No.

Ministry of Energy and Mineral Resources
The Republic of Indonesia

THE STUDY ON THE IMPROVEMENT MEASURES FOR ELECTRIC POWER GENERATION FACILITIES IN JAVA-BALI REGION IN THE REPUBLIC OF INDONESIA

FINAL REPORT
< SUMMARY >

November 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

NEWJEC INC.
THE KANSAI ELECTRIC POWER CO., INC.

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PREFACE

In response to a request from the Government of Republic of Indonesia, the Government of Japan decided to conduct the Study on the Improvement Measures for Electric Power Generation Facilities in Java-Bali Region in the Republic of Indonesia, and the study was implemented by the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Yasuharu Matsuda of the NEWJEC Inc., and consist of NEWJEC Inc. and KANSAI Electric Power Co., Inc. to Indonesia five times from November 2005 to October 2006.

The study team held discussions with the officials concerned of the Government of Indonesia and PT. PLN (Persero), and conducted related field surveys. After returning to Japan, the study team compiled the final results in this report.

I hope this report will contribute to improvement of electric power generation facilities and to enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Indonesia for their close cooperation throughout the study.

November 2006

Tadashi IZAWA
Vice President
Japan International Cooperation Agency

November, 2006

LETTER OF TRANSMITTAL

Mr. Tadashi Izawa
Vice President
Japan International Cooperation Agency
Tokyo, Japan

We are pleased to submit to you the report on the Study on the Improvement Measures for Electric Power Generation facilities in Java-Bali Region in the Republic of Indonesia.

This study was conducted by NEWJEC Inc., in association with KANSAI Electric Power Company Co., Inc. under a contract to JICA, in a period from October 2005 to November 2006. During the course of the study, the study team visited objective sixteen power stations and developed improvement measures for electric power generation facilities including operation and maintenance to meet a short/medium-term power demand in the relevant region.

Concerning power generation facilities, repowering plans in combination with shutdown of the existing less efficient power stations were proposed, in consideration of a current expensive fuel oil. For operation and maintenance aspects, effective measures to prevent the current frequent forced outages were proposed, based on the analysis of causes of forced outages and the current situation. Furthermore, technology transfer relating to Remaining Life Assessment aiming for effective and appropriate operation and maintenance was conducted.

We dearly wish that our proposed measures will contribute to the improvement of reliability of power supply and to the alleviation of the current tight balance of power supply-demand in Java-Bali region.

We would like to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry. We are also most grateful for the cooperation and assistance from the officials and personnel concerned in Indonesia, the Ministry of Energy and Mineral Resources, PT PLN (Persero), Indonesia Power, PJB and each power station.

Very truly yours,

Y. Matsuda

Yasuharu Matsuda
Team Leader,
The Study on the Improvement Measures
for Electric Power Generation Facilities
in Java-Bali Region
in the Republic of Indonesia

Abbreviation Table

Abbreviation	Full Description in English (Indonesian)
ADB	Asian Development Bank
AH	Air Heater
AI	Annual Inspection
ANDAL	Environmental Impact Analysis
AVR	Automatic Voltage Control System
BAPPENAS	National Development Planning Agency (Badan Perencanaan Pembanguanan Nasional)
BFP	Boiler Feed Water Pump
BLK	Block
BP	British Petroleum
BPMIGAS	Executive Agency for Upstream Oil and Gas Business Activity (Badan Pelaksana Kegiatan Usaha Hulu Minyak Dan Gas Bumi)
CB	Circuit Breaker
CBM	Condition Based Maintenance
CDF	Computer Fluid Dynamics
CWP	Circulating Water Pump or Cooling Water Pump
DSS	Daily Start and Stop
De-NOx	Denitration
De-SOx	Desulfurization
EIA/AMDAL	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
FOH	Forced Outage Hours
FOH (L)	Forced Outage Hours caused by power grid system
FOH(D)	Forced Outage Hours caused by power station
GI	General Inspection
GIB	Gas Insulated Busbar
GIS	Gas Insulated Switchgear
GOV	Governor
HHV	High Heat Value
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HSD	High Speed Diesel Oil
I & C	Instrumentation and Control
IP	Indonesia Power
IP	Intermediate Pressure
IPP	Independent Power Producer
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KA – ANDAL	Environmental Impact Analysis Term of Reference

Abbreviation	Full Description in English (Indonesian)
LFC	Load Frequency Control
LHV	Low Heat Value
LITBANG	PLN Research and Development Center for Electricity (PT PLN Penelitian dan Pengembangan Ketenagalistrikan)
LNG	Liquid Natural Gas
LP	Low Pressure
MELCO	Mitsubishi Electric Corporation
MEMR	Ministry of Energy and Mineral Resources
METI	Ministry of Economy, Trade and Industry
MFO	Marine Fuel Oil
MHI	Mitsubishi Heavy Industries
MO	Major Overhaul
MOH	Maintenance Outage Hours
NG	Natural Gas
P3B	Jawa Bali Transmission and Load Dispatching Center (Penyaluran Dan Pusat Pengatur Beban Jawa Bali)
PJB	PLN Java Bali Power Company (PT Pembangkitan Jawa-Bali)
PLN	Indonesia Electricity Corporation (Perusahaan Umum Listrik Negara PERSERO)
PLTA	Hydro Power Plant
PLTD	Diesel Power Plant
PLTG	Gas Turbine Power Plant
PLTGU	Combined Cycle Power Plant
PLTP	Geothermal Power Plant
PLTU	Steam Power Plant
POH	Planned Outage Hours
RH	Re-heater
RKL / UKL	Environmental Management Plan
RLA	Remaining Life Assessment
RPL / UPL	Environmental Monitoring Plan
RSH	Reserve Shutdown Hours
Rp.	Indonesian monetary unit (1 US$ = 9,000 Rp. in 2005)
SCADA	Sequential Control and data Acquisition System
SH	Super Heater
SH	Service Hours
TIT	Turbine Inlet Temperature
UBP	Generation Business Unit (Unit Busnis Pembangkitan)
WB	World Bank
WSS	Weekly Start and Stop
WW	Water Wall

Unit Table

Abbreviation	Unit
bbl	Barrel (1 bbl = 159 litter)
GWh	Gigawatt-hour
kW	Kilowatt
kWh	Kilowatt-hour (1 kWh = 860 kcal) (1 kcal = 3.968 BTU)
MMBTU	10^6 British Thermal Unit (MM = 10^6)
MMSCF	10^6 Standard Cubic Feet (MM = 10^6)
mmscfd	Million Standard Cubic Feet per Day
MSCF	10^3 Standard Cubic Feet (M = 10^3)
MVA	Mega-volt-ampere
MW	Megawatt
MWh	Megawatt-hour
VA	Volt-ampere

References

(1) "The Project Formation Study for the Improvement of Utilization of Electric Power Facilities in Java-Bali Region in the Republic of Indonesia", September 2003, JICA

(2) "The Preliminary Study for the Study on the Improvement Measures for Electric Power Generation Facilities in Java-Bali Region", June 29, 2005, JICA

(3) "Basic Strategy of Japan's ODA Loan (The Medium-Term Strategy for Overseas Economic Cooperation)", April 2005, Japan Bank for International Cooperation

(4) "Ex-post Evaluation Report on ODA Loan Project 1999 (Gas Firing Modification Works of Gresik Steam Power Plant Units III and IV)", Japan Bank for International Cooperation

(5) "Ex-post Evaluation Report on ODA Loan Project 2002 (Priok Steam Power Plant Unit 3 & 4 Rehabilitation Project)", Japan Bank for International Cooperation

(6) "Study Report for CDM/JI 2004 (Feasibility Study on the Effective Utilization of Biogas Recovery at Waste Disposal in Indonesia)", 2004, KAJIMA Corporation and YACHIYO Engineering CO., LTD.

(7) "Policy Working Paper 2438 (Measurements of Poverty in Indonesia 1996, 1999, and Beyond)", 2000, The World Bank

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1. General

1.1. Background

Power demand in the Republic of Indonesia has steadily increased since the economic crisis in 1997. However, the power supply system to the consumers still does not seem to work efficiently and seems to become the bottleneck toward the economic recovery in Indonesia. For the above reason, JICA carried out the study on the optimum power sources development in Java-Bali system (Power Sector Study for the Optimum Power Sources Development) from 2001 to 2002. In the Study, JICA proposed recommendations on short-term countermeasures and mid-term plans from the viewpoint of stable power supply especially in Java-Bali system, because the occurrence of shortage of reserve margin for power supply in Java-Bali system in 2004 had been anticipated. And the immediate implementation of those recommendations was required.

Based on the above needs, JICA conducted “Basic Study for Project Formation Related to Mining and Manufacturing (The Study on the Improvement Utilization for Electric Facilities in Java-Bali Region in the Republic Indonesia)” in June 2003. In the Preliminary Study, JICA mission studied on the current situation and identified the issues relating to the improvement measures for existing power generation facilities recommended in the Study in 2003, and formulated a specified project resulting from the confirmation of needs and consultation with relevant organizations in Indonesia. The specific content was stipulated in the Minutes of Meeting agreed on July 3, 2003 between JICA, Ministry of Energy and Mineral Resources (MEMR) and PT. PLN (Persero).

Based on the Project Formation Study, the Government of Republic of Indonesia officially requested the Government of Japan to implement the Study on the Improvement Utilization for Electric Facilities in Java-Bali Region in July 23, 2004 and the Government of Japan accepted the request and decided to conduct the Study in 2005.

The tight power supply balance in Java-Bali region envisaged at the project formation study was fortunately avoided due to the effect by tariff hike and depressing power demand such as restricted connection to new customers which had been imposed up to July 2003. In year 2004, the actual demand under ran the projected demand.

In year 2005, power demand has been increasing again and exceeded the past maximum peak load. On the other hand, any power stations except an expansion of thermal station (Muara Tawar Gas Turbine: 858 MW) have not been reinforced up to now since the economic crisis. For the above reason, the phenomena of shortage for power supply and appreciate reserve margin were observed since April 2005. The envisaged tight power supply balance imposing forced-demand control for large consumers has become the realistic issue.

In year 2006, new power stations are scheduled to start the commercial operation. On the other hand, due to the increase of power demand and decrease of exploitation of gas and oil in Indonesia, it is worried about stable supply of fuels for power stations. Further more, due to the difficulty of land acquisition, transmission expansion plan cannot keep the implementation schedule, which means that tight supply balance might not be resolved even though new power stations are put into operation.

For the above reasons, the study on the improvement measures for electric power generation facilities is expected.

1.2. Purpose of the Study

The purpose of the Study is to develop the improvement measures for existing power stations to meet the power demand in short and middle terms in Java-Bali region based on the above background and to conduct the technology transfer relating the effective and appropriate operation and maintenance for the existing power stations.

1.3. Study Area and Scope of Work

1.3.1. Study Area

The objective power stations are the following sixteen (16) power stations in Java-Bali regions and their locations are figure below.

Table 1.2-1 Objective Sixteen (16) Power Stations in Java-Bali Region

Owner	Power Station	Type	Fuel	Total Output (MW)	
IP	Suralaya	Conventional	Coal	400 MW × 4, 600 MW × 3	3,400
	Tanjung Priok	Conventional	MFO	50 MW × 2	
		C.C.	Gas/HSD	(130 MW × 3 + 200 MW) × 2 BL.	
		Gas Turbine	Gas/HSD	26 MW × 2	1,430
	Tambak Lorok	Conventional	MFO	50 MW × 2 + 200 MW	
		C.C.	Gas/HSD	(109.65 MW × 3 + 188 MW) × 2BL.	1,334
	Grati	C.C.	Gas/HSD	100.75 MW × 3 + 159.58 MW	
		Gas Turbine	HSD	100.75 MW × 3	764
	Perak	Conventional	MFO	50 MW × 2	100
	Pesanggaran	Gas Turbine	HSD	21.35 + 20.10 + 42.00 × 2	
		Diesel	HSD	9 units Total 65.68 MW	201
	Gilimanuk	Gas Turbine	HSD	133.8 MW	134
	Pemaron	C.C.	HSD	48.8 MW × 2 + 48.4 MW	150
	Saguling	Hydro	—	175.18MW × 4	700.72
	Soedirman	Hydro	—	60.30 × 3	180.9
PJB	Muara Karang	Conventional	Gas/MFO	100 MW × 3 + 200 MW × 2	
		C.C.	Gas/HSD	107.86 MW × 3 + 185.10 MW	1,209
	Gresik	Conventional	Gas/MFO	100 MW × 2 + 200 MW × 2	
		C.C.	Gas/HSD	(112.45 MW × 3 + 188.91 MW) × 3BL.	2,239
	Paiton	Conventional	Coal	400 MW × 2	800
	Muara Tawar	C.C.	Gas/HSD	140 MW × 5 + 220 MW	920
	Cirata	Hydro	—	126 MW × 8	1,008
	Sutami	Hydro	—	35 MW × 3	105

Note: HSD means High Speed Diesel Oil, MFO means Marine Fuel Oil.
C.C. means Combined Cycle.

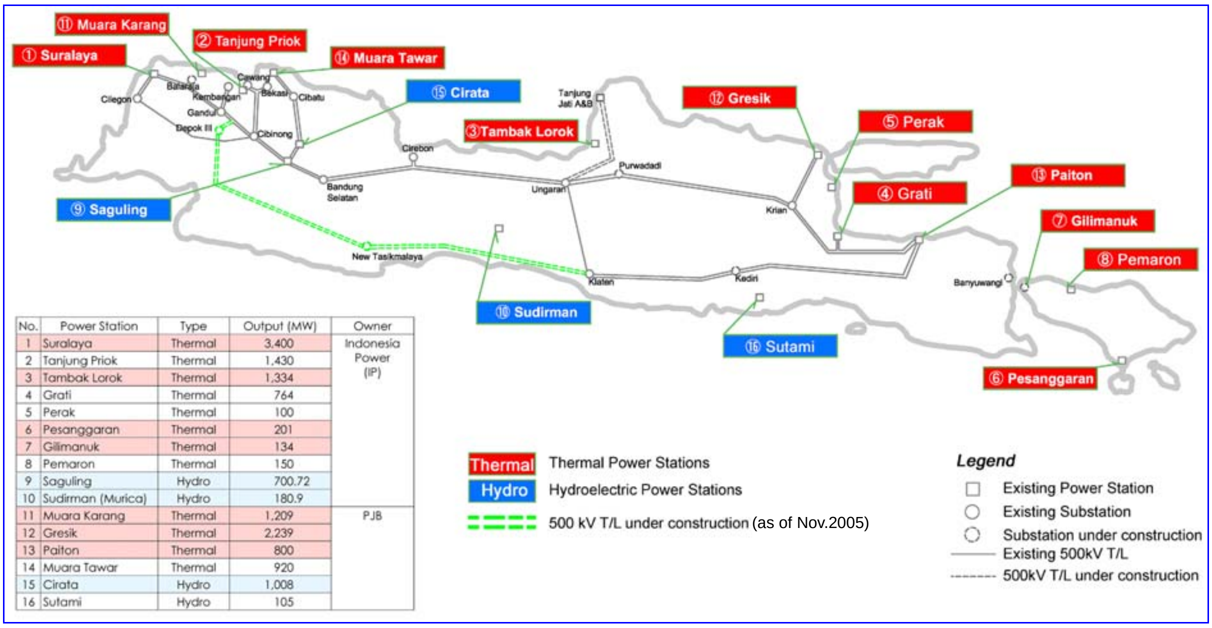


Figure 1.2-1 Location of Objective Power Station and 500kV Transmission Line

1.3.2. Scope of Work

The Study is to develop the improvement measures relating to the existing power facilities and operation and maintenance based on the analyses of current situation of the objective power stations in order to reduce the gap between the installed capacity (total rated capacity: approximately 19,500 MW) and available power supply capacity (approximately 14,500 MW), which is regarded as the cause of tight of power balance and accounted to about 5,000 MW (26 % of total installed capacity).
The Study is consisted of the following scope of work.

(1) Preliminary Survey Stage

The following survey will be carried out, in order to confirm the current situation of each power facilities in Java-Bali region.

1) Collection of data and information of the following items through the investigation of the relevant organization in Indonesia and electric power facilities in Java-Bali Region
    a) Performance of power generation facilities
    b) Current situation of operation, maintenance and inspection
    c) Organization and regulation for operation, maintenance and inspection
    d) Needs for the technology transfer on operation, maintenance and inspection
    e) 500 kV transmission line of Java-Bali system
    f) Plan of fuel supply
2) Review of the related reports and other relevant information

(2) Analysis and Examination Stage

Based on the result of the Preliminary Survey Stage, current situation and management system would be analyzed for each power generation facilities and necessary countermeasures would be examined. The following items will be considered in each power generation facilities.

1) Improvement measures of power generation facilities including rehabilitation, modification and re-powering
2) Improvement measures of management for operation, maintenance and inspection
3) Economic and financial analysis of the above mentioned improvement
4) Grading the power facilities in need of improvement

(3) Technology Transfer Stage

Based on the impact and the needs for the technology transfer on operation, maintenance and inspection with are confirmed in the Preliminary Survey Stage, technology transfer on operation, maintenance and inspection will be conducted at the time of maintenance and inspection.

(4) Recommendation Stage

Considering the results of the above mentioned stages, the following plan and recommendation will be submitted.

1) Rehabilitation, modification, or re-powering plan of the power generation facilities
2) Management plan and general guidelines of operation, maintenance and inspection
3) Recommendation to the organization and regulation for enhancing the capability of operation, maintenance and inspection
4) Development plan of human resources for operation, maintenance and inspection

2. Recognition of Current Situation in Java-Bali Region

2.1. Confirmation of Power Development Plan

(1) Power Development Plan based on April 25, 2005

The following tables show the power development plan from the year 2005 to 2015 for Java-Bali region and whole Indonesia as of April 2005.

Table 2.1-1 Power Development Plan in Java-Bali Region

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Required Energy												
Residents	GWh	28,612	30,074	31,640	33,315	35,107	37,016	38,984	41,015	43,111	45,277	47,515
Public	GWh	3,851	4,012	4,179	4,352	4,534	4,719	4,868	5,022	5,181	5,345	5,514
Commercial	GWh	13,013	14,526	16,202	18,060	20,121	22,478	25,102	28,024	31,279	34,906	38,948
Industry	GWh	35,674	38,484	41,759	45,439	49,508	54,205	59,176	64,515	70,290	76,557	83,372
Required Total	**GWh**	**81,150**	**87,095**	**93,779**	**101,166**	**109,269**	**118,418**	**128,131**	**138,576**	**149,861**	**162,085**	**175,350**
Growth Rate	%	-	7.3	7.7	7.9	8.0	8.4	8.2	8.2	8.1	8.2	8.2
System Loss (T&D)	%	11.4	11.0	10.4	10.3	10.3	10.2	10.1	10.1	10.0	10.0	10.0
Station Use	%	4	4	4	4	4	4	4	4	4	3	3
Total Loss		15	15	14	14	14	14	14	14	14	13	13
Load Factor	%	72	72	72	73	73	73	74	74	74	74	74
Generation	GWh	93,665	100,196	107,274	115,680	124,861	135,264	146,261	158,125	170,889	183,208	198,201
Peak Load	**MW**	**14,851**	**15,886**	**17,008**	**18,090**	**19,525**	**21,152**	**22,563**	**24,393**	**26,362**	**28,262**	**30,575**
Capacity at the beginning of the Year	**MW**	**18,658**	**18,658**	**21,573**	**22,298**	**23,823**	**25,773**	**28,153**	**30,296**	**32,002**	**34,363**	**36,684**
Committed Project												
# PLN Portion		0	730	60	945	720	0	0	0	0	0	0
Muara Karang Repowering	PLTGU				720							
Muara Tawar Extension	PLTGU				225							
Priok Extension	PLTGU					720						
Pemaron Extension	PLTGU			50								
Cilegon	PLTGU		730									
Cibuni	PLTP			10								
# Private Portion		0	2,040	290	580	0	0	0	0	0	0	0
Tanjung Jati B #1,2	PLTU		1320									
Cilacap #1-2	PLTU		600									
Kamojang #4	PLTP		60									
Wayang Windu	PLTP			110								
Dieng	PLTP			60	60							
Darajat #3	PLTP			110								
Patuha	PLTP		60		120							
Bedugul	PLTP			10								
Anyer	PLTGU				400							
New Project												
# Plan, Addition of New Generator		0	145	375	0	1,230	2,380	2,330	1,890	2,360	2,320	2,720
Muara Tawar Add On #2	PLTGU		145	225								
Kamojang #5	PLTP						60					
PLTU	PLTU					500	660	1,200	660	660	1,320	1,320
PLTG	PLTG						200	400		200		400
PLTGU	PLTGU			150		730	1,460	730	730	1,000	1,000	1,000
Pump Storage Upper Cisokan	PLTA								500	500		
# Total Additional Capacity	**MW**	**0**	**2,915**	**725**	**1,525**	**1,950**	**2,380**	**2,330**	**1,890**	**2,360**	**2,320**	**2,720**
Total System Capacity	**MW**	**18,658**	**21,573**	**22,298**	**23,823**	**25,773**	**28,153**	**30,483**	**32,186**	**34,362**	**36,683**	**39,404**
Reserve Margin	**%**	**26%**	**36%**	**31%**	**32%**	**32%**	**33%**	**35%**	**32%**	**30%**	**30%**	**29%**
Required Capacity	MW	20,048	21,446	22,961	24,421	26,359	28,556	29,332	31,711	34,271	36,741	39,748
Shortage or Surplus	MW	1,390	-127	663	598	586	403	-1,151	-475	-91	58	344

Source : KEPUTUSAN MENTERI ENERGI DAN SUMBER DAYA MINERAL NOMOR: 1213 K/31/MEM/2005 TENTANG RENCANA UMUM KETENAGALISTRIKAN NASIONAL 2005 - 2025
DEPARTMEN ENERGI DAN SUMBER DAYA MINERAL, JAKARTA, 25 April 2005

Table 2.1-2 Power Development Plan for Whole Indonesia

Items		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Required Energy	GWh	103,786	111,562	120,247	129,832	140,349	152,189	164,609	178,031	192,589	208,287	225,299
Growth Rate	%	-	7.5%	7.8%	8.0%	8.1%	8.4%	8.2%	8.2%	8.2%	8.2%	8.2%
Generation	GWh	119,458	127,973	137,239	148,067	159,943	173,344	187,331	202,510	171,545	235,061	254,207
Peak Load	**MW**	**19,942**	**21,354**	**22,902**	**24,432**	**26,375**	**28,568**	**30,540**	**32,991**	**36,489**	**38,242**	**41,309**
Existing Capacity	MW	24,097	24,089	23,894	23,781	23,769	23,757	23,764	23,548	23,256	23,152	23,052
Total System Capacity	MW	24,965	28,162	29,764	31,942	34,805	37,995	41,176	43,552	46,470	49,487	53,132
Required Capacity	MW	26,921	28,838	30,938	32,958	35,594	38,496	40,044	43,282	46,690	50,086	54,082
Shortage or surplus	MW	1,956	675	1,173	1,015	789	501	-1,133	-270	220	599	950

Source : KEPUTUSAN MENTERI ENERGI DAN SUMBER DAYA MINERAL NOMOR: 1213 K/31/MEM/2005 TENTANG RENCANA UMUM KETENAGALISTRIKAN NASIONAL 2005 - 2025
DEPARTMEN ENERGI DAN SUMBER DAYA MINERAL, JAKARTA, 25 April 2005

Referring to the above tables, the following findings are observed.

a) The Indonesian Government (MEMR) forecasts 7 ~ 8% of the growth rate for power demand in Java-Bali region and whole Indonesia.

b) The peak demand in the year 2010, five (5) years later, is estimated to 21,152 MW in Java-Bali region and 42 % more in comparison with 14,851 MW in the year 2005. To meet the peak demand in the year 2010, the new power stations and/or re-powering projects will be intensively implemented in the next four years from the year 2006. Since the most projects for the next four (4) years are committed projects, the materialization of the power development program is well expected.

c) Since there are not committed projects after the year 2010, the Indonesian Government has to prepare the concrete power development projects in cooperation with PLN in the next few years taken account of the long lead time for power source development.

