit Memorandum on the first power loan (574-CHA, Tachien Power Project) was prepared on December 30, 1976.

^{2/} These are explained in para. 4 of the Audit Memorandum on the first power loan (574-CHA).

5. The estimated and actual allocation of proceeds of the Bank Loan are given in the table below:

<u>Category</u>	<u>Allocation of Proceeds of Loan</u>	
	(US\$ million)	
	<u>Estimated</u>	<u>Actual</u>
I. Thermal generating station equipment and facilities	24.10	21.98
II. Hydroelectric generating station equipment and facilities	4.80	5.70
III. Transmission	5.70	6.65
IV. Engineering services	2.00	1.74
V. Consulting and training services	0.40	0.43
VI. Interest and other charges during construction	4.70	7.52
VII. Unallocated	<u>2.80</u>	<u>-</u>
<u>Total</u>	<u>44.50</u>	<u>44.01</u>

Two reasons contributed to the increase in interest and other charges during construction. Firstly, about US\$1.5 million from the loan funds were used to pay the interest on the loan in 1975; secondly, a simple calculation using the projected disbursements suggests that the interest and other charges were underestimated at the appraisal.

6. By combining the procurement of some of the equipment for Talin units No. 3 and No.4, and by the fact that these two units were identical, Taipower was able to obtain cost savings on Talin No. 4. In another case, where invitations for bidding resulted in only one valid bid (and where the Bank, because of the urgency of the situation, appropriately waived the requirement to call fresh bids), Taipower was able to obtain cost savings through price negotiation with the bidder. However, Taipower would have achieved a further substantial saving (about US\$0.9 million) on the purchase of the boiler, had Taipower and its consultants, Gibbs & Hill, fully observed Bank's procurement guidelines while calling for bids on Talin No. 3 plant. At the Bank's suggestion, Taipower had asked the bidders on plant for Talin No. 3 to give an option on plant for a second unit of the same size; but the documents, which asked for financing terms and provided the specifications on plant for Talin unit No.3, were issued to the prospective bidders without reference to a cash supply basis. (It was the intent to finance the unit through suppliers' credits and this was in fact done). By the time this omission was realized, it was too late to make the necessary amendments to the relevant documents. Taipower was therefore obliged to call in fresh bids for Talin No. 4. The boiler manufacturer for Talin No. 3, who had quoted the option price of US\$5.27 million, withdrew the option and quoted

a new price of US\$6.25 million^{1/}. This was still the lowest bid^{2/}.

7. Mainly because of shorter construction time against lower unit capital cost and better heat rate (PCR para. 3), the 375 MW machine was installed in preference to a 500 MW machine. In effect, the 375 MW set, a well-proven machine, emerged a better proposition than originally envisaged. Its unit capital cost^{3/} (US\$107/KW appraisal estimate as well as actual) was about the same as, and probably marginally lower in real terms than, that of the 500 MW set (US\$108/KW appraisal estimate; US\$134/KW provisional actual) installed in the third power project (Loan 749-CHA). The actual heat rate^{4/} of the smaller machine, at 9,285/BTU/KWh, is only marginally higher (about 1.2% worse, against the originally envisaged 5.6%, PCR para. 3) than 9,177 BTU/KWh of the larger machine^{5/}. On the other hand, the earlier than originally scheduled commissioning of the 375 MW set was a useful and timely addition to the system's generating capacity.

8. The actual (incremental) internal rate of return on Talin No. 4 is estimated at 13% (Table B) against 17% estimated in the appraisal report^{6/}.

9. Taipower's performance was satisfactory, and in some areas better than forecast (Table C). The work done by management and engineering consultants has helped Taipower to manage competently the large and complex expansion program, which has doubled energy sales and installed generating capacity, and tripled total fixed assets between 1969 and 1975 (and is expected to achieve a similar growth pattern again, between 1975 and 1985). As required under the loan covenant Taipower implemented the revised depreciation rates in the accounts of FY1970 and thereafter. The rate of return was higher than the covenanted 10%, and all other loan covenants were met.

10. This has been a successful project. The Bank made a useful contribution to the development of China's power sector. Its four supervision missions on the project, totalling about 2½ manweeks^{7/}, were adequate, since the borrower was technically and managerially competent to handle the project.

^{1/} Subsequently negotiated to US\$6.20 million. In fact, the same manufacturer also supplied turbo-generators for Talin Nos. 3 and 4, and had similarly quoted a new price, higher (by nearly US\$0.4 million) than the option price; it was subsequently reverted to the option price.

^{2/} Probably because of the short delivery period (27 to 30 month) or because of financing condition, only 3 turbo-generator suppliers (2 from Japan and 1 from Germany) and 2 boiler suppliers (Japanese and German) had submitted bids for Talin No. 3.

