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THE FEASIBILITY STUDY REPORT
ON
THE RENOVATION OF DAYEUHKOLOT WORKSHOP
IN
THE REPUBLIC OF INDONESIA

MARCH 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

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In response to the request of the Government of the Republic of Indonesia, the Government of Japan has decided to conduct a feasibility study on the Renovation of Dayeuhkolot Workshop in Indonesia, and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Indonesia a study team headed by Mr. Sumao Ichikawa, Nippon Koei Co., Ltd. from July 13 to August 10, 1987.

The team had discussions on the Project with the officials concerned of the Government of Indonesia and conducted field surveys in the project-related areas. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

March, 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

SUMMARY

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SUMMARY

BACKGROUND

1. BENGKEL MESIN DAYEUHKOLOT (hereinafter called as Dayeuhkolot Workshop) had been organized before the Independence Day of The Republic of Indonesia. Since the establishment, the minor extension had been carried out. But, the large-scale renovation and/or improvement have not been enforced.

2. The Dayeuhkolot Workshop belongs to PLN and is controlled by the PLN Regional Office for Generating and Transmission of West-Central Area of Jawa (PLN KJB). The Workshop is mainly repairing water-turbine and manufacturing replacement parts of auxiliary equipment for hydro-power station of PLN at West-Central areas, and also repairing auxiliary equipment for thermal, gas and geo-thermal power stations, and power transformer, and manufacturing hardware for transmission and distribution systems as well.

3. The total capability for power generation being 10,900 MW was observed in 1986/87 in the whole Indonesia, and PLN had solely the capacity of 6,200 MW at that time. PLN has generated 18,189 GWh, and the total generated energy including the external energy was 19,442 GWh in 1986/87. As a remarkable point, it is noted that 73.4% of the total generating capacity and 75.2% of the total generated energy were in Jawa Island.

4. In 5 years future, PLN has a plan to install generating facilities of 3,802 MW in total by 1992/93.

5. The items and the volume of works of the Dayeuhkolot Workshop are increasing gradually and steadily. However, the existing machine tools and almost all factory facilities become obsolete because almost all had been installed before 1979. For solving the above problem, the Government of Japan had been officially requested from the Government of the Republic of Indonesia to execute the feasibility study of renovation plan for the improvement of repair technic and the expansion of the Workshop. In response to the request, the Government of Japan had decided to investigate the present condition of the Dayeuhkolot Workshop to make plan, and entrusted the Japan International Cooperation Agency (JICA) with execution of the investigation and planning of the renovation of the Workshop, and the pre-investigation had been executed in February 1987.

   Based on the results of the pre-investigation, JICA sent a field investigation team from July 13, 1987 to August 11, 1987 for executing the feasibility study.

   The following is a summary of the above investigation.

DIAGNOSES FOR THE DAYEUHKOLOT WORKSHOP

6. The Dayeuhkolot Workshop is located in the South-East suburbs of Bandung, and has a plottage of about 12,300 m^2 and building of about 4,570 m^2 in total. The large machine shop, small machine shop, welding shop, casting shop and storehouse, etc. are arranged in the premises. There is an enough open space in the front of office building, however, the space among the buildings is very narrow. Many machine tools and auxiliaries, repaired goods, goods under repair, raw materials, disused articles, waste materials, etc. are placed in the disorder in each building and the narrow space becomes narrower accordingly.

7. The kind and the size of machine tools in the large machine shop are not enough for machining water turbine of 5,000 kW class. It is doubtful whether the large machines working over eight and half years and frequently used has a high machining accuracy or not. One arm-crane with 5-meter radius arm and one small gantry crane are provided, and these are used by a half ton and 2-ton chain-blocks.

In the small size machine shop, there are enough quantities and kinds of machine tools. A small gantry crane of 0.5-ton is provided for transporting raw materials and processed goods, and a 5-ton hand operated winch on 5 m fixed type gantry crane is used for many purposes. It is judged by the register book that the machining accuracy of machines over 8 years will be down.

In the welding shop, press, punching machines, cutting machines, rollers, electric welders, etc. for repairing runners and guide vanes of water turbine and manufacturing of air heater for boiler of thermal plant are provided. But no lifting facility is arranged. Draft tube and Spiral casing of water-turbine are manufactured at the open workshop.

Furnaces for casting bearing metal for turbine, hardware for transmission and distribution line systems such as clamp, terminal, etc. are installed and sand pits are also provided in the casting shop.

In the transformer shop, hand-operated winding machines are arranged. But any facilities for insulation could not be found and no crane is provided.

8. 219 persons of workers and staff including a manager of the Workshop were working at the time of the field investigation, and about 60 persons of temporary workers were also employed. Although the team had no chance to refer to the regulations of the workshop, it is judged by their organization chart and sections that the personal arrangement are not so poor. But, a quality control section is not arranged.

9. It seems that any systematic training for workers is not executed. There are no spaces and no facilities for training in the premises.

10. There is no special hazardous work, and general safety measures are provided. It is required to rearrange and clean the premises for providing walk way. Safety measures for electrical facilities are provided in good conditions. However, fire fighting and preventing facilities are poor.

11. The Workshop does not make industrial noises, vibrations, smoke, poisonous gas, stench because of its work substance. It is reported that any claim by surrounding inhabitants relating preservation of a good environment did not happen.

12. The work volume of the Workshop is remarkably increasing in recent years. In case of 6 average working hours per day, the average ratio of operation of main facilities was approximately 123% in December 1986. In fact, the workshop was operated in full swing.

    It is judged, however, that the present management system for the manufacturing process has to be improved.

13. It is a weak point that there is no quality control section. It is also concerned that, as for the quality control, there is a delicate shade of meaning between PLN staff and the managing staff of the factory.

14. The Dayeuhkolot Workshop submitted annually the accounting report formed with balance sheet, statement of profit and loss and fund flow table to PLN head office (PLN PUSAT), and the accounting data indicate only the financial statement of indirect cost. Transferred items corresponded to the capital from PLN is taken as major liabilities. It would be meaningless to review the assets of the Dayeuhkolot Workshop because of one section of PLN.

15. There is a close mutual relation between the material cost and the output of production in the direct cost. The output made a rapid progress as large as 60% per year, and the material cost also increased accordingly.

    The administration cost indicates a high ratio. Indirect manpower is larger than direct manpower and it shows a possibility of cost reduction.

16. The turn-over ratio for material consumption and stocks is calculated as 2 from 1984/85 to 1986/87, and this value should be reduced. More cost down will be considered, when such high value should be suppressed.

DEMAND FORECAST

17. The most important point to be taken for the renovation of the Dayeuhkolot Workshop is to make realistic forecast of "Volume of Work". The total numbers of Francis type water turbine in the whole Indonesia which are being operated at present are 103 units. After operation of every 40,000 hours, the major overhaul will be carried out and the repair work will be done at the same time, if any.

18. With increase of power demand in future, generating facilities will be expanded accordingly. The workshop capacity such as quantity and type of machine tools, and manpower in the Dayeuhkolot Workshop are to be reviewed.

FRAMING OF RENOVATION PLAN

19. When the renovation plan will be formulated, selection of type and quantity of the workshop facilities are based on the method, route and kinds of process machining of repair and manufacture.

Standard operation hours of machine tools selected by kinds of material to be processed will be set by the size and weight of the materials. If kinds and volume of materials/parts for repair and manufacture are estimated, the kinds and quantity of machine tools will be derived accordingly.

Before calculation of units machine tools needed, the load/operation hours of the machine should be decided, and the date per one machine tool will be calculated by the standard operation hours. And, then, the necessary quantity of machines will be decided by 40,000 hours of repair cycle (corresponding to about 6 years due to conditions of operation of hydro-power station).

20. The renovation plan is reviewed comparatively by both technical and economical matters as for the following basic four (4) plans.

Plan-1: Several items special facilities which are indispensable for machining main parts of water turbine are added to the existing facilities of the Dayeuhkolot Workshop.

Plan-2: In accordance with the forecast of main parts items and volume of repair works of water turbine to be repaired, the workshop facilities, kind, type and quantity of machine tools will be decided, and the existing facilities and machine tools shall be used as many as possible. However, special parts will be ordered to outside workshops, while almost all repair works will be executed at the Dayeuhkolot Workshop.

Plan-3: Several special machine tools for special parts are supplemented to arrangement in the Plan-2 in order to make orders to outside workshops zero.

Plan-D: Plan prepared by the Dayeuhkolot Workshop itself.

It is noted that specific machine tools are unnecessary for repairing thermal power generating facilities (steam, gas and geo-thermal), and hardware of transmission and distribution line systems.

It is also noted that civil and building works associated directly with the workshop facilities only to be renovated are considered.

21. The newly introduced machine tools and equipment for the respective plans are as follows:

Plan-1

Description	Q'ty (unit)
Lathe for shaft (810 x 7,000 mm)	1
Vertical lathe (3,000 mm dia.)	1
Heavy duty lathe (810 x 4,000 mm)	1
- ditto- (600 x 2,000 mm)	3
Radial drilling machine (3,000 mm)	1
Milling machine (1,600 mm)	1
Shaper with copying attachment (700 mm)	1
Gantry crane (10 ton)	1
Total of Items to be introduced	(7)10 units
Total of Existing Machine Tools which will be used as they are.	(31)48 units

Plan-2

(A) Machine tools for large size components

Description	Q'ty (unit)
Horizontal boring machine (1,830 mm)	1
Vertical boring machine (2,800 mm)	1
Lathe for shaft (810 x 7,000 mm)	1
Heavy duty lathe (600 x 2,000 mm)	2
- ditto - (600 x 3,000 mm)	1

Radial drilling machine (3,000 mm)	2
Milling machine (1,600 mm)	1
Shaper with copying attachment (700 mm stroke)	1
Press (10 ~ 30 ton)	1
Arc welding machine	3
Universal tool and cutter grinder	1
Pedestal grinder with dust collector	2
Total of Items to be introduced	(12)17 units
Total of Existing Machines which will be used as they are.	(3) 4 units

(B) Machine tools for small size components

Description	Q'ty (unit)
Lathe (600 x 2,000 mm)	1
Lathe (510 x 1,500 mm)	2
Lathe (510 x 1,000 mm)	1
Numerically controlled lathe (460 x 800 mm)	1
Screw cutting lathe	3
Key seater (450 mm)	1
Bending roller machine (5 ~ 6 mm t)	1
Shearing machine (1 ~ 3 mm t)	1
Hack sawing machine	2
Radial drilling machine	3
Tool and cutter grinder	1
Pedestal grinder with dust collector	2
Bench grinder (10")	7
Air grinder	6
Electric hand grinder	10
Punching machine (1 ~ 2 mm t)	1
Cutting grinder (10")	2
Total of Items to be introduced	(17)45 units
Total of Existing Machine Tools which will be used as they are.	(8)36 units

(C) Machine tools for thermal power plant, etc.

Description	Q'ty (unit)
Lathe (510 x 1,000 mm)	4

Shaper (500 x 850 mm)	2
Milling machine (1,600 mm)	1
Bending rollers (5 ~ 6 t x 1,200 mm)	1
Shearing machine (3 t x 1,200 mm)	1
Upright drilling machine (300 x 650 mm)	1
Arc welding machine (250 A)	4
Total of Items to be introduced	(7) 14 units
Total of Existing Machine Tools which will be used as they are.	(2) 2 units

(D) Testing apparatus and others

Description	Q'ty (unit)
Air compressor (12 kgf/cm^2)	3
- ditto - (7 kgf/cm^2)	3
Magnetic particle testing machine (AC 200 V, DC 2,000 A)	1
Ultrasonic testing machine (100 ds 1 ~ 5 MHz)	1
Surface plate for stage direction (1,200 x 2,400 mm)	1
Assembling table (3,000 x 3,000 mm)	1
Annealing furnace (3,000 x 3,000 mm) (Heavy oil, Automatic control type)	1 set
Measuring apparatus	2 sets
Total of Items to be introduced	(8) 13 units
Total of Existing Items which will be used as they are.	(5) 7 units

(E) Transportation/handling equipment.

Description	Q'ty (unit)
10-ton Gantry crane	3
5-ton Gantry crane	2
Wagon	1
Steel rail with turn table (300 m)	1
Ordinary truck (5-ton)	2
- ditto - (10-ton)	1
Jeep	2

Pick-up	1
Mini-bus	1
Sedan	1
Fork lift (3-ton)	1
- ditto - (5-ton)	1
Total of Items to be introduced	(12)16 units
Total of Existing Item which will be as it is.	(1) 1 unit

Plan-3 The following machine tools are supplemented to those in the Plan-2:

Description	Q'ty (unit)
Gantry type vertical lathe (3,000 m/mø - 20 ton)	1
Upright drilling machine (550 m/m) (replace with existing ones)	2
Bending machine (5 ~ 6 t x 2,500 m/m) (replace with existing one)	1
Total	4 units

Plan-D

Description	Q'ty (unit)
Lathe (heavy 42/light 20)	62
Shaper (heavy 3/light 9)	12
Milling machine (heavy 7/light 4)	11
Welding machine	23
Roller (heavy)	2
Shearing machine (heavy)	2
Punching machine	1
Sawing machine (each type)	5
Drilling machine (heavy 7/light 2)	9
Press (heavy), 100-ton	1
Bench grinder	35
Cutting grinder	6
Bending machine, 15 t x 2,500 mm	1
Air compressor	6
Crucible furnace	1

Testing/measuring apparatus	5
Coil-winding machine	3
Total	185 units

22. The special features for the respective Plans considering quantity, size, type of main machine tools and machining hours estimated for outside orders are as follows:

	Plan-1	Plan-2	Plan-3	Plan-D
- Processing limit in length (mm)	7,000	7,000	7,000	10,000
- Processing limit in outside diameter (mm)	3,000	2,000	3,000	2,000
- Processing limit in weight (ton)	20	1.2	20	2
- Horizontal boring machine	Nil	Exist	Exist	Nil
- Vertical boring machine	Nil	Exist	Exist	Nil
- Radial drilling machine	One unit shortage	Exist	Exist	Nil
- Machining hours for outside order (hour)	15,210	4,000	0	23,870

23. The estimated costs for the respective Plans are as follows:

(x ¥ 1,000, x Rp. 1,000)

	Plan-1	Plan-2	Plan-3	Plan-D
- New Building & Land Creation	Rp193,000	Rp778,000	Rp778,000	Rp2,300,000
- Improvement of Building	Rp59,000	Rp510,000	Rp510,000	Rp746,000
- Machinery facilities	¥289,700	¥553,700	¥736,600	¥1,599,250
- Others	Rp175,000	Rp355,000	Rp407,000	
	¥160,600	¥222,600	¥257,000	
Total	Rp427,000	Rp1,643,000	Rp1,695,000	
	¥450,300	¥776,300	¥993,600	

24. Manpower schedule for the respective Plans is planned considering the following.

a) Operators to operate machine tools installed.

b) Manpower for assembling parts processed and for inspecting the complete goods.

c) Probational workers for operating large machines and special facilities.

d) Administrative staffs for repair and manufacture works.

e) Group leaders arranged at each section.

f) Engineering staffs for designing of repair and manufacture.

PROCUREMENT OF MATERIALS

25. Raw materials for repair and manufacture at the Dayeuhkolot Workshop are mainly various steel, stainless steel, cooper, brass, white-metal, etc. All standard materials can be procured at local market at any time.

CONCLUSION

26. Cost saving on outside jobbing expenditure is taken as benefit for the Dayeuhkolot Workshop operation. The benefit is measured by machining hour charge.

Internal Rates of Return (IRR) are calculated from a cash flow for the respective Plans as follows;

Plan 1	10.3%
Plan 2	10.9%
Plan 3	7.6%

The Plan 2 has the highest IRR with the slight margin to the Plan 1. Both the Plan 2 and 1 exceed the generally assumed level of opportunity cost of capital of 10% in Indonesia.

RECOMMENDATION

27. It is recommendable to adopt the Plan-2 which is technically and economically justifiable as mentioned above.

In order to achieve this Plan-2, funds consisting of the foreign currency portion being ¥776,300,000 and the local currency portion being Rp.1,643,000,000 (An equivalent total by Rp/¥ rate being 11.94 is Rp.10,912,022,000.) are needed.

A period of 15.5 months is to be considered for a net construction time schedules for this Plan-2. As the pre-construction stage, the engineering services such as detailed design, preparation of tender documents, tender call, contract award, review of shop drawings, shop inspection, etc. will have to be done taking a period of one year, the total period required for completion of the Plan-2 would reach as long as about two years, while the beginning part of the construction stage can be over-lapped with the latter part of the pre-construction stage. On the other hand, some of water turbines would have to be overhauled soon. In this sense, formality and procedure for realization of the Plan-2 are to be taken as soon as possible.

REMOVAL OF ELECTRICAL SECTION TO KLENDER WORKSHOP

28. At the Dayeuhkolot Workshop, homemade hand-operated winding machines are working as repairing facilities of power transformer, and the temporary repair work only can be made. For repairing power transformer permanently, it is required to provide vacuum drying facilities, drying room, insulation oil purifier, etc.

In addition to the above facilities, wide access road, wide space for turning trailers, space for outside oil tanks, and open work space shall be required for a repair shop of power transformer. The Klender Workshop has a wide space not used now, and it is enough for providing necessary facilities for repairing power transformer. Therefore, to prevent double investment, the facilities for repairing transformer are not included in this renovation plan because it is recommendable to these facilities for repairing power transformers from the Dayeuhkolot Workshop to the Klender Workshop.

The repair works of 20 to 25 kV class distribution transformers and of power transformers at power stations and substations with the primary voltage up to 77 kV will be considered. But repair works of 150 kV class transformer are not included.

For providing full-scale repair facilities for power transformers, it is required to arrange the cost of approximate Yen 580 million and Rp 1,250 million. And, the space of about 2,100 m^2 is needed for working area.

GENERATOR REPAIR SHOP

29. Generator winding has generally a life of 30 years, and the windings insulation over 30 years may be broken down by an weak lightning surge or switching surge.

In accordance with the recent development of resin insulation materials, process of insulation and simple facilities, high reliability insulation can be applied to the winding insulation easily. Therefore, it is recommended to provide new coil repair facilities at the Dayeuhkolot Workshop, and to repair the existing old coils in order for getting high reliability.

Special materials such as resin will be imported. And, joint materials and consumables are arranged locally.

Approximate Yen 300 million and Rp 420 million will be needed for providing the generator winding repair facilities. And, the space of about 600 m^2 is required.

COMPARISON TABLE OF FOUR (4) PLANS

ITEM \ PLAN		PLAN – D	PLAN – 1	PLAN – 2	PLAN – 3
Features and Characteristics		◦ Medium, small size machines ◦ No large, special equipment ◦ Many hours of outside order ◦ Many machines and high cost but not effiective for turbine repair	◦ 20% of cost of Plan – D ◦ Included group leaders, design engineers, probational workers.	◦ Reasonable quantity of machines and equipment ◦ Some outside order because of limitation of large and special machines ◦ Included effective man power as same as Plan – 1	◦ Add special equipment to Plan – 2 aiming at no outside order ◦ Low operation rate and high cost in machines
Machine Quantity and Cost (×Rp1,000)	Existing	48	48	50	47
	New	217	10	105	109
	Total (unit) (*)	265 (171%)	58 (37%)	155 (100%)	156 (101%)
	Cost (×¥1,000) (*)	1,599,250 (302%)	289,700 (55%)	528,700 (100%)	711,600 (135%)
Total Employee		549	263	301	302
Outside order hours for repairing main turbine parts (**) (*)		23,870 (17%) (597%)	15,210 (10%) (380%)	4,000 (3%) (100%)	0
Land Creation, Expantion and Improvement of Building	New (×Rp1,000)	7,934 m² 2,300,000	890 m² 193,000	5,870 m² 778,000	5,870 m² 778,000
	Improvement (×Rp1,000)	3,824 m² 746,000	960 m² 59,000	3,360 m² 510,000	3,360 m² 510,000
	Total (×Rp1,000)	11,758 m² 3,046,000	1,850 m² 252,000	9,230 m² 1,288,000	9,230 m² 1,288,000
Ex-Factory cost of machines and equipment (×¥1,000)		1,599,250	289,700	528,700 25,000 (***)	711,600 25,000 (***)
Others	(×Rp1,000)	–	175,000	355,000	407,000
	(×¥1,000)		160,600	222,600	257,000
Total	(×Rp1,000)	–	427,000	1,643,000	1,695,000
	(×¥1,000)		450,300	776,300	993,600
Internal Rate of Return		–	10.3 %	10.9 %	7.6 %
Remarks		See Note (****).			

Note (*) Ratio compared with Plan – 2
(**) Ratio compared with total machining hours
(***) Necessary money for extension of pawer receiving facility.
(****) Expense in column for "Others" of the PLAN – D was not shown because "Others" include the training fee, a realistic figure of which is so difficult to estimate in view of various items and many quantities in the workshop facilities to be procured.

FOREWARD

FOREWORD

BENGKEL MESIN DAYEUHKOLOT (hereinafter referred to as "Dayeuhkolot Workshop") is under the control of PLN PEMBANGKITAN DAN PENYALURAN JAWA BAGIAN BARAT (PLN Generation and Transmission, Central and West Java. This organization is usually called as PLN KJB.)

The Dayeuhkolot Workshop was constructed, before independence of the Republic of Indonesia, by using old buildings of the Bandung Diesel Engine Power Station after removal of the generating equipment (two units of 1,000 kW each).