(2) Crash Program for New Coal-fired Thermal Power Stations

PLN has announced the development program of new coal fired thermal power plant projects to the amount of 10,000 MW within next three years on May 22, 2006 as shown blow. The purpose of the implementation of new coal fired thermal stations is to promote the diversification of energy, in other words, to cut the current expensive oil fuel according to the newspaper. In this connection, the Presidential Decree No. 71 (Team Formation) and No. 72 (List of Projects) was issued.

The Jakarta Post said “It expects that by 2010, the use of expensive fuel-fired power plants will be reduced to just 5 percent of total capacity from the current 30 percent, which would cut costs by as much as 80 percent.[1]” In line with the new crash program, MEMR has been revising the national power development plan (2006 ~ 2026) accordingly and released on June 30, 2006. The existing oil-fired power stations are more likely to be affected by the crash program in some way.

[1] Jakarta post, July 21, 2006

Table 2.1-4 Announcement of Coal Fired Power Plant Projects

**PT. PLN (PERSERO)
ANNOUNCEMENT FOR THE DEVELOPMENT PROGRAM
OF COAL FIRED POWER PLANT PROJECTS**

1. To improve the efficiency of National Oil utilization, PLN is required by the Government to accelerate the energy diversification by developing coal fired power plants with the total capacity up to 10,000 MW through-out Indonesia for the next 3 years.

2. The projects locations and size are as follows:

A. Coal Fired Steam Power Plant (CFSPP) in Jawa Island.

No	Name / Location	Capacity (MW)	Province
1	CFSPP Jabar Selatan	2 x 300	Jawa Barat
2	CFSPP Jatim Selatan, Pacitan	2 x 300	Jawa Timur
3	CFSPP Labuan	1 x 300	Jawa Barat
4	CFSPP Marunda	1 x 600	Jawa Barat
5	CFSPP Rembang	2 x 300	Jawa Tengah
6	CFSPP Suralaya Baru	2 x 660	Jawa Barat
7	CFSPP Teluk Naga	2 x 300	DKI Jakarta
8	CFSPP Jabar Utara	2 x 300	Jawa Barat
9	CFSPP Tanjung Awar-Awar	1 x 600	Jawa Timur
10	CFSPP Paiton Baru	2 x 660	Jawa Timur

B. Coal Fired Steam Power Plant (CFSPP) outside Jawa Island.

No	Name / Location	Capacity (MW)	Province
1	CFSPP Meulaboh	2 x 65	NAD
2	CFSPP Sibolga Baru	2 x 100	Sumatera Utara
3	CFSPP Sumbar Pesisir Selatan	2 x 100	Sumatera Barat
4	CFSPP Amurang Baru	2 x 25	Sulawesi Utara
5	CFSPP Tarahan Baru	2 x 100	Lampung
6	CFSPP Mantung	2 x 10	Bangka Belitung
7	CFSPP Air Anyer	2 x 10	Bangka Belitung
8	CFSPP Timika	2 x 7	Papua
9	CFSPP Bengkalis	2 x 7	Riau
10	CFSPP Selat Panjang	2 x 5	Riau
11	CFSPP Kendari	2 x 10	Sulawesi Tenggara
12	CFSPP Ende	2 x 7	Nusa Tenggara Timur
13	CFSPP Asam-Asam	2 x 65	Kalimantan Selatan
14	CFSPP Bone	2 x 15	Sulawesi Selatan

3. The projects are planned to be in operation latest by mid. 2009.
Jakarta, 22 May 2006

ACTING DIRECTOR FOR GENERATION AND PRIMARY ENERGY
PT PLN (Persero)

Source: Jakarta Post, 22 May 2006

(3) Expansion Plan for the Transmission Lines and Transformers in Ten Years

The expansion plans of 500 kV transmission line and 500 kV substation in ten years are shown in the following tables. 3,399 km transmission lines and 18,998 MVA transformers will be constructed in the next decade.

Expansion Plan of 500 kV Transmission Line (km)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
861	178	280	250	110	920	356	-	-	444

Expansion Plan of 500 kV Transformer (MVA)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3,498	3,000	-	1,000	500	2,500	2,000	2,000	1,500	3,000

Source; Rencana Usaha Penyediaan Tenaga Listrik 2006-2015

(4) Southern 500 kV Transmission Line (including Substation)

In order to supply from the eastern part which has a lot of power sources to the western part in Java including Jakarta which is the biggest demand area, it is necessary to solve the problem of system stability (Section 3.3.1) in Java-Bali system and to improve the reliability. That is why southern 500 kV transmission line from Paiton P/S to Depok III S/S[2] through Kediri S/S, Klaten S/S, and Tasikmalaya S/S is under construction as shown in the following figure.

The section from Paiton P/S to Klaten S/S was already constructed and is in operation as of November 2005. But the one from Klaten S/S to Depok III has not connected yet. 90% and more of construction works are completed, but construction works such as transmission lines around Depok III S/S are delayed because of the difficulties of the land acquisition around the area. This southerly transmission line will be operated by the end of 2006.

[2] The construction of southern 500kV transmission line was completed in June 2006.

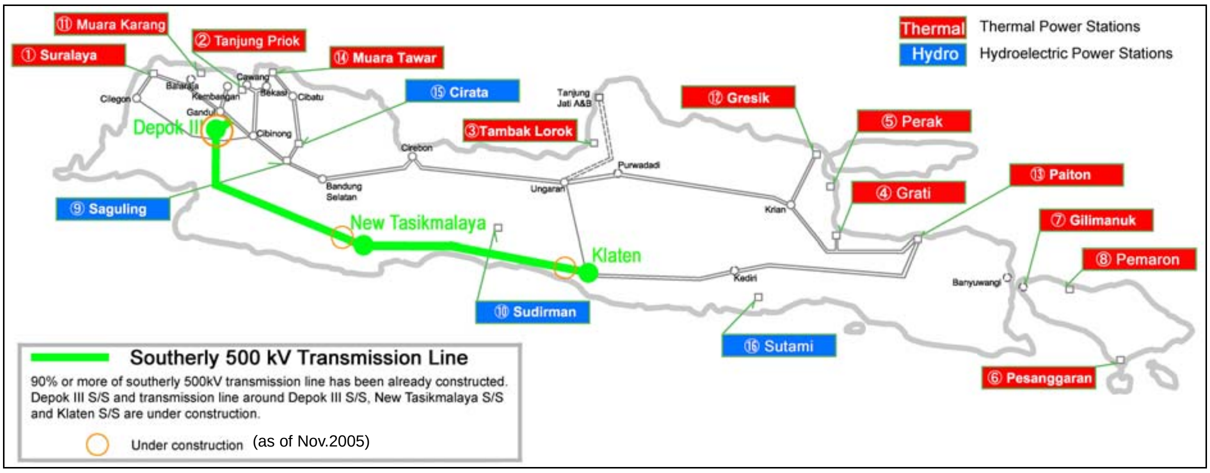


Figure 2.1-1 Southerly 500 kV Transmission Line

(5) Java-Sumatera Interconnection Project

According to RUPTL, a coal fired power plant will be constructed in Mulut Tamgbang, Sumatera. The total capacity is planned as 2,400 MW (600 MW × 2 in 2010 and 600 MW × 2 in 2011). 400 MW of the planned capacity will be supplied inside Sumatera and the rest 2,000 MW will be transmitted to Java-Bali System. As one of the methods of supply from Sumatera to Java, there is a plan as follows;

(6) Java-Bali Interconnection Project

According to RUPTL, in Bali Island the total supply capacity of the existing generators and newly installed generators, considering supply from Java Island, will reach 874 MW in 2008. But in the future the amount of demand will exceed the total supply capacity because the demand will be expected to highly increase.
Therefore, the new 500 kV transmission line will be constructed between Paiton substation in Java and newly installed Kapal substation in Bali in order to strengthen the system interconnection. As a result the supply capacity is enough for the demand in Bali as of 2015.
Hereafter a further study is necessary in accordance with the power development plan including the repowering plan of the existing generators which is recommended in this report.

Since a coal fired power station with 3 × 130 MW (Celukan Bawang (Northern part of Bali)) will be operated in 2009 and 2010 and a coal fired thermal power station with 2 x 100 MW (Eastern part of Bali) based on the infrastructure project will be operated in 2012, the Java-Bali Interconnection project will be after the implementation of these coal fired power stations.

Now PLN has been conducting pre-F/S on a coal fired thermal power station in Nusa Penida located at South of Bali Island.

2.2. Confirmation of Fuel Supply Plan

2.2.1. Fuel Oil Prices

The trend of fuel oil prices relating to MFO and HSD, which are used in power stations, for the period from February 2003 to April 2006, are shown in the figure below. As shown in the figure, fuel prices have skyrocketed in 2005 in line with the rise of crude oil worldwide. Since China, which had been one of the exporters of oil, is a oil importer substantially according to her sharp economic growth, the high fuel prices might be continued for some time. As of April 2006, the fuel prices for MFO and HSD have not been accompanied by any subsidies.

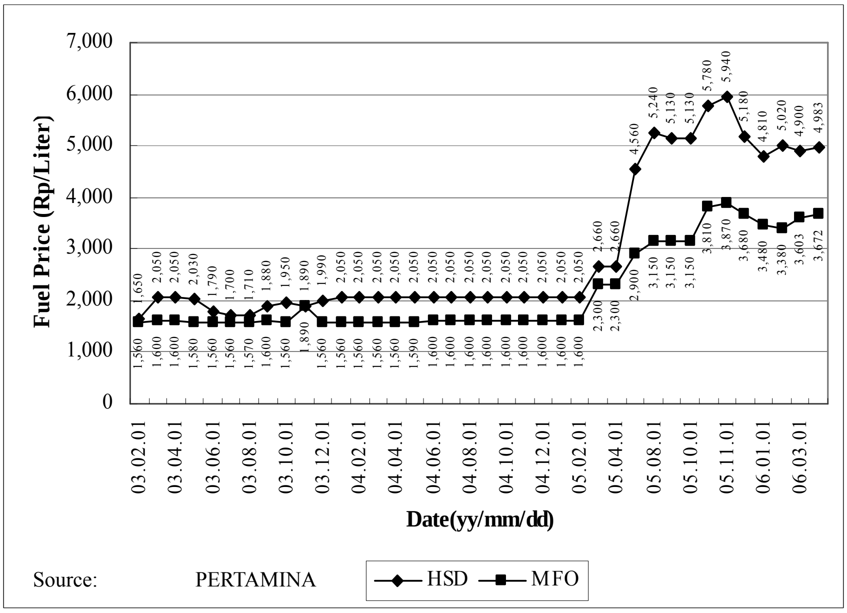


Figure 2.2-1 Trend of Fuel Oil Prices for HSD and MFO

2.2.2. Natural Gas

Table 2.2-1 shows the future gas demand and supply plan in Java-Bali region for the period from 2006 to 2015 as of August 2006 provided by PLN. However, the gas demand and supply plan does not reflect the actual situation. For example, Muara Tawar Block 1 & 2, Grati, Pesanggaran, Pemaron and Gilimanuk could use gas from the year 2006, although they are still forced to use oil as of July 2006. Measures for the shortage of gas supply as far as PLN concerned seem to be two alternatives. One is to cut the gas supply to power stations, the other is to request BPMIGAS, which is the government agency under the president's direct control and have the power to supervise the business activities relating to gas, to allocate more gas to Power Sector. At the moment PLN seems to be forced to select the former option in a short term even though the additional efforts are made as described in Section 2.2.3. The following table is reference only because gas supply is out of control of PLN.

Table 2.2-1 Gas Demand and Supply Balance from 2006 to 2015

				Capacity (MW)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gas Demand (mmscfd)	JAWA BARAT	Contracted													
		PLTU	Muara Karang	400	45	45	45	45	45	45	45	45	45	45	45
		PLTGU	Muara Karang	508	70	70	70	70	70	70	70	70	70	70	70
		PLTGU	Tanjung Priok	1,180	145	145	145	145	145	145	145	145	145	145	145
		Existing Power Plant													
		PLTGU	Muara Tawar I	640	76	76	76	76	76	76	76	76	76	76	76
		PLTG	Muara Tawar	280	18	18	18	76	76	76	76	76	76	76	76
		PLTG	Muara Tawar II	858	56	56	56	56	56	56	56	56	56	56	56
		New Power Plant													
		PLTGU	Muara Karang Ext.	720			38	75	75	75	75	75	75	75	75
		PLTGU	Muara Tawar II	255				27	27	27	27	27	27	27	27
		PLTGU	Tanjung Priok Ext.	750				40	80	80	80	80	80	80	80
		PLTGU	Culegon	750	40	80	80	80	80	80	80	80	80	80	80
		Plan Power Plant Project													
			West Java 1	750				80	80	80	80	80	80	80	80
			West Java 2	750					80	80	80	80	80	80	80
		Sub Total Demand			450	490	528	770	890	890	890	890	890	890	890
	JAWA TENGAH	Existing Power Plant													
		PLTGU	Tambak Lorok		120	120	120	120	120	120	120	120	120	120	120
		PLTU	Tambak Lorok		23	23	23	23	23	23	23	23	23	23	23
		Sub Total Demand			143	143	143	143	143	143	143	143	143	143	143
	JAWA TIMUR	PLTGU	Gresik		290	290	290	290	290	290	290	290	290	290	290
		PLTGU	Grati		20	20	20	20	20	60	60	60	60	60	60
		PLTGU	Gtati Extension							60	60	60	60	60	60
		LTGU	Pasuruan (IPP)					60	60	60	60	60	60	60	60
		Sub Total Demand			310	310	310	370	370	470	470	470	470	470	470
	Grand Total Demand in Java-Bali Region				**903**	**943**	**981**	**1,283**	**1,403**	**1,503**	**1,503**	**1,503**	**1,503**	**1,503**	**1,503**
Gas Supply (mmscfd)	JAWA BARAT	BP ONWJ			265	265	190	135	100	100	100	100	100	100	100
		CNOOC (Chaina)		signed		50	80	80	80	80	80	80	80	80	80
		LNG Terminal						158	342	598	598	598	598	598	598
		Pipe Line from South Sumatra					100	100	100	100	100	100	100	100	100
		Sub Total Supply			265	315	370	473	622	878	878	878	878	878	878
		Balance in JAWA BARAT			-185	-175	-158	-297	-268	-12	-12	-12	-12	-12	-12
	JAWA TENGA	Petronas (Malaysia)		signed				120	145	145	145	145	110	77	55
		Sub Total Supply						120	145	145	145	145	110	77	55
		Balance in JAWA TENGAH			-143	-143	-143	-23	2	2	2	2	-33	-66	-88
	JAWA TIMUR	KODECO (Korea)			100	100	100	86	70	55	40	27			
		KODECO Addition		negotiation				15	20	25	30	35	40	0	
		AMERADA HESS Schedule 1		signed		100	100	100	100	100	100	100	100	91	77
		AMERADA HESS Schedule 2					50	50	50	50	50	50	50	50	74
		SANTOS		?			40	40	40						
		Potential for EMP T/S						130	130	130	150	150	150	150	150
		Sub Total Supply			100	200	290	421	410	360	370	362	340	291	301
		Balance in JAWA TENGAH			-210	-110	-20	51	40	-110	-100	-108	-130	-179	-169
	Grand Balance in Java-Bali Region				-538	-428	-321	-269	-226	-120	-110	-118	-175	-257	-269

2.3. Confirmation of Financial Status of PLN and Power Generation Companies

(1) PLN

The financial status of PLN during the last 4 years is shown in the table below.

Table 2.3-1 Profit and Loss Statement of PLN

	Year 2004	Year 2003	Year 2002	Year 2001
Revenue				
Sale of electricity (Rp.)	58,232,002,384,555	49,809,637,097,889	39,018,461,721,493	28,275,982,649,678
Customer connection fees	387,082,924,469	342,256,833,433	302,307,820,340	265,857,730,605
Government subsidy	3,469,919,795,843	4,096,633,014,267	4,739,073,653,216	6,735,209,866,886
Others	184,056,742,945	182,250,855,819	123,510,049,750	82,907,269,363
Total Revenues	**62,273,061,948,491**	**54,430,777,892,400**	**44,183,353,332,336**	**35,359,957,601,387**
Operating Expenses				
Fuel and lubricants	24,491,052,475,395	21,477,867,200,890	17,957,261,628,798	14,007,295,529,403
Purchased electricity	11,970,810,669,931	10,837,795,807,894	11,168,842,948,716	8,717,140,537,841
Maintenance	5,202,146,146,536	4,827,605,605,099	3,588,827,620,484	3,404,113,925,841
Personnel	5,619,384,262,234	6,533,182,170,671	2,583,289,595,495	2,630,359,602,830
Depreciation	9,547,554,658,124	12,745,047,489,459	15,626,762,571,070	2,086,329,980,623
Others	2,879,818,751,609	2,164,999,534,730	1,420,607,273,725	1,094,147,262,141
Total Operating Expenses	**59,710,766,963,829**	**58,586,497,808,743**	**52,345,591,638,288**	**31,939,386,838,679**
Income (Loss) from Operations	**2,562,294,984,662**	**(4,155,719,916,343)**	**(8,162,238,305,952)**	**3,420,570,762,708**
Other Income (Charges)				
Interest income	231,789,383,338	307,927,532,053	665,414,275,826	363,856,350,535
Interest expense and financial charges	(4,485,927,611,880)	(3,581,495,290,148)	(2,152,231,840,512)	(2,619,507,159,806)
interest on taxes payable on revaluation increment of property, plant and equipment assumed by the Government	4,659,383,947,976	-	-	-
Gain (loss) on foreign exchange - net	(1,675,829,753,716)	1,010,385,428,406	2,725,596,125,676	(458,948,280,287)
Others - net	152,977,086,261	222,297,302,045	345,645,823,538	(139,826,909,462)
Other Charges - Net	**(1,117,606,948,021)**	**(2,040,885,027,644)**	**1,584,424,384,528**	**(2,854,425,999,020)**
Income (Loss) before Tax	**1,444,688,036,641**	**(6,196,604,943,987)**	**(6,577,813,921,424)**	**566,144,763,688**
Tax Expense	**(3,184,503,325,000)**	**(1,388,881,449,134)**	**(1,814,785,272,530)**	**(569,419,909,556)**
Loss from Ordinary Activities	**(1,739,815,389,038)**	**(7,585,486,484,113)**	**(8,392,599,281,491)**	**(3,275,230,723)**
Extraordinary Item - Net of Tax	**(281,551,180,257)**	**1,685,404,064,580**	**2,333,041,074,720**	**183,393,988,135**
Net Loss	**(2,021,366,569,295)**	**(5,900,082,419,533)**	**(6,059,558,206,771)**	**180,118,757,412**

Source; PLN Annual Report 2004

Indonesia suffered substantial price hikes of oil fuel twice in 2005 in March and October, which must have affected the financial position of PLN.

2.4. Review of Collected Data and Information Relating to Technology Transfer

(1) Thermal Power Station

Remaining Life Assessment carried out in Indonesia seems to be different from that of Japan. Remaining Life Assessment in Japan is used for the assessments whether a power station operated more than 20 years is still operational and whether the interval of periodical inspection for the power station is changeable from once two years to once four years from the viewpoint of the reliability. On the other hand, Remaining Life Assessment in Indonesia seems to be similar with the so-called “Equipment Diagnosis”, which has been conducted in a periodical inspection in Japan. And concerning the frequency of outages of power stations, number of outages in Japan is less than that of Indonesia because the technical standards oblige to replace the relevant component before the occurrence of serious abrasion of thickness in Japan.

1) Concerning a boiler, LITBANG has conducted Remaining Life Assessment by his manner and tubes for SH (Super Heater), RH (Re-heater), and WW (Water Wall), where happened abrasion of thickness, have been replaced sequentially. For Paiton unit 1 & 2, some countermeasures seem to be necessary because a number of times of steam leakage have happened at the same portion.

2) Relating to a turbine body, Remaining Life Assessment has not been conducted by PLN. Instead of PLN, a manufacturer has conducted Remaining Life Assessment and reported (Suralaya unit 2). The Study Team received the report. For Gresik unit 4, sea water leakage at a condenser tube has happened repeatedly and damage at the final stage of low pressure turbine probably caused by Cl included in sea water was observed.

3) Relating to a generator, for Suralaya unit 2, deterioration of electrical insulation for the stator is reported by a manufacturer. The evaluation of the material used for the insulator seems to be necessary.

(2) Hydropower Station

In the course of the 1st Field Work, the current situation and the necessity relating to Remaining Life Assessment, such as “Nondestructive Examination” and “Electrical Insulation Examination for the generator stator winding” mainly, were investigated for objective four (4) hydropower stations and the researching institute of PLN (LITBANG).