^{3/} Excluding customs duties.

^{4/} Source: Electric Power Industry in Taiwan, April 1976. (500 MW machine has probably not yet stabilized; its heat rate should therefore be considered provisional).

^{5/} Op Cit.

^{6/} Records are not available to show how this 17% internal rate of return was arrived at.

^{7/} These supervision missions also covered the two projects under loans 574 and 749.

Table A

PROJECT COSTS IN CURRENT AND CONSTANT PRICES
(US\$ million)

	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>Total</u> <u>Actual</u>	<u>Total</u> <u>Apprai-</u> <u>sal Est.</u>	Increase over Appraisal Est. (%)
Deflator (Wholesale Prices)	1.00	1.06	1.28	1.80	1.71	-	-	-
<u>Talin No. 4, 375 MW Unit</u>								
Annual Disburse- ments (current prices)	6.0	16.0	18.0	5.6	-	45.6	45.3	nil
Annual Disburse- ments (1971 prices)	6.0	15.0	14.0	3.1	-	38.1	45.3	-16%
<u>Lower Tachien, Nos. 3 & 4; 90 MW Units</u>								
Annual Disburse- ments (current prices)	1.5	3.5	3.0	1.1	-	9.1	9.8	-7%
Annual Disburse- ments (1971 prices)	1.5	3.3	2.3	0.6	-	7.7	9.8	-21%

- Notes:
1. Disbursements are assumed
 2. Excludes interest during construction

Table B

TANLIN NO.4: 375 MW UNIT (INCREMENTAL) INTERNAL RATE OF RETURN
(COSTS AND REVENUES IN NT\$ million)

	<u>Costs (Current Prices)</u>			<u>Revenues</u>	<u>Deflation</u> <u>Factor</u>	<u>Net Revenues(Costs)</u> <u>(1971 Prices)</u>
	<u>Capital Expenditure</u>		<u>Operating</u>	<u>(Current Prices)</u>		
	<u>A</u>	<u>B</u>	<u>Cost</u>	<u>Energy Sales</u>		
		<u>C</u>	<u>D</u>	<u>E</u>		
1971	236	177	-	-	1.00	(413)
1972	630	472	-	-	1.06	(1,041)
1973	709	532	-	-	1.28	(968)
1974	221	166	1,470	2,180	1.80	180
1975	-	-	1,560	2,280	1.71	420
1976	-	-	1,560	2,280	1.71	420
			⋮	⋮	⋮	⋮
			⋮	⋮	⋮	⋮
1985	-	-	1,560	2,280	1.71	420
1986	-	-	1,340	1,950	1.71	350
⋮			⋮	⋮	⋮	⋮
⋮			⋮	⋮	⋮	⋮
1995	-	-	1,340	1,950	1.71	350

(Incremental) Rate of Return 13%

Notes & Assumptions:

- A. Capital Expenditure on Talin 4 (includes customs duties but not interest; disbursements are assumed).
- B. Corresponding Expenditure on Transmission and Distribution (about 75% of capital expenditure on generation; disbursements are assumed).
- C. Cost of operation, maintenance, transmission, distribution (but excludes depreciation and interest charges) administration, etc.; estimated at NT\$0.64/KWh and NT\$0.68/KWh respectively in 1974 and 1975.
- D. Total energy generated at 0.7 load factor through 1985 and at 0.6 load factor thereafter, (less 8% systems loss); average tariff - NT\$1.03/KWh in 1974 and NT\$1.08/KWh in 1975.
- E. Wholesale Price Index.

Table C

KEY INDICATORS

Estimate v/s Actual

(All figures in NT\$ mil., unless stated otherwise)