At present, the Dayeuhkolot Workshop is executing repair of parts and manufacture of replacement parts for hydropower equipment, thermal power equipment (steam, gas turbine and geothermal) and diesel engine generating equipment which belong to PLN.

Besides works relating to these generating equipment, repair of power transformers and 3/6 kV class switchgear equipment as well and manufacture of hardware (clamps) for transmission/distribution lines are also included. In short, there are various items in the operation of the Dayeuhkolot Workshop.

It is noted, however, that workshop facilities in the Dayeuhkolot Workshop had never been improved intentionally and systematically until now, while several machine tools were often supplemented.

Most items of the workshop facilities being in everyday use are very aged because they were installed before 1979 almost all.

In view of various items and increasing quantities for works at the Dayeuhkolot Workshop at present, an official request for the feasibility study on renovation of this Workshop was issued from the Government of the Republic of Indonesia to the Government of Japan through diplomatic channel aiming at expansion of the facilities and elevation of repair technique.

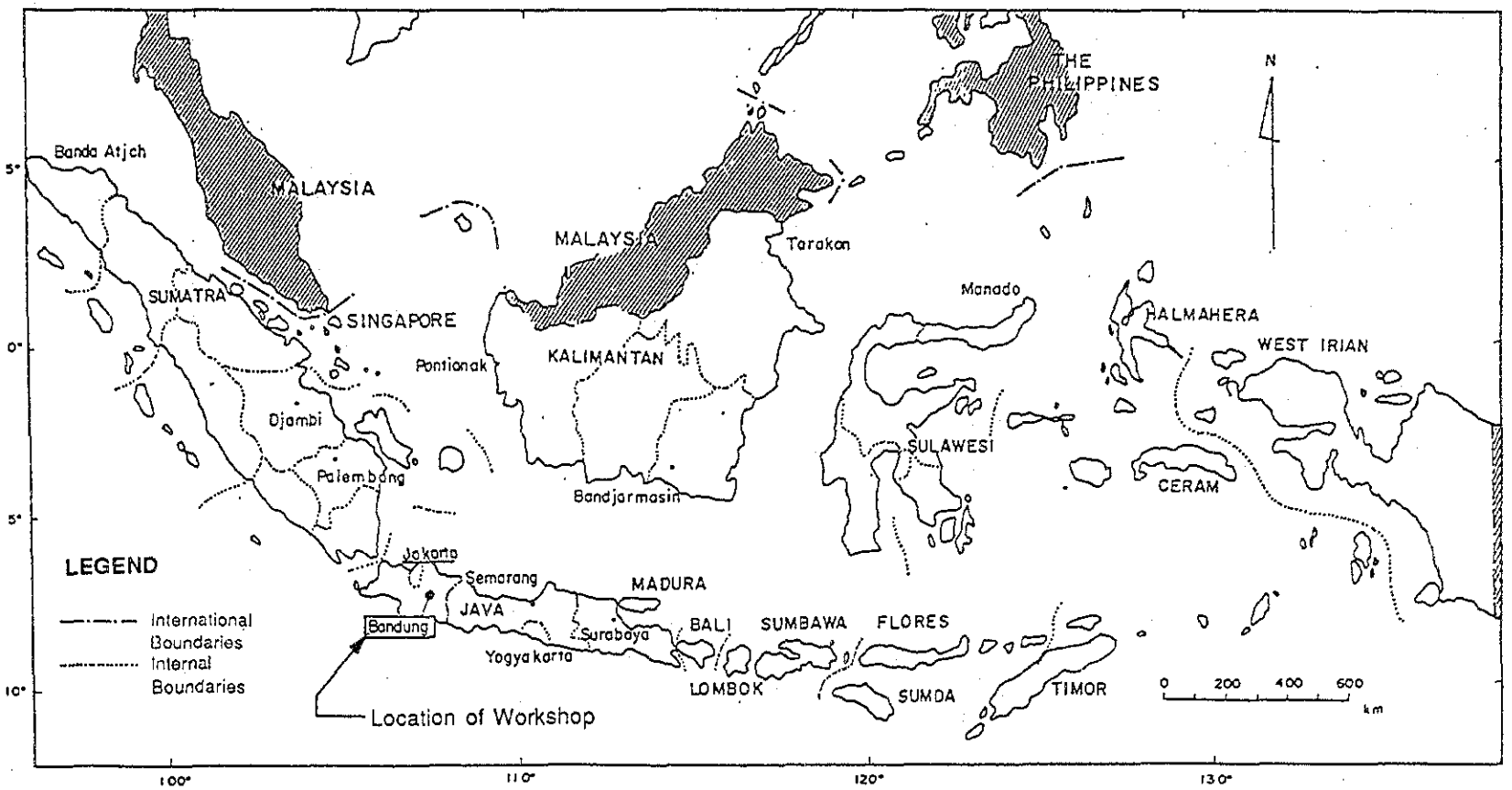
Essential targets of the renovation are to repair parts or components accurately and quickly and to manufacture replacement parts regardless of manufacturers or period of manufacture for these parts and components.

Moreover, PLN intends to reduce degree of dependency on external workshops at a low level as possible by elevation and improvement of technical level on repair and manufacture at the Dayeuhkolot Workshop.

The Klender Workshop situated in the suburbs of Jakarta is now under the direct control of PLN Pusat. But, operation of this workshop is not always brisk because production of welded steel pipe poles which was the principal item of the Klender Workshop production formerly is in rather low level while steel boxes for accommodating molded case circuit breakers (MCCB) for watthour meter are being manufactured.

Upon official request made for the JICA team by PLN Pusat during the field investigation, a superficial feasibility study concerning removal of electrical equipment category from the Dayeuhkolot Workshop to the Klender Workshop has been examined to mention the results in this Report.

LOCATION MAP



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CHAPTER - 1

BACKGROUND AND RELEVANT CONDITIONS FOR RENOVATION OF THE DAYEUHKOLOT WORKSHOP

CHAPTER - 1

BACKGROUND AND RELEVANT CONDITIONS FOR RENOVATION OF THE DAYEUHKOLOT WORKSHOP

1.1 Present Situation and Future Prospect of Electrical Power Facilities

1.1.1 Present Situation of Electrical Power Facilities

1) Generating Facilities

As of the March of 1987, the total installed capacity of generating facilities in the whole of the Republic was 10,900 MW. PLN's property was 6,200 MW (56.9% of the total), and remaining 4,700 MW was equal to the total of independent electric power plants. And, the total annual energy production of the PLN's facilities as of the end of the same year was 18,189 GWh. The gross value including energy that PLN had bought from independent power plants was 19,442 GWh.

Table 1-1 shows these data by classification of the generating facilities:

Table 1-1 Installed Capacity and Annual Energy Production (1986/1987)

Classification	Installed Capacity	Energy Production
Diesel Engine	1,326.2 MW (21.4%)	2,174.3 GWh (12.0%)
Hydropower	1,240.3 MW (20.0%)	4,935.2 GWh (27.1%)
Steam Power	2,486.9 MW (40.1%)	10,038.9 GWh (55.2%)
Gas Turbine	1,116.7 MW (18.0%)	808.4 GWh (4.4%)
Geothermal Power	30.0 MW (0.5%)	232.3 GWh (1.3%)
Total	6,200.1 MW (100.0%)	18,189.1 GWh (100.0%)

Java Island held 73.4% of the total of generating facilities and 75.2% of the total consumption of annual energy sold.

2) Transmission Line, Distribution Line and Substation Facilities

The total length of 500 kV, 150 kV, 70 kV and 30/20 kV transmission lines belonging to PLN was about 13,402 km (circuit length) and 8,096 km (route length). And, distribution lines were about 86,670 km in the total under the management of PLN. About two thirds (2/3) of the total of the transmission lines and the distribution lines existed in the Java Island.

PLN was operating 297 numbers of substation, as of the March of 1987, totalling about 14,089 MVA in the installed capacities.

1.1.2 Prospect for Extension of Electrical Power Facilities

During ten years from 1974/75 to 1984/85, the total installed capacity of the PLN's generating facilities had become about five (5) times to show an average annual increase rate being about 21.9%.

PLN's policy for extension of the generating facilities is to aim at a steady progress, though such a very increase as that in the past ten years is not always taken. Prospect for increase of the respective categories of electrical power facilities are as shown in Table 1-2:

Table 1-2 Prospect for Increase of Electrical Power Facilities (RENSALITA)

	1988/89	1989/90	1990/91	1991/92	1992/93	Total
Generating Facilities (MW)	1,767	510	219	408	898	3,802
Transmission Line Facilities (Kms)	1,264	570	1,978	1,031	1,076	5,919
Substation Facilities (MVA)	1,920	170	2,285	1,702	2,225	8,302
Distribution Facilities						
JTM (Kms)	6,977	8,316	9,605	11,074	12,620	4,859
JTR (Kms)	13,907	12,019	13,862	15,983	18,218	73,989
Substation (MVA)	1,086	1,665	1,922	2,217	2,539	9,429

1.2 Renovation Plan

As the renovation plan prepared by the PLN who is an executing authority of the Government of Indonesia, a document titled "REQUEST FOR PROJECT BY TECHNICAL ASSISTANCE FROM JICA/JAPAN 1986" (USULAN PROYEK BANTUAN TEKNIK PENDANAAN JICA/JEPANG TAHUN 1986) had been edited by the Dayeuhkolot Workshop. Although PLN Pusat and PLN KJB have not approved this document officially yet, results of a series numerical analyses are mentioned in detail. It would be possible, therefore, to regard this document as a definite plan for the renovation of the Dayeuhkolot Workshop for the time being.

Table 1-3 mentioned a comparative statement of the representative items on the present situation and future arrangement planned:

Table 1-3 Comparative Statement of Present Situation with proposed Arrangement mentioned in the Renovation Plan prepared by the Dayeuhkolot Workshop

Particulars	Existing	Future	Difference
Workshop Site	12,300 sq.m	18,820 sq.m	153 %
Total Floor Space of Building	4,570 sq.m	7,639 sq.m	169 %
- Guard/Watch House	-	103 sq.m	-
- Technical/Administration Buildings	880 sq.m	1,378 sq.m	157 %
- Workshop Buildings	2,430 sq.m	5,523 sq.m	227 %
- Warehouse	375 sq.m	450 sq.m	120 %
- Transformer Room	-	25 sq.m	-
- Laboratory	-	160 sq.m	-
- Vehicle Repair Shop	885 sq.m	-	-
Machine Tools			
- Lathes	15 Nos.	75 Nos.	+60 Nos.
- Shapers	3 Nos.	15 Nos.	+12 Nos.
- Milling Machines	3 Nos.	15 Nos.	+12 Nos.
- Welding Machines	15 Nos.	49 Nos.	+34 Nos.

- Bending Rollers	-	2 Nos.	+ 2 Nos.
- Shears	-	2 Nos.	
- Press	-	1 No.	+ 1 No.
- Saw	2 Nos.	6 Nos.	+ 4 Nos.
- Planers	-	1 No.	+ 1 No.
- Grinders	2 Nos.	45 Nos.	+43 Nos.
- Drilling Machines	2 Nos.	10 Nos.	+ 8 Nos.
- Pneumatic Hammers	1 No.	2 Nos.	+ 1 No.
- Plate Benders	1 No.	2 Nos.	+ 1 No.
- Air Compressors	4 Nos.	10 Nos.	+ 6 Nos.
- Crucibles	1 No.	2 Nos.	+ 1 No.
- Hoists	-	10 Nos.	+10 Nos.
- Transformers for Receiving	-	10 Nos.	+10 Nos.
- Transportation Facilities	-	26 Nos.	+26 Nos.
- Office Equipment	-	24 Nos.	+24 Nos.
- Laboratory Equipment	-	6 Nos.	+6 Nos.
- Winding Machines	-	3 Nos.	+ 3 Nos.
- Vacuum Pumps	-	2 Nos.	+ 2 Nos.
- Fire Extinguishers	-	19 Nos.	+19 Nos.
No. of Personnel	219 persons	549 persons	+330 persons

CHAPTER - 2

DIAGNOSIS OF THE DAYEUHKOLOT WORKSHOP

CHAPTER - 2
DIAGNOSIS OF THE DAYEUHKOLOT WORKSHOP

2.1 Comments on General Aspect

2.1.1 Location and Layout

The Dayeuhkolot Workshop is located at southeast of the suburbs of Bandung City, and the Citarum River, width of which is about 50 m, flows at southeast of the premises.

The present area and the total area of buildings are about 12,300 sq.m and about 4,570 sq.m, respectively.

From main street and the premises, an unpaved access, which is 4.5 m in width, 300 m in the total length and of reverse S-shaped curve runs. This access is being used for general passing by inhabitants to bring some safety problem, while this is capable of transportation of a heavy items such as three-phase transformer body of 30 MVA and 70 kV ratings.

It is possible to construct an exclusive access with a length of only 30 m from the main street to the premises, if embankment of low ground will be realized after removal of several houses which were built unlawfully, according to the Dayeuhkolot Workshop's information.

Layout of buildings of the Dayeuhkolot Workshop consist, viewed from characteristic feature thereof, of large-sized machine shop, small-sized machine shop, welding shop, casting shop and transformer shop.

The following are explanatory statement on the present conditions of the respective buildings:

(1) Large Machine Shop: [12.5 m x 30 m (375 m^2)]

Although space allocation itself around the machine tools is regarded appropriate, fairly wide area is occupied as grinding operation zone for runner and guide vanes after fabrication process and as manual finishing work zone for valves. Furthermore, some space is used as stockyard for products and materials. Then, the net area for machine

tool operation including spaces for transfer of the products and materials and for walking has become very narrow eventually.

Exclusive use warehouse for fabricated guide vanes is not provided, but several shelves are installed instead on the finishing work area to make the said area narrower.

(2) Small Machine Shop: [25 m x 30 m (750 m^2)]

As mentioned clearly in the machine tool register book, nine (9) lathes, three (3) shapers and two (2) milling machines totalling fourteen (14) machine tools had been installed before 1979. And one (1) lathe and one (1) milling machine were successively added in 1982 and 1983, respectively. Moreover, four (4) lathes were supplemented in 1985. Then, space required for operation of lathes has become around half as compared with the original space in 1979's. Accordingly, it is very difficult to keep an enough space for transfer purpose of products and materials and for walking of personnel.

A space with an effective width of 5 m running from an entrance and exit to the central part of the Small Machine Shop is now being used for disassembly/assembly areas of small capacity transformers. Used aluminium wires and clamps processed from the used aluminium wires are stored in this area. Old hydraulic turbines and turbine parts are also stored in the Small Machine Shop where working area and stockyard are not distinguished clearly.

(3) Welding Shop: [35 m x 19 m (about 670 m^2)]

Major items of this Welding Shop is air heater segment for boilers of steam powerplant. As manufacturing process of the air heater segment consists of fabrication of elements by corrugation roller, welding of frames and the assembly in serial steps. Then, working spaces for the manufacture of the air heater segment are used repeatedly. Accordingly, it is very difficult to secure the transfer paths between the facilities, the connection passage main way and routes leading to an entrance and exit.

Due to unavailableness of gantry type handling equipment in the Welding shop, transfer of products has to be done manually.

A space in the front of the Welding Shop is used as an outdoor working area for welding operation for spiral case and draft tube steel liner of hydraulic turbines.

(4) Transformer Shop: [8 m x 20 m (160 m^2)]

At present, core and coil of power transformer (30 MVA, 70/20 kV, 3-phase) sit down in the Transformer Shop for drying operation occupying a fairly wide space to make the working are for other purposes very tight.

2.1.2 Major Facilities in the Workshop

(1) Large Machine Shop:

The following major machine tools exist in the Large Machine Shop:

- Lathe	3,000 mm in dia.	1 No.
	2,100 mm in dia.	1 No.
	LC 4,000 mm	1 No.
	LC 1,800 mm	1 No.
- Drilling machine		2 Nos.

While four (4) lathes were all running in full, the drilling machine was in standstill during the field investigation. Viewed from size of the existing machine tools, the minimum level in productive capacity as the Large Machine Shop is not always secured to deal with repair and manufacture of hydraulic turbines with an output of upto 5,000 kW or 6,000 kW.

According to the machine tool register book, the existing four (4) lathes had been installed in the Workshop in 1979 to show elapse of 8.5 years until now. In this sense, it is rather hard to judge that these lathes be good enough having an acceptable accuracy.

No unloading/loading hoist is available, while two (2) arm revolving cranes in combination with a small gantry crane both with 0.5 to 2-ton chain blocks are being utilized for transfer purpose of products and materials.

(2) Small Machine Shop

The existing machine tools in the Small Machine Shop are as given below:

- Lathe	LC 900 mm	1 No.
	LC 1,500 mm	5 Nos
	LC 1,800 mm	3 Nos.
	LC 2,400 mm	8 Nos.
	LC 3,000 mm	1 No.
- Shaper	500 mm approx.	2 Nos.
	630 mm	3 Nos.
- Milling machine	small size	3 Nos
	400 x 1,600 mm	1 No.
- Drilling machine	small size	1 No.

Among these lathes, LC 1,800 mm sized one and two of belt driven LC 2,400 mm ones were in standstill. Two of milling machines out of four were also in standstill.

Medium sized lathes (nine in total, LC 1,800 mm to LC 3,000 mm) were mainly used for processing of main shafts and runners of hydraulic turbines and for thread-cutting on pipes. And, small sized lathes (six in total, LC 900 mm to LC 1,200 mm) were for small sized guide vanes, pins, bushes, etc. Four (4) shapers were for guide vanes and one (1) was for runner vane processing. The milling machines (fraise) were used for precision processing of small components.

There is no hoisting facility in the Small Machine Shop. Therefore, transfer of products and materials were made by means of a small gantry crane with 0.5-ton chain block. However, there is a "home-made" fixed type gantry hoist structure nearby the central entrance. By using a hand operated chain block having a capacity of around 5-ton, disassembly/assembly works of small capacity power transformers and transfer of old turbine parts were carried out as occasion demands.

Although exact years of manufacture for the respective machine tools are not clear, about 56 percent of the total installation of the lathes and about 75 percent of the shapers and the milling machines had been installed in the Small Machine Shop before 1979, according to the

machine tool register book. Then, in view of the year elapsed being about 8.5 year, it would be obvious that accuracy in processing has already lowered to a certain extent, unless proper maintenance and careful adjustment should be done periodically on all the machine tools.

(3) Welding Shop:

Major facilities installed in the Welding Shop are as mentioned below:

- Roller	2 Nos.
- Corrugation roller	2 Nos.
- Punching machine	1 No.
- Shear	2 Nos.
- Press (125 kg/cm^2)	1 No.
- Hand press	1 No.
- Drilling machine	1 No.
- Automatic gas cutter	1 No.
- Air compressor	2 Nos.
- Electric welding machine	6 Nos.

Two of the corrugation rollers were of "home-made" ones for fabrication of elements of the air heater segments. These corrugation rollers, automatic gas cutter, punching machine, electric welding machines and hand press were in a vivid operation for processing of the air heater segments. However, the remaining facilities were all in standstill.

No hoisting facility was available. Then, transferring operation of the air heater segments (760 mm long x 620 mm wide x 700 mm high approximately), valve casings, liners, etc. and materials was done by man-power probably of difficulty in utilizing movable gantry structure in the Shop where many products and materials laid scattered and heaped up here and there occupying a fairly spacious area.

Major operation going in the Welding Shop was processing of the air heater segments, runner and guide vanes of hydraulic turbines, valve casings, radiators of power transformers. In particular, processing of the runner, guide vanes and valve casings was done by weld of cut pieces of steel/iron sheets. In the outdoor working area, welding of spiral casing and draft tube liner was carried out. Use of stainless steel

sheets for welding of the runner and the guide vanes is worthy of note because welding operation of stainless steel is difficult depending on kind of the stainless steel.

(4) Casting Shop

These are installed by two (2) coke furnaces with sand pit and one (1) cupola-furnace. Besides these furnaces, there is one (1) revolving furnace which is at a standstill. A hoist crane with 1-ton capacity is available only in the Casting Shop.

Casting operation of bearings, guide vanes, gun metal bush, etc,. was continued. Clamps and terminals for power line use was also being cast by utilizing used aluminium wires and copper wires.

A part of the Casting Shop was used for repair of power transformer winding and small rotating machines. Processing of resistor elements was also carried out in the Casting Shop.

(5) Transformer Shop

One (1) set of "home-made" hand operated type winding machine with a rather simple construction was being used for re-winding operation of a power transformer coil.

No crane is available in the Transformer Shop.

Another hand operated winding machine is installed in a corner of the Casting Shop.

2.1.3 Personnel Organization

The present personnel organization is as shown in Table 2-1 with assignment of 219 persons in total, including the Workshop Manager, consisting of 28 persons in technical department, 141 persons in operation department and 50 persons in administration department. Besides the permanent staff being 219 persons given above, temporary employees being about 60 persons were working at the Dayeuhkolot Workshop at the time of the field investigation (July to August 1987). They said that number of the said temporary employees would vary slightly depending on degree of pressure of the working operation.