Based on the results of the 1st Field Work, it can be said that Remaining Life Assessment utilizing a nondestructive examination and an electrical insulation examination for hydro power stations has not been conducted basically. However, the relevant personnel showed strong concerns and well understand the necessity and effect. Therefore, the introduction of Remaining Life Assessment to hydro power stations is well advisable form the viewpoint of preventive maintenance expected to reduce serious accidents.

For the above reasons, related technologies for a nondestructive examination and an electric insulation examination for generator stator winding are proposed at present as Technology Transfer relating to Remaining Life Assessment for the purpose of further rooting the concept of preventive maintenance in Indonesia.

More specific items for Technology Transfer are as follows at the moment:

(a) Remaining Life Assessment by using the nondestructive examination results for a casing and a stay vane
(b) Remaining Life Assessment by using the management of welding volume for the turbine runner
(c) Remaining Life Assessment by using the results of electrical insulation examination for the generator stator winding

2.5. Current Status of JBIC Export Credit

A rehabilitation plan of PLN for application to JBIC Export Credit Line, which was disclosed to JICA Study Team during the 1st Field Investigation, is as follows.

(1) Muara Karang Thermal Power Plant Units No. 4 and No. 5

Output	:	422 MW (2 × 211 MW)
Initial Commercial Operation	:	Unit No. 4 (1981), Unit No. 5(1982)
Original Supplier	:	Mitsubishi Heavy Industries
Estimated Cost for Rehab.	:	Phase I (US$ 112 Million), Phase II (US$ 36 Million)
Proposed Rehabilitation	:	Replacement air preheater (AH) and GRF, etc.

(2) Suralaya Thermal Power Plant Units No. 1 through No. 4

Output	:	1,680 MW (4 × 420 MW)
Initial Commercial Operation	:	Unit No. 1 (1984), No. 2 (1985), No. 3 (1988) and No. 4 (1989)
Original Supplier	:	Mitsubishi Heavy Industries
Estimated Cost for Rehab.	:	US$ 201Million
Proposed Rehabilitation	:	Replacement 2nd superheater and reheater outlet, etc.

(3) Paiton Thermal Power Plant Units No. 1 and No. 2

Output	:	806.25 MW (2 × 403.25 MW)
Initial Commercial Operation	:	Unit No. 1 (1994), Unit No. 2(1993)
Original Supplier	:	Alstom and Toshiba
Estimated Cost for Rehab.	:	US$ 44 Million
Proposed Rehabilitation	:	Replacement of labyrinth and modification of boiler, etc.

(4) Saguling Hydro Power Plant Units No. 1 through No. 4

Output	:	700MW (4 × 175MW)
Initial Commercial Operation	:	Units No. 1/No. 2 (1985)、Units No.3/No. 4(1986)
Original Supplier	:	Toshiba
Estimated Cost for Rehab.	:	US$ 23Million
Proposed Rehabilitation	:	Replacement of turbine runner and governor system, etc.

Indonesia Power gives importance to Saguling Rehabilitation Project as a pilot project utilizing JBIC Export Credit Line, and they have a strong wish to implement rehabilitation of the Soedirman Hydro Power Plant using the same scheme of JBIC, if the Saguling rehabilitation is completed successfully in both technical and financial view points.
As of July 2006, recommendation letters for Suralaya and Muara Karang were submitted from BAPPENAS to the Ministry of Finance (MFO). According to PLN information, PLN intends to implement rehabilitation/modification works for Suralaya Power Station PLTU #3 & #4 and Muara Karang Power Station PLTU #4 & #5 by the next JBIC Export Credit Line, which were excluded from the above 1st credit line due to the limitation of Indonesia's budget.

2.6. Confirmation of Environmental Regulation Relating for Power Sector

The Environmental and social consideration in Indonesia shall be carried out by a project owner/executor. Therefore, the environmental and social consideration relating to rehabilitation/modification and repowering plans proposed in the Study shall be done by the generation companies, which are the owner of the power generation facilities. MEMR, a governing legal authority of Energy Sector, has environment sections/teams for each energy related activities. For example, Deputy Director of Electricity Environmental Protection under the Director General Electricity and Energy Utilization is one the personnel in charge of environmental issues for Power Sector (refer to Figure 2.6-1). Environment sections/ teams fills a role of giving instructions and advices to power enterprises (power generation companies and IPP) relating to environmental issues including KA-ANDAL and AMDAL to be submitted to BAPEDALDA. Environmental issues relating to rehabilitation plan for a power station developed in the FS stage are accepted by the Deputy Director of Electricity Installation and Safety under the Director General Electricity and Energy Utilization.

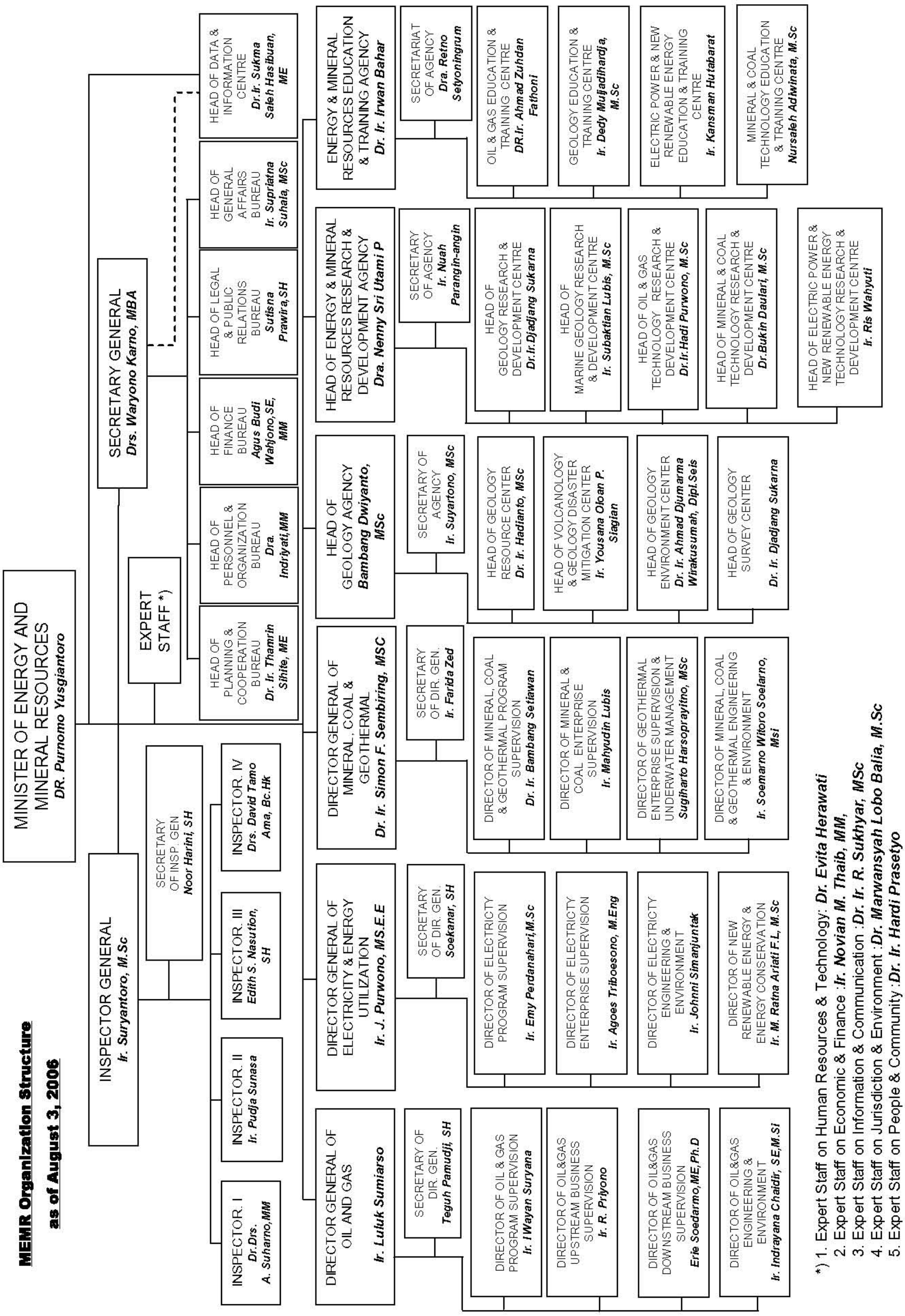


Figure 2.6-1(1) Organization Chart for Ministry Energy and Mineral Resources

3. Review of Existing Electric Power Generation Facilities

3.1. Confirmation of Current Status and Issues Relating to Facilities

3.1.1. Thermal Power Stations

3.1.1.1. Overall Status and Issues of the Objective Twelve (12) Thermal Power Stations

The thermal team of the JICA Study Team visited and investigated the objective twelve (12) thermal power stations in Java-Bali region during the 1st Field Work from November 17 through December 15, 2005. The Study Team got and collected the huge volume of the operational data in the forms of hard copies or soft copies supplied by each power station. Thereafter, the Study Team visited some thermal power stations again in order to complement these data using the timings of the 2nd and 3rd Field Works.

Then, it is noted that the figures of the total installed capacities of the objective thermal power stations have major difference between the Java-Bali region and our study of this time.
Both figures of total installed capacities are compared as follows;

		Total Capacity	Objective Capacity
Thermal Power	:	16,232 MW	12,660 MW
Hydro Power	:	2,548 MW	1,995 MW
Geo-thermal Power	:	754 MW	—
Total	**:**	**19,534 MW**	**14,655 MW**

The operation status on 20/06/2005 causing the serious power supply shortage in Java-Bali region are listed in the Table 3.1-1 for the review of the requirements for the Study as to the requirements of capacity gain measures recovering performance deterioration for the thermal power stations.

Table 3.1-1 Summary of Performance and Capacity Data of Objective 12 Thermal Power Stations (1/2)

Power Station		Unit Type No.	Installed Capacity MW	Commi-ssioning yy.mm	Manufacturer Boiler / HRSG	Manufacturer Turbine (ST/GT)	Manufacturer Gene-rator	(Max.) Available Capacity MW (As of Nov. 2005)	Dependable Capacity MW (As of Nov. 2005)	Derating Conditions	Operation Status of 20/06/2005: Depedable Capactity MW	Operation/ Outage	Capacity Derating ▲MW
Indonesia Power (IP)	Suralaya	PLTU #1	400	1985.04	B&W (Canada)	MHI	MELCO	400.0	371.0	・Mill&Tube	371.0	(・Scheduled)	
		PLTU#2	400	1985.06				400.0	371.0	・Mill&Tube		・Scheduled	371.0
		PLTU#3	400	1989.02				400.0	371.0	・Mill&Tube	371.0		
		PLTU#4	400	1989.11				400.0	371.0	・Mill&Tube		・Forced	371.0
		PLTU#1-#4 Σ	(1600)	1989.11				(1600.0)	(1484.0)		(742.0)		(742.0)
		PLTU#5	600(630)	1997.06	B&W (Canada)	MHI	MELCO	600.0	579.0	・Mill	579.0		
		PLTU#6	600(630)	1997.09				600.0	579.0	・Mill	579.0		
		PLTU#7	600(630)	1997.12				600.0	579.0	・Mill	579.0		
		PLTU#5-#7 Σ	(1800)	1997.12				(1800.0)	(1737.0)		(1737.0)		
	Tanjung Priok	PLTU#3	50.0	1972.xx	MHI	MHI	MELCO	45.0	30.0	・Commissioning		・Longterm	30.0
		PLTU#4	50.0	1972.xx				45.0	30.0	・Commissioning		・Longterm	30.0
		GT-1-1	131.4	1994.09	ABB	ABB	ABB	125.0	120.0	・Gas or Oil		・GT Inspect.	120.0
		GT-1-2	131.4	1994.09				125.0	120.0	・Gas or Oil	120.0		
		GT-1-3	131.4	1994.10				125.0	120.0	・Gas or Oil	120.0		
		ST-1-0	203.5	1994.10				175.0	170.0	・Condenser	117.0	・2-2-1 Operat.	53.0
		PLTGU BLK 1	(597.7)	1994.10				(550.0)	(530.0)		(357.0)		(173.0)
		GT-2-1	131.4	1994.02	ABB	ABB	ABB	125.0	120.0	・Gas or Oil	120.0		
		GT-2-2	131.4	1994.02				125.0	120.0	・Gas or Oil	120.0		
		GT-2-3	131.4	1994.03				115.0	110.0	・Generator	110.0		
		ST-2-0	203.5	1994.12				160.0	160.0	・Condenser	160.0		
		PLTGU BLK 2	(597.7)	1994.12				(525.0)	(510.0)		(510.0)		
		PLTG#1	26.0	1976.09	-	WH	WH	18.0	18.0	・Deterioration	18.0		
		PLTG#3	26.0	1976.02	-	WH	WH	18.0	18.0	・Deterioration		・Stopped	18.0
	Tambak Lorok	PLTU#1	50.0	1978.09	FW	GE	GE	45.0	44.5	・Burner	44.5		
		PLTU#2	50.0	1078.10				45.0	44.5	・Burner	44.5		
		PLTU#3	200.0	1983.07	Mitsui-RL	MHI	MELCO	200.0	195.0		195.0		
		GT-1-1	109.65	1993.08	Austrian-EE	GE	GE	105.0	100.0	・Oil	100.0		
		GT-1-2	109.65	1993.10				105.0	100.0	・Oil	100.0		
		GT-1-3	109.65	1993.10				105.0	100.0	・Oil	100.0		
		ST-1-0	188.00	1993.11				170.0	160.0	・Oil	160.0		
		PLTGU BLK 1	(516.95)	1993.11				(485.0)	(460.0)		(460.0)		
		GT-2-1	109.65	1996.07	Austrian-EE	GE	GE	105.0	100.0	・Oil		・GT Inspect.	100.0
		GT-2-2	109.65	1996.08				105.0	100.0	・Oil	100.0		
		GT-2-3	109.65	1996.09				105.0	100.0	・Oil	100.0		
		ST-2-0	188.00	1997.05				170.0	160.0	・Oil	107.0	・2-2-1 Operat.	53.0
		PLTGU BLK 2	(516.95)	1997.05				(485.0)	(460.0)		(307.0)		(153.0)
	Grati	GT-1-1	112.45	1996.10	CMI	MHI	Siemens	100.75	100.0	・Oil		・Fuel supply	100.0
		GT-1-2	112.45	1996.10				100.75	100.0	・Oil		・Fuel supply	100.0
		GT-1-3	112.45	1996.10				100.75	100.0	・Oil		・Fuel supply	100.0
		ST-1-0	189.50	1997.03				159.58	150.0	・Oil		・Fuel supply	150.0
		PLTGU BLK 1	(526.85)	1997.03				(461.83)	(450.0)			・Fuel supply	(450.0)
		GT-2-1	113.84	2002.10	-	MHI	Siemens	101.90	100.0	・Oil		・Fuel supply	100.0
		GT-2-2	113.84	2002.10				101.90	100.0	・Oil		・Fuel supply	100.0
		GT-2-3	113.84	2002.10				101.90	100.0	・Oil		・Fuel supply	100.0
		PLTG BLK 2	(341.52)	2002.10				(305.70)	(300.0)			・Fuel supply	(300.0)
	Perak	(PLTU#1)	(25.0)	(1964)	(FW)	(GE)	(GE)						
		(PLTU#2)	(25.0)	(1964)	(FW)	(GE)	(GE)						
		PLTU#3	50.0	1978.04	MHI	MHI	MELCO	45.0	30.0	・Burner&WW	30.0		
		PLTU#4	50.0	1978.07	MHI	MHI	MELCO	45.0	30.0	・Burner&WW	30.0		
	Pessangaran	PLTD#1~#11	Total 75.82	1972-1987	-	BS, others		Total 60.91	Total 58.64		Totol 54.14	・TD#1Stopped	4.5
		PLTG#1	21.4	1985.02	-	Alsthom	Alsthom	19.5	Total 109.7	・Oil&Ambient	Total 109.7		
		PLTG#2	20.1	1993.05	-	GE	GE	18.0		・Oil&Ambient			
		PLTG#3	42.0	1994.07	-	WH	WH	37.1		・Oil&Ambient			
		PLTG#4	42.0	1994.08	-	WH	WH	35.1		・Oil&Ambient			
	Gilimanuk	PLTG#1	133.8	1997.07	-	ABB	ABB	133.8	132.0		132.0		
	Pemaron	PLTG#1	48.8	2004.00	-	GE	GE	45.0	45.0	・Oil&Others	45.0		
		PLTG#2	48.8	2005.00	-			45.0	45.0	・Oil&Others		・Installation	45.0
		(ST-1-0)	(48.4)		(CE)	(MHI)	(MELCO)						
		(PLTGU BLK 1)	((146.0))	C/C conversion of PLTGs is postponed by PLN.									

Table 3.1-1 Summary of Performance and Capacity Data of Objective 12 Thermal Power Stations (2/2)

Power Station		Unit	Installed Capacity	Commi-ssioning	Manufacturer			(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
		Type No.	MW	yy.mm	Boiler / HRSG	Turbine (ST/GT)	Gene-rator	As of Nov. 2005 MW	MW		Depedable Capactity MW	Operation/ Outage	Capacity Derating ▲MW
PJB	Muara Karang	PLTU#1	100.0	1979.02				90.0	85.0	・Boiler Aging	85.0		
		PLTU#2	100.0	1979.02	B&W	MHI	MELCO	90.0	85.0	・Boiler Aging	85.0		
		PLTU#3	100.0	1979.06				90.0	85.0	・Boiler Aging	85.0		
		PLTU#4	200.0	1981.11	MHI	MHI	MELCO	190.0	165.0			・AH/Inspection	165.0
		PLTU#5	200.0	1982.06				190.0	165.0		165.0		
		GT-1-1	107.86	1993.10				103.0	100.0	・Gas or Oil	100.0		
		GT-1-2	107.86	1993.10				103.0	100.0	・Gas or Oil	100.0		
		GT-1-3	107.86	1993.10	Austrian-EE	GE	GE	103.0	100.0	・Gas or Oil	100.0		
		ST-1-0	185.00	1995.xx				160.0	150.0	・Gas or Oil		・ST/Inspection	150.0
		PLTGU BLK 1	(508.58)	1995.xx				(469.0)	(450.0)		(300.0)		(150.0)
	Gresik	PLTU#1	100.0	1981.08	IHI	Toshiba	Toshiba	95.0	92.0		92.0		
		PLTU#2	100.0	1981.11				95.0	94.0		94.0		
		PLTU#3	200.0	1988.08	IHI	Toshiba	Toshiba	200.0	195.0		195.0		
		PLTU#4	200.0	1988.11				200.0	195.0			・Scheduled	195.0
		GT-1-1	112.45	1992.03				105/100	100/95	・Gas or Oil	95.0		
		GT-1-2	112.45	1992.05				105/100	100/95	・Gas or Oil	95.0		
		GT-1-3	112.45	1992.06	MHI	MHI	MELCO	105/100	100/95	・Gas or Oil	95.0		
		ST-1-0	188.91	1993.04				180/170	170/160	・Gas or Oil	160.0		
		PLTGU BLK 1	(526.26)					(495/470)	(470/445)		(445.0)		
		GT-2-1	112.45	1992.07				100.0	95.0	・(Gas or) Oil	95.0		
		GT-2-2	112.45	1992.08				100.0	95.0	・(Gas or) Oil	95.0		
		GT-2-3	112.45	1992.09	MHI	MHI	MELCO	100.0	95.0	・(Gas or) Oil	30.0	・GT Compres.	65.0
		ST-2-0	188.91	1993.08				170.0	160.0	・(Gas or) Oil	95.0	・Comp. Crack	65.0
		PLTGU BLK 2	(526.26)					(470.0)	(445.0)		(315.0)		(130.0)
		GT-3-1	112.45	1993.01				105.0	100.0	・Gas (or Oil)	100.0		
		GT-3-2	112.45	1993.01				105.0	100.0	・Gas (or Oil)	100.0		
		GT-3-3	112.45	1993.01	MHI	MHI	MELCO	105.0	100.0	・Gas (or Oil)	100.0		
		ST-3-0	188.91	1993.11				180.0	170.0	・Gas (or Oil)	170.0		
		PLTGU BLK 3	(526.26)					(495.0)	(470.0)		(470.0)		
		Gilitimur PLTG	(40.1)	PLTG#1&#2 were moved to Gilitimur, Madura Island.									
		PLTG#1	20.1	1978.06	-	Alstom	Alstom	17.0	15.5	・Oil & Others	15.5		
		PLTG#2	20.1	1978.06				17.0	15.5	・Oil & Others	15.5		
		PLTG#3	((20.1))	1984.08	PLGT#3 was moved to Sumatra.								
	Paiton	PLTU#1	400.0	1994.04	CE	Toshiba	Toshiba	400.0	400.0			・ST Vibration	400.0
		PLTU#2	400.0	1993.11				400.0	400.0		400.0		
	Muara Tawar	GT-1-1	145.0	1997.01				133.8	132.0	・Oil	132.0		
		GT-1-2	145.0	1997.03				133.8	132.0	・Oil		・GT Inspect.	132.0
		GT-1-3	145.0	1997.04	ABB	ABB	ABB	133.8	132.0	・Oil	132.0		
		ST-1-0	225.0	1997.10				202.0	185.0	・Oil	123.0	・2-2-1 Operat.	62.0
		PLTGU BLK 1	(660.0)					(603.4)	(581.0)		(387.0)		(194.0)
		GT-2-1	145.0	1997.03	-	ABB	ABB	133.8	132.0	・Oil	132.0		
		GT-2-2	145.0	1997.06				133.8	132.0	・Oil	132.0		
		(GT-2-3)	(145.0)	GT was moved to Bali in 1997.									
		PLTG BLK 2	(290.0)					(267.6)	(264.0)		(264.0)		

Table 3.1-2 shows the summarized capacity data of the objective twelve (12) thermal power stations on June 20, 2005 when the serous power supply shortage had occurred in Java-Bali region.