		<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
Peak Load (MW)	Est.	1,848	2,164	2,463	2,784	3,134	3,512	3,923
	Act.	1,848	2,131	2,399	2,734	3,134	3,452	3,765
Installed Capacity (MW)	Est.	2,245	2,725	3,078	3,633	4,167	4,367	4,974
	Act.	2,245	2,720	2,774	3,519	4,124	4,358	5,300
Energy Sales (GWh)	Est.	10,051	11,696	12,941	14,669	16,454	18,437	20,599
	Act.	10,051	11,964	13,836	16,081	17,938	18,881	21,217
Total Operating Revenues	Est.	5,598	6,661	7,576	8,633	9,729	10,955	12,299
	* Act.	5,598	6,986	8,220	4,463	9,960	14,886	22,059
Total Operating Cost	Est.	3,777	4,377	4,952	5,658	6,143	6,884	7,618
	* Act.	3,818	4,528	5,749	3,176	7,186	11,078	16,864
Oper. Income (less deprec.)	Est.	1,751	2,284	2,624	2,975	3,586	4,071	4,681
	* Act.	1,780	2,458	2,471	1,287	2,774	3,808	5,195
Total Internal Cash Generation	Est.	2,625	3,220	3,692	4,195	4,991	5,682	6,432
	* Act.	2,625	3,530	3,873	2,079	4,471	6,407	8,068
Net Internal Cash Generation	Est.	1,011	1,606	1,635	1,719	1,983	2,295	2,676
	* Act.	1,238	1,882	1,896	947	1,669	2,965	3,337
Construction Expenditure (excl. IDC)	Est.	3,103	5,714	8,140	7,471	6,309	5,808	6,407
	* Act.	3,103	3,816	6,615	4,005	10,144	18,650	20,577
Rate Base: Average Net Fixed Assets in Operation and Working Capital	Est.	17,177	20,420	23,908	26,873	31,014	35,695	39,021
	* Act.	17,138	19,730	22,770	23,994	25,773	28,750	37,718
Rate of Return %	Est.	10.2	11.2	11.0	11.1	11.6	11.4	12.0
	* Act.	10.4	12.3	10.9	5.4	10.8	13.9	13.8
Debt/Equity Ratio	Est.	48/52	49/51	53/47	55/45	54/46	52/48	50/50
	* Act.	48/52	46/54	47/53	51/49	52/48	56/44	52/48
Debt Service Coverage (incl. IDC)	Est.	1.7	2.1	1.9	1.8	1.7	1.7	1.8
	* Act.	1.9	2.2	2.0	1.9	1.7	1.9	1.8
Net Internal Cash Gen. as % of Constr. Expenditure	Est.	.32	.28	.20	.23	.31	.40	.42
	* Act.	.39	.49	.28	.23	.16	.16	.16
Tariff (NT\$)	Est.	.54	.56	.57	.57	.58	.58	.58
	Act.	.537	.565	.567	.564	.576	1.031	1.070
Oper. Cost/KWh sold (NT\$)	Est.	.37	.37	.38	.38	.37	.37	.37
	Act.	.370	.371	.400	.390	.427	.800	.853
Consumer Price Index	Act.	100	104	106	110	119	175	184

Note: Estimates refer to calendar year; actuals shown with an asterisk refer to Fiscal Year.

CHINATAIWAN POWER COMPANY (TAIPOWER)LOAN 671-CHASECOND POWER PROJECTProject Completion Report ^{1/}

- | | |
|---------------------------------------|--|
| 1. Borrower: | Taiwan Power Company |
| 2. Guarantor: | Republic of China |
| 3. Loan Amount: | US\$ 44.5 million |
| 4. Date Loan Signed: | May 16, 1970 |
| 5. Effective Date: | September 8, 1970 |
| 6. Closing Date: | December 31, 1974 (Original)
December 31, 1975 (Final) |
| 7. Period of Grace: | 5 years |
| 8. Term of Loan: | 20 years |
| 9. Interest Rate: | 7% p.a. |
| 10. Commitment Charge: | 3/4% p.a. |
| 11. Amortization: | Half yearly, April 15, 1975 - October 15, 1990 |
| 12. Exchange Rate: | Appraisal - US\$10 = NT\$40.0
Current - US\$1 = NT\$38.1 |
| 13. Appraisal Report
No. and Date: | PU-29a, March 25, 1970 |
| 14. Fiscal Year: | Calendar Year through 1971, January 1 - June 30
in 1972, and July 1 - June 30 thereafter. |

	<u>COSTS</u>	<u>US\$ million</u>
Appraisal Cost Estimate (includes Transmission element)	Foreign Exchange	44.5
	Local Currency	<u>26.3</u>
	<u>Total</u>	70.8
Appraisal Cost Estimate (excluding Transmission element)	Foreign Exchange	37.4
	Local Currency	<u>21.6</u>
	<u>Total</u>	59.0
Final Costs (excluding Transmission element)	Foreign Exchange	36.8
	Local Currency	<u>22.3</u>
	<u>Total</u>	<u>59.1</u>

^{1/} This report was prepared on information provided by Taipower and does not include the transmission element.

A. Talin No.4 Thermal Unit (375 MW)Summary

Talin No.4 was completed ahead of schedule and within the original cost estimate.

1. Basic Information

Appraisal:	October/November 1969
Reappraisal:	February/March 1970
Board Date:	April 21, 1970
Signing Date:	May 16, 1970
Effectiveness:	September 8, 1970
Project Completion: (scheduled)	December 1973 (First Synchronization)
(actual)	October 23, 1973 (Full Commercial)
Closing Date:	December 31, 1975
Loan Amount:	US\$ 31.5 million including IDC. Talin No.4 only.