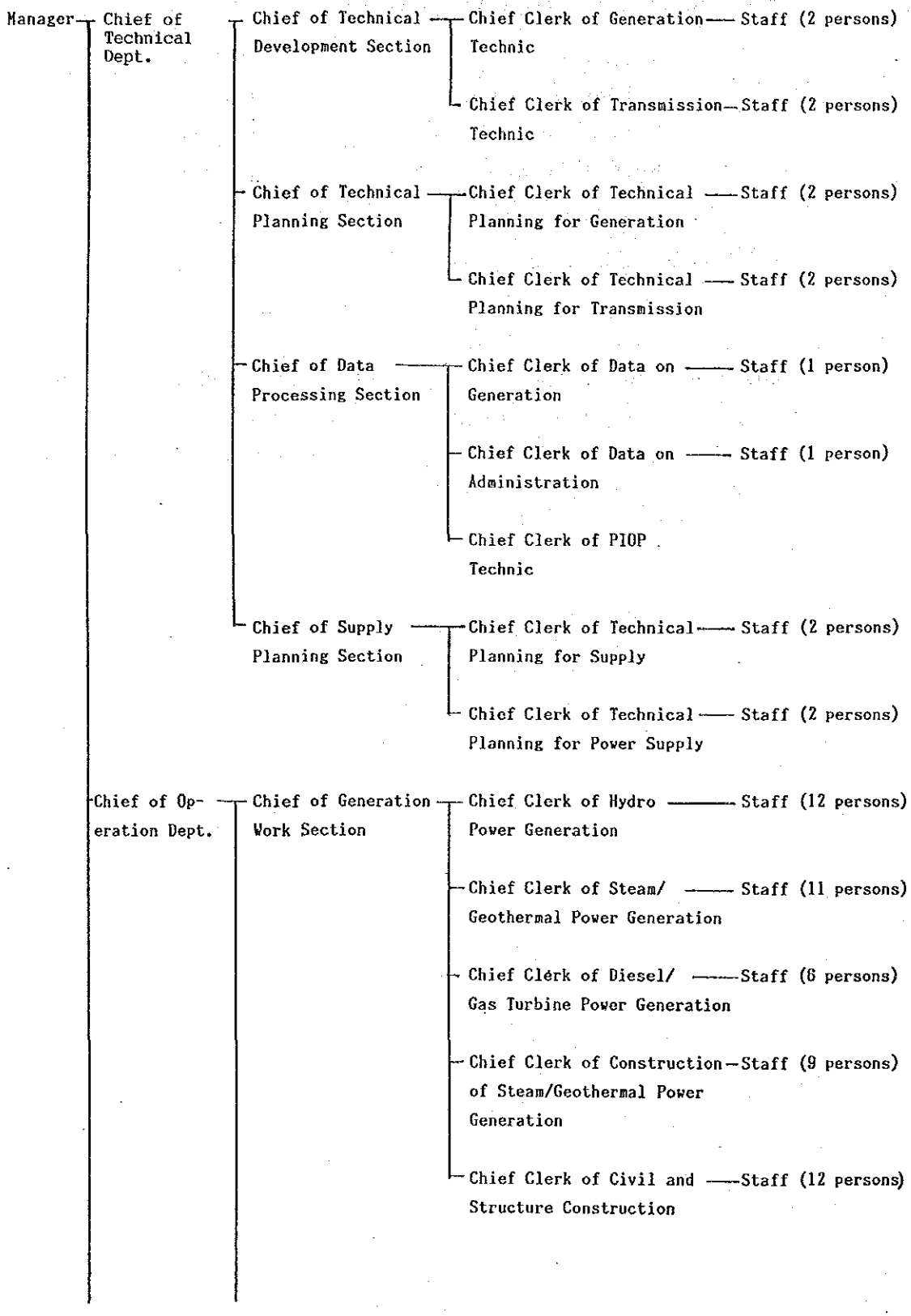
Composition of the working personnel was as given below:

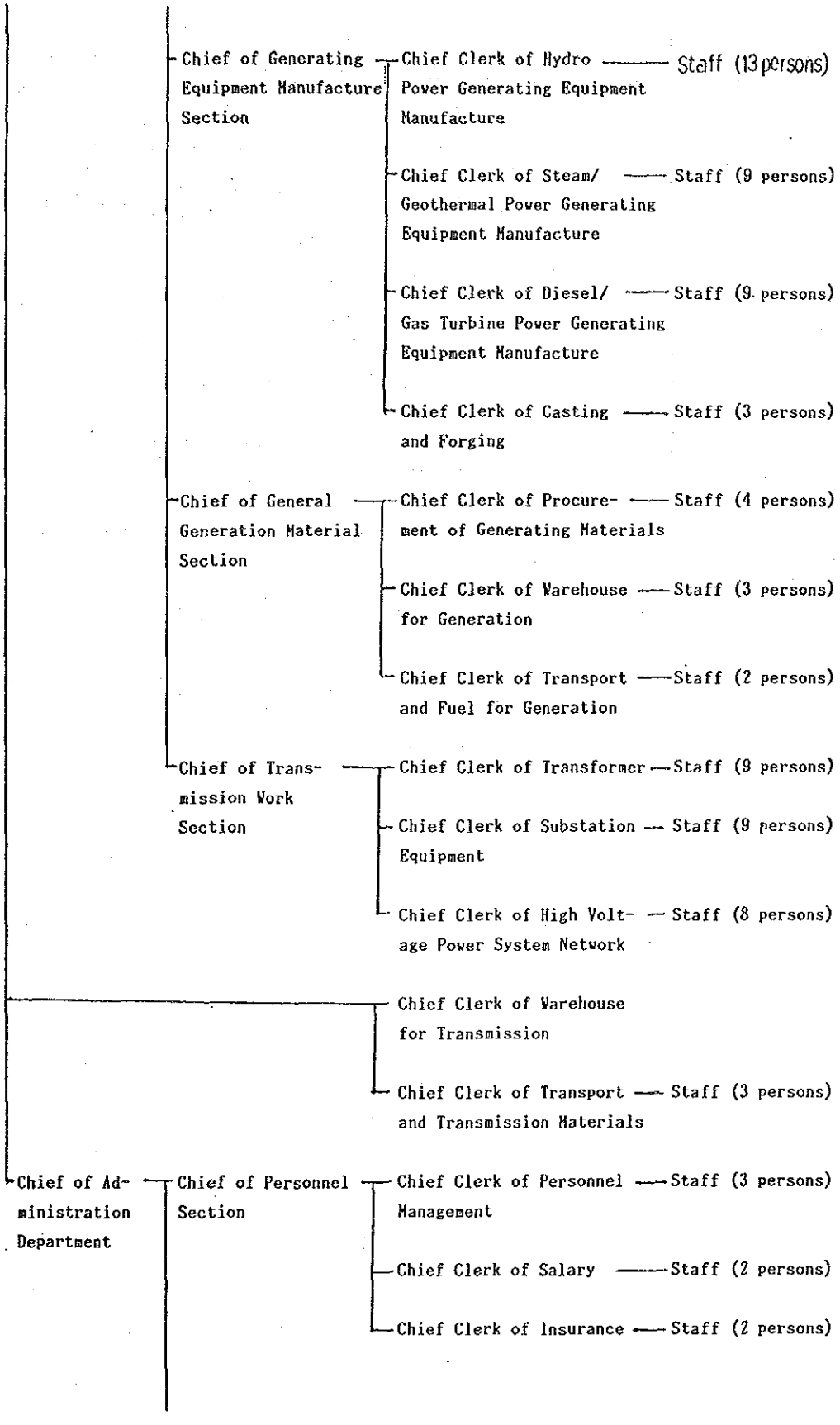
- Officials in responsible posts:

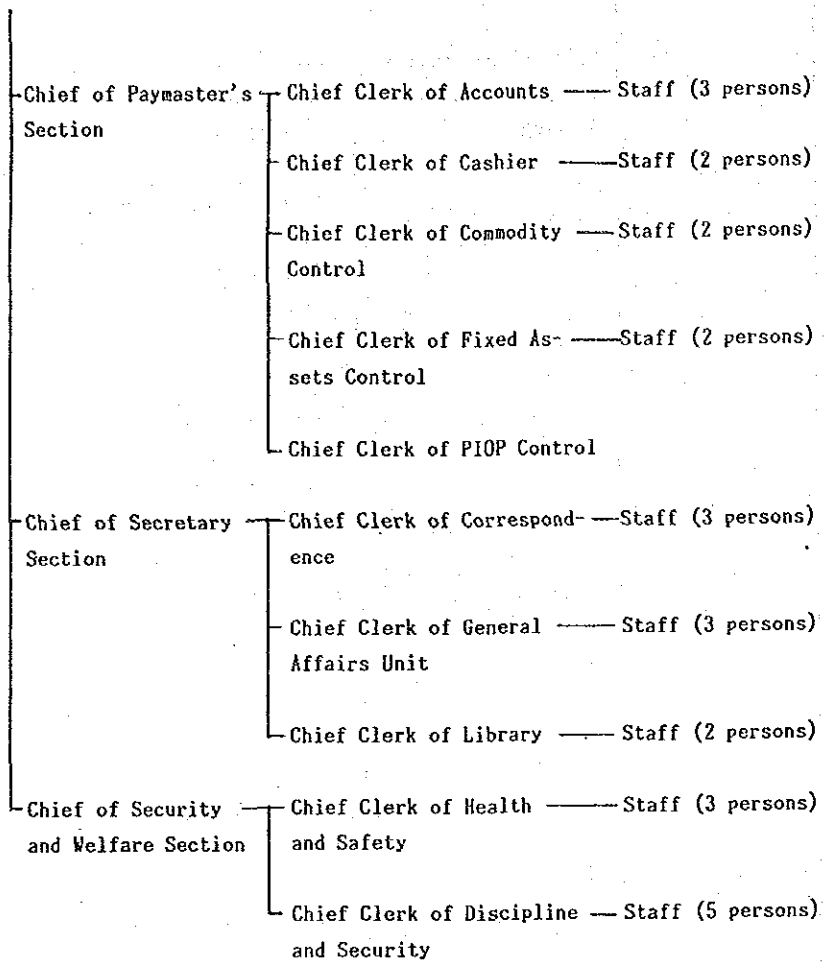
Manager	1	(0.5%)
Department chief	2	(0.9%)
Section chief	12	(5.5%)
Subsection chief	35	(15.9%)
Sub total	50	(22.8%)
- Staff in general	169	(77.2%)
Total	219	(100.0%)

Although the current rule on division of duties could not be referred to in case of the field investigation, the present organization and personnel assignment at the Dayeuhkolot Workshop could be seemingly reasonable in view of the formation.

LIST 2-1 : PRESENT PERSONNEL ORGANIZATION AT THE DAYEUHKOLOT WORKSHOP




Chief of Generating Equipment Manufacture Section
Chief Clerk of Hydro Power Generating Equipment Manufacture
Staff (13 persons)
Chief Clerk of Steam/ Geothermal Power Generating Equipment Manufacture
Staff (9 persons)
Chief Clerk of Diesel/ Gas Turbine Power Generating Equipment Manufacture
Staff (9 persons)
Chief Clerk of Casting and Forging
Staff (3 persons)
Chief of General Generation Material Section
Chief Clerk of Procurement of Generating Materials
Staff (4 persons)
Chief Clerk of Warehouse for Generation
Staff (3 persons)
Chief Clerk of Transport and Fuel for Generation
Staff (2 persons)
Chief of Transmission Work Section
Chief Clerk of Transformer
Staff (9 persons)
Chief Clerk of Substation Equipment
Staff (9 persons)
Chief Clerk of High Voltage Power System Network
Staff (8 persons)
Chief Clerk of Warehouse for Transmission
Chief Clerk of Transport and Transmission Materials
Staff (3 persons)
Chief of Administration Department
Chief of Personnel Section
Chief Clerk of Personnel Management
Staff (3 persons)
Chief Clerk of Salary
Staff (2 persons)
Chief Clerk of Insurance
Staff (2 persons)


Chief of Paymaster's Section
Chief Clerk of Accounts — Staff (3 persons)
Chief Clerk of Cashier — Staff (2 persons)
Chief Clerk of Commodity Control — Staff (2 persons)
Chief Clerk of Fixed Assets Control — Staff (2 persons)
Chief Clerk of PIOP Control
Chief of Secretary Section
Chief Clerk of Correspondence — Staff (3 persons)
Chief Clerk of General Affairs Unit — Staff (3 persons)
Chief Clerk of Library — Staff (2 persons)
Chief of Security and Welfare Section
Chief Clerk of Health and Safety — Staff (3 persons)
Chief Clerk of Discipline and Security — Staff (5 persons)

2.1.4 Methods and Actual Conditions in Repair and Manufacture

The principal working purpose for repair and manufacture at the Dayeuhkolot Workshop which is a "speciality repair shop" is to restore parts and components damaged and/or worn out to the original state. For this purpose, sketches drawn with reference to the relevant parts and components and shop drawings prepared by manufacturers of the day will have to be used. It has been observed during the field investigation that the manufacturers' drawings were principally being used.

Considering that such manufacturers drawings do not mention so often adequate information on processing and fitting of the parts and components, design for repair shall be established to aim at keeping accuracy.

there is nothing particular to be pointed technically in the present processing method by machine tools. It is recommended, however to keep an exclusive area for the processing purpose including assembly and inspection operation for achievement of quality and safety control.

Forged steel including forged stainless steel is generally used for parts and components of hydraulic turbines. As it is somewhat difficult in the Republic to procure these forged steel materials, welding and bending operation by use of steel plates and/or stainless steel plates area adopted for manufacture of runners, guide vanes liners, etc. of the hydraulic turbines. Welding techniques at the Dayeuhkolot Workshop has already reached an apprcciable level. But, it is problematic that heat treatment on welded portions is not carried out at present.

Repair of parts and components for hydraulic turbines such as runners, guidc vanes, liners, valves, bearing metals, etc. including small auxiliary parts like shafts, pines, bushes, etc., and for auxiliary equipment of thermal power generating equipment such as valves, bearing metals, cooling pipes, etc. is being executed with a good level in the repairing technique. Besides the repairing operation, manufacture of air heater units for boiler of thermal power plant is being carried out briskly.

However, in view of insufficiency in cargo handling facilities and working areas, it is rather difficult to deal with parts and components used for hydraulic turbines with an output of 5,000 kW or more, figuratively speaking.

2.1.5 Education and Training

It has been observed that systematic course for education and training of the workshop staff was not operated.

No facility nor space was allocated for this purpose.

2.1.6 Safety Control and conservation of Environment

(1) Safety Control

In view of characteristic marks of the works, rate of danger is not always high,. It is necessary, however, to take minimum measures against risk and hazard. Security measure were provided for machine tools. anyway, keeping passage and putting in order must be settled first in interior and exterior of the workshop buildings.

Workmen in the Dayeuhkolot Workshop were clothed properly with safety goods like helmets, shoes, etc. to show a high consciousness on their own safety.

Safety measures for electrical facilities were in the passing mark, while fire prevention equipment was rather poor.

(2) Conservation of Environment

Although there are many houses of inhabitants nearby the Dayeuhkolot Workshop, no claim against noise, shock, poisonous gas, soot and smoke, bad smell, etc. had never come out from them until now, according to a key person.

No countermeasures are taken for the purpose of conservation of environment.

When a large or weigh item such as transformer body should pass on access, an annoyance may arise to the neighbors while such problem will be of temporary one.

2.2 Comments on Management Aspect

2.2.1 Operation of the Existing Machine Tools

An increasing tendencies in work items and amount in the recent four (4) years (from 1983/84 to 1986/87) are as shown in Table 2-2.

Table 2-2 Change of Work Items and Amount of Outside Workshops and the Dayeuhkolot Workshop

Year	Unit	Outside Workshops		Dayeuhkolot Workshop		Total	
1983/84	SPK	436	(100%)	222	(100%)	658	(100%)
	Rp	533,083,422	(100%)	21,638,015	(100%)	554,766,457	(100%)
1984/85	SPK	447	(102.5)	294	(132.4)	741	(121.6)
	Rp	575,239,730	(107.9)	62,043,198	(286.7)	637,283,928	(114.9)
1985/86	SPK	664	(129.6)	406	(183.0)	1,070	(162.6)
	Rp	981,227,957	(184.1)	193,167,567	(892.7)	1,174,395,542	(211.7)
1986/87	SPK	565	(129.6)	503	(226.6)	1,174	(178.4)
	Rp	933,986,121	(175.2)	360,697,027	(1,667)	1,294,683,148	(233.4)

As seen in the Table 2-2, the increasing rates are remarkable, while absolute figures themselves on the Dayeuhkolot Workshop are not so large.

In fact, most machine tools at the Dayeuhkolot Workshop were being operated actively. It is not altogether exaggerated that the rate of operation in the average value for the machine tools is as large as 123% in December 1986 in case of operating hour per day being six (6) hours.

It is indispensable for repair and manufacture to grasp and control the time schedules. For example, an objective under welding operation will move in order of welding shop, large-sized machine shop, assembly shop, etc., along one direction. Sometime this object will make a return trip on the course. Therefore, passing paths among the workshop buildings and among the machine tools to establish realistic schedule, on which so-called "critical path" has to be found out. By doing so, "working load time" of the respective machines can be known clearly.

It is very important for machine tool operators to know thoroughly the working schedules of the respective machine tools.

2.2.2 Quality Control

Quality Control (QC) is a synthetic concept by keeping a good quality in design, in time schedule and in process during the various stages. In case of hydraulic turbines, the following matters are fundamental in particular:

- To mention "tolerance" on the fabrication drawings clearly for fitting in particular.
- To indicate "degree of finishing" on the drawings.
- To review the design by the person in charge of processing.
- To refer to the drawings concerned during processing.
- To inspect by the person in charge of inspection and to record the inspection results.

2.3 Comments on Technical Aspect

2.3.1 Working Conditions and Areas for Processing and Finishing Operation

Layout of the workshop buildings and arrangement of tools and facilities inside the workshop buildings are not so good enough for the purpose of adequate fulfillment of function of these tools and facilities.

Generally speaking, assembly area, finishing work area, warehouse, etc. are not distinguished clearly in the whole of the Workshop.

In view of manufacture of products with a good quality under safety circumstance, dangerous operation such as grinding and welding shall be kept as far from the machine shop as possible. In an unavoidable case, partition walls may be useful for the purpose of shutting off dust and spark.

A clean environment being free from dust, a high humidity, corrosive air, etc. should be maintained in high voltage transformer shop aiming at realization of a good insulation treatment.

Processing and finishing shall be executed in separated areas independently, while it may be difficult at present in the Workshop to follow this idea.

Accurate assembly of power transformer, after repair, needs a stable baseplate which has to be positioned horizontally to achieve accurate insertion of coils into the cores. Incorporation of this baseplate (2 m x 2 m) should be considered positively, if repair of power transformers will continue in earnest.

Poorness in cargo handling facilities is a fatal weakness of the Dayeuhkolot Workshop at present. This problem should be improved soon.

Drying operation of coil after application of natural drying type varnish was done by exposure of the coil to the sun. This method is too primitive to ensure the coil insulation. Use of a suitable drying chamber is recommended.

2.3.2 Machine Tools

It is possible that working accuracy of the machine tools is appropriate in view of the time elapsed after manufacture.

Temporary measure was used to expand the working capability (distance between centers) of lathe. This would bring a bad effect on the overall accuracy of the product.

2.3.3 Electric Power

Electric power necessary for operation of the Dayeuhkolot Workshop is fed from 20 kV distribution line. There is no problem at all relating to power receiving.

No emergency power supply system was installed.

2.3.4 Test and Inspection

Individual inspection of parts and components has to be carried out during and after processing. Moreover, test and inspection should be also carried out in assembled condition, in the workshop, of these parts and components for hydraulic turbines in particular.

There is a room for improvement on method for test and inspection at the Dayeuhkolot Workshop.

Welded structures shall be inspected to detect interior defect by appropriate nondestructive inspection methods such as color penetration check, ultrasonic test (UT), magnetic particle test(MT) radiographical test, etc.

Stress relief shall be done by annealing after welding. For this purpose, a suitable annealing furnace shall be installed.

2.3.5 Workshop Buildings and Warehouse

It can be said generally that exclusive areas are not allocated to the respective work categories. Then, the works have to be done by utilizing an available location, whenever needed, here and there.

Assembling work and finishing work were executed so often simultaneously in adjacent places with each other. Dust from grinding operation and spark from welding work are injurious to the finishing work. Suitable countermeasures against such dust and spark have to be taken to keep a good quality of products.

To raise productivity of the Workshop, the walking passages among the respective facilities shall be secured adequately.

Passages from doorway to the facilities are also to be secured, and to be marked clearly.

The following matters shall be achieved to facilitate welding operation of hydraulic turbine parts:

- Scraps and unused materials and equipment shall be cleared off.
- Outdoor working spaces shall be expanded.
- An area for full size pattern for cutting welding pieces and segments is to be allocated.

2.4 Comments on Financial Aspects

2.4.1 Financial Statements

Every year the Dayeuhkolot Workshop submits its financial statements which consist of the balance sheet, profit and loss statement, and fund flow table, accompanied by supplementary data. However, the formats for

reporting are made for the use at power generation plants and are not suited to describe the activities at the Dayeuhkolot Workshop. The main three tables which are presented in Table 2-3 ~ Table 2-5 do not carry production costs nor the payment for the costs by PLN.

The balance sheet of the Dayeuhkolot Workshop consists of the assets and liabilities. The assets are divided into current assets and fixed assets and the liabilities are made of equities and loans. The majority of the liabilities are transfer of fund from the PLN, which is called "Final Account". The Dayeuhkolot Workshop is only a part of the PLN. Therefore there is no point of questioning the financial soundness with regard to the assets. The analysis should center around the operations in its comparison to the stocks.