Table 3.1-2 Capacity Data Summaries of 12 Thermal Power Stations

● Installed Capacity	:	12,660 MW
(Installed Capacity Hydro	:	1,995 MW)
(Installed Capacity Total (Thermal + Hydro)	:	14,655 MW)
● Available Capacity	:	11,962 MW
(Capacity Derating	:	698 MW)
● Dependable Capacity	:	11,408 MW
● Outage Capacity	:	3,179.5 MW
(Scheduled Outage	:	1,528.5 MW)
(Unscheduled Outage	:	1,651 MW)
● Operational Capacity	:	8,233.5 MW
Breakdown of Installed Capacity	:	12,660 MW (100%)
✧ Capacity Derating	:	698 MW (5.5%)
✧ Operational Margin	:	554 MW (4.4%)
✧ Operational Capacity	:	8,233.5 MW (65.0%)
✧ Scheduled Outage	:	1,528.5 MW (12.1%)
✧ Unscheduled Outage	:	1,651 MW (13.0%)

3.1.1.2. Each Power Station

(1) Muara Tawar Power Station

Muara Tawar power station belongs to two organizations. Block 1 & 2, of which commercial operation was 1997, belong to PJB, and Block 3 & 4 consisting of other six (6) gas turbines manufactured by Siemens, of which commercial operation was 2004, belong to PLN (UBPMT: Unit Bisnis Pembangkitan Muara Tawar).

Main features of PJB power stations are as follows.

Table 3.1-4 Main Features for Muara Tawar (PJB) Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
GT-1-1	145.0	133.8	132.0	Oil	132.0		
GT-1-2	145.0	133.8	132.0	Oil		GT Inspect.	132.0
GT-1-3	145.0	133.8	132.0	Oil	132.0		
ST-1-0	225.0	202.0	185.0	Oil	122.0	2-2-1 Operat.	62.0
PLTGU BLK 1	**(660.0)**	**(603.4)**	**(581.0)**		**(386.0)**		**(194.0)**
GT-2-1	145.0	133.8	132.0	Oil	132.0		
GT-2-2	145.0	133.8	132.0	Oil	132.0		
(GT-2-3)	(145.0)						
PLTG BLK 2	**(290.0)**	**(267.6)**	**(264.0)**		**(264.0)**		

Note: Gas Turbine Model – ABB GT-13E2

(2) Gresik Power Station

Gresik power station consists of conventional units (PLTU: boiler/turbine), combined cycle units (PLTGU: gas turbine/HRSG/steam turbine), and open cycle gas turbines (PLTG : simple cycle gas turbine) and the total rated capacity is 2,259 MW. Two units of gas turbines (PLTGs) out of five (5) open cycle gas turbines moved to Madura Island (about 2 km far from Gresik) and have been operated as Gilitimur power station. Gilitimur power station is under control of Gresik power station.

The following table shows the main features for Gresik power station including Gilitimur power station.

Table 3.1-5 Main Features for Gresik Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
Type No.	MW	As of 2005 Nov.		Capacity Degradation	Dependable Capacity	Operation/ Outage	Capacity Derating
		MW	MW		MW		▲MW
GT-1-1	112.45	105/100	100/95	Gas or Oil	95.0		
GT-1-2	112.45	105/100	100/95	Gas or Oil	95.0		
GT-1-3	112.45	105/100	100/95	Gas or Oil	95.0		
ST-1-0	188.91	180/170	170/160	Gas or Oil	160.0		
PLTGU BLK 1	**(526.26)**	**(495/470)**	**(470/445)**		**(445.0)**		
GT-2-1	112.45	100.0	95.0	(Gas or) Oil	95.0		
GT-2-2	112.45	100.0	95.0	(Gas or) Oil	95.0		
GT-2-3	112.45	100.0	95.0	(Gas or) Oil	30.0	GT Compres.	65.0
ST-2-0	188.91	170.0	160.0	(Gas or) Oil	95.0	Comp. Crack	65.0
PLTGU BLK 2	**(526.26)**	**(470.0)**	**(445.0)**		**(315.0)**		**(130.0)**
GT-3-1	112.45	105.0	100.0	Gas (or Oil)	100.0		
GT-3-2	112.45	105.0	100.0	Gas (or Oil)	100.0		
GT-3-3	112.45	105.0	100.0	Gas (or Oil)	100.0		
ST-3-0	188.91	180.0	170.0	Gas (or Oil)	170.0		
PLTGU BLK 3	**(526.26)**	**(495.0)**	**(470.0)**		**(470.0)**		
PLTU #1	100.0	95.0	92.0		92.0		
PLTU #2	100.0	95.0	94.0		94.0		
PLTU #3	200.0	200.0	195.0		195.0		
PLTU #4	200.0	200.0	195.0		195.0	Scheduled	195.0
PLTU	(600.0)	(590.0)	(576.0)		(576.0)		
PLTG #1	20.1	17.0	15.5	Oil & Others	15.5		
PLTG #2	20.1	17.0	15.5	Oil & Others	15.5		
PLTG #3	((20.1))	GT#3 was moved to Sumatera.					
PLTG	(40.2)	(34.0)	(31.0)		(31.0)		
PLTG #1	20.0	-	-		-		
PLTG #2	21.0	-	-		-		
Gilitimur	(41.0)	-	-		-		

Source: JICA Preliminary, June 29, 2005 and partly modified.

Note: Gas Turbine Model – MHI M701 (used to be MW701D)

(3) Paiton Power Station

Paiton power station locates 142 km East from Surabaya City and Paiton coal firing power complex consists of PJB (PLTU #1 & #2) and IPP (PLTU #5 ~ #8) portions. The expansion space for unit 3 & 4 is already prepared and common facilities are also constructed in the complex area. Boilers for PLTU #1 & #2 are manufactured by CE (Combustion Engineering), and turbines/generators are manufactured by Toshiba.

Design coal has HHV (High Heating Value) of 5,200 Kcal/kg, whereas the current coal of three kinds from Kalimantan Island is lower ranked with HHV 4,800 kcal/kg. This causes requiring five (5) mills operation including a spare mill.

The table below shows the main features for Paiton Power Station belonging to PJB.

Table 3.1-6 Main Features for Paiton Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTU#1	400.0	400.0	400.0			ST Vibration	400.0
PLTU#2	400.0	400.0	400.0		400.0		

(4) Perak Power Station

Perak power station belongs to Perak-Grati Generating Business Unit, which has the total capacity of 864 MW, although the location of Perak power station is different from Grati power station. The main features for Perak power station are shown in the following table . Units 1 & 2 have been retired since 1996 due to the economic reason. Boilers and turbines for PLTU #3 & #4 are manufactured by Mitsubishi Heavy Industry (MHI).

Table 3.1-7 Main Features for Perak Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
(PLTU#1)	(25.0)						
(PLTU#2)	(25.0)						
PLTU#3	50.0	45.0	30.0	burner&WW	30.0		
PLTU#4	50.0	45.0	30.0	burner&WW	30.0		

(5) Tanjung Priok Power Station

Tanjung Priok power station consists of two (2) PLTUs (conventional), two (2) blocks of PLTGUs (combined cycle) and two (2) PLTGs (open cycle gas turbines). Two (2) older PLTGs of 26 MW each were retired in 1988 and are now under clearing out works. Gas turbines of 1,100°C class of PLTGUs show 28% of turbine efficiency and PLTGUs (combined cycle) show 42% of plant efficiency. The main features for Tanjung Priok power station are shown in the table below.

Tale 3.1-8 Main Features for Tanjung Priok Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTU#3	50.0	45.0	30.0	Commissioning		Long term	30.0
PLTU#4	50.0	45.0	30.0	Commissioning		Long term	30.0
GT-1-1	131.4	125.0	120.0	Gas or Oil		GT Inspect.	120.0
GT-1-2	131.4	125.0	120.0	Gas or Oil	120.0		
GT-1-3	131.4	125.0	120.0	Gas or Oil	120.0		
ST-1-0	203.5	175.0	170.0	Condenser	117.0	2-2-1 Operat.	53.0
PLTGU BLK 1	**(597.7)**	**(550.0)**	**(530.0)**		**(357.0)**		**(173.0)**
GT-2-1	131.4	125.0	120.0	Gas or Oil	120.0		
GT-2-2	131.4	125.0	120.0	Gas or Oil	120.0		
GT-2-3	131.4	115.0	110.0	Generator	110.0		
ST-2-0	203.5	160.0	160.0	Condenser	160.0		
PLTGU BLK 2	**(597.7)**	**(525.0)**	**(510.0)**		**(510.0)**		
PLTG#1	26.0	18.0	18.0	Deterioration	18.0		
PLTG#3	26.0	18.0	18.0	Deterioration		Stopped	18.0

Note: Gas Turbine Model – ABB GT-13E

(6) Muara Karang Power Station

Muara Karang power station consists of five (5) PLTUs (conventional) and one (1) PLTGU Block (combined cycle plant). Muara Tawar power station was once under control of Muara Karang power station and has become an independent power station since 2003. The main features for Muara Karang power station are shown in the following table.

Table 3.1-9 Main Features for Muara Karang Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTU#1	100.0	90.0	85.0	Boiler Aging	85.0		
PLTU#2	100.0	90.0	85.0	Boiler Aging	85.0		
PLTU#3	100.0	90.0	85.0	Boiler Aging	85.0		
PLTU#4	200.0	190.0	165.0			AH/Inspection	165.0
PLTU#5	200.0	190.0	165.0		165.0		
GT-1-1	107.86	103.0	100.0	Gas or Oil	100.0		
GT-1-2	107.86	103.0	100.0	Gas or Oil	100.0		
GT-1-3	107.86	103.0	100.0	Gas or Oil	100.0		
ST-1-0	185.00	160.0	150.0	Gas or Oil		ST/Inspection	150.0
PLTGU BLK 1	**(508.58)**	**(469.0)**	**(450.0)**		**(300.0)**		**(150.0)**

Note: Gas Turbine Model – GE 9E

(7) Tambak Lorok Power Station

Tambak Lorok power station consists of three (3) PLTUs (conventional) and two (2) Blocks of PLTGUs (combined cycle plant) and belongs to UBP Semarang. The table below shows the main features for Tambak Lorok power station.

Table 3.1-10 Main Feature for Tambak Lorok Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTU#1	50.0	45.0	44.5	Burner	44.5		
PLTU#2	50.0	45.0	44.5	Burner	44.5		
PLTU#3	200.0	200.0	195.0		195.0		
GT-1-1	109.65	105.0	100.0	Oil	100.0		
GT-1-2	109.65	105.0	100.0	Oil	100.0		
GT-1-3	109.65	105.0	100.0	Oil	100.0		
ST-1-0	188.00	170.0	160.0	Oil	160.0		
PLTGU BLK 1	**(516.95)**	**(485.0)**	**(460.0)**		**(460.0)**		
GT-2-1	109.65	105.0	100.0	Oil		GT Inspect.	100.0
GT-2-2	109.65	105.0	100.0	Oil	100.0		
GT-2-3	109.65	105.0	100.0	Oil	100.0		
ST-2-0	188.00	170.0	160.0	Oil	107.0	2-2-1 Operat.	53.0
PLTGU BLK 2	**(516.95)**	**(485.0)**	**(460.0)**		**(307.0)**		**(153.0)**

Note: Gas Turbine Model – GE 9E

(8) Grati Power Station

Grati power station consists of PLTGU combined cycle and PLTG open cycle gas turbine plants. Perak - Grati Generating Business Unit Office is in the site of Grati Power Station. The following table shows the main features for Grati power station.

Table 3.1-11 Main Features for Grati Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
GT-1-1	112.45	100.75	100.0	Oil		Fuel supply	100.0
GT-1-2	112.45	100.75	100.0	Oil		Fuel supply	100.0
GT-1-3	112.45	100.75	100.0	Oil		Fuel supply	100.0
ST-1-0	189.50	159.58	150.0	Oil		Fuel supply	150.0
PLTGU BLK 1	**(526.85)**	**(461.83)**	**(450.0)**			**Fuel supply**	**(450.0)**
GT-2-1	113.84	101.90	100.0	Oil		Fuel supply	100.0
GT-2-2	113.84	101.90	100.0	Oil		Fuel supply	100.0
GT-2-3	113.84	101.90	100.0	Oil		Fuel supply	100.0
PLTG BLK 2	**(341.52)**	**(305.70)**	**(300.0)**			**Fuel supply**	**(300.0)**

Note: Gas Turbine Model – MHI M701 (used to be MW701D)

(9) Suralaya Power Station

Suralaya power station consists of conventional (steam) power plant. The following table shows the main features for Suralaya power station.

Table 3.1-12 Main Features for Suralaya Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTU #1	400	400.0	371.0	Mill＆Tube	371.0	(Scheduled)	
PLTU#2	400	400.0	371.0	Mill＆Tube		Scheduled	371.0
PLTU#3	400	400.0	371.0	Mill＆Tube	371.0		
PLTU#4	400	400.0	371.0	Mill＆Tube		Forced	371.0
PLTU#1-#4Σ	**(1600)**	**(1600.0)**	**(1484.0)**		**(742.0)**		**(742.0)**
PLTU#5	600(630)	600.0	579.0	Mill	579.0		
PLTU#6	600(630)	600.0	579.0	Mill	579.0		
PLTU#7	600(630)	600.0	579.0	(Mill)	579.0		
PLTU#5-#7Σ	**(1800)**	**(1800.0)**	**(1737.0)**		**(1737.0)**		

(10) Pesanggaran Power Station

Pesanggaran power station consists of eleven (11) PLTD diesel generators and four (4) PLTG open cycle gas turbine plants.

UBP Bali, Bali Generation Business Unit of Indonesian Power located in Pesanggaran power station manages and controls these Pesanggaran units and other power units in Gilimanuk and Pemaron power stations.

Table 3.1-13 Main Features for Pesanggaran Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTD#1~#11	**Total 75.82**	**Total 60.91**	**Total 58.64**		**Total 54.14**	**TD#1Stopped**	**4.5**
PLTG#1	21.4	19.5	Total 109.7	Oil & Ambient	Total 109.7		
PLTG#2	20.1	18.0		Oil & Ambient			
PLTG#3	42.0	37.1		Oil & Ambient			
PLTG#4	42.0	35.1		Oil & Ambient			

Manufacturer for PLTD#1 to #7 : Mirrlees BS, Manufacturer for PLTD#8 to #11 : SWD
GT#1 Model: Alstom PG.5341 P, GT#2 Model: GE MS.500, GT#3&#4 Model: WH 251B11

(11) Gilimanuk Power Station

Gilimanuk power station has only one gas turbine plant, which was moved from Muara Tawar power station in 1997. Transmission line from Java Island is connecting to Bali grid system at 150 kV Gilimanuk switchyard by the submarine cable.

The following table shows the main features for Gilimanuk power station.

Table 3.1-14 Main Features for Gilimanuk Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTG#1	133.8	133.8	132.0		132.0		

GT Model; ABB GT-13E2

(12) Pemaron Power Station

Pemaron power station has two gas turbine generators, which were moved from Tanjung Priok power station in 2002. The unit 1 and the unit 2 have just started the commercial operation since November 2004 and October 2005, respectively.

HRSG blocks, a completely assembled steam turbine and a assembled generator necessary for a bottoming cycle plant to be combined to these gas turbines had been purchased and are now being stored in the site.

The table below shows the main features for Pemaron power station.

Table 3.1-15 Main Features for Pemaron Power Station

Unit	Installed Capacity	(Max.) Available Capacity	Dependable Capacity	Derating Conditions	Operation Status of 20/06/2005		
					Dependable Capacity	Operation/ Outage	Capacity Derating
Type No.	MW	As of 2005 Nov.		Capacity Degradation			
		MW	MW		MW		▲MW
PLTG#1	48.8	45.0	45.0	Oil & Others	45.0		
PLTG#2	48.8	45.0	45.0	Oil & Others		Installation	45.0
(ST-1-0)	(48.4)						
(PLTGU BLK 1)	((146.0))	C/C conversion is postponed.					

GT Model: GE MS.7001

3.1.1.3. Original Proposals of Rehabilitation, Modification and Repowering Plans

After the 1st Field Work, JICA Study Team proposed at the 1st Workshop, Table 3.1-16 (1) Original Proposals of Rehabilitation, Modification and Repowering Plans for IP units and Table 3.1-16 (2) -Ditto- for PJB below;

Table 3.1-16 (1) Original Proposals of Rehabilitation, Modification and Repowering Plans for IP

Power Station		Proposed Plan	MW Gain
Suralaya		—	—
Perak	PLTU#3&#4	Modification Plan: Burner system modification & turbine uprating plan (PLTU#3&#4)	30 MW
	PLTU#3&#4	Repowering Plan: One block of C/C conversion of PLTU#3&#4 STs (1-1-2)	250 MW (GT)
Tanjung Priok	Block-I & Block-II	Rehabilitation/Modification Plan: Block 1 & 2 condenser and cooling system modification plan	30 MW
	PLTU#3&#4	Repowering Plan: One block of C/C conversion of PLTU#3&#4 STs (1-1-2)	250 MW (GT)
Tambak Lorok	PLTU#1&#2	Rehabilitation/Uprating Plan: Boilers/Turbines/Generators refurbishment plan of PLTU#1&#2	20 MW
	PLTU#1&#2	Repowering Plan: One block of C/C conversion of PLTU#1&#2 (1-1-2)	250 MW (GT)
Grati	PLTG B-II	Repowering Plan: One block of C/C conversion of PLTG B-II GTs (3-3-1)	160 MW (ST)
Pesanggaran	PLTU#3&#4	Repowering Plan: One block of C/C conversion of PLTU#3&#4 (2-2-1)	40 MW (ST)
Gilimanuk	PLTG	Repowering Plan: One block of C/C conversion of PLTG gas turbine (1-1-1)	65 MW (ST)

Table 3.1-16 (2) Original Proposals of Rehabilitation, Modification and Repowering Plans for PJB

Power Station	Proposed Plan	MW Gain
Gresik	Repowering Plan: Two (2) blocks of C/C conversion of PLTU#1&#2 STs (1-1-1 × 2)	500MW
Paiton	Modification Plan: Final RH four (4) panels replacement (T11/12⇒T91)	Equivalent. 75MW
Muara Tawar	Repowering Plan: One block of C/C conversion of PLTG Block 2 GTs (3-3-1)	295MW
Muara Karang	—	—

3.1.1.4. Additional Proposals of Oil Reduction Plans

After further study of the operation and performance data of objective twelve (12) thermal stations as overviewed thoroughly in the Section 3.1.1.1 of this chapter, additional themes to combine with the Study: “Oil Reduction” was clearly closed up.

- Oil consumption reduction plan with repowering concept, sometimes even no repowering to be required.
- Totally real oil reduction scheme per UBP, this means stopping less efficient oil fired units and conversion to higher efficient C/C plant of another less efficient oil fired units
- Oil reduction means less oil consumption and less CO2 emission.

After over viewing the objective twelve (12) thermal power stations per UBP again, three (3) oil reduction plans are thought out as listed in the Table 3.1-17 below by combining with repowering concepts.

Table 3.1-17 Additional Proposals of Oil Reduction Plans

Power Station	Proposed Plan	MW Gain
UBP Semarang T.Lorok, Sunyaragi, Cilacap	One block of combined cycle conversion plan (PLTGU 1-1-2) consisting of a newly installed large GT instead of the existing Sunyaragi PLTG #1 to #4 and Cilacap PLTG #1&#2, a HRSG and the existing PLTU#1&#2 two (2) steam turbines.	100MW (238-(80+58))
UBP Perak Grati Perak Grati	One block of combined cycle conversion project (PLTGU 3-3-1) combining the existing PLTG Block 2 three (3) gas turbines, newly installed three (3) HRSGs and one (1) steam turbine instead of the existing Perak PLTU #3&#4 STs.	60MW (160-100)
UBP Bali Gilimanuk, Pesanggaran	One block of combined cycle conversion project (PLTGU 1-1-1) combining the existing Gilimanuk gas turbine, a newly installed HRSG and a newly installed steam turbine instead of the existing Pesanggaran PLTG #1&#2 GTs.	24MW (65-20-21)

3.1.2. Hydropower Stations

The main features of the objective power stations are shown in the Table 3.1-19.

Table 3.1-19 Main Features of Objective Hydropower Stations

	Saguling	Cirata	Soedirman	Sutami
Company name	IP	PJB	IP	PJB
River name	Citarum	Citarum	Serayu	Brantas
Plant output	700.72 MW	1,008 MW	180.9 MW	105 MW
Turbine rated value				
Type	Vertical Francis	Vertical Francis	Vertical Francis	Vertical Francis
Output	178.8 MW	129.6 MW	61.5 MW	36 MW
Net head	355.7 m	106.8 m	88.5 m	78.0m
Discharge	56 m^3/s	132.5 m^3/s	74 m^3/s	53.5 m^3/s
Speed	333.3 r/m	187.5 r/m	230.8 r/m	250 r/m
Number of unit	4	8	3	3
Manufacturer	TOSHIBA	VOEST ALPINE	BOVING	TOSHIBA
Generator rated value				
Output	206.1MVA	140MVA	67.01MVA	39MVA
Power factor	0.85	0.9	0.9	0.9
Voltage	16.5kV	16.5kV	13.8kV	11kV
Frequency	50Hz	50Hz	50Hz	50Hz
Number of unit	4	8	3	3
Manufacturer	MITSUBISHI	ELIN	ASEA	TOSHIBA
Main transformer rated value				
Output	412.2 MVA (for 2units)	280 MVA (for 2units)	70 MVA	39 MVA
Voltage	16.5/525kV	16.5/525kV	13.8/154kV	11/154kV
Number of unit	2	4Bank (1ϕ×3)	3	3
Manufacturer	MITSUBISHI	ALSTOM	ASEA	TOSHIBA
Commencement date of commercial operation	#1;12/Oct/1985 #2;28/Nov/1985 #3;3/Apr/1986 #4;29/May/1986	#1;25/May/1988 #2;29/Feb/1988 #3;30/Sep/1988 #4;10/Aug/1988 #5;15/Aug/1997 #6;15/Aug/1997 #7;15/Apr/1998 #8;15/Apr/1998	Nov./1988	#1; Sep/1973 #2; Feb/1976 #3; Feb/1976
Purpose	Power	Power	Power	Irrigation, Power, Water Supply, Flood Control
Reservoir				
Catchment Area	2,283 km^2	4,119 km^2	1,022 km^2	2,052 km^2
HWL	643.00	220.00	231.00	272.5
LWL	623.00	205.00	224.50	246.0
Gross volume	881 Million m^3	1,920 Million m^3	165 Million m^3	343 Million m^3
Effective Volume	609 Million m^3	796 Million m^3	47 Million m^3	253 Million m^3

Source; PJB & INDONESIA POWER data

(1) Saguling

Any derating of power output for every unit is not reported at the moment.
For unit No.3, minimum output is restricted to 100 MW due to the reason that the thrust bearing temperature has risen abnormally during the operation at less than 100 MW since the last 3 years.