2. Project Scope

Extension of the existing Talin oil-fired steam Power Station (Units 1-3 = 975 MW) at Kaohsiung in southern Taiwan by the addition of a fourth 375 MW unit to meet power demand in the two densely populated and industrially developed areas of Taiwan (Taipei - Keelung area in the north, and Kaohsiung area in the south). Financing under loans 574-CHA and 671-CHA also included a double circuit 345 kV transmission line connecting the two load centers plus a feed-in substation for hydro generated energy in Central Taiwan. The unit includes one indoor tandem compound four flow turbine at 375 MW, 2400 psig, and 1000°F; one indoor hydrogen cooled generator rated for maximum capacity of 422 MVA; and one outdoor-type oil-fired boiler rated at 2,625,000 lbs/hr of steam flow at the superheater outlet.

3. General Project Considerations (Feasibility Report May 1969)

- (i) The existing plant site Talin was chosen in preference to Linkou in the North because of cost advantages in fuel supply and transmission;
- (ii) Taipower considered international competitive bidding advantageous and accordingly approached the Bank for financial assistance;

A.3

- (iii) A unit capacity of 350 MW was compared to a 500 MW unit.

	<u>350 MW</u>	<u>500 MW</u>
Capital investment/kW	US\$ 122.2	US\$ 110.8
Generation Costs US mills/kWh	5.881	5.553
Average systems generating costs 1968		7.27 US mills/kWh.

On this basis -- since the system would have permitted the installation of a 500 MW unit -- a 500 MW unit was the preferred solution. However, the ultimate decision was for the 375 MW unit -- the same as Unit 3 -- in order to profit from erection experience already gained and to save time in design and construction. A further consideration was that at that time only a limited number of manufacturers produced 500 MW units. The reasons for not considering a hydro alternative were:

- (i) to meet projected demand a base load unit was required-- the system load factor was already 68%;
- (ii) no hydro sites meeting the required characteristics were available for implementation; and
- (iii) in any event, the construction time for a hydro plant -- if available -- was longer;

(iv) Incremental Rate of Return

Cost Stream = Cost of Talin No.4; associated 345 kV transmission facilities, plus other transmission and distribution facilities required to transmit and distribute Talin No.4 output; Operating and Maintenance Costs; plus Fuel at US\$ 15/t net of taxes.

Benefit Stream = Cost Savings from the initial displacement of less efficient generating plant and subsequent revenues from the supply of new load (US cents 1.43/kWh assumed to be the average revenues 1970-1975).

Rate of Return 17%

4. Load Forecast

	Installed capacity		Maximum Demand		Generation		Sales	
	MW		MW		GWh		GWh	
	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
1969	2245	2245	1850	1848	n.a.	11119	10002	10051
1970	2720	2720	2164	2131	n.a.	13213	11696	11964
1971	2770	2774	2463	2399	n.a.	15171	12941	13836
1972	3350	3519	2784	2734	n.a.	17449	14669	16081
1973	3800	4124	3134	3134	n.a.	19805	16454	17938

-
1. Appraisal
 2. Actual

Taipower's power market -- maximum demand -- developed as forecast, however, actual sales were higher by about 9% with a corresponding increase in the average annual load factor, a surprising 72% achieved in 1973.

5. Consultants

Taipower engaged the services of Gibbs & Hill Inc., of New York (GH) for Plant Engineering & Design and to act as Taipower's Procurement Agent. Taipower is satisfied with the performance of GH -- "have done a good job. Due to their cooperation, particularly expediting delivery of piping materials, construction progressed smoothly and full load operation was achieved 4 months ahead of schedule".

6. Design & Procurement

Engineering and Design work by GH started in August 1969 and kept on forecast schedule until July 1971, dropping thereafter -- about 5% maximum in December 1972. Procurement started in May 1970 and was 92% complete by February 1972. The forecast procurement schedule for the first 18 months was too ambitious to achieve. By February 1973 procurement was essentially complete having taken 34 months. The project suffered no delays due to engineering or procurement. All materials, arrived on or even ahead of schedule with the exception of some valves that eventually were airfreighted.

7. Gibbs & Hill Organization

A Project Manager was supported by an Engineering Manager, a Purchasing Manager and a Construction Manager. Excluding drafting personnel, the Engineering Manager had an expatriate supporting staff of 17 engineers/architects. The Purchasing Manager had one expatriate assistant and the Construction Manager was supported by a Resident Engineer and a Testing-Start-Up Engineer.

8. Taipower Organization

Taipower assumed primary responsibility for site supervision and erection of equipment. Its Head office in Taipei was responsible for:

- (i) Review of Shop Inspection & Test Reports;
- (ii) Job-site Inspection and Quality Control;
- (iii) Design of minor items; review of GH engineering; approval of specifications; and justification of equipment costs;
- (iv) Coordination;
- (v) Accounting;
- (vi) Foreign purchases of miscellaneous items;
- (vii) Insurance, shipping and transportation;
- (viii) Personnel; and
- (ix) Financial management Bank loan.