2.4.2 Stock Management

The assets of the Dayeuhkolot Workshop have grown rapidly over the last three years as shown in Fig. 2-1. Among all the material and spareparts stocks have shown the largest increase. The part of the reasons for this growth pertains to the increase in the production. Since the products from the Dayeuhkolot are not sold to the third party, no production figure as a whole exists. However, the level of the production is reflected in the consumption of the materials. The comparison of the material consumption and stocks gives some insight into the stock management. The turn-over ratio of the material is derived by the formula as follows:

$$\text{Turn-over ratio} = \frac{\text{material consumption}}{\text{material stock}}$$

The formula is applied to the data between 1984/85 ~ 1986/87 and the results are shown in Table 2-6.

The ratio was 1.5 up to 1985/86 but was slightly improved to 2 in 1986/87. The ratio of 2 means that the Dayeuhkolot has half a year worth stock., The private workshops are keen to reduce the stock as much as possible to lessen the amount.

2.4.3 Production Level

Table 2-7 presents the Profit and Loss Statement (P/L) of the Dayeuhkolot Workshop in an ordinary accounting format which is estimated from the available data of the Workshop.

The production volume has grown rapidly over the last three years, as is obvious with the growth of the direct costs. Among the direct costs the material costs have the highest corelation with the production.

The repair and reproduction requirement for the power generation equipment fluctuates year by year. The future production volume cannot be easily projected from the last three years data. However during the last three years the production increased at an annual rate of 60%.

The administration costs comprised 25.3% of total costs in 1984/85 but its share reduced to 12.2% in 1986/87. The material costs on the other hand increased from 45.4% to 56.9% and the labor costs from 6.5% to 10.6% during the same period. The drastic change in the cost composition indicates the low production level in 1984/85 approaching a normal level. Nevertheless the Dayeuhkolot Workshop still has indirect workforce larger than that in direct production, which can be reduced furthermore.

2.4.4 Personnel Management

The Dayeuhkolot Workshop organization has six layers of hierarchy of manager, deputy manager, section chief, foreman, general worker and daily worker. Table 2-8 shows the personnel allocation in matrix differentiated by position and section. Functionally the Workshop is divided into production section and administration section. Administration consists of technical and clerical sections whereas production consists of mechanical and electrical sections. When the employees are differentiated as direct and indirect labor, management above foreman in production section is included as indirect labor. The ratio between direct labor and indirect labor in number is 37 to 63. The indirect workforce far exceeds the direct labor. It is understood that due to the variety of products the Workshop has to produce the production requires much work at planning, design and control. However, if it were operated by a private firm, the ratio would be inversed to be 4~6:1.

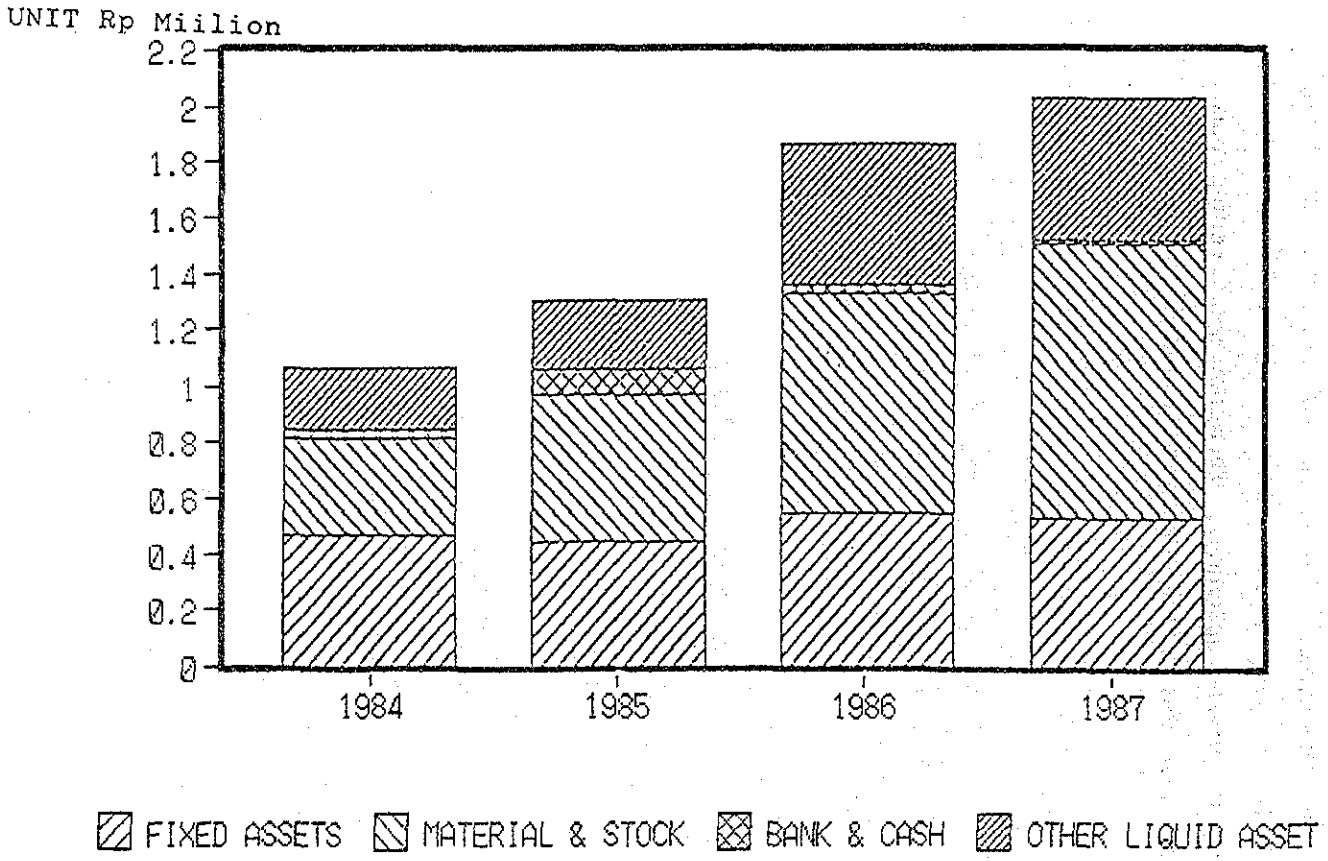
Table 2-9 shows the wage level by position at the Dayeuhkolot Workshop in 1986/87. Based upon the wage level and personnel allocation, wage and salary payment by position and section are computed in Table 2-10.

Indirect workforce includes higher management which is more costly than direct labor in production. Thus the wage payment ratio between direct

and indirect workforce becomes 30:70, clearly indicating top-heavy personnel composition.

The Dayeuhkolot Workshop has assurance of obtaining job-contracts from PLN and can dispense with marketing personnel which is inevitably required in private operation. Therefore some ceiling must be placed on the indirect labor force while the work volume increases.

FIG 2-1 DAYEUHKOLOT ASSETS VALUE



STATE ELECTRICITY CORPORATION
ADM. Unit: DAYEUHKOLOT

TABLE 2-3(a) BALANCE SHEET

	March 31, 1986	March 31, 1985
	Rp.	Rp.
ASSETS		
FIXED ASSETS		
Generators	94,915,742	11,494,334
Transmission		
Distribution		
General	913,342,171	742,225,434
Total Gross Fixed Assets	1,008,257,913	853,719,768
ACCUMULATED DEPRECIATION	463,459,996	411,786,588
Total Net Fixed Assets	544,797,917	441,933,180
WORK IN PROGRESS		
OTHER ASSETS		
LIQUID ASSETS		
Other Liquid Assets	443,694,459	226,127,726
PPs/PPh & Total Development Funds	-	-
Advance Payments	18,907,484	13,296,484
Materials & Stock(Gross)	780,913,839	521,698,248
Materials & Stock set Aside	-	-
Total Materials & Stock (net)	780,913,839	524,698,248
Advance Payments, Employees	6,509,222	3,176,834
External Receivables (Gross)	-	8,030
External Receivables Set Aside	-	-
Total External Receivables (Net)	-	8.030
Bank	61,443,662	16,577,110
Cash	6,278,900	76,280,275
Total liquid Assets	1,317,747,566	860,164,707
TOTAL ASSETS	1,862,545,483	1,302,097,887

PPs: Corporate Tax
PPh: Income Tax

MARCH 31, 1986

TABLE 2-3 (b) BALANCE SHEET

	MARCH 31, 1986	MARCH 31, 1985
	Rp.	Rp.
LIABILITIES		
CAPITAL LIABILITIES		
Capital		
Balance of Accumulated Profits of previous year		
Balance of Stock set of for Materials, Spareparts & Receivables		
TOTAL CAPITAL LIABILITIES		
FINAL ACCOUNT		
Final Account/Statement	2,604,430,622	2,025,832,664
Profit & Loss () Current Year	(765,979,919)	(760,205,351)
Total Final Statement	1,838,450,703	1,265,627,313
LONG TERM LIABILITIES		
Long-Term Loans		
Loans From Customers		
Pension Centributions	1,117,414	856,153
Customer Guarantees	-	-
Total Long-Term Liabilities	1,117,414	856,153
CONNECTION COSTS		
LIQUID ASSETS		
Provisions for PPs/PPh		
External Payables	9,395,715	12,320,746
Long Term Loans Due		
Tax Debts	860,293	193,611
Internal Debts	63,320	62,240
Indebted *)	12,658,038	23,037,824
TOTAL LIQUID LIABILITIES	22,977,366	35,611,421
TOTAL LIABILITIES	1,862,545,483	1,302,097,887

Dayeuhkolot May 17, 1986

STATE ELECTRICITY CORPORATION
ADM. UNit: DAYEUHKOLOT

(stamped) (Signed)

SOEHARMOTO, BME
Management/Head.....

STATE ELECTRICITY CORPORATION LPT 1985/1986

ADM. Unit: DAYEUHKOLOT

TABLE 2 - 4 PROFIT AND LOSS CALCULATION FOR PERIOD ENDING MARCH 31, 1986

	PERIOD 1985/1986	PERIOD 1984/1985
	Rp	Rp
OPERATION PROCEEDS:		
Sale of Electric Power		
Proceeds from Electric Connections		
Other Proceeds		
OPERATIONAL COSTS:		
1. Purchase of Electric Power		
2. Fuel oil & Lubricant		
3 Maintenance:	211,605,220	194,361,395
3.1. Materials & Spareparts	345,077,443	47,168,794
3.2 Contracts	166,527,777	147,192,601
4 Personnel:	343,510,936	332,265,459
4.1 Salary & Wages	244,676,336	224,855,559
4.2 Holiday and Others	98,834,600	107,409,900
5. Depreciation	153,604,008	73,108,380
6. Other Operational Costs	102,969,324	120,977,326
PROFIT & LOSS ( ) OPERATIONS	811,689,568	720,712,560
	(45,709,649)	39,492,791
MISCELLANY:		
1. Research ( )		
2 Output/Load ( ) AT withdrawal		
3 Output/Load ( ) Third Party Work		
4 Depreciation, Questionable Receivables ( )		
5 Interest, Loans		
6 Price Difference and Others *) 985	5,731,317	(11,516,552)
7 Pension Fund and Other *) 989 + 980	(51,440,966)	51,009,343
NET PROFIT & LOSS ( ) CURRENT YEAR	765,979,919	760,205,351

See Explanation Profit & Loss

Dayeuhkolot May 17, 1986

STATE ELECTRICITY CORPORATION

ADM. Unit: Dayeuhkolot

(Stamped) (Signed)

Soehamoto BME

Management/Head .....

STATE ELECTRICITY CORPORATION

ADM. UNIT: DAYEUHKOLOT

TABLE 2-5 FUND FLOW

SOURCE & UTILIZATION FUNDS (WORK CAPITAL) 1985/1986

SOURCE OF FUNDS	624,758,059
1. Internal Of Funds	45.898,840
Profit & Loss (Opertaion_	(90,977,008)
Depreciation of Fixed Assets	51,673,408
Product/Load ( ) Miscellany	85,202,440
2. External Source of Funds:	578,859,219
2.1. Capital Liabilities	-
- Capital	
- Other (Exclusive Profit & Loss)	-
2.2 Final Account	
- Final/Intermediate Account (exclusive Profit & Loss)	578,597,958
2.3. Long Term Liabilities	-
- Long Term Loans	-
- Customer Loans	-
- Pension Constribtuion/Fund	261,261
- Customer Deposits	-
2.4 Connection Costs	-
UTILIZATION OF FUNDS	154,538,145
- Increase of Fixed Assets	154,538,145
- Increase of Work in Progress	-
- Increase of other Assets	-
- Final/intermediat Account *)	-
ADDITION OF WORK CAPITAL (A-B)	470,219,914

*) Especially for Central PLN

/ Dayeuhkolot May 17, 1986
STATE ELECTRICITY CORPORATION
ADM. Unit BEL. DAYEUHKOLOT
(Stamped) (Signed)
(SOEHARMOTO, BME)
Management/Head of .....

TABLE 2 - 6 MATERIAL TURN-OVER RATIO Rp MILLION

	1984/85	1985/86	1986/87
MATERIAL CONSUMPTION	679.2	969.5	1824.2
AVERAGE MATERIAL STOCK	436.3	653.3	878.1
MATERIAL TURN-OVER RATIO	1.56	1.48	2.08

TABLE2-7 DAYEUHKOLOT PROFIT AND LOSS STATEMENT (ESTIMATED) 1984/85-1986/87

	1984/85		1985/86		1986/87	
Estimated sales	3293.3		5500.2		n.a.	
Direct cost	1118.1	74.7%	1544.4	79.0%	2835.5	87.8%
Raw material	679.2	45.4%	969.5	49.6%	1824.2	56.5%
Direct labor	97.7	6.5%	174	8.9%	341.6	10.6%
Maintenance	109.9	7.3%	125.2	6.4%	354.3	11.0%
Other operation cost	168.2	11.2%	148	7.6%	226.5	7.0%
Depreciation	63.1	4.2%	127.7	6.5%	88.9	2.8%
gross profit	2175.2	145.3%	3955.8	202.3%	n.a.	0.0%
Indirect cost	379.4	25.3%	410.8	21.0%	393.79	12.2%
Adminstration salary	332.2	22.2%	343.5	17.6%	244.49	7.6%
Adminstration cost	47.2	3.2%	67.3	3.4%	149.3	4.6%
current profit	1795.8	119.9%	3545	181.3%	n.a.	0.0%
Total cost	1497.5	100.0%	1955.2	100.0%	3229.29	100.0%
Total direct cost	1118.1	74.7%	1544.4	79.0%	2835.5	87.8%
Direct/indirect cost ratio		115.7%		139.9%		256.8%
exclusive of material						

TABLE2-8 PERSONNAL ALLOCATOR AT DAYEUHKOLOT BY POSITION AND SECTION

	MANAGER	DEPUTY	SECTION	FOREMAN	GENERAL	DAILY WORK	TOTAL
MANAGEMENT							
TECHNOLOGY		1	5	13	56	8	83
ADMINISTRATION	1	1	4	12	26	7	51
PRODUCTION							0
MACHINERY			2	6	13	30	51
TRANSMISSION			1	4	19	10	34
TOTAL	1	2	12	35	114	55	219
PAYMENT Rp'000	6698	10201	48479	124524	289418	66910	546229

TABLE2-9 AVERAGE WAGE LEVEL BY POSITION AND SECTION

	PER PERSON SALARY	x1,000 Rp / YEAR
MANAGER	5358	
DEPUTY MANAGER	4080	
SECTION CHIEF	3232	
FOREMAN	2846	
GENERAL WORKER	2031	
DAILY WORKER	973	
TOTAL		

TABLE2-10 WAGE PAYMENT BY POSITION AND SECTION

	MANAGER	DEPUTY	SECTION	FOREMAN	GENERAL	DAILY WORK	TOTAL	
MANAGEMENT								
TECHNOLOGY	0	4080	16160	37002	113736	7784	178761	41%
ADMINISTRATION	5358	4080	12928	34155	52806	6811	116138	27%
PRODUCTION	0	0	0	0	0	0	0	
MACHINERY	0	0	6464	17078	26403	29190	79134	18%
TRANSMISSION	0	0	3232	11385	38589	9730	62936	14%
TOTAL	5358	8161	38783	99619	231534	53515	436970	100%
PAYMENT Rp'000								
INDIRECT LABOR	304595.42	70%						
DIRECT LABOR	132374.70	30%						

CHAPTER - 3

DEMAND FORECAST

CHAPTER - 3
DEMAND FORECAST

3.1 General

It is essential for the feasibility study on the renovation of the Dayeuhkolot Workshop to make forecast of "handling item" and "handling quantity".

On the other hand, PLN will promote extension of power system equipment to meet increase of demand. Possible influence due to increase of the power system equipment was also examined to ascertain whether what kind of effect will be given to facilities at the Dayeuhkolot Workshop.

3.2 Demand Forecast for the Dayeuhkolot Workshop

The demand forecast was examined for the following categories:

i) Parts and components for generating plants (PLTA, PLTU and PLTG)
ii) Hardware (fittings) for transmission lines and distribution lines
iii) Electrical equipment and parts for substations, transmission lines and distribution lines

It is noted that the parts and components for diesel engine generating plant (PLTD) was put aside from the study on the renovation of the Dayeuhkolot Workshop because PLN has a line of policy that the diesel engine generator sets be retired from utilization in Java Island within a near future.

1) Parts and Components for Generating Plants:

Items and quantities of parts and components to be repaired and supplemented annually were presumed with reference to the records for periodical inspection and overhaul of the generating equipment.

The current execution rules for the periodical inspection and overhaul of PLN are as given below:

(a) PLTA

- Annual Inspection
- General Inspection (At interval of 20,000 hours' operation)
- Major Overhaul (At interval of 40,000 hours' operation)

(b) PLTU (including PLTP)

- Simple Inspection (At interval of 8,000 hours' operation)
- Main Inspection (At interval of 16,000 hours' operation)
- Serious Inspection (At interval of 32,000 hours' operation)

(c) PLTG

- Combustion Test (Every 250 times of start operation)
- Hot Gas Path Inspection (Every 500 times of start operation)
- Major Inspection (Every 1,000 times of start operation)

With reference to records and reports on the tests and inspections stated above, "Reference Base" for the demand forecast was formulated.

Although it is a sure method for demand forecast to refer to the past trend, it has been found that compliance with only the past records be not always appropriate with the following reasons:

- Data and information obtained and collected during the field investigation were not sufficient for systematic analysis.

- The actual past demand of the Dayeuhkolot Workshop had varied widely by years.

Therefore, the following methods were applied to the demand forecast to aim at more accurate study:

- Average service span of life of the parts and components was examined in comparison with figures which are adopted generally.

- It was assumed that the Dayeuhkolot Workshop takes charge of repairing of all the parts and the components which will become necessary in case of the major overhaul at every 40,000 hours' operation for Francis turbines.

- Number of power stations (or number of units) where periodical inspection and overhaul are scheduled to be carried out was calculated basing on statistics concerned to determine numbers of the parts and the components.

- From analysis of annual reports of the Dayeuhkolot Workshop, the work items which are within the limits of capability of the Workshop were derived to find "Base Demand".

- "Final Demand" was obtained taking irregular factor due to accidents and necessity of repair of the Dayeuhkolot Workshop's own facilities into consideration.

2) Hardware for Transmission Lines and Distribution Lines:

Forecast was done for maintenance and improvement of only the existing transmission lines and distribution lines (including re-routing portion). Demand by new lines which will be constructed under new development projects was excluded from the study.

Presumption of quantities of the hardware was calculated with reference to yearly renovation (rehabilitation) program of the existing lines by using an idea that demand of the hardware varies substantially in proportion to the renovation program, base of which was put on figures of 1985/86.

3) Electrical Equipment and Parts for Transmission Line, Distribution Line and Substation:

As work item in the study, power transformers were taken. With reference to the existing numbers of transformers in the PLN power systems, number of the transformers to be repaired was assumed. Actual data observed in Japan were also referred to the study.

4) Other Item

Fabrication of air heater units (segments) for boilers of PLTU is a major item of products at the Dayeuhkolot Workshop.

According to information of PLN, these air heater units have to be renewed once every two years. Because demand forecast for the air heater units can be done easily, study on this item was excluded from Items 1) to 3) given above. Demand for the air heater units in the PLTU Tanjung Priok and the PLTU Muara Karang, both of which are located in the West Java was excluded from the study because these air heater units are being manufactured by the workshop belong to the Sektor Priok.

3.3 Demand Forecast on Power System Facilities

1) Generating Facilities:

Generating units belonging to PLN are listed numerically and shown also graphically by years of commissioning including accumulated numbers in the respective types. Lists 3-1 and 3-2 and Graph 3-A are for hydropower facilities (PLTA). Lists 3-3 and 3-4 and Graph 3-B are for steam power facilities (PLTU). And, Lists 3-5 and 3-6 and Graph 3-C are for gas turbine power facilities (PLTG). The List 3-1 shows expected dimensions and specific speeds, too.

In view of the demand forecast for works items of the Dayeuhkolot Workshop, forecast for increase of number of units is meaningful. The forecast for generating units is as summarized, hereunder, with reference to PLN's forecast mentioned in "Peak Load, Production and Installed Capacity":

	1985 (existing)	1994	Increase
Hydropower facilities (PLTA)	119	160	41
Thermal power facilities (PLTU/PLTP)	25	42	17

No plan for expansion is given to the gas turbine plant (PLTG).

2) Hardware for Transmission Line and Distribution Line:

It is assumed that fittings for transmission and distribution lines will be manufactured at the Dayeuhkolot Workshop for maintenance purpose, and the demand forecast for the fittings was made on the basis of the following conditions:

- Fittings for these lines to constructed newly will be provided under the respective contract as spare parts. No consideration was given to these fittings for the new lines.