(2) Cirata

Any derating for every unit is not reported at the moment.
Due to the deterioration of the reservoir water quality, closed circuit cooling water system is planned to prevent the relevant troubles in the cooling system (water leakage, corrosion in the piping).Cirata has the LFC (load frequency control) function to adjust the frequency of the Java Bali Power Grid System.

(3) Soedirman

Any derating for every unit is not reported at the moment.
Whole unit is operated normally at present. Therefore overhaul of the main machines has not been carried out.

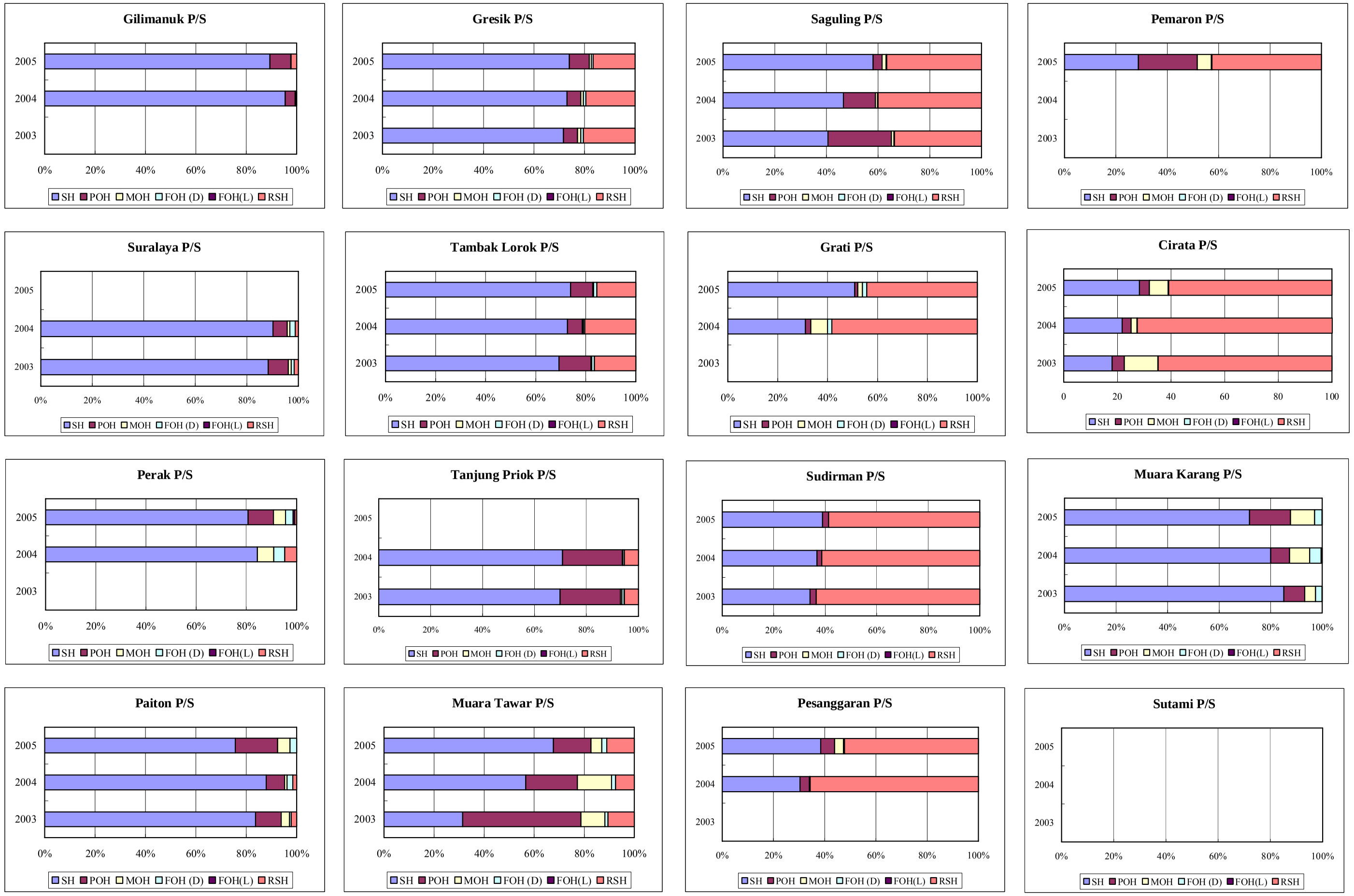
(4) Sutami

Any derating for every unit is not reported at the present.
Whole unit is operated normally at present without serious trouble.

3.2. Confirmation of Current Status and Issues Relating to Operation and Maintenance

3.2.1. Thermal Power Stations

Figure 3.2-2 shows the annual operation records of Year 2004 seen from the viewpoint of operation hours of the thermal power stations under the study.



Gilimanuk P/S (PLTG)

	2003	2004	2005
SH	-	95.5	89.3
POH	-	3.9	8.3
MOH	-	0	0
FOH (D)	-	0.4	0.1
FOH(L)	-	0	0
RSH	-	0.2	2.2
Total	-	100	100

Tanjung Priok P/S (PLTGU+PLTG+PLTU)

	2003	2004	2005
SH	69.9	70.8	-
POH	23.3	23.0	-
MOH	0.6	0.2	-
FOH (D)	0.8	0.6	-
FOH(L)	0.1	0.0	-
RSH	5.4	5.4	-
Total	100	100	-

Suralaya P/S (PLTU)

	2003	2004	2005
SH	88.4	90.3	-
POH	7.8	5.5	-
MOH	1.2	1.0	-
FOH (D)	1.1	2.1	-
FOH(L)	0.0	0.0	-
RSH	1.6	1.2	-
Total	100	100	-

Muara Tawar P/S (PLTGU + PLTG)

	2003	2004	2005
SH	31.4	56.6	67.7
POH	47.2	20.6	15.0
MOH	9.6	13.6	4.3
FOH (D)	1.2	1.6	2.0
FOH(L)	-	-	-
RSH	10.5	7.5	11.0
Total	100	100	100

Perak P/S (PLTU)

	2003	2004	2005
SH	-	84.4	80.7
POH	-	0	10.1
MOH	-	6.5	4.8
FOH (D)	-	4.4	3.0
FOH(L)	-	0	0.7
RSH	-	4.7	0.7
Total	-	100	100

Saguling P/S (PLTA)

	2003	2004	2005
SH	40.6	46.5	58.1
POH	24.5	12.4	3.4
MOH	1	0.8	1.6
FOH (D)	0.2	0.2	0.2
FOH(L)	-	-	-
RSH	33.7	40	36.7
Total	100	100	100

Paiton P/S (PLTU)

%	2003	2004	2005
SH	83.7	88	75.7
POH	10.2	7.3	16.8
MOH	3.3	1.0	4.9
FOH (D)	0.7	2.3	2.6
FOH(L)	-	-	-
RSH	2.1	1.5	0
Total	100	100	100

Grati P/S (PLTGU +PLTG)

	2003	2004	2005
SH	-	31.1	50.9
POH	-	2.2	1.2
MOH	-	6.7	1.9
FOH (D)	-	1.7	1.7
FOH(L)	-	-	-
RSH	-	58.3	44.3
Total	-	100	100

Gresik P/S (PLTGU + PLTG + PLTU)

	2003	2004	2005
SH	71.7	73.1	73.9
POH	5.5	5.4	7.9
MOH	1.3	1.1	0.8
FOH (D)	1.1	0.9	0.7
FOH(L)	-	-	-
RSH	20.4	19.5	16.6
Total	100	100	100

Sudirman P/S (PLTA)

	2003	2004	2005
SH	34.1	36.8	39
POH	2.4	1.8	2.3
MOH	-	-	-
FOH (D)	0	0.1	0
FOH(L)	-	-	-
RSH	63.5	61.3	58.7
Total	100	100	100

Tambak Lorok P/S (PLTGU + PLTU)

	2003	2004	2005
SH	69.3	72.7	73.9
POH	12.8	5.9	8.8
MOH	0.3	0.5	0.4
FOH (D)	1.0	0.5	1.3
FOH(L)	0.0	0.0	0.0
RSH	16.6	20.4	15.6
Total	100	100	100

Pesanggaran P/S (PLTG + PLTD)

	2003	2004	2005
SH	-	30.4	38.4
POH	-	3.7	5.5
MOH	-	0.1	3.4
FOH (D)	-	0.1	0.4
FOH(L)	-	0.1	0
RSH	-	65.8	52.3
Total	-	100	100

Pemaron P/S (PLTG)

	2003	2004	2005
SH	-	-	28.7
POH	-	-	22.9
MOH	-	-	5.5
FOH (D)	-	-	0.2
FOH(L)	-	-	0
RSH	-	-	42.6
Total	-	-	100

Cirata P/S (PLTA)

	2003	2004	2005
SH	18	21.8	28.2
POH	4.6	3.3	3.7
MOH	12.5	2.2	7
FOH (D)	0.1	0.1	0.2
FOH(L)	-	-	-
RSH	64.8	72.7	60.9
Total	100	100	100

Muara Karang P/S (PLTGU + PLTU)

	2003	2004	2005
SH	85.1	80	71.7
POH	8.1	7.3	15.9
MOH	4.2	7.8	9.3
FOH (D)	2.5	4.5	2.9
FOH(L)	-	-	-
RSH	0.1	0.4	0.1
Total	100	100	100

Sutami P/S (PLTA)

	2003	2004	2005
SH			
POH			
MOH			
FOH (D)			
FOH(L)			
RSH			
Total	0	0	0

Note:

PLTU :	Conventional thermal power station (Oil-fired Power Station and Coal-fired Power Station or block)
PLTG:	Gas turbine thermal power station (or block)
PLTGU:	Combined Cycle power station (or block)
PLTD:	Diesel Power Station (or block)
PLTA:	Hydro power station

SH:	Service Hours
POH:	Planned Outage Hours
MOH:	Maintenance Outage Hours
FOH (D):	Forced Outage Hours caused by power station
FOH(L):	Forced Outage Hours caused by power grid system
RSH:	Reserve Shutdown Hours (=Stand by)

Source: Developed by the JICA Study Team based on the provided data by each power station

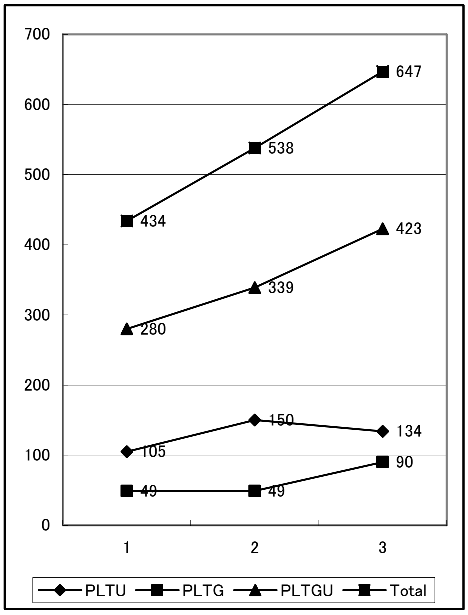
Figure 3.2-2 Annual Operation Performance Relating Hours (%) for Objective Power Stations

The number and hours of forced outages are analised including the causes as mentioned later for 75 units (PLTU: 23, PLTG: 12, PLTGU: 40) among the objective thermal power stations.

(1) Number of outages and hours by unit type

The numbers of outages and hours during the three years from 2003 to 2005 are as shown below[3].

Table 3.2-1 Forced Outage (Times) for Thermal Power Stations

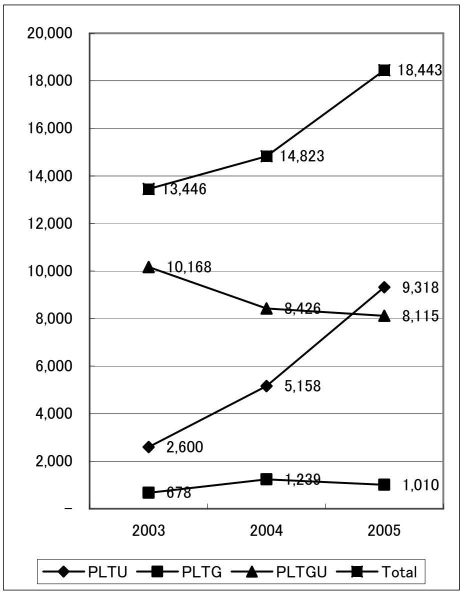


Type	2003	2004	2005	Total
PLTU	105	150	134	389
PLTG	49	49	90	188
PLTGU	280	339	423	1,042
Total	434	538	647	1,619

Numbers of Forced Outages are too many and have been increasing in the past 3 years.

Sources : INDONESIA POWER & PJB data

Table 3.2-2 Forced Outage (Hours) for Thermal Power Stations



Type	2003	2004	2005	Total
PLTU	2,600	5,158	9,318	17,076
PLTG	678	1,239	1,010	2,927
PLTGU	10,168	8,426	8,115	26,709
Total	13,446	14,823	18,443	46,712

Forced Outage Hours are also too many and have been increasing in the past 3 years.

Sources : INDONESIA POWER & PJB data

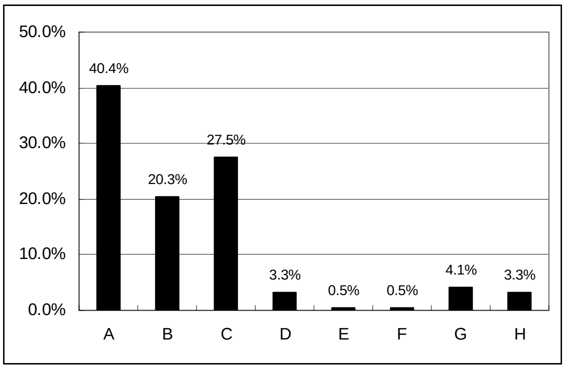
[3] The electricity-related accidents for hydropower stations and thermal power stations for 2004 in Japan are 115 and 72 respectively for your reference (Source: nuclear and Industrial Safety Agency, METI).

(2) Number of outages by unit type

The numbers of forced outages by unit type during the three years from 2003 to 2005 are as shown below.

Table 3.2-3 Number of Forced Outages (Times) for PLTU

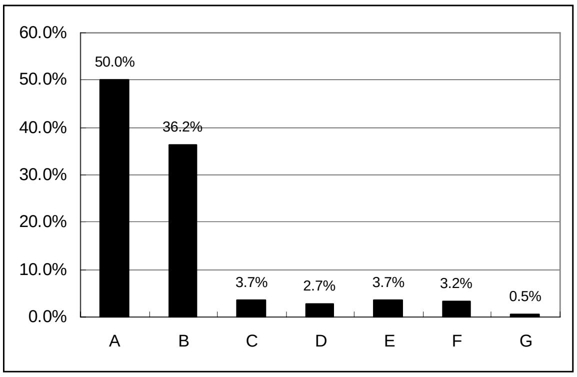
Causes of Forced Outage		Code	%	Times
A:	Instrumentation and Control	A	40.4%	157
B:	Turbine/Generator	B	20.3%	79
C:	Boiler and Auxiliaries	C	27.5%	107
D:	Cable/Relay	D	3.3%	13
E:	Inerter	E	0.5%	2
F:	Transformer	F	0.5%	2
G:	System Fault or Irregular Frequency	G	4.1%	16
H:	Others	H	3.3%	13
Total			100.0%	389



Dominant causes are:
- I & C : 40.4%
  (e.g.)
  - MFT Trip
  - Drum Level High/Low
  - Furnace Draft Press. High/Low
  - Flame Out Trip
- Boiler & Auxiliaries: 27.5%
  (e.g.)
  - Boiler/Tube Leak
- Turbine & Generator: 20.3%
  (e.g.)
  - Balancing Turbine/Generator

Table 3.2-4 Number of Forced Outages (Times) for PLTG

Causes of Forced Outage		Code	%	Times
A:	Instrumentation and Control	A	50.0%	94
B:	Turbine/Generator	B	36.2%	68
C:	Cable/Relay	C	3.7%	7
D:	Electrical Fault or Irregular Frequency	D	2.7%	5
E:	System Fault or Irregular Frequency	E	3.7%	7
F:	Derating	F	3.2%	6
G:	Others	G	0.5%	1
Total			100.0%	188

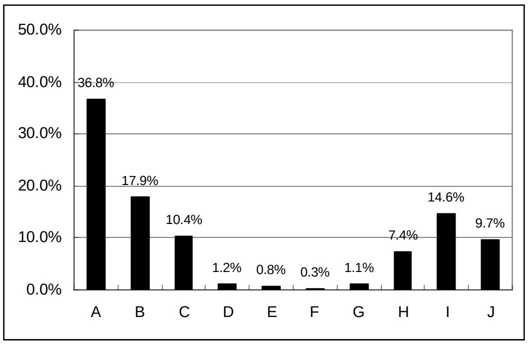


Dominant causes are:
- I & C : 50.3%
  (e.g.)
  - Ignition Trouble
  - Temperature Control Trouble
  - Flame Out Trip
- Turbine & Generator: 36.2%
  (e.g.)
  - Balancing Turbine/Generator
  - Exciter System Trouble

Sources : INDONESIA POWER & PJB data

Table 3.2-5 Number of Forced Outages (Times) for PLTGU

Causes of Forced Outage		Code	%	Times
A:	Instrumentation and Control	A	36.8%	383
B:	Turbine/Generator	B	17.9%	186
C:	HRSG and Auxiliaries	C	10.4%	108
D:	Relay	D	1.2%	12
E:	6kV Bus	E	0.8%	8
F:	UPS System	F	0.3%	3
G:	Electrical	G	1.1%	11
H:	System Fault or Irregular Frequency	H	7.4%	77
I:	Derating	I	14.6%	152
J:	Others	J	9.7%	101
Total			100.0%	1041



Dominant causes are:
- I & C : 36.8%
  (e.g.)
  - Exhaust Temperature High
  - Flame Out Trip
  - Ignition Trouble
- Turbine & Generator: 17.9%
  - Condenser Plugging
  - Starting Motor Trouble
- HRSG & Auxiliaries: 10.4%
  (e.g.)
  - Exhaust Dumper Trouble

Sources : INDONESIA POWER & PJB data

(3) Sharing of roles between Power Station and Maintenance Business Unit (UBHAR/UHAR) for Scheduled Maintenance

As shown in Table 3.2-9 and Table 3.2-10, there are differences between Indonesia Power and PJB in the details of assistance provided by the Maintenance Business Unit (UBHAR/UHAR) in Scheduled Inspection Work and Scheduled Special Order Maintenance Work.

Indonesia Power's UBHAR/UHAR: Main facilities such as boilers, turbines, generators, etc.
PJB's UBHAR/UHAR : All facilities such as main turbines, auxiliary machinery and commonly used facilities.

Table 3.2-9 Sharing of Role between Maintenance Department of the Power Station and Maintenance Business Unit (UBHAR/UHAR)

○ : Responsible Task

Category of Maintenance	Indonesia Power		PJB	
	Power Station	UBHAR	Power Station	UBHAR
1. Corrective Maintenance & Emergency work for PLTU, PLTGU and PLTG e.g. ① Unscheduled maintenance work (Fire accident or Trouble) ② Maintenance work against malfunctions of facilities in operating division	○ ○	(Major Accident or Trouble)	○ ○	(Major Accident or Trouble)
2. Predictive Maintenance for PLTU, PLTGU and PLTG e.g. ① Condition-based maintenance should be carried out on the low priority facilities ・Pump/Motor/Fan/Compressor, etc.	○	−	○	−
3. Preventive Maintenance for PLTU, PLTGU and PLTG e.g. ① Daily maintenance work ② Planning maintenance ③ Scheduled inspection work ④ Scheduled special order maintenance work	○ ○ (・Auxiliary ・Ancillary ・Quality control ・Unit start-up)	− − (・Main Facility ・Quality control)	○ ○ (・Quality control ・Unit start-up)	− − (・Main Facility ・Auxiliary ・Ancillary ・Quality control)

Remarks; UBHAR ; Maintenance Business Unit

Table 3.2-10 Support System in UBHAR for Scheduled Maintenance/Inspection Work

< Indonesia Power >

− UBHAR Head-office in Jakarta city carries out two services as follows

UBHAR
- Internal Service for Indonesian Power's Power station
- External Service for another IPP/companies

−UBHAR Teams are dispatched to 5 units to support maintenance areas of each thermal power station in JAVA-BALI Region

・Suralaya Area, T. Priok Area, Perak-Grati Area and Bali Area, Semarang Area

−Each UBHAR Area Team carries out coordinating Scheduled Inspection works and Special Order Maintenance works

−UBHAR Head-office dispatches 1 or 2 persons (Expert persons) in order to support Quality Control for UBHAR Area Team during Scheduled Inspection work which are Serious (Major), Mean and Simple Inspection

<PJB>

− UBHAR Head-office at Gresik carries out the internal service only for PJB's power station

− Every thermal power station in PJB has unit support maintenance as subordinate of UBHAR
They works for Scheduled Inspection Work and Special Order Maintenance Work

− UBHAR Head-office dispatches 2 persons (Specialist, Supervisor) in order to support Quality Control of UBHAR at power station during Scheduled Inspection works which are Serious (Major), Mean and Simple Inspection

3.2.2. Hydropower Stations

Annual generation energy for each objective power station is shown in the following table.

Annual Generation Energy (MWh)

Year	Saguling	Cirata	Soedirman	Sutami
1995	2,254.9	1,406.3	598.2	
1996	2,504.0	1,472.6	524.3	
1997	1,325.9	851.8	283.2	
1998	3,131.8	1,734.2	629.4	
1999	2,319.1	1,358.6	616.7	
2000	2,272.5	1,285.4	569.1	
2001	2,959.3	1,694.3	617.7	509.8
2002	2,313.3	1,368.7	361.8	490.1
2003	1,780.2	952.0	420.2	400.5
2004	1,990.5	1,132.9	437.8	451.1
2005	2,123.7	1,265.6	368.3	342.6

Note; Annual generation energy for the year 2005 is up to October. Source; PJB & INDONESIA POWER data

(1) Annual Start & Stop Frequency

1) Saguling

Number of annual start and stop frequencies for each unit are shown in the following table.