Field supporting staff covered the following activities:

- (i) General Services;
- (ii) Purchasing, transportation, storage;
- (iii) Site accounting;
- (iv) Safety;
- (v) Installation and Erection;
- (vi) Civil Engineering & Architecture; and
- (vii) Supervision of local civil contractors.

9. Construction

Actual progress was always ahead of the original schedule. Construction started in July 1970, parallel with Talin No.3 which was completed in December 1972. Construction progress can be summarized as follows:

	<u>Completion %</u>	
	<u>Schedule</u>	<u>Actual</u>
July 1, 1970	0	0
July 1, 1971	8.16	8.39
July 1, 1972	30.97	32.93
July 1, 1973	75.78	85.51
December 30, 1973	96.72	100.00
July 1, 1974	100.00	-

10. Troubles occurring during construction were:

- (i) delivery delay in piping valves - airfreighted;
- (ii) turbine internal balancing pipe broken during initial operation - no damage to turbine, new pipe successfully fitted;
- (iii) poor efficiency of make-up water treatment equipment - change of resin type in ion-exchangers solved problem;
- (iv) high pressure heater tube leakage due to stress - being corrected by annealing at jobsite.

None of these difficulties affected costs and the delay caused amounted to only a few days.

11. Taipower's assessment of quality and performance of manufacturers and contractors: because of earlier than anticipated commissioning, Taipower considers performance and quality as satisfactory.

12. Taipower's assessment of the Bank's performance is also satisfactory, particularly in respect to the Bank's involvement and responsiveness with procurement, which according to Taipower went smoothly and contributed to the early completion of the Project.

13. Principal Suppliers financed by Loan 671-CHA

<u>Item</u>	<u>Contractor</u>	<u>Amount US\$ equivalent (10³)</u>
Engineering Services	Gibbs & Hill	1529
Turbo Generator etc.	Mitsubishi	6932
Boiler	Mitsubishi	7998
Condenser Tubes	Mitsubishi	552
Power Piping	Tubeco (USA)	2690
Transformer & Switchyard Equipment	Mitsubishi	443

14. Principal Items financed with Supplier's Credits

Boiler Feedwater Pumps	Byron Jackson	675
Condensate Coolers	Mitsubishi	87
Main Power Transformer	Toshiba	835

15. Items financed by Taipower directly

Computer control equipment, other	2055
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16. Acceptance and Performance Tests

Performance tests were carried out in November 1973. The results are summarized as follows:

	<u>Test Result</u>	<u>Guarantee</u>	<u>Difference</u>
Boiler Efficiency (%)	89.42	88.47	+ 0.95%
Turbo-Generator Heat Rate (BTU/kWh)	7350	7435	- 1.1 %

17. Financing Arrangements and Costs

The feasibility report prepared by Taipower estimated total costs (excluding IDC) at US\$ 48.3 million equivalent and financing was originally envisaged as follows:

IBRD	US\$ 24.6 million	51%
Taipower	17.3	36%
Suppliers Credit	1.5	3%
Customs Duties	<u>4.9</u>	<u>10%</u>
Total	<u>48.3</u>	<u>100%</u>

The Bank appraisal mission, after review of the Project, estimated total costs at US\$ 45.3 (again without IDC) and proposed financing of the foreign exchange component and the following financing plan:

IBRD	US\$	28.2 million	62%
Taipower		<u>17.1</u> "	<u>48%</u>
Total	US\$	<u>45.3</u> "	<u>100%</u>

18. During the course of construction Taipower, because of its capital intensive program, could not contribute the US\$ 17.1 million and was forced to borrow funds on the local market, in addition to which three suppliers credits had to be negotiated (see paragraph 14) totalling about US\$ 1.6 million equivalent.

19. A comparison between estimated and tentative actual costs is given in the Annex to this report. Summarized the position is as follows:

	<u>In thousands of US\$ equivalent</u>		
	<u>Local</u>	<u>Foreign</u>	<u>Total</u>
Appraisal Estimate	17100	28200	45300
Tentative Actual	<u>18347</u>	<u>27222</u>	<u>45569</u>
Increase (Decrease)	<u>1247</u>	<u>(978)</u>	<u>269</u>

Cost increases occurred mainly in (i) Civil Works; (ii) Construction equipment; (iii) Pressure Piping; and (iv) Miscellaneous mechanical equipment which can be offset by allocation of the contingency item provided for in the original estimate. The resultant increased costs are therefore indirectly attributable to customs duties only.