- Fittings to be manufactured at the Dayeuhkolot Workshop are for only those for conductors and overhead ground wires use. No consideration was given to supports use.

The data for length of transmission and distribution lines based on km-circuit value were collected during the field investigation. With reference to these data, numbers of supports (towers and poles), figures were estimated as given below:

- Transmission Lines:

Transmission line route length	L = 12,321 km-circuit
Average span length	S = 0.3 km (300 m)
Nos. of tower	N = L/S = 12,321/0.3 = 41,070 Nos.
Assumed Nos. of suspension tower	60% of the total: 24,600 Nos.
Nos. of suspension clamp	24,600 x 3 = 73,800 Nos.
Assumed Nos. of tension tower	40% of the total: 16,000 Nos.
Nos. of tension clamp	16,400 x 6 = 98,400 Nos.

- Distribution lines:

Distribution line route length	L = 36,854 km-circuit
Average span length	S = 40 m
Assumed Nos. of poles	N = L/S = 36,854/0.04 = 9,213,500
Nos. of tension/angle poles	50% of the total: 4,610,000 Nos.
Nos. of tension clamps	41,610,000 x 3 = 13,830,000 Nos.

(As bind wires are used for straight poles to fix conductors, no clamp is used.)

These fittings are not required normally to be replaced with new ones unless accident should occur. It is judged, therefore, that production of numbers corresponding to one (1) percent of the total would be enough.

Exclusive machine tools and exclusive devices are not necessary for production of these fittings.

Data on these lines are as shown in List 3-7.

3) Electrical Equipment for Substation:

Statistical data on power transformers installed in power stations and substations and on distribution transformers are as mentioned in Lists 3-8, 3-9 and 3-10.

The forecast on transformers' quantities was made basing on the following conditions:

- Numbers of transformers to be repaired for the year were calculated basing on PLN's data on damaged transformers which are shown in List 3-11. The rate of damage is about 5% being very identical to figure in Japan.

- PLN's forecast on power demand which is shown in List 3-11 was taken for increase of numbers of damaged distribution transformers.

The following figures are forecast for the damaged distribution transformers:

Primary Voltage	25kV	15kV	12kV	10kV	7kV
Nos. of Damaged Transformers	500	5	20	10	200

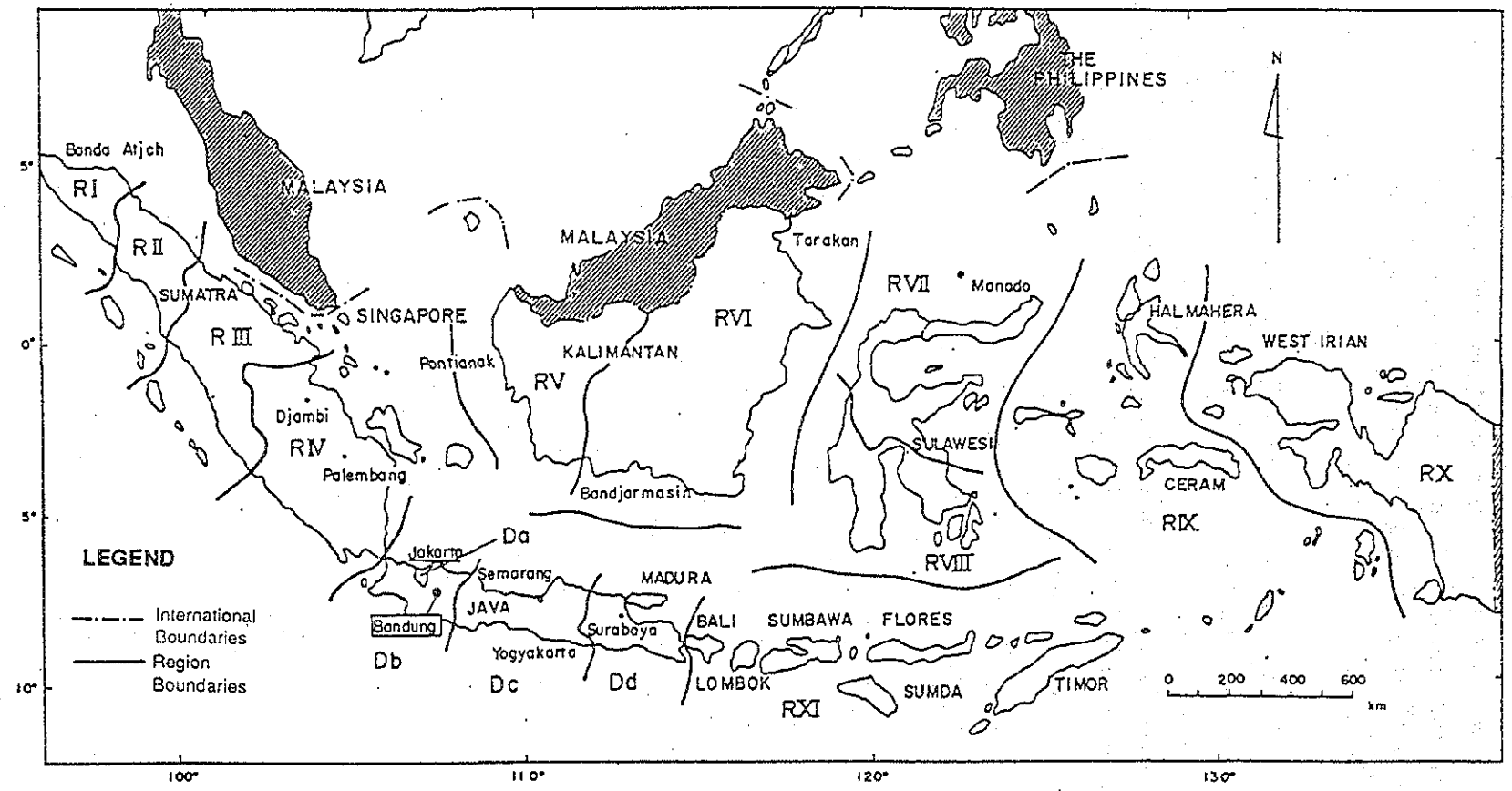
The distribution transformers belonging to PLN are mainly 25 kV and 7 kV in the primary voltage. Then, the total numbers of damaged transformers would be about 750 Nos. to be repaired annually.

Increase of numbers of the distribution transformers is shown graphically in Graph 3-D.

Power transformers connected to 150 kV system or more at power stations and substations need high technique and special parts and materials for repair. Then, these power transformers with large capacity were excluded from the study.

It is very difficult technically to make forecast for occurrence of accident on circuit breakers. On the other hand, there is little possible of trouble and accident on the circuit breakers, if a series of appropriate maintenance is executed periodically. Then, repair of the circuit breakers was eventually excluded from the study.

OPERATING REGIONS OF PLN



LIST 3 - 1a

HYDRAULIC GENERATING EQUIPMENT

(AS OF END OF 1986)

NAME OF P/S	TYPE	NOS. OF UNITS	INSTALLED YEAR	OPERATED PERIOD (YEAR)	SPEED (RPM)	TURBINE OUTPUT (kW)	HEAD (M)	DISCHARGE (cu.m/s)	ESTIMATED DIMENSION OF TURBINE				
									RUNNER DIA. (mm)	COVER DIA. (mm)	G/VANE WID (mm)	SHAFT DIA. (mm)	Ns (m-kW)
CIJEDIL	H/F	3	1921	66	1,000	154	35	0.36	500	1,000	110	70	146
CIJEDIL	H/F	4	1921	66	1,000	154	35	0.36	500	1,000	110	70	146
PLENGAN	H/F	1	1922	65	750	1,050	90	1.66	600	978	75	145	88
PLENGAN	H/F	2	1922	65	750	1,050	90	1.66	600	978	75	145	88
PLENGAN	H/F	3	1922	65	750	1,050	90	1.66	600	978	75	145	88
BENGKOK/DAGO	H/F	1	1923	64	750	1,050	104	1.37	600	943	60	145	73
BENGKOK/DAGO	H/F	2	1923	64	750	1,050	104	1.37	600	943	60	145	73
BENGKOK/DAGO	H/F	3	1923	64	750	1,050	104	1.37	600	943	60	145	73
BENGKOK/DAGO	H/F	4	1923	64	750	700	104	1.37	600	943	60	145	73
CIJEDIL	H/F	1	1923	64	1,000	122	35	0.3	500	1,000	100	65	130
CIJEDIL	H/F	2	1923	64	1,000	122	35	0.3	500	1,000	100	65	130
LAMAJAN	V/F	1	1924	63	600	6,400	216	3.6	900	1,384	65	280	58
UBRUG	H/F	1	1924	63	600	5,400	74	11.59	1,200	2,368	420	280	219
UBRUG	H/F	2	1924	63	600	5,400	74	11.59	1,200	2,368	420	280	219
LAMAJAN	V/F	2	1925	62	600	6,400	216	3.6	900	1,384	65	280	58
TARUTUNG	H/F	1	1926	61	1,500	60	60	-	500	1,000	50	50	70
TARUTUNG	H/F	2	1926	61	1,500	60	60	-	500	1,000	50	50	70
KLONDING	H/F		1927	60	1,000	52	-	-	500	1,000	-	50	-
KRACAK	V/F	1	1927	60	750	5,525	104	8.9	1,060	1,747	280	250	168
KRACAK	V/F	2	1927	60	750	5,525	104	8.9	1,060	1,747	280	250	168
MENDALAN	H/F	1	1930	57	750	5,600	152.5	5.25	1,250	1,929	190	250	105
LAMAJAN	V/F	3	1934	53	600	6,400	216	3.6	900	1,384	65	280	58
SIMAN	V/F	1	1935	52	600	3,600	98	4.5	850	1,368	145	230	117
GIRINGAN	H/F	1	1937	50	1,000	1,400	106.5	1.13	600	940	100	145	109
JELOK	H/F	1	1937	50	600	5,120	144	4.48	1,250	1,929	150	260	86
JELOK	H/F	2	1938	49	600	5,120	144	4.46	1,250	1,929	150	260	86
JELOK	H/F	3	1938	49	600	5,120	144	4.46	1,250	1,929	150	260	86
KETENGER	H/P	1	1939	48	600	3,520	272.5	1.615	-	-	-	230	32
KETENGER	H/P	2	1939	48	600	3,520	272.5	1.615	-	-	-	230	32
SAWITO	V/K	1	1940	47	250	540	6.8	10	-	-	-	165	529
SAWITO	V/K	2	1940	47	250	540	6.8	10	-	-	-	165	529
WONOSOBO	H/F		1943	44	750	124	-	-	500	1,000	-	75	-
BANJARNEGARA	H/F		1949	38	1,000	256	25	2	600	1,200	280	85	286
TONSEA LAMA	V/F	1	1950	37	500	4,440	96	6.4	800	1,400	130	260	111
UBRUG	H/F	3	1950	37	600	6,300	74	11.59	1,200	2,368	420	280	219
GIRINGAN	H/F	2	1955	32	1,000	900	106.5	1.13	600	941	75	125	88
GIRINGAN	H/F	3	1955	32	1,000	900	106.5	1.17	600	941	75	125	88
MENDALAN	H/F	2	1955	32	750	5,800	152.5	5.3	1,250	1,929	195	250	107
MENDALAN	H/F	3	1955	32	750	5,800	152.5	5.3	1,250	1,929	195	250	107
MENDALAN	H/F	4	1955	32	750	5,800	152.5	5.3	1,250	1,929	195	250	107
PARAKAN	H/F	1	1955	32	600	2,496	52.6	6	800	1,579	275	205	212
PARAKAN	H/F	2	1955	32	600	2,496	52.6	6	800	1,579	275	205	212
PARAKAN	H/F	3	1955	32	600	2,496	52.6	6	800	1,579	275	205	212
PARAKAN	H/F	4	1955	32	600	2,496	52.6	6	800	1,579	275	205	212
SIMAN	V/F	2	1955	32	600	3,600	98	4.5	850	1,368	145	230	117
SIMAN	V/F	3	1955	32	600	3,600	98	4.5	850	1,368	145	230	117
SUNGAI PENUH	H/F	-	1957	30	1,000	70	32	0.3	400	800	65	55	110
KRACAK	V/F	3	1958	29	750	5,525	104	8.9	1,060	1,747	280	250	168
GOLANG	H/F	1	1959	28	1,000	900	88.5	1.37	600	943	100	125	111
GOLANG	H/F	2	1959	28	1,000	900	88.5	1.37	600	943	100	125	111
GOLANG	H/F	3	1959	28	1,000	900	88.5	1.37	600	943	100	125	111
TES	H/F	1	1959	28	1,000	660	43.5	1.5	425	838	160	110	230
TES	H/F	2	1959	28	1,000	660	43.5	1.5	425	838	160	110	230
CIKALONG	H/F	1	1960	27	750	6,400	140	5.5	1,180	2,612	215	260	125
CIKALONG	H/F	2	1960	27	750	6,400	140	5.5	1,180	2,612	215	260	125
CIKALONG	H/F	3	1960	27	750	6,400	140	5.5	1,180	2,612	215	260	125
CLEBINONG	H/F		1962	25	1,000	20	-	-	400	800	65	55	110
JELOK	H/F	4	1962	25	600	5,120	144	4.48	1,250	1,929	150	260	86
PLENGAN	H/F	4	1962	25	750	2,000	90	2.85	800	1,304	145	180	121
TIMO	H/F	1	1963	24	750	4,000	103	4.6	1,060	1,667	230	220	145
TIMO	H/F	2	1963	24	750	4,000	103	4.6	1,060	1,667	230	220	145
TIMO	H/F	3	1963	24	750	4,000	103	4.6	1,060	1,667	230	220	145
NGEBEL	H/F		1968	19	1,000	2,200	183.5	1.41	800	1,235	65	170	69
TONSEA LAMA	V/F	1	1970	17	600	4,500	89.5	6.49	750	1,357	165	250	146
CENAE	H/F		1971	16	625	90	12.5	-	500	900	200	70	252
IR. PM. NOOR	V/F	1	1971	16	273	10,000	39.8	30.34	1,320	2,780	580	420	272
IR. PM. NOOR	V/F	2	1971	16	273	10,000	39.8	30.34	1,500	2,710	660	420	273
NGARGOYOSO	H/F		1971	16	750	60	30	0.33	500	900	60	60	83
KARANG ASEM	H/F		1972	15	588	80	11.15	0.3					
SAWITO	V/K	3	1973	14	250	540	6.8	10	-	-	-	165	529
SELOREJO	V/K		1973	14	500	4,080	37.1	14.7	-	-	-	260	349
SUTAMI	V/F	1	1973	14	250	35,000	78	53.5	2,000	3,600	640	650	202
SUTAMI	V/F	2	1973	14	250	35,000	78	53.5	2,000	3,600	640	650	202
SUTAMI	V/F	3	1974	13	250	35,000	78	53.5	2,000	3,600	640	650	202
BATANG AGAM	H/F	1	1976	11	750	3,500	90.8	4.49	1,000	1,629	240	210	158
BATANG AGAM	H/F	2	1976	11	750	3,500	90.8	4.49	1,000	1,629	240	210	158
HARUYAN	BULB		1976	11	460	200	-	-	-	-	-	100	-
MUNTHE	H/F		1976	11	446	80	9.45	1.05	500	900	190	75	241
NARMADA	H/F		1976	11	750	120	15.3	1	500	900	220	70	272
CIPAYUNG	H/F		1977	10	1,000	400	40	-	500	900	155	95	199
KOTO ANAU	H/F		1977	10	1,000	160	27.5	0.9	500	900	160	70	201
MAJA	H/F		1977	10	750	75	11.6	0.925	500	900	245	60	303
SLAMANGGU	H/F		1977	10	606	154	-	-	500	900	120	80	158
T.KANING	H/F		1977	10	660	100	14.3	0.95	500	900	190	70	237
TENGA	H/F		1977	10	1,000	180	23.5	-	500	900	210	75	259

LIST 3 - 1b

HYDRAULIC GENERATING EQUIPMENT

(AS OF END OF 1986)

NAME OF P/S	TYPE	NOS. OF UNITS	INSTALLED YEAR	OPERATED PERIOD (YEAR)	SPEED (RPM)	TURBINE OUTPUT (kW)	HEAD (M)	DISCHARGE (cu.m/s)	ESTIMATED DIMENSION OF TURBINE				
									RUNNER DIA. (mm)	COVER DIA. (mm)	G/VANE WID (mm)	SHAFT DIA. (mm)	Ns (m·kW)
WAMENA	V/F		1977	10	197	120	5	3.6	500	900	235	110	289
TANGGUL	V/K		1978	9	500	60	40	1.8	-	-	-	65	39
TONJONG	H/F		1978	9	600	208	-	-	500	900	-	90	-
WLINGI	V/K	1	1978	9	143	27,000	22	143	-	-	-	720	493
WLINGI	V/K	2	1978	9	143	27,000	22	143	-	-	-	720	493
LEMPUR	H/F		1979	8	1,000	80	29	0.5	500	900	100	55	133
PAKIS BARU	H/P		1979	8	1,000	120	-	-	-	-	-	70	-
PONTAK	V/F		1979	8	150	60	5	2.1	500	900	120	95	155
RUTENG	H/F		1979	8	740	120	17.35	-	500	900	180	70	229
IR. PM. NOOR	V/F	3	1980	7	273	10,000	39.8	30.34	1,500	2,710	660	420	273
MANINJAU	V/F	1	1980	7	600	17,200	226	8.73	1,130	1,760	145	390	90
MANINJAU	V/F	2	1980	7	600	17,200	226	8.73	1,130	1,760	145	390	90
MANINJAU	V/F	3	1980	7	600	17,200	226	8.73	1,130	1,760	145	390	90
MANINJAU	V/F	4	1980	7	600	17,200	226	8.73	1,130	1,760	145	390	90
MEJAGONG	BULB		1980	7	802	575	14.37	5.1	-	-	-	120	687
SEMPOR	H/F		1980	7	750	1,000	30	3.13	475	1,204	265	140	338
BAJAWA/OGI	H/F		1981	6	1,327	160	54	0.47	500	900	85	65	115
BATANG AGAM	H/F	3	1981	6	750	3,500	90.8	4.49	1,000	1,629	240	210	158
TONSEA LAMA	V/F	3	1981	6	600	5,440	93.25	6.77	850	1,490	200	270	153
WONODADI	BULB		1981	6	720	210	3.8	7.2	-	-	-	100	-
WONOGIRI	V/K	1	1981	6	273	6,200	20.4	36.7	-	-	-	360	496
WONOGIRI	V/K	2	1981	6	273	6,200	20.4	36.7	-	-	-	360	496
GARUNG	V/F	1	1982	5	750	13,200	195	7.92	1,130	1,758	195	330	118
GARUNG	V/F	2	1982	5	750	13,200	195	7.92	1,130	1,758	195	330	118
IR. H. JUANDA	V/F		1982	5	272	25,000	66	45	1,760	3,490	635	570	229
LODOYO	H/K		1982	5	150	4,500	8.5	67.5	-	-	-	390	693
MUARA LABUH	H/F		1982	5	750	400	35	1.87	500	1,000	135	105	176
K. CURUP	H/F		1983	4	750	1,000	63	2.25	475	864	95	140	134
SAWIDAGO	H/F		1983	4	695	120	15.3	1.06	500	1,000	205	70	258
WIDAS	CROSS		1983	4	239	650	21.6	4.5	-	-	-	180	131
SAGULING	V/F	1	1984	3	333.3	175,000	335.7	56	2,000	3,600	280	1,020	97
SAGULING	V/F	2	1984	3	333.3	175,000	335.7	56	2,000	3,600	280	1,020	97
HANGA HANGA	H/F		1985	-	-	1,600	-	-	-	-	-	-	-
SAGULING	V/F	3	1985	2	333.3	175,000	335.7	56	2,000	3,600	280	1,020	97
SAGULING	V/F	4	1985	2	333.3	175,000	335.7	56	2,000	3,600	280	1,020	97
ANGKUP	BULB	1	-		659	372	9	5.1					
ANGKUP	BULB	2	-		659	372	9	5.1					
TALANG KRASAK	-		-	-	-	-	-	-	-	-	-	-	-

LIST 3 - 2

CHANGE OF NOS. OF HYDROPOWER
GENERATING UNITS BY YEAR

OPERATED PERIOD	NOS	INSTALLED YEAR	ACCUMU LATED
66	2	1921	2
65	3	1922	5
64	6	1923	11
63	3	1924	14
62	1	1925	15
61	2	1926	17
60	4	1927	21
59	0	1928	21
58	0	1929	21
57	1	1930	22
56	0	1931	22
55	0	1932	22
54	0	1933	22
53	1	1934	23
52	1	1935	24
51	0	1936	24
50	2	1937	26
49	2	1938	28
48	2	1939	30
47	2	1940	32
46	0	1941	32
45	0	1942	32
44	1	1943	33
43	0	1944	33
42	0	1945	33
41	0	1946	33
40	0	1947	33
39	0	1948	33
38	1	1949	34
37	2	1950	36
36	0	1951	36
35	0	1952	36
34	0	1953	36
33	0	1954	36
32	11	1955	47
31	0	1956	47
30	0	1957	47
29	0	1958	47
28	6	1959	53
27	3	1960	56
26	0	1961	56
25	2	1962	58
24	3	1963	61
23	0	1964	61
22	0	1965	61
21	0	1966	61
20	0	1967	61
19	1	1968	62
18	0	1969	62
17	1	1970	63
16	4	1971	67
15	1	1972	68
14	4	1973	72
13	1	1974	73
12	0	1975	73
11	5	1976	78
10	7	1977	85
9	4	1978	89
8	4	1979	93
7	7	1980	100
6	6	1981	106
5	5	1982	111
4	3	1983	114
3	2	1984	116
2	3	1985	119
Forecasted	3	1986	122
Forecasted	3	1987	125
Forecasted	3	1988	128
Forecasted	3	1989	131
Forecasted	3	1990	134
Forecasted	3	1991	137
Forecasted	3	1992	140
Forecasted	4	1993	144
Forecasted	4	1994	148

LIST 3 - 3

STEAM GENERATING UNITS

(AS OF END OF 1986)

SERIAL NO.	NAME OF POWER STATION	UNIT OUTPUT (MW)	INSTALLED YEAR
1	BELAWAN I	65.0	1984
2	BELAWAN II	65.0	1984
3	BELAWAN III	65.0	**1989**
4	BELAWAN IV	65.0	**1990**
5	OMBILIN I	-	-
6	OMBILIN II	-	-
7	KERAMASAN I	12.5	1974
8	KERAMASAN II	12.5	1974
9	BK, ASAM I	65.0	**1988**
10	BK. ASAM II	65.0	**1989**
11	TELLO I	12.5	1971
12	TELLO II	12.5	1971
13	TG PRIOK I	25.0	1962
14	TG PRIOK II	25.0	1964
15	TG PRIOK III	50.0	1972
16	TG PRIOK IV	50.0	1972
17	M. KARANG I	100.0	1979
18	M. KARANG II	100.0	1979
19	M. KARANG III	100.0	1979
20	M. KARANG IV	200.0	1981
21	M. KARANG V	200.0	1982
22	SULALAYA I	400.0	1984
23	SULALAYA II	400.0	1985
24	SULALAYA III	400.0	**1989**
25	SULALAYA IV	400.0	**1990**
26	SEMARANG I	50.0	1978
27	SEMARANG II	50.0	1978
28	SEMARANG III	200.0	1983
29	PERAK I	25.0	1964
30	PERAK II	25.0	1964
31	PERAK III	50.0	1978
32	PERAK IV	50.0	1978
33	GRESIK I	100.0	1981
34	GRESIK II	100.0	1981
35	GRESIK III	200.0	**1988**
36	GRESIK IV	200.0	**1989**

Note: Installed year in bold figure shows future program.