Annual Start and Stop Frequency

Year	Unit 1	Unit 2	Unit 3	Unit 4
2000	205	198	188	158
2001	199	163	178	183
2002	74	151	227	163
2003	101	159	260	246
2004	245	229	240	152
2005	158	174	245	177

Note; Annual start & stop for the year 2005 are up to October.
Source; INDONESIA POWER data

2) Cirata

Number of annual start and stop frequencies for each unit are shown in the following table.

Annual Start and Stop Frequency

Year	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
2000	130	337	247	307	351	320	340	347
2001	122	222	49	297	312	339	331	325
2002	288	218	153	282	333	333	330	298
2003	280	302	0	253	292	286	320	291
2004	265	272	229	242	306	274	258	240
2005	238	239	222	211	238	218	223	110

Till end of Oct. in 2005 Source; PJB data

3) Soedirman

Number of annual start and stop frequencies for each unit are shown in the following table.

Annual Start & Stop Frequency

Year	Unit 1	Unit 2	Unit 3
2000			
2001	273	255	265
2002	276	278	272
2003	252	236	211
2004	263	283	261
2005	298	306	318

For the year 2005 is up to October   Source; INDONESIA POWER data

4) Sutami

Number of annual start and stop frequencies for each unit are shown in the following table.

Annual Start & Stop Frequency

Year	Unit 1	Unit 2	Unit 3
2000			
2001	132	146	246
2002	125	109	236
2003	211	113	277
2004	133	118	263
2005	129	128	266

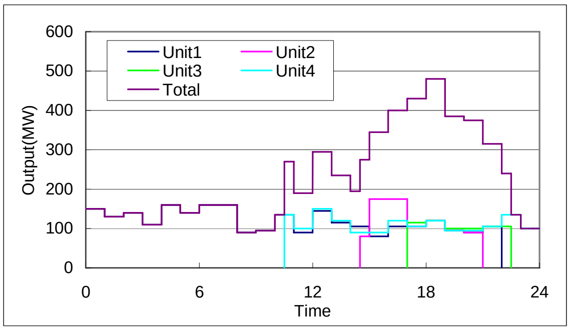
For the year 2005 is up to October   Source; PJB POWER data

(2) Typical Daily Operation Pattern

1) Saguling

Units operation is usually corresponding to peak load and units start/stop operation is requested by P3B Gandul Dispatching Center.

Also units output is controlled manually according to LFC (Load Frequency Control) system signal (This system is probably not a full automatic load frequency control.)



Source ; INDONESIA POWER data (2005.8.15)

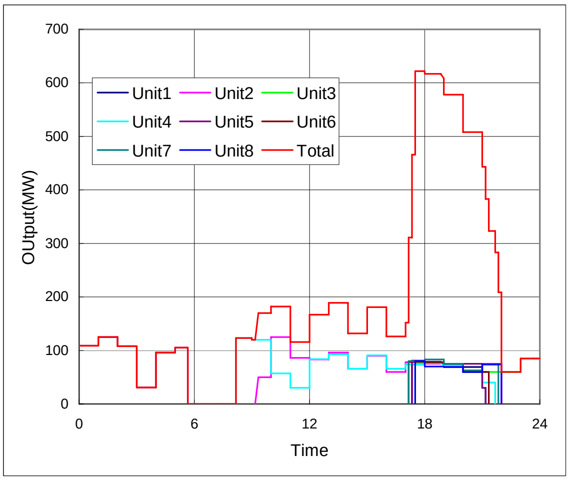
Saguling Daily Operation Pattern (Load Curve)

2) Cirata

Units operation is usually corresponding to peak load and units start/stop operation is requested by P3B Gandul Dispatching Center.

Also units output is controlled manually according to LFC (Load Frequency Control) system signal (This system is probably not a full automatic load frequency control.)

LFC condition is the same as Saguling.

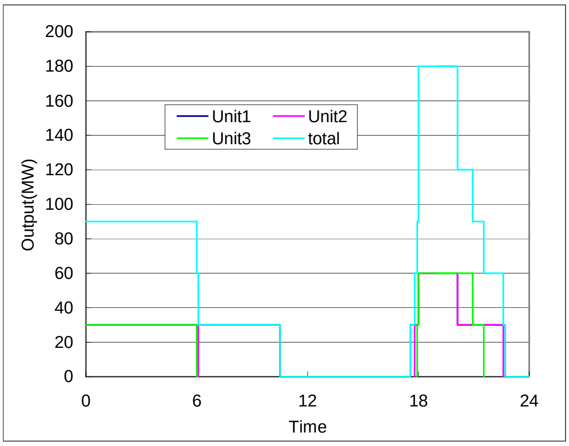


Source; PJB data (2005.09.15)

Cirata Daily Operation Pattern (Load Curve)

3) Soedirman

Units operation is usually corresponding to peak load.

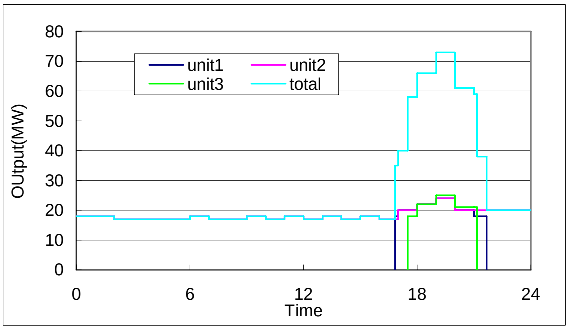


Source; INDONESIA POWER data (2005.1.15)

Soedirman Daily Operation Pattern (Load Curve)

4) Sutami

Units operation is basically corresponding to peak load, although one (1) unit is operated for a whole day. During the rainy season, sometimes full load operation is carried out for all day long.



Source; PJB data (2005.8.28)

Sutami Daily Operation Pattern (Load Curve)

(3) Routine Management (check items, frequency, etc.)

For all power stations, all areas in the powerhouse and switchyard are kept very clean and good arrangement. Any harmful rust and/or peeling of paint on all equipment were not observed. Emergency exit indications are installed at all stairs for safety.

Generally, the number of labels indicating the equipment/machine name, abbreviation number for whole equipment seems to be insufficient. Valve No. and valve open/close indicating tags are not found out for every power station.

Indication of normal range for the various meters such as pressure gauges, oil level gauges, and temperature meters seems to be insufficient.

(4) Organization of Operation and Maintenance Management

The organization of operation and maintenance is basically same for all power stations.
The organization is as follows:

Operation team; The power station is controlled and supervised in full time by three(3) shifted four(4) groups. The operation staff is stationed in the control room and the powerhouse.
The staff in the control room controls the unit start and stop, output, voltage, and supervises the unit's condition. And the staff in the power house supervises the whole equipment in the power station.

Maintenance team; The maintenance team basically consists of three (3) groups such as "Mechanical", "Electrical" and "Control and Instrument" and weekly inspection, monthly inspection, periodical inspection are planned and inspected by the staff. Also repairing work is carried out by the staff.

The periodical job rotation between operation staff and maintenance staff is generally rare.

(5) Integrated Reservoir Operation on Citarum River

For integrated reservoir operation, rule curves for reservoir operation have been made every year of the existing three (3) reservoirs: Saguling, Cirata and Jatilhur on the Citarum River. These three reservoirs have been operated following the rule curves to efficiently use water resources of the Citarum River without any conflicts among stakeholders.

The rule curves are made by a coordination committee headed by SPK-TPA. Sekretariat Pelaksana Koordinasi Tasa Pengatura Air (Secretariat of Water Management Coordination).

A reservoir simulation study of the three reservoirs is actually carried out by Pusat Penelition & Peugemerongon Air under the ministry of Public Works so as to establish rule curve every year.

The simulation software is programmed to meet water demand at the most down stream reservoir: Jatilhur, which should release the water for irrigation and industrial/residential water supply in the downstream area as well as power generation with the priority below;

1st: Municipal water supply
2nd: Irrigation requirement
3rd: Water requirement for industry
4th: Flushing for cleaning of channels in the cities
5th: Power generation at the three reservoirs

It can be seen in Figure 3.2-4 that the both power stations have made good effort to follow the rule curves. Therefore, if the rule curves are set up at higher water level than ones presented in Figure 3.2-4, more energy could have been generated by the same volume of inflow and out flow with higher hydraulic head and higher efficiency of generator and turbine.

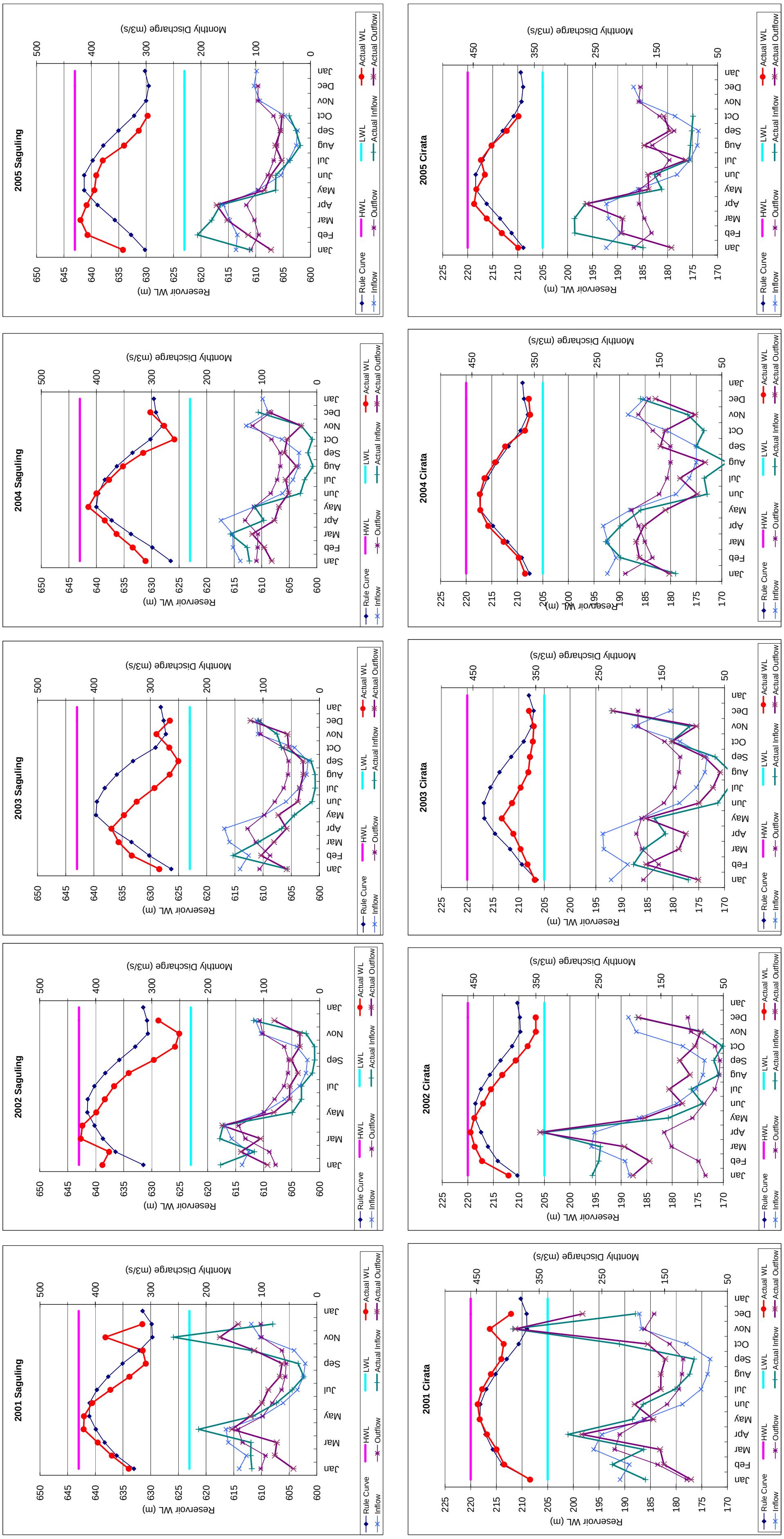


Figure 3.2-4 Reservoir Operation in Saguling and Cirata

3.3. Confirmation of Current Status and Recommendation on Improvement Relating to the Existing Power Facilities

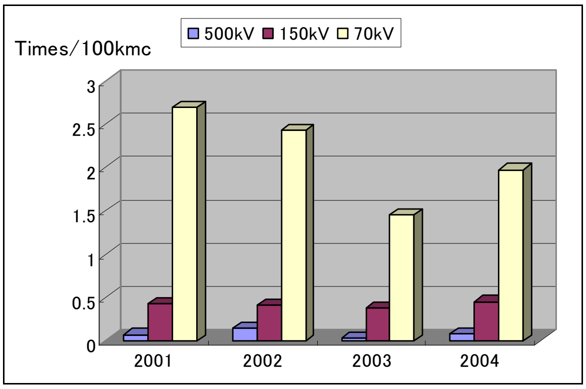
(1) Outline of facilities

As a result of the site investigation of 500 kV substation by the study team, the latest 500 kV facilities such as Gas Insulated Busbar (GIB) and Gas Insulated Switchgear (GIS) are installed in Paiton substation. On the other hand, in the substation of the suburbs of Jakarta, the old type air blast circuit breakers which have been already discontinued by manufactures are installed. In September 2002, there was a large scale blackout because the old type air blast circuit breaker which should have been operated in the accident of 500 kV transmission line was not able to be worked. Spare parts of this type circuit breaker are few and it is recommended that the old type circuit breakers are replaced with new type gas circuit breakers.

(2) Availability

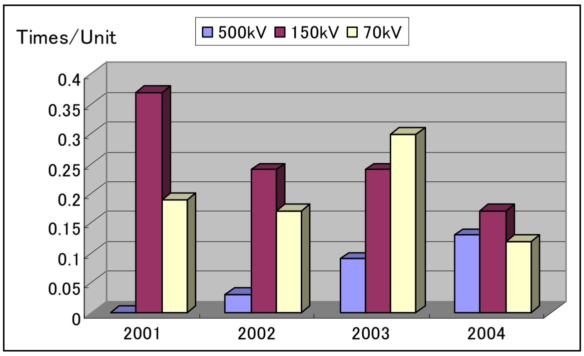
In 500 kV transmission line, only the section which is restricted by system stability (described in Section 3.3.1) is not satisfied with N-1 criteria. As for 500/150kV transformers, the ratio of transformers whose availability is over 60% is 90% or more, therefore, almost all transformers do not meet N-1 criteria.

(3) Number of Service Interruptions



Source; PLN P3B STATISTIK 2004

Figure 3.3-3 Number of Service Interruptions of Transmission Line per 100 km Circuit



Source; PLN P3B STATISTIK 2004

Figure 3.3-4 Number of Service Interruption of Transformer per Unit

According to the above figures, in 500 kV facilities, the number of service interruptions due to transmission line faults is small, but the one due to transformer faults is increasing year by year. If service interruption caused by a fault in 500 kV facilities occurred, it is likely to cause a large scale blackout. As mentioned in Section 3.3.2, the number of 500 kV transformers whose availability is over 80% are twenty one out of thirty two. Therefore, 500 kV transformer accidents have a significant impact on the society. In fact, the amount of energy not supplied in 2004 increased by 2.5% from the previous year 2003, although the number of service interruptions in 2004 is 13% smaller that in 2003.

Considering these situations as well as the availability described in Section 3.3.2, 500 kV transformers have to be expanded.

(4) Frequency

According to the information acquired in the site investigation, generators owned by IPPs and PLN (Muara Tawar 3.1, 3.2, 3.3, 4.1, 4.2, 4.3) are operated with governor free mode, but generators owned by IP and PJB do not carry out governor free operation. Therefore, it is IPP and some of Muara Tawar that control frequency in short period. ATURAN JARINGAN Java-Madura-Bali regulates that all power stations have to be operated with governor free mode. In addition, P3B UBOS instructed each power station to operate with governor free mode. In order to keep frequency stable, it is recommended that these generators of IP and PJB are operated with governor free.

4. Rehabilitation, Modification and Repowering Plans based on Existing Facilities

4.1. Thermal Power Stations

4.1.1. Technical Study

(1) Tambak Lorok PLTU#1&#2 Combined Cycle Conversion Plan

The basic design figures of the main components of the plan are as follows:-

◊ GT& Generator ;	F-Type Gas Turbine, 240 MW Capacity at 30°C Gas/HSD Dual Firing, DLN*1 for Gas & Water Injection for HSD*2 282 kVA Generator and Step-up Transformer
◊ HRSG ;	One Drum Type, Steam Condition 88 kg/cm^2g × 510°C
◊ Existing STs & Generators ;	Single-flow Condensing Type Steam Turbines, 50MW Capacity × 2 sets Rehabilitation of Turbine Rotor and Renewal of Governor
◊ Existing ST Generators & Step-up Transformers ;	Capacity 60kVA × 2sets, Rehabilitation of Stator Coil Rewinding
◊ Instrument & Control Systems ;	C/C Operation System
◊ Major BOP;	BFPs (Boiler feedwater Pumps), Steam & Water Piping and Valves
◊ Electrical Equipments & S/S ;	Conventional Type (150kV Connection)

*1) DLN: Dry Low NOx Combustion
*2) HSD: High Speed Diesel Oil

The summary of the repowering plan;

① Repowering; 186.4MW
② EPC cost; 159.3 Million US$

(2) Grati Block II PLTGs Combined Cycle Conversion Plan

The basic design figures of the main components of the plan are basically same as Block I and are as follows:-

◊ Existing GT & Generator ;	701D-Type × 3 sets, Gas/HSD Dual Firing Capacity 112.45MW for Gas, 100.75MW for HSD at 32°C Generator & Step-up Transformer 135 kVA × 3 sets

◊	HRSG;	Two Drum Type × 3 sets, 75 kg/cm^{2}g × 505°C & 5.2 cm^{2}g × 176°C
◊	ST & Generator;	HP/LP Tandem Compound Condensing Type × 1 set, Capacity 189.5 MW, Condenser Vacuum 0.085P Generator/Step-up Transformer 225kVA
◊	Instrument & Control Systems;	C/C Control System
◊	Major BOP;	Intake/Discharge Facilities, CWPs (Cooling Water Pumps) & CW, Piping, BFPs (Boiler Feedwater Pumps)
◊	Station Electrical Equipments & S/S;	Conventional Type (150kV Connection)

The repowering output of the plan for oil firing is 159.58MW as ST output.
The EPC cost of the above repowering plan is estimated as 159.3 Million US$.

(3) Gilimanuk PLTG Combined Cycle Conversion Plan

The basic design figures of the main components of the plan are as follows:-

◊	Existing GT & Generator ;	13E2-Type × 1set, HSD Firing (Originally Gas/HSD Dual Firing) Capacity 133.8 MW for HSD Generator & Step-up Transformer 170kVA × 1set
◊	HRSG;	Two Drum Type × 1 set, 70 kg/cm^{2}g × 510°C & 5.2 kg/cm^{2}g × 155°C
◊	ST & Generator;	T/Compound Condensing Type × 1 set Capacity 67 MW, Condenser Vacuum 0.15 kg/cm^2 Generator/Step-up Transformer 80 kVA
◊	Air Cooled Condenser*;	L 52m × W 50m × H 34m, Fan/Motor 149kW × 16 sets
◊	Instrument & Control Systems;	C/C Control System
◊	BOP;	ST Exhaust Piping, CWPs & CW Piping, BFPs & FW Piping
◊	Station Electrical Equipments & S/S;	Conventional Type (150kV Connection)

The repowering output of the plan is 67.0MW as the steam turbine output.
The EPC cost of the above repowering plan is estimated as 66.4 Million US$. This cost includes the installation expenditure of ACC (Air Cooled Condenser) system, but, does not include the purchasing expense of the land for the site extension.

(4) Concept of Oil Reduction Plans

The basic idea of oil reduction plans is based on the followings;

◊ Reduce Oil Consumption Totally per UBP*

◊ Stop the Operation of the Existing Less Heat Efficient Simple Cycle Gas Turbines (PLTGs) and/or Steam Plants (PLTUs) within the UBP's management territory

◊ Instead of above Stopping Units (as the alternative plant),
① To convert the Existing GTs to a Higher Efficient Combined Cycle Plant, this means a Conversion-type Repowering Plan, or,
② To install a newly Higher Efficient Combined Cycle Plant, this means a Scrap & Build-type Repowering Plan

(5) UBP Semarang Oil Reduction Plan

UBP Semarang manages and controls the following thermal power stations and their power units. The following oil reduction scheme will be born;

◊ Less Efficient Oil Firing Plants to be stopped

T.Lorok PLTU #1& #2 (MFO Firing)	50MW × 2 units
Sunyaragi PLTG #1- #4(HSD Firing)	20MW × 4 units
Cilacap PLTG #1& #2(HSD Firing)	26MW + 29MW
Total Capacity of above Stopping Plants	235MW

◊ An Alternative Combined Cycle Plant to be newly installed

F-type GT+HRSG+ST/Generator	PLTGU (1-1-1)
C/C Output at HSD Firing	307.4MW

◊ Repowering & Oil Consumption Reduction to be obtained

Repowering	(307.4 – 235 = 72.4)	72.4MW
Oil Reduction	PLTGU Consumption < Stopping Plants Consumption	

The basic specification data of the alternative C/C Plant (1-1-1) is as follows;

◊ GT& Generator ;	F-Type, Capacity 240MW at 30°C Gas/HSD Dual Firing with Low NOx Combustor Generator & Step-up Transformer 285 kVA
◊ HRSG;	RH & Three Drums Type, Steam Condition 110 kg/cm^{2}g × 538/566°C
◊ ST& Generator;	RH T/C Condensing Type, ST Capacity 133MW, Generator & step-up Transformer 160kVA
◊ Instrument & Control Systems;	C/C Control System

◊ BOP; Intake & Discharge Water Facilities, Steam & Feedwater Piping and Valves

◊ Electrical Equipments & S/S; Conventional Type (150kV Connection)

This combined cycle PLTGU (1-1-1) will be proposed to be installed at the open space area now being used as the football field next to the existing PLTU#3 unit.