20. Project Justification in Retrospect

Taipower has not yet calculated generating costs of the new unit. An estimate made in 1973 after commissioning gave the following indications:

- (i) In 1973 the average generating costs for Taipower's system amounted to US mills 6.95/kWh;
- (ii) Generating costs at Talin (2 x 300 MW plus 2 x 375 MW - including Unit No.4) totalled US mills 5.69/kWh. Since Talin No.4 is the newest unit and the more efficient, its generating costs are if not less, at least equal to US mills 5.69/kWh comparing favorably to the estimate made in paragraph 3 (iii). As a result system savings (1974) can be estimated at about US\$ 3.0 million or about 1.4-1.5% of total operating expenses in that year.

B. Lower Tachien Hydro Project (Phase II, 2 x 90 MW)

Summary

Lower Tachien Units No.3 & 4 were commissioned about six months behind and below estimated costs.

21. Basic Information

Appraisal - Effectiveness as for Talin No.4
 Project Completion (scheduled) Dec. 1972.
 (actual) Unit 3 May 29, 1973
 Unit 4 June 30, 1973

Closing Date: December 31, 1975
 Loan Amount: US\$ 5.6 million equivalent including IDC
 (Lower Tachien No.3 & 4 only, Penstock steel
 procured by Taipower excluded).

22. Project Scope

The Chingshan (Lower Tachien) Hydro Power Plant on the Tachia River is the second up-stream development of five possible developments and downstream of the Tachien Dam Project financed under Loan 574-CHA. Lower Tachien, thus benefits from the regulation provided by the Tachien storage. Chingshan was developed in two stages with all major civil works completed in the initial stage (2 x 90 MW) financed by US AID and commissioned in December 1970. The Project (Stage 2) was thus limited to the installation of the two remaining units No.3 & 4 bringing installed capacity to 360 MW. Completion of this Project made the Chingshan Power Station the largest hydro facility in Taipower's system.

23. General Project Considerations

With the construction of the Tachien Dam Project underway, expansion of Chingshan was a logical step since operation of Units 3 & 4 would be coordinated with that of the other plants on the river benefitting from the storage provided by the Tachien Project. The location of Lower Tachien -- between the northern and southern load centers -- was also beneficial for operation as a peaking plant.

24. Project Execution

Installation of the Units was carried out by Taipower personnel with assistance provided by manufacturers. Construction started in March 1972 and all work was completed by end June 1973. The organization set-up for project implementation was:

- (i) Erection Team: Responsible for transportation and erection;
- (ii) E & M Division: Responsible for penstock installation and engineering services;
- (iii) Shop Division: Manufacture of steel metal works and maintenance and repair of construction equipment;
- (iv) E & M Inspection Team: Inspection of installation work;
- (v) Civil Inspection Team: Inspection of civil works; and
- (vi) TPC Construction Team: Erection of Transformers and Switchyard.

25. Construction Difficulties

The following difficulties were encountered:

- (i) Generator No.4 Spider boss could not be tightly connected because spring key did not fit. Spring key trimmed and fitted at local iron works;
- (ii) Cotter keys of No.4 Rotor were thicker than design tolerance. Local iron works could not correct deficiency and manufacturer was requested for replacements which were airfreighted. This defect caused delays which were made up by concentrating on other work;
- (iii) Pipe fittings supplied by manufacturers were either not processed or erroneously processed. Time was wasted in re-modelling and re-processing;
- (iv) Station service switchboard arrived late due to time-consuming ocean-freight requiring power for the auxilliary equipment during test running to be supplied from the Unit 2 switchboard;
- (v) Main valve water seal. Downstream seal operated by hydraulic pressure. Upstream seal by turn-buckles. With the penstock full, the upstream seal was difficult to operate. TPC recommends hydraulic operated seals for convenience and efficiency;
- (vi) Transformer Unit No.3 because of shipping difficulties arrived late. Because transformer was over-weight for highway transportation, traffic permit issued by Taiwan Highway Administration was delayed.

26. Taipower's Views on Contractors and Manufacturers

- (i) Turbine-generator manufacturers (Mitsubishi) shipped equipment as scheduled. Transformers (Tyree-Australia), and station service switchboards (Abbots-USA) arrived late (mainly because of distance and ocean freight);
- (ii) Some spare parts and accessories procured in Japan were found short-shipped; and
- (iii) Some spare parts and accessories supplied by manufacturers were found defective. However, suppliers took prompt action for adjustments or replacements.
- (iv) Technicians dispatched to site by manufacturers for erection assistance were competent and cooperative. TPC, however, recommends that supplier's agents could improve on liaison between their Head Office and TPC, particularly with regard arrangements for manufacturer's technicians to arrive on site.
- (v) The local contractor for civil works was competent and carried out works in accordance with the specifications.