LIST 3 - 4

CHANGE OF THERMAL POWER GENERATING UNITS BY YEAR

INSTALLED YEAR	NOS. OF UNITS	ACCUMU LATED
1964	3	3
1965	0	3
1966	0	3
1967	0	3
1968	0	3
1969	0	3
1970	0	3
1971	2	5
1972	2	7
1973	0	7
1974	2	9
1975	0	9
1976	0	9
1977	0	9
1978	4	1.3
1979	3	16
1980	0	16
1981	3	19
1982	1	20
1983	1	21
1984	3	24
1985	1	25
1986	0	25
1987	0	25
1988	2	27
1989	4	31
1990	2	33
1991	3	36
1992	3	39
1993	3	42
1994	4	46

LIST 3 - 5

GAS TURBINE GENERATING UNITS

(AS OF END OF 1986)

SERIAL NO.	NAME OF POWER STATION	UNIT OUTPUT (MW)	INSTALLED YEAR
1	GLUGUR I	12.5	1968
2	GLUGUR I	19.8	1976
3	P. PASIR I	14.0	1976
4	P. PASIR II	14.0	1976
5	P. PASIR III	20.1	1977
6	P. PASIR IV	20.1	1977
7	P. PASIR V	20.1	1983
8	PADANG I	20.1	1983
9	PADANG II	20.1	1983
10	KERAMASAN I	12.5	1968
11	KERAMASAN II	11.7	1976
12	KERAMASAN III	12.5	1979
13	KERAMASAN IV	20.1	1984
14	BARITO	20.1	-
15	TELLO I	12.5	1977
16	TELLO II	20.1	1983
17	TELLO III	20.1	1984
18	TG. PRIOK I	26.0	1976
19	TG. PRIOK II	20.1	1974
20	TG. PRIOK III	26.0	1976
21	TG. PRIOK IV	48.0	1977
22	TG. PRIOK V	48.0	1977
23	TG. PRIOK VI	48.0	1977
24	TG. PRIOK VII	48.0	1977
25	P. GADUNG I	20.0	1974
26	P. GADUNG II	20.0	1974
27	P. GADUNG III	20.1	1973
28	P. GADUNG IV	20.0	1976
29	P. GADUNG V	26.0	1976
30	P. GADUNG VI	26.0	1976
31	SUNYARAGI I	20.1	1976
32	SUNYARAGI II	20.1	1976
33	SUNYARAGI III	20.1	1976
34	SUNYARAGI IV	20.1	1976
35	SEMARANG I	12.1	1967
36	SEMARANG II	19.8	1973
37	SEMARANG III	20.1	1977
38	SEMARANG IV	20.1	1983
39	PERAK	25.0	1975
40	GRESIK I	20.1	1977
41	GRESIK II	20.1	1977
42	GRESIK III	20.1	1984
43	PESANGGARAN	20.1	-

LIST 3 - 6

CHANGE OF GAS TURBINE GENERATING UNITS BY YEAR

INSTALLED YEAR	NOS. OF UNITS	ACCUMU LATED
1967	1	1
1968	2	3
1969	0	3
1970	0	3
1971	0	3
1972	0	3
1973	2	5
1974	3	8
1975	1	9
1976	13	22
1977	10	32
1978	0	32
1979	1	33
1980	0	33
1981	0	33
1982	0	33
1983	5	38
1984	3	41
1985	3	44
1986	3	47
1987	0	47
1988	0	47
1989	0	47
1990	0	47
1991	0	47
1992	0	47
1993	0	47
1994	0	47

LIST 3 - 7

TRANSMISSION LINE AND DISTRIBUTION LINE

(AS OF END OF 1986)

REGION/DIST	TL	DL
	KM-CIRCUIT	KM-CIRCUIT
REGION I	-	613.7
REGION II	390.3	3,241.6
REGION III	264.4	1,509.4
REGION IV	223.8	1,879.9
REGION V	-	570.6
REGION VI	112.7	1,314.6
REGION VII	-	1,136.6
REGION VIII	178.9	1,436.5
REGION IX	-	292.6
REGION X	-	310.9
REGION XI	-	2,065.6
OUTSIDE JAVA	**1,170.1**	**14,372.0**
DIST.JATIM	3,017.7	5,863.7
DIST.JATENG		5,610.9
DIST.JABAR	-	4,567.5
DIST.JAYA/TGR	447.8	6,439.8
K.J.T	7,685.4	
K.J.B	7,915.6	
TOTAL IN JAVA	**19,066.5**	**22,481.9**
GRAND TOTAL	**20,236.6**	**36,853.9**
AVE. SPAN (M)	300.0	30.0
NOS. OF SUPPORTS (approx.)	**67,500**	**1,053,000**

LIST 3 - 8

DISTRIBUTION TRANSFORMERS

(AS OF END OF 1986)

REGION/DIST	25 KV	15 KV	12 KV	11 KV	7-6 KV	3 KV	TOTAL	YEARS	5% OF TOTAL
REGION I	356	0	0	0	324	0	680		34
REGION II	2,324	0	23	465	769	0	3,581		179
REGION III	818	0	0	0	632	0	1,450		73
REGION IV	648	0	619	0	847	0	2,114		106
REGION V	481	0	0	0	155	0	636		32
REGION VI	1,289	0	0	7	857	0	2,153		108
REGION VII	501	187	0	0	538	0	1,226		61
REGION VIII	862	0	331	4	406	0	1,603		80
REGION IX	317	0	0	0	55	0	372		19
REGION X	28	0	0	0	278	0	306		15
REGION XI	1,156	0	0	0	679	0	1,835		92
OUTSIDE JAVA	8,780	187	973	476	5,540	0	15,956	1985	798
DIST. JAYA	4,574	0	0	0	16	0	4,590		230
DIST. JABAR	4,391	0	0	0	1,539	0	5,930		297
DIST. JATENG	1,249	15	0	0	1,181	0	2,445		122
DIST. JATIM	12,198	8	0	5	2,647	0	14,858		743
TOTAL IN JAVA	22,412	23	0	5	5,383	0	27,823		1,391
GRAND TOTAL	31,192	210	973	481	10,923	0	43,779		2,189
NOS IN 1985	31,192	210	973	481	10,923	0	43,779	1985	2,189
FORECASTED IN 1986	34,935	235	1,090	539	12,234	0	48,595	1986	2,430
FORECASTED IN 1987	39,127	263	1,221	603	13,702	0	53,940	1987	2,697
FORECASTED IN 1988	43,823	295	1,367	676	15,346	0	59,874	1988	2,994
FORECASTED IN 1989	49,081	330	1,531	757	17,188	0	66,460	1989	3,323
FORECASTED IN 1990	54,971	370	1,715	848	19,250	0	73,770	1990	3,689
FORECASTED IN 1991	61,567	415	1,921	949	21,560	0	81,885	1991	4,094
FORECASTED IN 1992	68,956	464	2,151	1,063	24,147	0	90,892	1992	4,545
FORECASTED IN 1993	77,230	520	2,409	1,191	27,045	0	100,890	1993	5,045
FORECASTED IN 1994	86,498	582	2,698	1,334	30,290	0	111,988	1994	5,599
FORECASTED IN 1995	96,878	652	3,022	1,494	33,925	0	124,307	1995	6,215
FORECASTED IN 1996	108,503	730	3,385	1,673	37,996	0	137,981	1995	6,899

NOTE: Annual increase ratio (11%) for power demand made by PLN has been applied for the above.

LIST 3 - 9

TRANSFORMERS AT POWER STATION & SUBSTATIONS

(AS OF END OF 1986)

REGION/DIST	25 KV TRANS.		30 KV TRANS.		70 KV TRANS.		150 KV TRANS.		275 KV TRANS.		500 KV TRANS.	
	P/S	S/S	P/S	S/S	P/S	S/S	P/S	S/S	P/S	S/S	P/S	S/S
	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.	NOS.
REGION I	-	-	-	-	-	-	-	-	-	-	-	-
REGION II	-	2	-	-	-	-	-	12	-	2	-	-
REGION III	3	2	-	-	-	-	4	7	-	-	-	-
REGION IV	-	-	-	7	-	9	-	6	-	-	-	-
REGION V	-	-	-	-	-	-	-	-	-	-	-	-
REGION VI	-	-	-	-	3	8	-	-	-	-	-	-
REGION VII	1	-	3	4	-	7	-	-	-	-	-	-
REGION VIII	2	-	-	10	-	3	-	5	-	-	-	-
REGION IX	-	-	-	-	-	-	-	-	-	-	-	-
REGION X	-	-	-	-	-	-	-	-	-	-	-	-
REGION XI	-	-	-	-	-	-	-	-	-	-	-	-
OUTSIDE JAVA	6	4	3	21	3	27	4	30	0	2	0	0
DIST.JATIM	-	-	-	-	-	-	-	-	-	-	-	-
DIST.JATENG	-	-	-	-	-	-	-	-	-	-	-	-
DIST.JABAR	-	-	-	-	-	-	-	-	-	-	-	-
DIST.JAYA/TGR	-	-	-	-	-	-	-	-	-	-	-	-
K.J.T	7	3	-	24	5	76	5	29	-	-	-	-
K.J.B	3	12	17	53	13	111	2	117	-	-	2	15
TOTAL IN JAVA	10	15	17	77	18	187	7	146	0	0	2	15
GRAND TOTAL	16	19	20	98	21	214	11	176	0	2	2	15
TOTAL OF P/S AND S/S		35		118		235		187		2		17

LIST 3 -10

CIRCUIT BREAKERS

(AS OF END OF 1986)

REGION/DIST	6 KV	7 KV	12 KV	15 KV	20KV	25 KV	30 KV	70 KV	150 KV	275 KV	500 KV
REGION I	-	-	-	-	-	-	-	-	-	-	-
REGION II	-	2	-	-	79	-	-	-	49	1	-
REGION III	10	-	-	-	37	-	-	-	17	-	-
REGION IV	5	-	43	-	12	-	10	40	13	-	-
REGION V	-	-	-	-	-	-	-	-	-	-	-
REGION VI	21	-	-	-	10	-	-	18	-	-	-
REGION VII	10	-	-	-	19	-	11	17	-	-	-
REGION VIII	-	5	14	-	27	-	21	24	7	-	-
REGION IX	-	-	-	-	-	-	-	-	-	-	-
REGION X	-	-	-	-	-	-	-	-	-	-	-
REGION XI	-	-	-	-	-	-	-	-	-	-	-
OUTSIDE JAVA	46	7	57	0	184	0	42	99	86	1	0
DIST.JATIM	-	-	-	-	-	-	-	-	-	-	-
DIST.JATENG	-	-	-	-	-	-	-	-	-	-	-
DIST.JABAR	-	-	-	-	-	-	-	-	-	-	-
DIST.JAYA/TGR	-	-	-	-	-	-	-	-	-	-	-
K.J.T	153	-	-	-	240	18	39	234	115	-	-
K.J.B	285	-	139	-	2,038	-	203	482	512	-	47
TOTAL IN JAVA	438	0	139	0	2,278	18	242	716	627	0	47
GRAND TOTAL	484	7	196	0	2,462	18	284	815	713	1	47

LIST 3 - 11

RECORD FOR DAMAGED DISTRIBUTION TRANSFORMERS

REGION/DIST	NOS OF TR. 1984/83	NOS. OF TR. DAMAGED	RATIO	ESTIMATED NOS. OF OUTAGE BY PLN				
				84/85	85/86	86/87	87/88	88/89
REGION I	-	-		29	33	38	42	47
REGION II	-	-		162	178	195	214	233
REGION III	-	-		47	53	60	69	80
REGION IV	-	-		30	37	44	52	61
REGION V	-	-		25	31	37	42	49
REGION VI	-	-		82	88	95	103	112
REGION VII	-	-		38	44	49	54	60
REGION VIII	-	-		53	59	68	78	88
REGION IX	-	-		10	12	14	16	18
REGION X	-	-		11	12	13	14	15
REGION XI	-	-		58	61	64	68	69
OUTSIDE JAVA	-	-		545	608	677	752	832
DIST. JAYA	4,587	223	4.86	185	197	210	224	242
DIST. JABAR	3,956	287	7.25	541	577	615	657	708
DIST. JATENG	11,591	500	4.31	429	458	488	521	562
DIST. JATIM	9,190	400	4.35	214	228	248	260	280
TOTAL IN JAVA	29,324	1,410	4.81	1,369	1,460	1,561	1,662	1,792
GRAND TOTAL	29,324	1,410	4.81	1,914	2,068	2,238	2,414	2,624

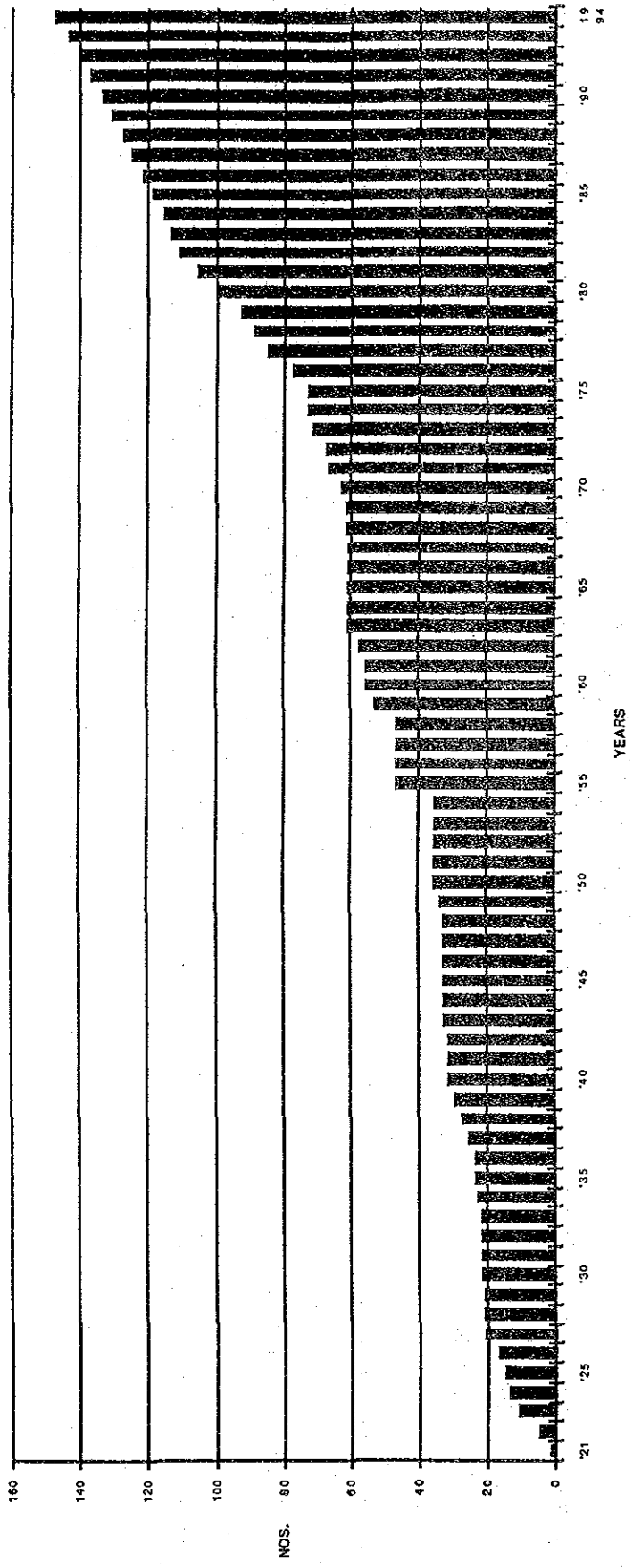
LIST 3 - 12

DEMAND FORECAST MADE BY PLN
FROM 1983/84 TO 1993/94

DESCRIPTION	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
POPULATION (10E6)	97	98	100	102	104	106	108	109	11	113	115
NOS. OF FAMILY (10E6)	19	20	20	20	21	21	22	22	22	23	23
ELECTRIFICATION (%)	14.5	16.4	18.9	21.3	23.8	26.4	29.0	31.8	34.5	37.2	49.9
NUMBER OF CONSUMER (10E3)	2,802	3,234	3,791	4,347	4,944	5,581	6,238	6,954	7,664	8,429	9,220
UNIT CONSUMPTION (kWH)	1,147	1,061	1,044	1,139	1,190	1,232	1,180	1,221	1,214	1,262	1,312
RESIDENTIAL CONSUMPTION (GWH)	3,212.0	3,432.4	3,958.2	4,950.0	5,884.6	6,877.3	7,363.9	8,493.4	9,327.4	10,636.0	12,092.9
COMMERCIAL CONSUMPTION (GWH)	1,714.0	1,881.0	2,969.1	2,276.0	2,503.7	2,754.0	3,084.5	3,454.6	3,869.2	4,333.5	4,853.5
INDUSTRIAL CONSUMPTION (GWH)	2,987.7	3,484.6	4,084.2	5,003.2	6,409.2	7,477.3	8,818.2	9,729.4	11,158.2	12,282.8	13,517.7
TOTAL CONSUMPTION (GWH)	7,914	8,798	10,112	12,229	14,797	17,109	19,267	21,677	24,355	27,253	30,464
ANNUAL DEMAND INCREASE (%)	-	11	15	21	21	16	13	13	12	12	12