The performance data of the alternative C/C Plant will be as follows;

Gas Firing	GT Output	236.9MW
	ST Output	133.0MW
	Plant Output	369.9MW
	Plant Efficiency	56.4% (LHV)
HSD Firing	GT Output	206.4MW
	ST Output	101.0MW
	Plant Output	307.4MW
	Plant Efficiency	50.4% (LHV)

(6) UBP Perak/Grati Oil Reduction Plan

UBP Perak/Grati manages and controls both of Perak and Grati Power Stations and their Power Units.
The following oil reduction scheme will be born;

◊ Less Efficient Oil Existing Plants to be stopped.
Perak PLTU#3&#4 (MFO Firing) 50MW × 2 units

◊ Grati BLK II PLTG#1-#3 101.90MW × 3units to be converted into a higher efficient Alternative Combined Cycle Plant.
Newly Installed HRSG × 3+ST/Generator × 1 PLTGU (3-3-1)
C/C Output at HSD Firing 461.83MW

The Basic Specification of Grati BLK II PLTGU (3-3-1) is as follows;

◊ Existing GT& Generator ; 701D-Type × 3 sets, Gas/HSD Dual Firing
Capacity 112.45MW for Gas, 100.75MW for HSD at 32°C

◊ HRSG; Two Drum Type × 3 sets, 75 kg/cm^{2}g × 505°C T & 5.2 kg/cm^{2}g × 176°C

◊ ST& Generator; HP/LP T/Compound Condensing Type × 1 set,
Capacity 189.5MW, Condenser Vacuum 0.085ata

◊ Instrument & Control Systems; C/C control system

◊ BOP; Intake/Discharge Facilities, CWPs & CW Piping, BFPs & Piping

◊ Station Electrical Equipments & S/S;	Conventional Type (150kV Connection)

It is noted that Grati Block II PLTGU (3-3-1) Specification is just same as Block I (3-3-1).

Then, HSD firing performance of Grati Block II Alternative C/C is the same as Block I.

◊ GT/ST Output	100.75MW × 3/159.58MW
◊ Plant Output	461.83MW
◊ Plant Thermal Efficiency	47.1% (LHV)

(7) UBP Bali Oil Reduction Plan

UBP Bali manages and controls three thermal power stations and the grid power from Java Island.

The following oil reduction scheme will be born;

◊ Less Efficient Oil Fired Existing Plants to be stopped.

Pesanggaran PLTG #1& #2 (HSD Firing)	21.4+20.1MW
Pesanggaran PLTD #1- #4 (HSD Firing)	5.08MW × 4

◊ Gilimanuk PLTG to be converted to a Higher Efficient Alternative Combined Cycle Plant.

One Newly Installed HRSG + One ST/Generator	PLTGU (1-1-1)
C/C Output at HSD Firing	200MW

◊ Repowering & Oil Consumption Reduction to be obtained.

Repowering	67.0 – (41.5+ 20.3) = 5.2	5.2MW

Oil Reduction; Oil Consumption by Stopping Plants

The basic design figures of the main components of the plan are as follows:-

◊ Existing GT& Generator ;	13E2-Type × 1 set, HSD Firing (Originally Gas/HSD Dual Firing), Capacity 133MW for HSD
◊ HRSG;	Two Drum Type × 1 set, 70 kg/cm^{2}g × 510°C & 5.2 kg/cm^{2}g × 155°C
◊ ST& Generator;	T/Compound Condensing Type × 1 set, Capacity 67MW, Condenser Vacuum 0.15P
◊ Air Cooled Condenser*	L 52m × W 50m × H 34m Structure and Cooling Surfaces, Fan/Motor 149kW × 16 sets
◊ Instrument & Control Systems;	C/C Control System
◊ BOP;	ST Exhaust Piping, CWPs & CW Piping, BFPs & FW Ping
◊ Station Electrical Equipments & S/S;	Conventional Type (150kV Connection)

4.1.2. Economic Financial Analysis

(1) Proposed Repowering Plans

Table 4.1-5 Outline of Proposed Plans

Case No.	Final Plans	Fuel Type	Proposed Plan		Investment Cost (Additional Output)
1	**Tambak Lorok**		Conversion to C/C (PLTGU 1-1-2) by utilizing existing PLTU #1&#2 and adding one (1) GT & one (1) HRSG		
1.1		HSD	GT output ST output Plant output Plant efficiency	206.4 MW 40.0 MW × 2 units 286.4 MW 47.0 % (LHV base)	179.0 M.US$ (186.4 MW)
1.2		Gas	GT output ST output Plant output Plant efficiency	236.9 MW 50.7 MW × 2 units 338.3 MW 51.6 % (LHV base)	179.0 M.US$ (238.3 MW)
2	**Grati**		Conversion to C/C (PLTGU 3-3-1) by utilizing existing BLK 2 PLTG #1, #2 and #3, and adding three (3) HRSG & one (1) ST		
2.1		HSD	GT output ST output Plant output Plant efficiency	100.75 MW × 3 units 159.58 MW 461.83 MW 47.1 % (LHV base)	179.0 M.US$ (120.3 MW)
2.2		Gas	GT output ST output Plant output Plant efficiency	112.45 MW × 3 units 189.5 MW 526.85 MW 49.8 % (LHV base)	179.0 M.US$ (185.4 MW)
3	**Gilimanuk**		Conversion to C/C (PLTGU 1-1-1) by utilizing existing PLTG and adding one (1) HRSG & one (1) ST		
3.1		HSD	GT output ST output Plant output Plant efficiency	133.00 MW 67.00 MW 200.00 MW 49.6 % (LHV base)	74.6 M.US$ (66.2 MW)
4	**UBP Semarang** Shutdown of Tambak Lorok PLTU #1 & #2 (50 MW each) and also shutdown of Sunyaragi #1~#4 (20 MW each) and Cilacap PLTG #1 & #2 (29 MW and 26 MW each)		New C/C (PLTGU 1-1-1) consisting of a new large GT, one HRSG and one ST.		
4.1		HSD	GT output ST output Plant output Plant efficiency	206.4 MW 101.0 MW 307.4 MW 50.4 % (LHV base)	238.6 M.US$ (72.4 MW)
4.2		Gas	GT output ST output Plant output Plant efficiency	236.9 MW 133.0 MW 369.9 MW 56.4 % (LHV base)	238.6 M.US$ (134.0 MW)
5	**UBP Grati and Perak** Shutdown of Perak PLTU #3 (50 MW) & #4 (50 MW)		Conversion to C/C (PLTGU 3-3-1) by utilizing of Grati BLK 2 PLTG #1~#3 and adding three (3) HRSG and one (1) ST. Shutdown of Perak PLTU #3 and #4.		
5.1		HSD	GT output ST output Plant output Plant efficiency	100.75 MW x 3 units 159.58 MW 461.83 MW 47.1 % (LHV base)	179.0 M.US$ (20.3 MW)
5.2		Gas	GT output ST output Plant output Plant efficiency	112.45 MW x 3 units 189.5 MW 526.85 MW 49.8 % (LHV base)	179.0 M.US$ (85.4 MW)
6	**UBP Bali** [4] Shutdown of Pesanggaran PLTG #1 (21 MW) & #2 (20 MW)		Conversion to C/C (PLTGU 1-1-1) by utilizing existing Gilimanuk GT and adding one HRSG and one ST. Shutdown of Pesanggaran PLTG #1 and #2		
6.1		HSD	GT output ST output Plant output Plant efficiency	133.00 MW 67.00 MW 200.00 MW 49.6 % (LHV base)	74.6 M.US$ (25.2 MW)

[4] There seems to be possibility of shutdown of Pesanggaran PLTD #1 ~ #4.

(2) Economic Analysis

The economic analysis for the proposed plans is resulted in as follows;

Table 4.1-6 Result of Ecnomic Analysis

	Case	Fuel Type (new plans)	EIRR (2006 Price)	Fuel Saving (KL/year)	Fuel Saving (M.US$/year)	EIRR (2003 Price)	Judgment
Tambak Lorok	1.1	HSD	N.A	-48,200	-2.4	N.A	×
	1.2	Gas	18.3 %	-58,949	-43.7	-1.0 %	×
Grati	2.1	HSD	15.1 %	-67,120	-37.3	-0.3 %	×
	2.2	Gas	25.4 %	-71,100	-61.9	5.3 %	×
Gilimanuk	3.1	HSD	54.8 %	-122,862	-68.2	24.3 %	○
	3.2[5]	Gas	76.1 %	-122,886	-111.8	34.5 %	○
UBP Semarang	4.1	HSD	11.9 %	-116,347	-40.2	-2.7 %	×
	4.2	Gas	29.2 %	-133,205	-95.2	7.2 %	×
UBP Grati/ Perak	5.1	HSD	18.2 %	-114,112	-43.9	1.3 %	×
	5.2	Gas	37.4 %	-122,867	-97.9	11.6 %	×
UBP Bali	6.1	HSD	61.4 %	-144,699	-80.4	28.1 %	○
	6.2	Gas	83.5 %	-144,695	-129.5	38.8 %	○

Note: 1) N.A means EIRR cannot be calculated.
2) Fuel Saving for gas case is expressed in equivalent of oil (KL).

The above results indicate all proposed plans except case 1.1 are economically feasible significantly. If HSD, MFO and Natural Gas price were 1,780 Rp/l, 1,270 Rp/l, and 26,600 Rp/MMBTU respectively, which were the fuel prices of Gresik Power Station in the year 2003 for example, economically feasible plans narrow to Gilimanuk (Case 3) and UBP Bali (Case 6) for the case of HSD as shown in the above table. The above sensitivity test regarding the fuel oil prices indicates that the repowering plans have had economic advantages significantly under the current expensive fuel situation.

(3) Financial Analysis

Since the project FIRR exceeding the hurdle rate of 12 % cannot be expected resulting from the above annualised generation cost because the annualized generation cost does not consider the station use of 5 %, the power selling price meeting the hurdle rate of 12 % for earning after tax (EAT) was calculated and the results are shown in the following table.

[5] The case of gas firing for Gilimanuk P/S is reference because the possibility of gas supply to Bali Island seems to be pessimistic at the moment.

Table 4.1-7 Result of Fianncial Analysis

	Case	Fuel Type	Generation Energy (MWh)	Selling Price 12 % FIRR (a) (Rp/kWh)	Selling Price to PLN (b) (Rp/kWh)	(a)/(b)	(a) – (b) (Rp/kWh)
Tambak Lorok	1.1	HSD	596,806	1,527	1,033	1.48	494
	1.2	Gas	596,806	874	502	1.74	372
Grati	2.1	HSD	365,060	1,834	1,033	1.78	801
	2.2	Gas	365,060	1,203	502	2.40	701
Gilimanuk	3.1	HSD	707,391	1,174	1,033	1.14	141
	3.2	Gas	707,391	590	502	1.18	88
UBP Semarang	4.1	HSD	841,807	1,447	1,033	1.40	414
	4.2	Gas	841,807	830	502	1.65	328
UBP Grati/ Perak	5.1	HSD	801,140	1,419	1,033	1.37	386
	5.2	Gas	801,140	784	502	1.56	282
UBP Bali	6.1	HSD	797,891	1,168	1,033	1.13	135
	6.2	Gas	797,891	585	502	1.17	83

Note: Generation cost for Case 4, 5 and 6 don't include fuel cost saving to be shutdown.

(4) Measures toward Implementation

Table 4.1-8 Measures toward Implementation

	Case	Base Generation Energy (MWh)	Price Difference (Rp/kWh)	Additional Burden by PLN (a) (M.US$)	Annual Fuel Saving (b) (M.US$)	(a)/(b) ABS((a)/(b))	Net Profit for PLN -(a)-(b) (M.US$)
UBP Bali	**6.2**	797,891	136	12.1	-129.8	0.09	117.7
Gilimanuk	**3.2**	707,391	163	12.8	-112.0	0.11	99.2
UBP Bali	**6.1**	797,891	184	16.3	-81.0	0.20	64.7
UBP Grati/Perak	**5.2**	801,140	440	39.2	-97.9	0.40	58.7
UBP Semarang	**4.2**	841,807	438	41.0	-95.2	0.43	54.2
Gilimanuk	**3.1**	707,391	211	16.6	-68.8	0.24	52.2
Grati	**2.2**	365,060	1,068	43.3	-61.9	0.70	18.6
Tambak Lorok	**1.2**	596,806	593	39.3	-43.7	0.90	4.4
UBP Grati/Perak	**5.1**	801,140	547	48.7	-43.9	1.11	-4.8
Grati	**2.1**	365,060	1,163	47.2	-37.3	1.27	-9.9
UBP Semarang	**4.1**	841,807	607	56.8	-40.2	1.41	-16.6
Tambak Lorok	**1.1**	596,806	717	47.5	-2.4	19.79	-45.1

The above table shows the relationship between additional burden by PLN and net profit for PLN and is ranked in descending order of net profit for PLN.

If PLN can compensate UBP Bali for the shutdown of Pesanggaran PLTG #1 and #2 with money amounted to 12.0 Million US$ per annum, case 6.1 can become financially feasible and PLN can still enjoy the fuel saving to the amount of 68.4 Million US$ per annum. If the above compensation is adapted to the current trade system between PLN and a power seller (PT Indonesia Power), eleven (11) plans out of twelve (12) plans could become financially feasible subject to positive net profit for PLN.

(5) Conclusion and Recommendation

Based on the economic and financial analyses, conclusion and recommendation are as follows;

1) All repowering plans except case 1 resulted in economically feasible. PLN can expect to save a large amount of oil, which leads to reduction of generation cost and financial burden of PLN as a power purchaser. The higher fuel prices rise, the higher EIRR is expected. Furthermore, the saved amount of fuel can be allocated to other industries for further production or to export to gain more hard currencies. However, all repowering plans resulted in financially not feasible under the current average power selling prices.

2) "Economically feasible and financially not feasible" might be interpreted as the current power selling prices[6] to PLN are rather low taken account of expensive fuel.

3) If PLN can compensate for the UBP involved in shutdown with money of part of fuel saving, most repowering plans could be financially feasible and the both parties, a seller and a buyer, could share the profits by implementation of repowering/oil reduction plans.

4) Economic and financial analyses indicated that UBP Bali (Case 6) was the most attractive plans. Therefore, the implementation of case 6 is strongly recommended.

5) Under the current fuel situation in Indonesia, the concept of proposed repowering/oil reduction might indicate the future directional movement relating to oil fired thermal stations in parallel with the promotion of the new crash program.

6) Concerning rehabilitation/modification plans to improve the reliability of operation mainly, utilization of export credit as mentioned in Section 2.5 is recommended.

4.1.3. Environmental and Social Consideration

This section evaluates the environmental burden relating to rehabilitation/modification and repowering plans for the existing power generation facilities. Concerning the thermal power stations, rehabilitation and modification plans, such as restoring the capacity and/or replacement of power facilities, are already planned by IP, PJB and PLN and some repowering plans are proposed by the JICA Study Team.

And it seems there are not any issues to be considered form the viewpoint of environmental and social consideration in respect of "Improvement Measures for Operation and Maintenance for the existing power generation facilities".

[6] Power tariff rate for consummers has not been changed since 2003 by the President Decree No. 104.

(1) Environmental Impact Scoping relating to Repowering Plans

Proposed repowering plans are all conversion plans from the existing plants to PLTGU for Tambak Lorok Power Station, Grati Power Station and Gilimanuk Power Station. In combination with these power stations, oil reduction plans are also proposed in manner of shutdown of the existing lower thermal efficiency plants by UBP basis.
The outline of the proposed plans is as mentioned in Section 4.1.1.

1) Each Repowering Plans

Outline of repowering plan, envisaged environmental impact and surrounding condition for each repowering plan are as follows.

Tambak Lorok Power Station

－Outline－

The existing PLTU boilers for unit 1 and unit 2 will be removed. One gas turbine and one HRSG will be newly constructed. In combination with the existing two steam turbines and generators, the existing plants are converted to PLTGU (1-1-2).
PLTGU will be designed as dual firing of gas and HSD as well as the existing PLTGU. However, it seems to be unforeseeable to promote the repowering plan by gas firing.

－Environmental Impact－

The amount of combustion gas would be more than that of existing two boilers. However, if a new gas turbine adopts the low NOx combustion technology, the total pollutant amount consisting of SOx, NOx, dust and so on seem to be not increased. Since the power output of steam turbine does not increase, the thermal effluent from the condenser remains the current level.

－Surrounding Condition－

According to the atmospheric monitoring data in 2005, NO_2 and dust were lower than the emission standard values and SO_2 was close to the upper limit of the emission standard for PLTU unit 1 and unit 2 (no monitoring data for PLTU unit 3). Concerning the water quality monitoring data, water temperatures at intake and outlet indicated 29.5°C and 36.2°C respectively.
Field survey conducted in 1999 reported the existence of the avicennia alba near the power station, which is widely observed in south-eastern Asia. Other precious fauna and flora were not identified (IP, 2004 [7])

－Others－

The ground settlement with about 4 cm per annum occurs at the periphery of the power station and peripheral roads are submerged. The power station is also

[7] Indonesia Power, 2004, "ANDAL Revisi Pengembangan PLTGU Tambaklorok I - Semarang"

sometimes submerged and is forced to stop the operation due to the unavailability of the cooling pump. Tambak Lorok power station seems to be constructed on the reclaimed land and the ground resettlement might occur according to the map.

Grati Power Station

－Outline－

The conversion to PLTGU as well as Block I is achieved in manner of adding new three (3) HRSG and one steam turbine/generator to existing three gas turbines in Block II (3-3-1).

－Environmental Impact－

Since the amount of fuel consumption will not increase, the total emission also will not increase. However, thermal effluent from the condenser will increase twice as high due to the addition of a new steam turbine.

－Surrounding Condition－

According to the atmospheric monitoring data in 2005, NO_2, SO_2 and dust from the current six (5) gas turbines cleared the emission standard. The air quality at the monitoring point also cleared the air standard. The water temperatures measured in December 2003 at intake and outlet indicated 32.0°C and 35.0°C respectively (IP, 2004[8]).

The field survey in 2004 reported the existence of kingfisher race and heron race at the periphery of the power station, of which number has been rather decreased recently worldwide. Other precious fauna and flora were not identified (IP, 2004[4]).

－Others－

There seems to be no ecological importance area, such as mangrove, and residential area near the power station. According to the results of scoping as described later, increase of thermal effluent is seems to make the most impact on the ambient surrounding. The AMDAL approved in March 2005 for Block III was prepared in manner of adding new Block III to the current Blocks. The AMDAL said that the diffusion of thermal effluent would enlarge within a certain area only. Therefore, the thermal effluent seems to cause minor impact. The new or revised AMDAL for the proposed repowering plan in Block II might not be necessary because the AMDAL in March 2005 for Block III could be utilized for the proposed repowering plan.

Gilimanuk Power Station

－Outline－

PLTGU will be achieved in manner of adding one bottoming plant HRSG and one steam turbine/generator to the existing gas turbine (1-1-1).

[8] Indonesia Power, 2004, “Review ANDAL PLTGU Grati I & II Pasuruan”

－Environmental Impact－

Since the amount of fuel consumption will not increase, the total emission also will not increase. Emission gas temperature will lower and the concentration on the ground of air contaminant will change accordingly. However, there seems to be no occurrence of environmental issues because the existing plants adopt the low NOx combustion technology although it is necessary to confirm no occurrence of environmental issues by the diffusion simulation of air contaminant.

Since the cooling water by seawater seems to be difficult due to the relevant landscape (existing plants are installed at +4 m or more above sea level and the candidate site is located at inland with 1 km far from the seashore.), air cooling condenser is provisionally proposed. The type of cooling system will be further studied in combination with the study on the availability of seawater.

－Surrounding Condition－

According to the atmospheric monitoring data in 2004 and 2005 for a gas turbine, NO_2, SO_2 and dust cleared the emission standard.

Field survey conducted in 1997 reported the existence of Biawak (scientific name: *Varanus salvator*), which belong to Appendix II of Washington Convention. Addition to Biawak, mangrove forest, marine forest and shelf of coral were also identified (PT. PLN, 1998[9]).

－Others－

Repowering plan for Gilimanuk requires extension of area to a certain degree because of new installation of steam turbine. The extension of area shall be carefully considered to avoid the adjacent national park, and houses spread in the north of the power station.

Because ecological importance sea area, such as mangrove forest and shelf of coral, are spread at the periphery of Gilimanuk power station, study on the thermal effluent impact is required in case of using seawater as cooling water.

2) Oil Reduction Plan

The above power stations involved in the repowering plans are managed by UBP (Unit Bisnis Pembangkitan: Generation Business Unit). The outline of oil reduction plan by UBP basis and envisaged environmental impact is as follows. Since the surrounding conditions and so on for oil reduction plan are the same as those of each repowering plan as mentioned above, the relevant description is omitted here.

UBP Semarang

－Outline－

New one-axis PLTGU by F-type GT (1-1-1) will be constructed adjacent to the

[9] PT.PLN, 1998, "Analisis Dampak Lingkungan (ANDAL) PLTG Gilimanuk, Bali"

existing PLTU unit 3. On the other hand, Sunyaragi power station PLTG unit 1 to unit 4, Cilacap power station PLTG unit 1 and 2, which are belonging to UBP Semarang, and Tambak Lorok PLTU unit 1 and unit 2 will be shutdown for the fuel oil saving.

－Environmental Impact－

Regarding the amount of combustion gas and total pollutant amount are the same condition as those of above repowering plan. However, since the power output of a new steam turbine proposed in UBP Semarang is bigger than the total power outputs of existing PLTU unit 1 and unit 2 of Tambak Lorok, thermal effluent will increase in compared with the current level.

In connection with the shutdown of Sunyaragi and Cilacap power stations, social consideration to the peripheral residents, whose livelihood depend on the power stations, handling of unnecessary power facilities and utilization of empty lots shall be carefully considered.

UBP Perak/Grati

－Outline－

Outline of repowering plan is the same as that of Grati power station. Furthermore, Perak PLTU unit 3 and unit 4 belonging to UBP Perak/Grati will be shutdown for the fuel oil saving.

－Environmental Impact－

Environmental burden will be decreased in proportion to the shutdown of Perak PLTU unit 3 and unit 4. In connection with the shutdown of Perak power station, social consideration to the peripheral residents, whose livelihood depend on the power station, handling of unnecessary power facilities and utilization of empty lots shall be carefully considered.

UBP/Bali

－Outline－

Outline of repowering plan is the same as that of Gilimanuk power station. Furthermore, Pesanggaran PLTG unit 1 and unit 2 and possibility of PLTD unit 1 to unit 4 will be shutdown for the fuel oil saving.