27. Main Suppliers

<u>Item</u>	<u>Manufacturer/Supplier</u>	<u>Amount US\$ equivalent (10³)</u>
Turbo-Generator	Mitsubishi	4133 (US\$ 23/kW)
Transformer (115 MVA)	Tyree	550 (US\$ 5/kVA)
Power Cable (161 kV O.F.)	Furukawa (Japan)	190
Station Transformer (2000 kVA)	Mitsubishi	146 (US\$ 73/kVA)
Power C.B. (161 kV)	Mitsubishi	68
Civil Works	Tulin (Taiwan)	70

28. Costs

Estimated to cost US\$ 9.8 million equivalent (excluding IDC) of which US\$ 4.5 million in local currency and US\$ 5.3 million in foreign currency, the Project was completed at a cost of US\$ 9.115 million (Local US\$ 3.3 million; Foreign US\$ 5.815 million). Details are given in the Annex to this report.

29. Whilst it appears that Civil Works and Miscellaneous items were over-estimated and the cost of E & M equipment under-estimated, it could be that TPC in their final cost figures included penstocks and associated valves under E & M whilst usually these items are considered part of the civil works. Nevertheless, the Project was completed at US\$ 685,000 below the estimate.

30. Taipower's Views of Bank Involvement

With regard procurement, disbursements and supervision Taipower is satisfied. TPC, however, recommends that the Bank take effective measure to ensure supplier's compliance with regard contractual shipment dates. This, however, should not be a function of the Bank.

C. Recommendations and Conclusions

31. Since these Projects have been successfully completed and are in service, further supervision activity can be suspended. Because Loan 749-CHA, Talin No.5 is still active, financial reporting on Taipower's activities will continue.

32. Installation and Erection of both Projects were carried out by Taipower personnel, who have fully demonstrated their capability.

33. Procurement and disbursements proceeded satisfactory, causing no delay in project implementation.

34. The load forecast prepared at the time of appraisal proved to be accurate in terms of demand but under-estimated in terms of energy due to a more rapid improvement on system load factor. Thus the decision to implement the Talin No.4 Project proved to be fully justified and its earlier than anticipated commissioning a welcomed capacity addition. The delay in implementing the Tachien Dam Project -- Loan 574-CHA -- resulted in initial under-utilization of Lower Tachien No.3 & 4. This could, however, not be foreseen at the time. Given the low incremental investment in these two units (US\$ 51/kW excluding IDC)

the financial consequences of the early investment, 6 months ^{1/}, are negligible.

35. The principal objectives of the loan -- provision of base load energy (Talin No.4) and peaking power (Lower Tachien No.3 & 4) were fully met, improving system operations and reducing operating costs. Only the delay in the transmission element included in loans 574-CHA and 671-CHA -- which will be the subject of a separate completion report -- have detracted from the realization of all objectives. It can be stated here that the delay in commissioning the transmission element can be attributed to political factors only, beyond the control of Taipower.

1/ Initial impoundment at Tachien, and thus regulation of the Tachia flow started December 1973.

East Asia and Pacific Regional Office
February 27, 1975.

CHINA
TAIWAN POWER COMPANY (TAIPOWER)
LOAN 671-CHA TALIN NO.4 AND LOWER TACHIEN NO.3 & NO.4
COST COMPARISON IN THOUSANDS OF US\$ EQUIVALENT