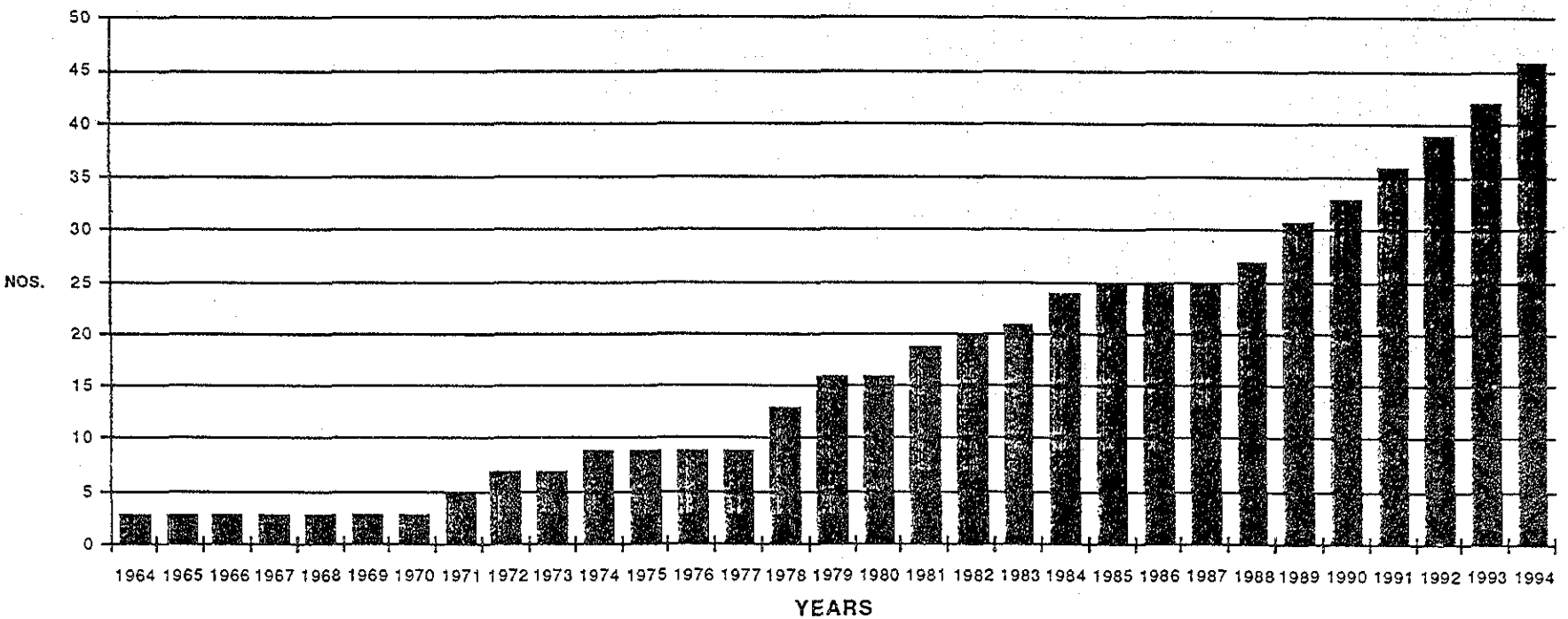
GRAPH 3 - A

CHANGE OF HYDROPOWER GENERATING UNITS BY YEAF



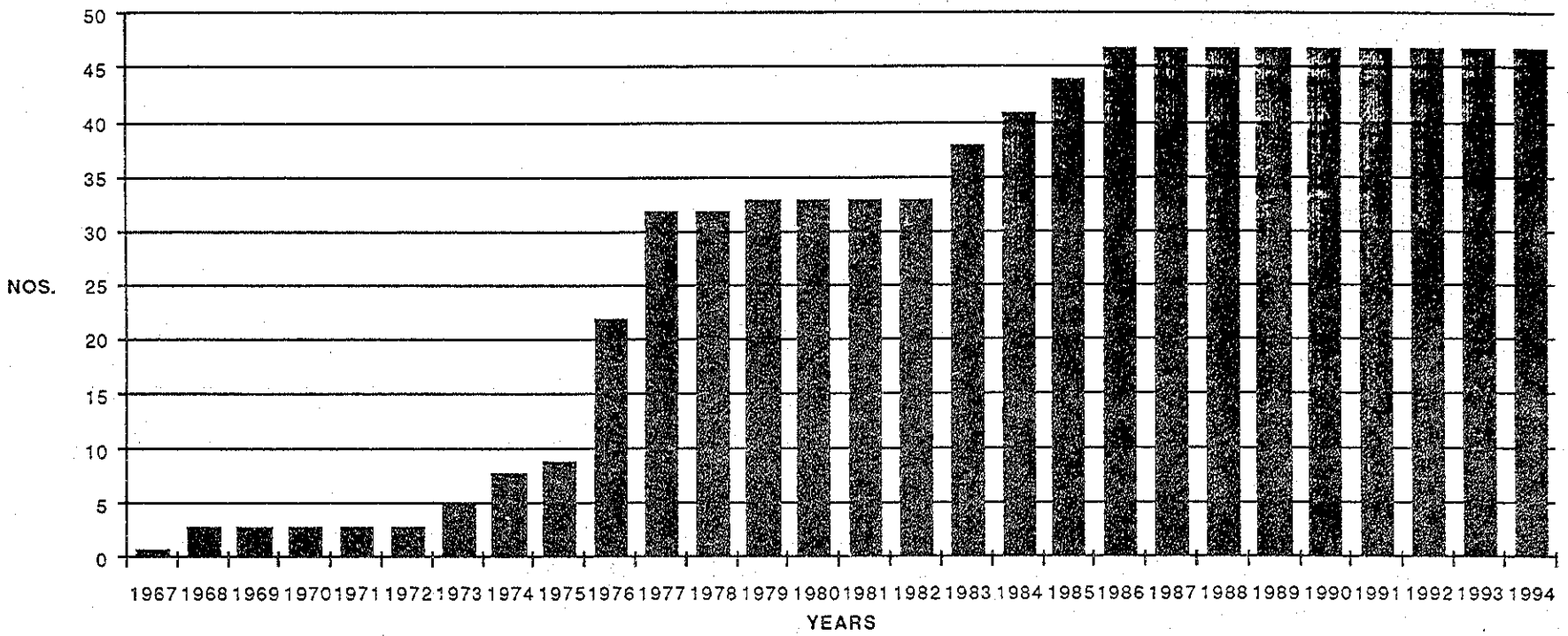
GRAPH 3 - B

CHANGE OF THERMAL GENERATING UNITS BY YEAR
(STEAM AND GEOTHERMAL PLANTS)



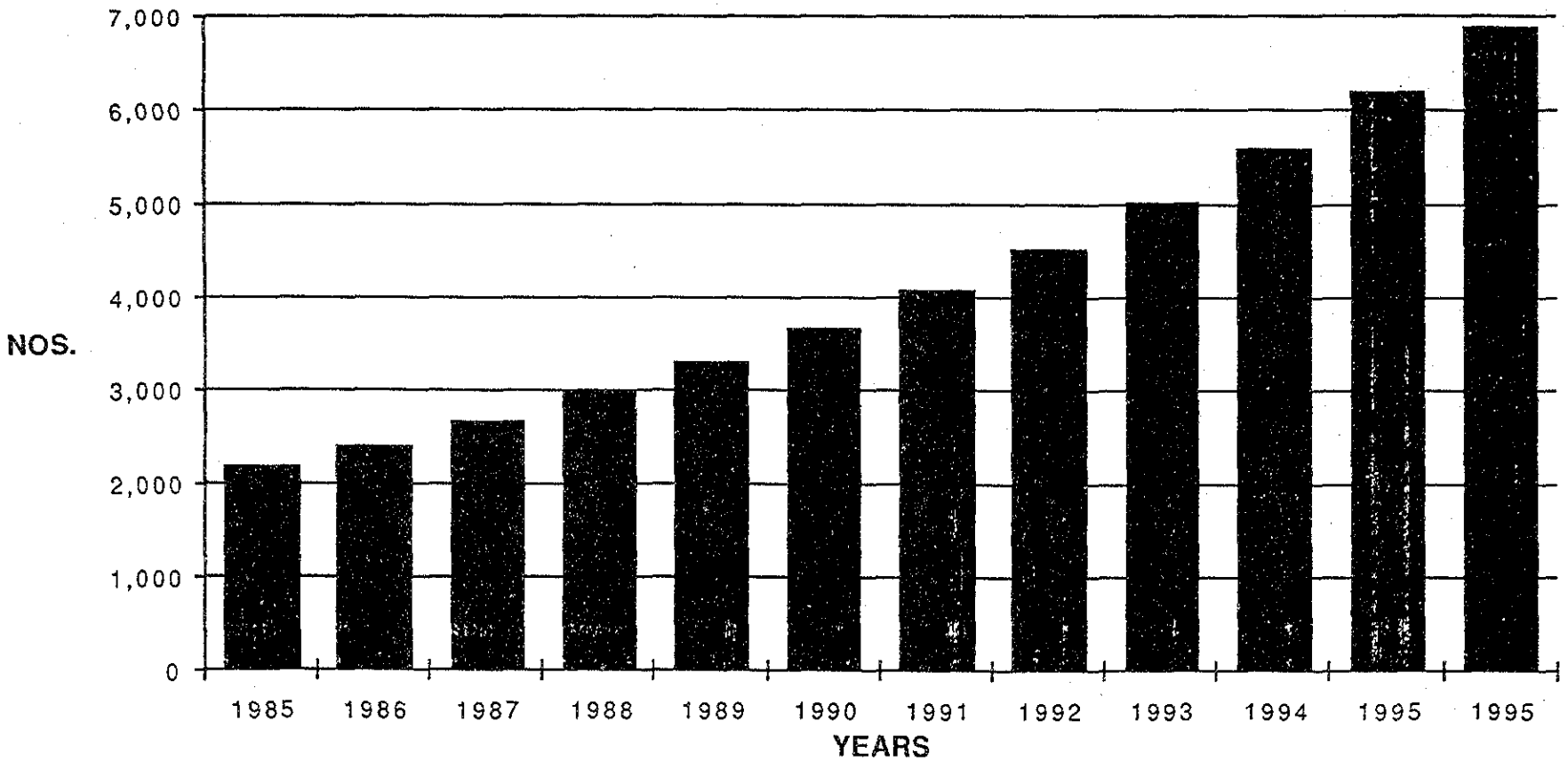
GRAPH 3 - C

CHANGE OF GAS TURBINE GENERATING UNITS BY YEAR



GRAPH 3 - D

CHANGE OF DISTRIBUTION TRANSFORMERS BY YEAR



CHAPTER - 4

MATERIAL PROCUREMENT

CHAPTER - 4

MATERIAL PROCUREMENT

4.1 General

Principal materials to be required for maintenance and repair of hydraulic turbines are various steel materials, and secondary stainless steel materials and non-ferrous materials such as copper, brass, white metal, etc. and these required materials are possible to procure in the Indonesian markets.

The following materials are generally used for maintenance and repair works for the hydraulic turbines.

4.2 Material to be used Generally

(1) Rolled Steel for General and Welded Structures

Steel plate	:	1 ~ 50 mm thick	:	900 x 1,800 mm size
- ditto -	:	- ditto -	:	1,200 x 1,200 mm size
Steel round bar	:	3 ~ 30 mm dia.	:	5,000 mm long

(2) Foregings

Round bar	:	50 ~ 300 mm dia.	:	7,000 mm long

(3) Special Steel Materials

Stainless steel plate	:	1 ~ 25 mm thick	:	900 x 1,800 mm size
Stainless steel round bar	:	10 ~ 50 mm dia.	:	5,000 mm long

(4) Non-Ferrous Materials

Copper plate	:	1 ~ 5 mm thick	:	500 x 1,000 size
Copper round bar	:	3 ~ 25 mm dia.	:	3,000 mm long
Brass plate	:	1 ~ 5 mm thick	:	500 x 1,000 mm size
Brass round bar	:	3 ~ 25 mm dia.	:	3,000 mm long
White metal				

(5) Every Kind of Welding Rods

(6) Electric Wiring Materials

CHAPTER - 5

PLAN AND RENOVATION

CHAPTRER - 5

RENOVATION PLAN

5.1 Outline of Renovation Plan

For the renovation of the Dayeuhkolot Workshop, the following four plans are studied from the technical and economical view points.

Plan-1 : The existing facilities and machine tools/equipment are used as many as possible. However the indispensable facilities and machine tools/equipment necessary for repair works of major components of water turbines are added to the existing ones.

Plan-2 : Based on the forecast of repair works demand, kind, type and quantity of facilities and machine tools/equipment are decided. And, the existing facilities and machine tools are used as many as possible. Almost all repair works are executed at the Dayeuhkolot Workshop except the special components which will be executed at outside repair shops.

Plan-3 : This is a complete plan to cover the whole works without placement of orders on outside repair shops.

Plan-D : Plan prepared by the Dayeuhkolot Workshop.

The construction costs of the relevant civil and building works are included in every plan similarly. But, the facilities for common use, such as office building, dinning room, etc. are excluded from the Construction Cost estimate.

Rewinding plan of the generator coils is shown in the ANNEX.

5.2 Renovation Plans of Workshop (Machine Shop)

5.2.1 Plan-1

Machine tools necessary for processing major large size components of water turbines to be provided in the machine shops and their application are as follows:

Name of Machine	General Application
· Lathe for shaft	: Turbine shafts, etc.
· Face lathe	: Runners, seat liners, light flat parts such as covers
· Turning vertical lathe	: Heavy flat parts, covers, runners and gate rings.
· Radial drilling machine	: Boring, spot facing and tapping
· Milling machine	: Guide vanes, etc.
· Shaper	: Large size guide vanes

In addition to the above, the following recommended machine tools are planned in the Workshop.

Name of Machine	General Application
· Horizontal boring machine	: Bend pipe, flange face and holes and horizontal machining
· Vertical boring machine	: Key seating and horizontal facing

In the existing machine tools in the Dayeuhkolot Workshop, only two lathes, one 4,000 mm lathe and one 2,000 mm face lathe are available for large size parts processing. Considering this status, the following machine tools are introduced to the machine shops.

Name of Machine		Q'ty (unit)
· Lathe for shaft	800 x 7,000 mm	1
· Turning vertical lathe	3,000 mm	1

· Heavy duty lathe	810 x 4,000 mm	1
· - ditto -	600 x 2,000 mm	3
· Radial drilling machine	1,300 mm	1
· Milling machine	1,600 mm	1
· Shaper	1,700 mm	1

Repair of components of thermal, gas-turbine and geo-thermal power plants and transmission lines can be done using the existing machine tools and equipment.

5.2.2 Plan-2

The Plan-2 is made based on the demand forecast, that is, most of the existing water turbines are Francis type, hours, turbine and overhaul of these turbines will be done in every 40,000 operation hours in accordance with the PLN's maintenance regulation. The.large size turbine components will be processed and repaired at the Dayeuhkolot Workshop during overhaul.

The Plan-2 is derived as follows:

(1) Hydropower Plants

(a) Type of turbines
(Data from PLN's Inventory-PLTA, 1986)

Type of Turbine	No.of Unit
· Francis type turbine	103
· Kaplan type turbine	10
· Pelton type turbine	3
· Turbular type turbine	5
· Crossflow type turbine	1
Total	122 units

The water turbines except Francis type turbine are excepted from this Plan with the following reasons.

- Other type turbines are few in quantity.
- High technique and special machine tools will be necessary for repairing the runner brade (Kaplan and Tubular type) and runner bucket (Pelton type).

(b) Lapse of time of existing Francis type turbines
(Data from PLN's Inventory-PLTA, 1986)

Lapse of time (Year)	Q'ty (Unit)	
5	11	
10	20	
15	8	Total 39 units
20	6	
25	6	
30	9	
35	11	
40	3	
45	1	
50	4	
55	7	
60	17	Total 64 units

Grand Total 103 units

As the water turbines which are used for more than 20 years will be of a high extent of deterioration, major turbine components are required to replace with new ones. In general, the limitation of number of repair times for major parts will be estimated at three (3) times, because the strength of base material will be weakened due to the weld heat and deformation, etc.

(2) Thermal, Gas-Turbine and Geo-Thermal Power Plants

On the other hand, the components to be repaired for the thermal, gas-turbine and geo-thermal power plants are limited to the auxiliary equipment such as air heaters, expansion joints, valves and motors. The major components to be repaired will be machined and repaired at the maker's factories.

The components and spare parts for repair works are estimated basing on the repair records of the Dayeuhkolot Workshop.

(3) Major Components to be Objected

(a) For the hydropower plants

Required major component to be used for repair works are estimated based on the following conditions.

- Dual runner turbine will not be provided in the existing power plants to give the same numbers of the runners as the numbers of the turbines.

- Each two sets of the seat liner and protection liner are provided in a turbine. Therefore, total quantity of line liner is 412 pieces. (103 units x 4 sets = 412 pieces)

All liners should be renewed at the time of overhaul, because those will be defaced.

- Numbers of guide vane are given according to the every turbine size.

Major components of 103 units of the existing turbines are summarized below:

Component	To be Renewed	To be Repaired
· Runner	64 units	39 units
· Turbine shaft	64 units	39 units
· Liner	412 pcs.	0
· Guide vane	922 pcs.	594 pcs

(b) For the thermal, gas-turbine, geo-thermal power plants and transmission line fittings.

(i) Air heater

- The air heaters for Priok and Muara Karang power plants are manufactured at Priok Workshop. Then, the objective power plants to be studied are as follows.

Name of Plant	Quantity of Generator
Suralaya	400 MW x 2 units
Semarang	50 MW x 2 units
- ditto -	200 MW x 1 unit

- Quantity of Air Heater Element

Name of Plant	Quantity of Element
Suralaya	912 x 2 = 1,824 pcs.
Semarang (50 MW)	288 x 2 = 576 pcs.
- ditto - (200 MW)	720 x 1 = 710 pcs.
Total	3,120 pcs.

- As standard frequency for replacement of elements is once per two years, the required quantity of the element per year is computed as follows.

  3,120 ÷ 2 = 1,560 pcs./year

  1,560 ÷ 260 = 6 pcs./day

- No.3 and No.4 units in the Suralaya thermal power plant are just under construction and the commencement of commercial operation thereof is scheduled from 1989 and 1990, respectively. Therefore, the required element for units will be added to the above estimated quantity of element.

  Consequently, total required quantity of air heater element to be manufactured becomes 2,500 pcs./year.

(ii) Repairing parts for thermal power plants

- Out of various components in the thermal power plant, only auxiliary equipment will be repaired at the Dayeuhkolot Workshop. As repairing method of the component for the thermal power plant except air heater will be similar to those of hydropower plant, the ratio of components to be repaired is decided from the repair records of the Dayeuhkolot Workshop by means of repair cost

comparison of the components for both hydropower plant and thermal power plant.

Description	Period and Cost (x Rp. 1,000) 1984/1985	1985/1986
· For hydropower plant	52,858	68,809
· For thermal power plant	9,847	13,613
· Ratio of repair cost for the thermal power plant	15.7%	16.5%
· Mean ratio		16.1%

- Most of thermal power plants are located in the Java island and the number of generator units of thermal power plants is as follows:

. Existing plant	21 units (including one unit of geo-thermal power plant)
. Under the construction	6 units (including two units of geo-thermal power plant)

The commencement of commercial operation of the generating units in under construction scheduled as follows:

· Year of commencement	1988	1989	1990
· Number of units	3	2	1

(iii) Fittings for transmission lines

According to the PLN's records, about 1,300 sets of the electrical fittings such as clamps, joints, etc. have been manufactured for maintenance and repair of transmission lines and the mean rate of increase is 15 percent per year.

5.2.3 Plan-3

The Plan-3 is a revised plan to improve the processing capability by introducing several new machine tools with higher processing ability in order to relieve the incapable processes in the machine tools in the Plan-2.

(1) Machine Tools to be Newly Introduced

(a) Since the appropriate number of face lathe is two (2) units, the existing two (2) units are applied in the Plan-2. However, as the processing limits in outside diameter and weight are 2,000 mm and 1.2-ton, respectively, and the estimated processing-hour of the runners and liners to be processed at the outside factory due to oversize and/or overweight is 4,000 hours.

Assuming the maximum runner weight be 20-ton, the following lathe is newly introduced :

Vertical lathe (gantry type) : 3,000 mm ø, 20 ton 1 unit

(2) Machine Tools to be Replaced with New Ones

(a) Although the year of manufacture of the existing upright drilling machines has not been confirmed, the deterioration of accuracy is considered. Since the estimated total processing-hour of the machine is about 12,000 hours and the deterioration of accuracy and quality of the existing machines are doubtful, the existing machines are replaced with the following new ones:

Upright drilling machine : 500 mm 2 units

(b) The runners, guide vanes and automatic control device components are presently made by steel plates in lieu of castings at the Dayeuhkolot Workshop. Since the appropriate number of bending machine is one (1) unit, the existing one (1) unit is applied in the Plan-2. However, the existing one is applicable only to thin plates of not more than 3 mm. Therefore, the existing bending machine has to be replaced with the following one:

Bending machine : 5 ~ 6t x 2,000 mm 1 unit

5.3 Decision of Quantity and Kind of Machine Tools

5.3.1 Basic Quantity of Machine Tools

Basic quantity and kind of the machines required for the machine shop are estimated and decided basing on the minimum requirement of machine tools estimated in the following conditions.

(1) Effective Operating Days of Machine

Number of working days for machines operators and workers to be employed in the works is taken at to 300 days per year in consideration of the sun-days, national holidays and the work-hour being 7 hours per day.

The effective operating day of the machines tools and equipment is estimated in consideration of 15% of loss time including processing losses, maintenance and repair period of machines and equipment, etc. And the estimated result is 260 days per year (= 300 day/year x 1/1.15).

(2) Required Processing Hour

The required processing hour and working hour of major components in existing power plants are estimated basing on the attached Table 5-1 showing "Standard Processing Hour for Major Components" and Table 5-3, showing "Dimension of Major Components".

(3) Periodical Maintenance and Repair

Overhaul of water turbines will be done in every 40,000 operation hours (equivalent to 6 years) in accordance with the PLN's maintenance regulation.

(4) Estimating Method

The basic quantity and kind of machine tools required are estimated by the following process.

(a) Classified table of existing major components

Dimensions of major components, such as runner, cover, liner, guide vane, turbine shaft of each power plant are obtained as tabulated in Table 5-2.

(b) Mean processing hour

Mean processing hour of each component is estimated basing on the required processing hour, working hour, etc., and the result of estimation is summarized in Table 5-4.

(c) Basic quantity of each kind of machine tools

From the mean processing hour of component and number of component to be newly produced and/or repaired, total processing hour of each machine tool can be derived. Then, basic quantity of each machine tool is estimated by the total yearly machine operating hour (7 hours/day x 260 days) and maintenance period of 6 years.

The estimated result is summarized in Table 5-5.

5.3.2 Estimated Basic Quantity and Kind of Machine Tools

(1) For Hydropower Plant

(a) Machine tools necessary for processing large size components

Name of Machine	Application	Year	Q'ty(unit)
· Lathe for shaft	Shaft, spindle	6.5	1
· Face lathe, vertical lathe	Liner, runner	11.9	2
· Horizontal boring machine	Runner, shaft	2.2	1
· Vertical boring machine	- ditto -	2.2	1
· Radial drilling machine	Runner, liner, shaft	7.9	2
· Heavy duty lathe	Runner, guide vane	26.9	4
· Milling machine	Liner, guide vane	10.5	2
· Shaper	Guide vane	10.5	2
· Press	Runner, guide vane	7.5	2
· Welding machine	Runner, liner guide vane	53.0	8

Note: Total processing hour (year) shown in the above table is estimated by using each machine load.