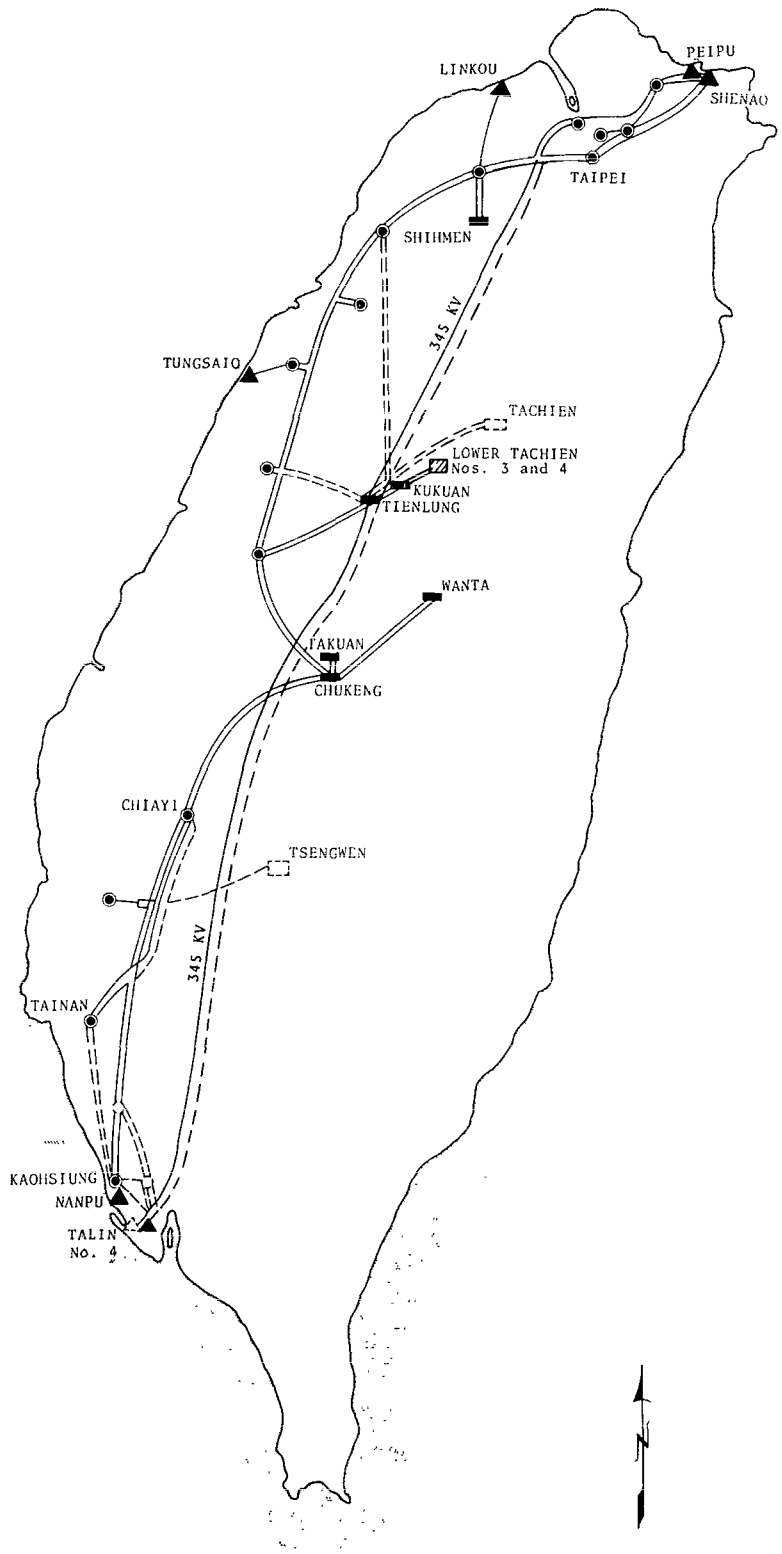
	Appraisal Estimate		Tentative Final Costs		Difference Increase/(Decrease)
	Local	Foreign	Local	Foreign	
<u>TALIN NO.4</u>					
Civil Works	6400		7796	-	1396
Construction Equipment	4300	300	5174	861	1435
Turbo-Generator & Auxilliary	-	7500	-	7364	(136)
Boiler & Auxilliary	-	8400	-	8528	128
Transformers & Switchgear	-	1100	-	1185	85
Miscellaneous Electrical Equipment	-	2000	-	1032	(968)
Pressure Piping	-	2000	-	2821	821
Miscellaneous Mechanical Equipment	-	2000	-	2805	805
Spare Parts	-	1200	-	1010	(190)
Engineering Services	-	2000	-	1616	(384)
Contingencies	1300	1700	-	-	(3000)
Sub-total	12000	28200	12970	27222	(8)
Customs Duties	5100	-	5377	-	277
TOTAL TALIN NO.4	17100	28200	18347	27222	269
<u>LOWER TACHIEN NO.3 & 4</u>					
Civil Works	2600	400 ^{2/}	514	-	(2486)
Miscellaneous	500	-	145	-	(355)
Turbines & Generators	-	3400	959	4700	2259
Other Equipment	-	1000	228	1115	343
Contingencies	600	500	-	-	(1100)
Sub-total	3700	5300	1846	5815	(1339)
Customs Duties	800	-	1454	-	654
TOTAL LOWER TACHIEN NO.3 & 4.	4500	5300	3300	5815	(685)
INTEREST DURING CONSTRUCTION ^{1/} (excludes Transmission Element)	-	4000	612	3393	5
GRAND TOTAL	21600	37500	22259	36430	(411)

Annex

Note: ^{1/} Taipower information on IDC covers Loan 671-CHA Talin No.4 and Lower Tachien No.3 & 4 plus transmission and substation elements financed by Loans 574-CHA and 671-CHA. The allocation of IDC to the two above projects is therefore only approximate.

^{2/} Penstock steel financed by Taipower -- not included in Loan 671-CHA.

TAIWAN POWER COMPANY SECOND POWER PROJECT



- HYDRO STATION
- ▲ THERMAL STATION
- PRIMARY SUBSTATION
- 154KV TRANSMISSION LINE
- - - - WORKS UNDER CONSTRUCTION, OR PLANNED
- PROJECT SHOWN IN RED