(b) Machine tools for small size components

Name of Machine	Application	Year	Q'ty(unit)
· Lathe	Element of runner, cover guide vane, general parts	99.8	15
· Milling machin	- ditto -	12.8	2
· Shaper	- ditto -	13.0	2
· Upright drilling machine	- ditto -	6.8	1
· Screw cutting lathe	- ditto -	7.1	1
· Key seater	- ditto -	3.5	1
· Bending roller	Parts for vehicle, auxiliary equipment, piping	1.7	1
. Shearing machine	- ditto -	2.8	1
· Bending machine	Runner, guide vane, cover metalwork	5.8	1
· Hack sawing machine	Vehicle's parts, general parts	10.9	2
· Welding machine	Overall parts	69.0	10

(2) For Thermal, Gas-Turbine, Geo-Thermal Power Plants and Transmission Line Fittings

Each one unit of the bending roller, shearing machine, electric welding machine will be required for the manufacturing 2,500 nos. of air heaters.

Other required machines are planned on the consideration of the working ratio, the rate of increase, etc. Moreover, one unit of shaper is planned for manufacture of the fittings for transmission lines.

Name of Machine	Existing	Calculated	Requirement
Lathe	19	3.8	4 units
Milling machine	4	0.8	1
Shaper	5	1.0	1
Drilling machine	3	0.6	1
Welding machine	15	3.0	3

Total of required machines is as given below:

Name of Machine	Q'ty(unit)
Lathe	4
Milling machine	1
Shaper	2
Drilling machine	1
Welding machine	4
Bending roller machine	1
Shearing machine	1

5.3.3 Estimated Machine Tools/Equipment and Prices

(1) Plan-1

The machine tools/equipment to be newly introduced and their prices are as follows:

Code	Name of Machine	Q'ty(unit)	Price(x ¥ 1,000)
B1	Lathe for shaft (810 x 7,000 mm)	1	19,800
B19	Vertical lathe (3,000 mm dia.)	1	173,000
B4	Heavy duty lathe (810 x 4,000 mm)	1	16,700
B9	- ditto - (600 x 2,000 mm)	3	24,600
BR4	Radial drilling machine (3,000 mm)	1	23,000
F1	Milling machine (1,600 mm)	1	11,300
S3	Shaper with copying attachment (700 mm stroke)	1	6,300
T3	Gantry crane (10 ton)	1	15,000
	Total of supplement	10 units	¥289,700
	Total of existing	48 units	-

(2) Plan-2

The machine tools/equipment to be newly introduced and their prices are as follows:

(a) Machines for large size components

Code	Name of Machine	Q'ty(unit)	Price(x ¥ 1,000)
B17	Horizontal boring/milling machine (1,830 mm)	1	33,000
B18	Vertical boring/milling machine (2,800 mm)	1	50,900
B1	Lathe for shaft (810 x 7,000 mm)	1	19,800
B9	Heavy duty lathe (600 x 2,000 mm)	2	16,400
B5	- ditto - (600 x 3,000 mm)	1	9,300
BR5	Radial drilling machine (3,000 mm)	2	46,000
F1	Milling machine (1,600 mm)	1	11,300
S3	Shaper with copying attachment (700mm stroke)	1	6,300
PM1	Press (10 ~ 30 ton)	1	4,200
L	Welding machine	3	2,300
GR3	Universal tool and cutter grinder	1	5,100
GR5	Pedestal grinder with dust collector	2	800
	Total of supplement	17 units	¥205,400
	Total of existing	4 units	-

(b) Machine tools for small size components

Code	Name of Machine	Q'ty(unit)	Price(x ¥ 1,000)
B9	Lathe (600 x 2,000 mm)	1	8,200
B10	Lathe (510 x 1,500 mm)	2	11,200
B12	Lathe (510 x 1,000 mm)	1	5,400
B13	Numerically controlled lathe (460 x 800 mm)	1	18,000
B15	Screw cutting lathe	3	20,700
F3	Key seater (450 mm)	1	8,300
RP3	Bending roller machine (5 ~ 6 mm t)	1	5,000
G3	Shearing machine (1 ~ 3 mm t)	1	2,000
GG5	Hack sawing machine	2	1,600
BR3	Radial drilling machine	3	600
GR4	Tool and cutter grinder	1	800
GR5	Pedestal grinder with dust collector	2	800
GR1	Bench grinder (10")	7	5,600
GR6	Air grinder	6	300
GR7	Electric handy grinder	10	500
P1	Punching machine (1 ~ 2 mm t)	1	3,000
GR2	Cutting grinder (10")	2	400
	Total of supplement	45 units	¥92,400
	Total of existing	36 units	-

(c) Machine tools for thermal power plant, etc.

Code	Mane of machine	Q'ty(unit)	Price(x ¥1,000)
B12	Lathe (510 x 1,000 mm)	4	21,600
S2	Shaper (500 x 850 mm)	2	4,000
F1	Milling machine (1,600 mm)	1	11,300
RP3	Bending roller (5 ~ 6 t x 1,200 mm)	1	5,000
G3	Shearing machine (3 t x 1,200 mm)	1	2,000
BR2	Upright drilling machine (300 x 650 mm)	1	1,300
L1	Arc welding machine (250 A)	4	1,600
	Total of supplement	14 units	¥46,800
	Total of existing	2 units	-

(d) Testing apparatus and others

Code	Name of Apparatus	Q'ty(unit)	Price(x ¥ 1,000)
C1	Air compressor (12 kgf/cm^2)	3	4,500
C2	- ditto - (7 kgf/cm^2)	3	3,300
MG1	Magnetic particle testing machine (AC 200V, DC 2,000A)	1	1,500
MG2	Ultrasonic testing machine (100 ds 1 - 5 MHz)	1	2,500
KM1	Surface plate for stage direction (1,200 x 2,400 mm)	1	1,800
KM2	Assembling table (3,000 x 3,000mm)	1	5,000
A	Annealing furnace (3,000 x 3,000mm) (Heavy oil, Automatic control)	1 set	50,000
MT	Measuring apparatus	2 sets	8,000
	Total of supplement	13 units	¥76,600
	Total of existing	7 units	-

(e) Transportation/handling equipment

Code	Name of Equipment	Q'ty(unit)	Price(x ¥ 1,000)
T3	10 Ton Gantry crane	3	45,000
T2	5 Ton Gantry crane	2	14,000
M19	Dolly with rail (300 m)	1	3,500
M1	Ordinary truck (5 ton)	2	10,000
M2	- ditto - (10 ton)	1	12,000
M5	Jeep	2	5,000
M6	Pick-up	1	2,000
M7	Mini-bus	1	3,000
M8	Sedan	1	3,000
M11	Forklift (3 ton)	1	3,000
M12	- ditto - (5 ton)	1	7,000
	Total of supplement	16 units	¥107,500
	Total of existing	1 unit	-

(f) Total price

Description	Price (x ¥ 1,000)
Machine tools for large size components	205,400
Machine tools for small size components	92,400
Machine tools to be used for thermal power plant	46,800
Testing apparatus and others	76,600
Transportation/handling equipment	107,500
Total	¥528,700

(3) Plan-3

The estimated prices of the machine tools to be newly introduced for supplement to those in the Plan-2 are as follows:

Code	Name of Machine	Q'ty(unit)	Price(x ¥ 1,000)
B19	Vertical lathe (Gantry type) (3,000 mm$^{\phi}$ ~ 20 ton)	1	173,000
BR1	Upright drilling machines (550 mm) (Replace with existing ones)	2	4,000
LP1	Bending machine (5 ~ 6 t x 2,500 mm) (Replace with existing one)	1	5,900
	Total	4 units	¥182,900

(4) Plan-D

The estimated prices of machine tools/equipment to be newly introduced are as follows:

Code	Name of Machine/Equipment	Q'ty(unit)	Price(x ¥ 1,000)
B1 ~ 16	Lathe (heavy 35/light 20)	62	776,900
S1,2	Sheaper (heavy 3/light 9)	12	25,500
F1,2	Milling machine (heavy 7/light 4)	11	62,200
L1 ~ 9	Welding machine	23	21,800
RP1,2	Roller (heavy)	2	17,000
G1,2	Shearing machine (heavy)	2	9,500
P	Punching machine	1	3,000
GG1 ~ 4	Sawing machine (each type)	5	13,500
BR1,2	Drilling machine (heavy 7/light 2)	9	16,600
PM1,2	Press (heavy) (100 ton)	1	20,000
GR1	Bench grinder	35	16,750
GR2	Cutting grinder	6	1,200
LP1,2	Bending machine (15 t x 2,500 mm)	1	8,500

C1,2	Air compressor	6	7,800
CR	Crucible furnace	1	5,000
ST,MB,SST	Testing/measuring apparatus	5	46,000
LK1 ~ 3	Coil-winding machine	3	15,000
	Total	185 units	¥1,069,000

The estimated total price of the whole supplemental machine tools/equipment including transportation/handling equipments is as follows:

Description	Q'ty(unit)	Price(x ¥.1,000)
Machine tools for large size components		628,000
Machine tools for small size components		367,450
Other equipments		73,800
Subtotal	185 units	¥1,069,250
Transportation/handling equipment		
Cranes	9	121,000
Vehicles	23	409,000
Total	217 units	¥1,599,250

(5) Total Price Comparison of the Respective Plans

	Plan-1	Plan-2	Plan-3	Plan-D
Number of new machines/ (existing machines)	10/(48)	105/(50)	109/(47)	217/(48)
• Machine tools for large size components	289,700	205,400	378,400	582,100
• Machine tools for small size components	-	92,400	102,300	413,350

· Machine tools for thermal power/ other plants	-	46,800	46,800	-
· Other equipment	-	76,600	76,600	73,800
Sub-total	(289,700)	(421,200)	(604,100)	(1,069,250)
· Transportation/ handling equipment	-	107,500	107,500	530,000
Grand total (x ¥ 1,000)	¥289,700	¥528,700	¥711,600	¥1,599,250

5.3.4 Processing-Hour of Outside Order Portion

The process, machine tools to be applied and processing-hour in the standard manufacture of water turbine components are almost established for a line system. But, if a machine tool to be applied for the process of a component or portion is not available or a machine tool ability is inappropriate to the process, the entire process of component or portion has to be completed with ordered process to outside workshops.

Estimating the processing-hour of the component(s) or portion(s) to be ordered to the outside workshops in the process of major components of water turbines components, the processing conditions of major machine tools are compared with each Plan.

(1) Plan-D

(a) Turbine shafts

Process : lathe for shaft -> horizontal boring and milling machine -> vertical boring and milling machine -> radial drilling machine

i) New production : 64 sets

- Total processing-hour : 12,200 H (estimated)

- Processing-hour of outside order portion : 2,360 H (19%)
  - Horizontal boring/milling machine : 960 H
  - Vertical boring/milling machine : 1,280 H
  - Radial drilling machine : 120 H

ii) Repair : 39 sets

- Total processing-hour : 2,700 H (estimated)
- Processing-hour of outside order portion : 650 H (24%)
  - Horizontal boring/milling machine : 230 H
  - Vertical boring/milling machine : 390 H
  - Radial drilling machine : 30 H

Notes:

- The process of shafts having a length of not more than 10 m is capable, but, since the horizontal and vertical boring/milling machines, and radial drilling machines are not provided, the processes of coupling holes and key seats are incapable.
- Out of total 8 units of lathe for shaft, 2 units are assumed to be in actual operation.
- Total processing-hour of outside order portion: 3,010 H (20%)

(b) Runners

Process : face lathe -> horizontal boring and milling machine -> vertical boring and milling machine -> radial drilling machine

i) New production : 64 sets

- Total processing-hour : 12,350 H (estimated)
- Processing-hour of outside order portion : 3,250 H (26%)
  - Horizontal boring/milling machine : 1,850 H
  - Vertical boring/milling machine : 1,280 H
  - Radial drilling machine : 120 H

ii) Repair : 39 sets

- Total processing-hour : 6,000 H (estimated)
- Processing-hour of outside order portion : 1,240 H (20%)
  - Horizontal boring/milling machine : 850 H
  - Vertical boring/milling machine : 390 H

Number of runners having a weight of more than the face lathe weight limit of 2 ton : 8 sets

- Total processing hour by face lathe : 8,400 H
- Processing-hour by face lathe at the outside factory : 650 H (8%)

Notes:

- Since the horizontal and vertical boring/milling machines, and radial drilling machines are not provided, the processes of reamer bolt holes and key seats are incapable.

- 8 sets of runners cannot be processed due to weight limit of the face lathe (2.0 ton).

- Total processing-hour of outside order portion : 5,140 H (28%)

(c) Liners

Process : face lathe -> radial drilling machine -> milling machine

i) New production : 412 sets

- Total processing-hour : 30,900 H (estimated)

- Processing-hour of outside order portion : 11,500 H (37%)

  · Radial drilling machine : 11,500 H

Number of liners having a outside diameter of more than the face lathe dimensional limit of 3 mØ : 24 sets

- Total processing-hour by face lathe : 12,300 H

- Processing-hour by face lathe at the outside factory : 620 H (5%)

Notes:

- Since the radial drilling machines are not provided, the processes of drilled holes and screwed holes are incapable.

- 24 sets of liners cannot be processed due to dimensional limit of face lathe (3.0 mØ)

- Total processing-hour of outside order portion : 12,120 H (39%)

(d) Guide vanes

Process: lathe -> milling machine -> shaper

- Total processing-hour : 57,700 H (estimated)
- Processing-hour of outside order portion : Nil

(e) Accessories (inlet valves, pressure regulators, bend pipes, large bore valves, etc.)

Process : face lathe -> lathe -> horizontal boring and milling machine -> vertical boring and milling machine -> milling machine -> shaper -> radial drilling machine

i) New production : 64 sets

Repair : 39 sets

- Total processing-hour : 22,200 H (estimated)
- Processing-hour of outside order portion : 3,600 H (16%)
  - Horizontal boring/milling machine : 230 H
  - Vertical boring/milling machine : 750 H
  - Radial drilling machine : 2,620 H

Note:

- Since the special machine tools such as horizontal boring/milling machines, vertical boring/milling machines and radial drilling machines are not provided, the required processes by the same are incapable.

The total processing-hour of the portions to be ordered to the outside workshop in Plan-D is as follows:

Turbine shafts	3,010 H (20%)
Runners	5,140 H (28%)
Liners	12,120 H (39%)
Accessories	3,600 H (16%)
Total	23,870 H

The above total processing-hour of the outside order portion is 6% of the total processing-hour of the whole machine tool (405,000 H) to be applied and is 17% of the processing-hour of machine tools for large size components (144,000 H). Notwithstanding the drastic increase of the machine tools, the entire process is still affected by the processing ability of selected machine tools.

(2) Plan-1

The number of major components, processes, and total processing-hour are the same as those in the Plan-D. Only the processing-hour of the outside order portion is estimated.

(a) Turbine shafts

- Total processing-hour : 14,900 H (estimated)
- Processing-hour of outside order portion : 2,860 H (19%)
  - Horizontal boring/milling machine : New production : 960 H; Repair : 230 H
  - Vertical boring/milling machine : New production : 1,280 H; Repair : 390 H

Note:

- The process limit of shafts is improved from 4 m to 7 m in length by introducing the new lathe for shaft with larger capacity (810 x 7,000 mm). However, since the horizontal and vertical boring/milling machines are not provided, the processes by the same are ordered to the outside workshop.

(b) Runners

- Total processing-hour : 18,350 H (estimated)

- Processing-hour : 4,370 H (24%)
  of outside order portion

- Horizontal boring/ milling machine	: New production:	: 1,850 H
	: Repair	: 850 H
- Vertical boring/: milling machine	: New production:	: 1,280.H
	: Repair	: 390.H

Note:

- The process limits of runners are improved to 3,000 mm in outside diameter and 20 ton in weight by introducing the vertical lathe (gantry type), but the processes by horizontal and vertical boring/drilling machines are ordered to the outside workshop.

(c) Liners

- Total processing-hour : 30,900 H (estimated)

- Processing-hour : 5,700 H (18%)
  of outside order portion

- Radial drilling machine	: 5,700 H (by 1 unit)

Note:

- The supplemental radial drilling machine is only one unit and one more unit is necessary for the whole process of liners. Thus, the processing-hour of the outside order portion by 1 unit of the machine is estimated.

- The process limits of liners are improved to 3,000 mm in outside diameter and 20-ton in weight by introducing the vertical lathe (gantry type).

(d) Guide vanes

- Total processing-hour : 57,500 H (estimated)
- Processing-hour of outside order portion : Nil

Note:

- The process efficiency for large size vanes is anticipated to be higher (3,000 H up) than that in the Plan-D applying one unit of new shaper with copying attachment.

(e) Accessories

- Total processing-hour : 22,200 H (estimated)
- Processing-hour of outside order portion : 2,280 H (10%)
  - Horizontal boring/ milling machine : 230 H
  - Horizontal boring/ milling machine : 750 H
  - Radial drilling machine : 1,300 H

The total processing-hour of the portions to be ordered to the outside workshop in the Plan-1 is as follows:

Turbine shafts	2,860 H	19%
Runners	4,370 H	24%
Liners	5,700 H	18%
Accessories	2,280 H	10%
Total	15,210 H	

The above total processing-hour at the outside workshop is 4% of the total processing-hour of the whole machine tool (405,000 H) and is 10% of the processing-hour of machine tools for large size components (144,000 H). Compared with the Plan-D, the total processing-hour at the outside workshop can considerably be reduced.

(3) Plan-2

The Plan-2 is a plan to apply the existing machine tools as many as possible, but to introduce the machine tools which are short and/or indispensable considering the appropriate number of machine tools based on the forecasted repair work demand. Therefore, the existing machine tools are investigated on the processing ability such as dimensional and weight limits, and the processing-hour of the portions to be ordered to the outside factory is estimated under the same conditions as those in the Plan-D and the Plan-1.

(a) Runners/liners

- Total processing-hour by face lathe	Runners :	8,400 H (estimated)
	Liners :	12,000 H (estimated)
- Processing-hour of outside order portion	Runners :	2,400 H (28%)
	Liners :	1,600 H (14%)
	Total :	4,000 H (20%)

Notes:

- The number and processing-hour of the runners and liners which are ordered to the outside factories due to dimensional limit of face lathe (2.0 m^{ϕ} in max. outside diameter) are as follows:

Runners	15 sets	(14%)	1,200 H
Liners	15 sets	(14%)	1,600 H

- The number and processing-hour of the runners which are ordered to the outside factory due to weight limit of face lathe (1.2 ton in max. weight) are as follows:

Runners	15 sets	(14%)	1,200H

The total processing-hour of the portions to be ordered to the outside workshops in the Plan-2 is as follows:

Runners	2,400 H	28%
Liners	1,600 H	14%
Total	4,000 H	

The total processing-hour at the outside workshop given above is 1% of the total processing-hour of the whole machine tool (405,000 H) and is 3% of the processing-hour of machine tools for large size components (144,000 H).

(4) Plan-3

The Plan-3 is a revised plan to cover the whole process at the outside workshops in Plan-2 introducing each one (1) unit of lathe for shaft (810 x 7,000 mm) and vertical lathe (gantry type, 3,000 mmØ). Therefore, there is no component or portion to be ordered to the outside workshops in the Plan-3.

(5) Comparison Table of the Respective Plans on Processing-Hour of Outside Order Portion:

	Plan-D	Plan-1	Plan-2	Plan-3
- Turbine shafts	3,010 (20%)	2,860 (19%)	0	0
- Runners	5,140 (28%)	4,370 (24%)	2,400 (28%)	0
- Liners	12,120 (39%)	5,700 (18%)	1,600 (14%)	0
- Guide vanes	0	3,000 H higher than the process efficiency in Plan-D	Same as Plan-1	Same as Plan-1
- Accessories	3,600 (16%)	2,280 (10%)	0	0
Total	23,870 H	15,210 H	4,000 H	0

(6) Comparison Table of the Respective Plans on Major Machine Tools

Name of machine	Plan-D	Plan-1	Plan-2	Plan-3
- Lathe for shaft	10m limit in length	7m limit in length	7m limit in length	7m limit in length
- Face lathe	2.0 ton limit in weight	20 ton limit in weight	1.2 ton limit in weight	20 ton limit in weight
- Horizontal boring/ milling machine	Not provided	Not provided	Provided	Provided

- Vertical boring/ milling machine	Not provided	Not provided	Provided	Provided
- Radial drilling machine	Not provided	1 set short	Provided	Provided
- Processing-hour of outside order portion	23,870 H	15,210 H	4,000 H	0
- Ratio to total processing-hour of machine tools for large size components (144,000H)	17%	10%	3%	0
- Ratio to total processing-hour of whole machine tool (405,000H)	6%	4%	1%	0

(7) Relation to Outside Workshop

In each plan, there are some limits on the avaibable type kind of machine tool and the size as shown in the said item (6). The incapable process portions due to such limits are ordered to the outside workshops (State-operated factory: BARATA, etc., Private factory: CHOW GROUP, P.T NUSCACAO PERK PERKUSA, etc.) and are completed taking a close contact with the workshops.

Further, the unexpected repair work demand which may occur due to an accident, etc. is to be absorbed as much as possible at the Dayeuhkolot Workshop. but, if the same cannot be absorbed due to busy and full operation situation, the whole or partial process is ordered to the outside workshops.