－Environmental Impact－

Environmental burden will be decreased in proportion to the shutdown of Pesanggaran PLTG unit 1 and unit 2 and PLTD unit 1 to unit 4. In connection with the shutdown of parts of Pesanggaran power station, social consideration to the peripheral residents, whose livelihood depend on the power station, handling of unnecessary power facilities and utilization of empty lots shall be carefully considered.

Based on the consultation with the environmental staff in the IP head office regarding the proposed repowering plans, the scoping for environmental burden was prepared provisionally. Table 4.1-14 shows the scoping relating to repowering plans and Table 4.1-15 shows the scoping relating to the combination of repowering and oil reduction plans.

(2) Required Investigation toward Implementation

Based on the results of scoping about proposed repowering and oil reduction plans, the following items deem to be required investigation toward the implementation of proposed plans.

Tambak Lorok Power Station

Items	Assessment Procedure	Survey Items
Air Quality	Pollution Prediction	- Meteorological Investigation (Air Temperature, Humidity, Wind Direction, Wind Velocity, Atmospheric Stability, etc.) - Parameters of Exhaust Gas (Amount of Emission, Temperature of Exhaust Gas, etc.)
Water Quality	-	-
Taking the cooling water	-	-
Soil and Ground	Situation and Forecast of Ground Settlement	- Leveling - Drilling Survey (Geologic Condition, Type of Soil, etc.)
Fauna and Flora	-	-
Endangered Species	-	-
Noise and Vibration	Prediction of Noise and Vibration	- Survey of Noise and Vibration - Equipment Noise Level and Vibration Level
Waste	-	-
Offensive Odor	-	-
Population and Industry	-	-
Poverty Group and Ethnic Tribes	-	-
Water Usage	-	-
Protective Zone	-	-
Cultural Facilities	-	-
Sanitary Conditions	-	-
Landscape	-	-
Land Usage	-	-
Impacts during Construction -Living and Livelihood -Air Pollution -Water Pollution -Noise and Vibration	- Reduction Measures - Proper Plan at Construction Period - Education to worker - Selection of Construction Machine - Others (Water Spray, Installation of Portable Toilets, etc.)	- Use of Optimization Technique (For instance PERT Technique) - Conduct of Monitoring Study during Construction Period (Population, Industry, Air Quality, Water Quality, Noise and Vibration, etc.)

Grati Power Station

Items	Assessment Procedure	Survey Items
Air Quality	-	-
Water Quality	-	-
Taking the cooling water	-	-
Soil and Ground	-	-
Fauna and Flora	-	-
Endangered Species	-	-
Noise and Vibration	Prediction of Noise and Vibration	- Survey of Noise and Vibration - Equipment Noise Level and Vibration Level

Items	Assessment Procedure	Survey Items
Waste	-	-
Offensive Odor	-	-
Population and Industry	-	-
Poverty Group and Ethnic Tribes	-	-
Water Usage	-	-
Protective Zone	-	-
Cultural Facilities	-	-
Sanitary Conditions	-	-
Landscape	-	-
Land Usage	-	-
Impacts during Construction - Conflict of Interests -Living and Livelihood -Air Pollution -Water Pollution -Noise and Vibration	- Understanding of Consideration of Resident to Power Station - Reduction Measures - Proper Plan at Construction Period - Education to worker - Selection of Construction Machine - Others (Water Spray, Installation of Portable Toilets, etc.)	- Attitude Survey to Power Station (Survey by Questionnaire) - Use of Optimization Technique (For instance PERT Technique) - Conduct of Monitoring Study during Construction Period (Population, Industry, Air Quality, Water Quality, Noise and Vibration, etc.)

Gilimanuk Power Station

Items	Assessment Procedure	Survey Items
Air Quality	-	-
Water Quality	Diffusion Prediction of Thermal Effluent	- Hydrographic Investigation (Water Temperature, Current Direction, Current Velocity, etc.) - Meteorological Investigation (Air Temperature, Humidity, Wind Velocity, Cloud Cover, etc.) - Investigation of Organism (Sessile Organisms, Vegetation, etc.) - Parameters of Thermal Effluent (Amount of Discharge, Temperature of Thermal Effluent)
Taking the cooling water	Prediction of intake of plankton	Investigation of Organism (Plankton)
Soil and Ground	-	-
Fauna and Flora	Examination of Additional Site	Investigation of Land Usage (Mangrove, etc.)
Endangered Species	-	-
Noise and Vibration	Prediction of Noise and Vibration	- Survey of Noise and Vibration - Equipment Noise Level and Vibration Level
Waste	-	-
Offensive Odor	-	-
Population and Industry	-	-
Poverty Group and Ethnic Tribes	Examination of possibility about unfairly distribution between Bali Native and Java People	Social Investigation (Industrial Structure, Employed Workforce, etc.)
Water Usage	Prediction of Volume of intake Water	Survey of Water Usage (Fisheries Industry, etc.)
Protective Zone	Diffusion Prediction of Thermal Effluent	- Hydrographic Investigation (Water Temperature, Current Direction, Current Velocity, etc.) - Meteorological Investigation (Air Temperature, Humidity, Wind Velocity, Cloud Cover, etc.) - Investigation of Organism (Sessile Organisms, Vegetation, etc.) - Parameters of Thermal Effluent (Amount of Discharge, Temperature of Thermal Effluent)
Cultural Facilities	-	-
Sanitary Conditions	-	-
Landscape	Prediction of Scenery	Situation and Prediction of Scenery
Land Usage	Examination of Additional Site	Investigation of Land Usage (residential land, etc.)
Impacts during Construction ・Living and Livelihood ・Air Pollution ・Water Pollution ・Noise and Vibration	- Reduction Measures - Proper Plan at Construction Period - Education to worker - Selection of Construction Machine	- Use of Optimization Technique (For instance PERT Technique) - Conduct of Monitoring Study during Construction Period (Population, Industry, Air Quality, Water Quality, Noise

Items	Assessment Procedure	Survey Items
	- Others (Water Spray, Installation of Portable Toilets, etc.)	and Vibration, etc.)

UBP Semarang

Items	Assessment Procedure	Survey Items
Air Quality	Pollution Prediction	- Meteorological Investigation (Air Temperature, Humidity, Wind Direction, Wind Velocity, Atmospheric Stability, etc.) - Parameters of Exhaust Gas (Amount of Emission, Temperature of Exhaust Gas, etc.)
Water Quality	Diffusion Prediction of Thermal Effluent	- Hydrographic Investigation (Water Temperature, Current Direction, Current Velocity, etc.) - Meteorological Investigation (Air Temperature, Humidity, Wind Velocity, Cloud Cover, etc.) - Investigation of Organism (Sessile Organisms, Vegetation, etc.) - Parameters of Thermal Effluent (Amount of Discharge, Temperature of Thermal Effluent)
Taking the cooling water	Prediction of intake of plankton	Investigation of Organism (Plankton)
Soil and Ground	Situation and Forecast of Ground Settlement	- Leveling - Drilling Survey (Geologic Condition, Type of Soil, etc.)
Fauna and Flora	-	-
Endangered Species	-	-
Noise and Vibration	Prediction of Noise and Vibration	- Survey of Noise and Vibration - Equipment Noise Level and Vibration Level
Waste	-	-
Offensive Odor	-	-
Population and Industry	Examination of Change in Industrial Structure	Social Investigation (Industrial Structure, Employed Workforce, etc.)
Poverty Group and Ethnic Tribes	-	-
Water Usage	Prediction of Volume of intake Water	Survey of Water Usage (Fisheries Industry, etc.)
Protective Zone	Diffusion Prediction of Thermal Effluent	- Hydrographic Investigation (Water Temperature, Current Direction, Current Velocity, etc.) - Meteorological Investigation (Air Temperature, Humidity, Wind Velocity, Cloud Cover, etc.) - Investigation of Organism (Sessile Organisms, Vegetation, etc.) - Parameters of Thermal Effluent (Amount of Discharge, Temperature of Thermal Effluent)
Cultural Facilities	-	-
Sanitary Conditions	-	-
Landscape	Prediction of Scenery	Situation and Prediction of Scenery
Land Usage	-	-
Impacts during Construction -Living and Livelihood -Air Pollution -Water Pollution -Noise and Vibration	- Reduction Measures - Proper Plan at Construction Period - Education to worker - Selection of Construction Machine - Others (Water Spray, Installation of Portable Toilets, etc.)	- Use of Optimization Technique (For instance PERT Technique) - Conduct of Monitoring Study during Construction Period (Population, Industry, Air Quality, Water Quality, Noise and Vibration, etc.)

UBP Perak-Grati

Items	Assessment Procedure	Survey Items
Air Quality	-	-
Water Quality	-	-
Taking the cooling water	-	-
Soil and Ground	-	-
Fauna and Flora	-	-
Endangered Species	-	-
Noise and Vibration	Prediction of Noise and Vibration	- Survey of Noise and Vibration

Items	Assessment Procedure	Survey Items
		- Equipment Noise Level and Vibration Level
Waste	-	-
Offensive Odor	-	-
Population and Industry	Examination of Change in Industrial Structure	Social Investigation (Industrial Structure, Employed Workforce, etc.)
Poverty Group and Ethnic Tribes	-	-
Water Usage	-	-
Protective Zone	-	-
Cultural Facilities	-	-
Sanitary Conditions	-	-
Landscape	Prediction of Scenery	Situation and Prediction of Scenery
Land Usage	-	-
Impacts during Construction - Conflict of Interests -Living and Livelihood -Air Pollution -Water Pollution -Noise and Vibration	- Understanding of Consideration of Resident to Power Station - Reduction Measures - Proper Plan at Construction Period - Education to worker - Selection of Construction Machine - Others (Water Spray, Installation of Portable Toilets, etc.)	- Attitude Survey to Power Station (Survey by Questionnaire) - Use of Optimization Technique (For instance PERT Technique) - Conduct of Monitoring Study during Construction Period (Population, Industry, Air Quality, Water Quality, Noise and Vibration, etc.)

UBP Bali

Items	Assessment Procedure	Survey Items
Air Quality	-	-
Water Quality	Diffusion Prediction of Thermal Effluent	- Hydrographic Investigation (Water Temperature, Current Direction, Current Velocity, etc.) - Meteorological Investigation (Air Temperature, Humidity, Wind Velocity, Cloud Cover, etc.) - Investigation of Organism (Sessile Organisms, Vegetation, etc.) - Parameters of Thermal Effluent (Amount of Discharge, Temperature of Thermal Effluent)
Taking the cooling water	Prediction of intake of plankton	Investigation of Organism (Plankton)
Soil and Ground	-	-
Fauna and Flora	Examination of Additional Site	Investigation of Land Usage (Mangrove, etc.)
Endangered Species	-	-
Noise and Vibration	Prediction of Noise and Vibration	- Survey of Noise and Vibration - Equipment Noise Level and Vibration Level
Waste	-	-
Offensive Odor	-	-
Population and Industry	Examination of Change in Industrial Structure	Social Investigation (Industrial Structure, Employed Workforce, etc.)
Poverty Group and Ethnic Tribes	Examination of possibility about unfairly distribution between Bali Native and Java People	Social Investigation (Industrial Structure, Employed Workforce, etc.)
Water Usage	Prediction of Volume of intake Water	Survey of Water Usage (Fisheries Industry, etc.)
Protective Zone	Diffusion Prediction of Thermal Effluent	- Hydrographic Investigation (Water Temperature, Current Direction, Current Velocity, etc.) - Meteorological Investigation (Air Temperature, Humidity, Wind Velocity, Cloud Cover, etc.) - Investigation of Organism (Sessile Organisms, Vegetation, etc.) - Parameters of Thermal Effluent (Amount of Discharge, Temperature of Thermal Effluent)
Cultural Facilities	-	-
Sanitary Conditions	-	-
Landscape	Prediction of Scenery	Situation and Prediction of Scenery
Land Usage	Examination of Additional Site	Investigation of Land Usage (residential land, etc.)
Impacts during Construction ・Living and Livelihood	- Reduction Measures	- Use of Optimization Technique (For instance PERT

Items	Assessment Procedure	Survey Items
・Air Pollution ・Water Pollution ・Noise and Vibration	- Proper Plan at Construction Period - Education to worker - Selection of Construction Machine - Others (Water Spray, Installation of Portable Toilets, etc.)	Technique) - Conduct of Monitoring Study during Construction Period (Population, Industry, Air Quality, Water Quality, Noise and Vibration, etc.)

(3) Mitigation Plans

According to the results of scoping, all plans are envisaged to be occurrences of the following impacts;

- atmospheric contamination and water contamination during the construction period
- degradation of hygiene viewpoint and disagreement between workers and peripheral residents due to the increase of workers

Regarding the atmospheric contamination, measures such as setting of the construction schedule preventing the concentrated works and conducting water spray seem to be necessary. In view of hygiene and water contamination, measures such as installation of portable toilets and so on seem to be necessary. And education of workers also seems to be necessary.

After commercial operation, atmospheric contamination and thermal effluent are envisaged. The low NOx technology can reduce atmospheric contamination to a certain degree.

- New AMDAL will be required for Tambak Lorok repowering plan and UBP Semarang oil reduction plan because both plans will increase thermal effluent in comparison with the current level.
- Since the AMDAL for Grati Block III is already approved, the approved AMDAL might be applied to the proposed repowering plan in Block II.
- Cooling water system by seawater for Gilimanuk repowering plan and UBP Bali oil reduction plan is required for further study from the viewpoint of environmental consideration because ecological importance area, such as mangrove forest, shelf of coral and marine forest, spread at the periphery of the power station. Furthermore, Gilimanuk repowering plan and UBP Bali oil reduction plan require the extension of area and the extension of area shall be carefully considered to avoid the adjacent national park, houses and mangrove forest.

Concerning the oil reduction plan consisting of shutdown of the existing units/power station, any measures will be required for the peripheral residents, whose livelihoods depend on the existing power stations. And handling of unnecessary power facilities and utilization of empty lots are also to be considered.

Table 4.1-14(1) Scoping Results of the Repowering Plan in Tambak Lorok Thermal Power Station

Criteria	Rating		Reasons
	Con	Ope	
Involuntary Resettlement	D	D	Since facilities will be added to the existing power station on its site, no local residents will ask relocation.
Local economy such as livelihood, etc.	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Land use and utilization of local resources	C	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Social institution such as social infrastructure and local decision making institution	C	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Existing social infrastructures and services	C	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
The poor, indigenous and ethnic people	C	D	Although the additional number of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Misdistribution of benefit and damage	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Cultural heritage	D	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated.
Local conflict of interests	C	D	Although the additional number of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Water Usage or Water Rights and Rights of Common	D	D	Since the steam turbine output will not increase, the intake volume of cooling water will not increase.
Sanitation	C	D	Although increase in the staff members is unknown, no increase of sewage will be anticipated. However, during construction, since the number of the worker increase, the increase of sewage will be anticipated.
Hazards (Risk) Infectious diseases such as HIV/AIDS	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, there is a possibility that the risk of infectious diseases increases.
Topography and Geographical features	D	D	Since additional facilities will not be large in scale, no impact will be anticipated.
Soil Erosion	D	C	Since ground subsidence in the site has been reported, the impact will depend on the type of the additional facilities.
Groundwater	C	D	If groundwater use for sanitation during construction, minor impact to groundwater will be anticipated
Hydrological Situation	D	D	Since the steam turbine output will not increase, the intake volume of cooling water will not increase.
Coastal Zone	D	D	Since the steam turbine output will not increase, the volume of the thermal effluent will not increase.
Flora, Fauna and Biodiversity	D	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated.
Meteorology	D	D	Since additional facilities will be not large in scale, no influence will be anticipated.
Landscape	D	D	Although facilities will be added to the existing power station on its site, minor impact to the scenery will be anticipated.
Global Warming	D	D	Since CO2 emissions will increase by additional facilities in small scale, minor impact will be anticipated.
Air Pollution	C	B	The proposed plan is the gas firing. The amount of gas emission will increases when the HSD firing. During construction, air pollution by construction machines will be anticipated.
Water Pollution	C	D	The volume of the thermal effluent will not increase. However, during construction, water pollution by construction machines will be anticipated.
Soil Contamination	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Waste	C	D	During construction, since the number of the worker increase, waste will increase.
Noise and Vibration	C	C	Since facilities will be added to the existing power station on its site, some impact to the surrounding environment will be anticipated. During construction, noise and vibration by construction machines will be anticipated
Ground Subsidence	D	C	Since ground subsidence in the site has been reported, the impact will depend on the type of the additional facilities
Offensive Odor	D	D	No source of bad odors will be added.
Bottom sediment	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Accident	C	D	Since additional facilities will be small in scale, the risk of accidents will not increase. However, during construction, there is a possibility that the risk of accidents increase.

Mention of marks on the “Rating” in the table as follow:

A : significant impact to the environment will be anticipated
B ; minor impact to the environment will be anticipated
C : impact to the environment may or may not occur right now
D ; no environmental impact will be anticipated (no problem)
Con: Construction phase
Ope: Operation phase

Table 4.1-14(2) Scoping Results of the Repowering Plan in Grati Thermal Power Station

Criteria	Rating		Reasons
	Con	Ope	
Involuntary Resettlement	D	D	Since facilities will be added to the existing power station on its site, no local residents will ask relocation.
Local economy such as livelihood, etc.	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Land use and utilization of local resources	C	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Social institution such as social infrastructure and local decision making institution	C	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Existing social infrastructures and services	C	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
The poor, indigenous and ethnic people	C	D	Although the additional number of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Misdistribution of benefit and damage	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Cultural heritage	D	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated.
Local conflict of interests	C	D	Although the additional number of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the surrounding residents are conservative, there is a possibility that conflict between the residents and the workers happens.
Water Usage or Water Rights and Rights of Common	D	D	The intake volume of cooling water is increased. However, its impact has been already evaluated. According to it, the impact is only in the limited range.
Sanitation	C	D	Although increase in the staff members is unknown, no increase of sewage will be anticipated. However, during construction, since the number of the worker increase, the increase of sewage will be anticipated.
Hazards (Risk) Infectious diseases such as HIV/AIDS	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, there is a possibility that the risk of infectious diseases increases.
Topography and Geographical features	D	D	Since additional facilities will not be large in scale, no impact will be anticipated.
Soil Erosion	D	D	Although facilities will be added to the existing power station on its site, no impact will be anticipated.
Groundwater	C	D	If groundwater use for sanitation during construction, minor impact to groundwater will be anticipated
Hydrological Situation	D	D	The intake volume of cooling water will increase. However, its impact has been already evaluated. According to it, the impact will be only in the limited range.
Coastal Zone	D	D	Since the volume of the thermal effluent will be increased, some impact to the surrounding aquatic organisms will depend on the volume of the thermal effluent.
Flora, Fauna and Biodiversity	D	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated.
Meteorology	D	D	Since additional facilities will be not large in scale, no influence will be anticipated.
Landscape	D	D	Although facilities will be added to the existing power station on its site, minor impact to the scenery will be anticipated.
Global Warming	D	D	Since fuel consumption is not increased, the amount of CO_2 emission will not increase.
Air Pollution	C	D	Since fuel consumption will not increase, the value of air pollutants will not increase. However, during construction, air pollution by construction machines will be anticipated.
Water Pollution	C	D	The volume of the thermal effluent is increased. However, its impact has been already evaluated. According to it, the impact is only in the limited range. During construction, water pollution by construction machines will be anticipated.
Soil Contamination	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Waste	C	D	During construction, since the number of the worker increase, waste will increase.
Noise and Vibration	C	C	Since facilities will be added to the existing power station on its site, some impact to the surrounding environment will be anticipated. However, its impact has been already evaluated. According to it, the impact is only in the limited range. During construction, noise and vibration by construction machines will be anticipated
Ground Subsidence	D	D	Since additional facilities will be small in scale, no impact will be anticipated.
Offensive Odor	D	D	No source of bad odors will be added.
Bottom sediment	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Accident	C	D	Since additional facilities will be small in scale, the risk of accidents will not increase. However, during construction, there is a possibility that the risk of accidents increase.

Mention of marks on the “Rating” in the table as follow

A : significant impact to the environment will be anticipated **B ;** minor impact to the environment will be anticipated
C : impact to the environment may or may not occur right now **D ;** no environmental impact will be anticipated (no problem)
Con: Construction phase **Ope:** Operation phase

Table 4.1-14(3) Scoping Results of the Repowering Plan in Gilimanuk Thermal Power Station

Criteria	Rating		Reasons
	Con	Ope	
Involuntary Resettlement	D	C	The site of the power station will be expanded. There are some houses near the site. Therefore, the additional site must be avoided their place.
Local economy such as livelihood, etc.	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Land use and utilization of local resources	C	C	The site of the power station will be expanded. There are some houses and the national park near the station. Therefore, the additional site must avoid their place. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Social institution such as social infrastructure and local decision making institution	C	C	The site of the power station will be expanded. There are some houses and the national park near the station. Therefore, the additional site must avoid their place. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Existing social infrastructures and services	C	C	The site of the power station will be expanded. There are some houses and the national park near the station. Therefore, the additional site must avoid their place. During construction, since the number of the worker increase, some impact to the surrounding residents is anticipated.
The poor, indigenous and ethnic people	C	D	Although the additional number of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Misdistribution of benefit and damage	C	C	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, since the Bali native and the people from Jawa live near the power plant, there is a possibility that the profit and damage unfairly distribute between them. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Cultural heritage	D	D	The site of the power station will be expanded. However, there are not historical monuments around the site.
Local conflict of interests	C	D	Although the additional number of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Water Usage or Water Rights and Rights of Common	D	B	If the air-cooled condenser is installed, the cooling water will not need. If not, since the cooling water will need, some impact to the surrounding residents will be anticipated.
Sanitation	C	D	Although increase in the staff members is unknown, no increase of sewage will be anticipated. However, during construction, since the number of the worker increase, the increase of sewage will be anticipated.
Hazards (Risk) Infectious diseases such as HIV/AIDS	C	D	Although increase in the staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, there is a possibility that the risk of infectious diseases increases.
Topography and Geographical features	D	D	Since additional facilities will not be large in scale, no impact will be anticipated.
Soil Erosion	D	C	The site of the power station will be expanded. Therefore there is a possibility that the risk of the soil erosion increase in the additional site.
Groundwater	C	D	The low NOx combustion technology (using groundwater) has been introduced in the existing gas turbine. Since fuel consumption will not increase, the volume of use of groundwater will not increase. However, if groundwater use for sanitation during construction, some impact to groundwater will be anticipated
Hydrological Situation	D	B	If the air-cooled condenser is installed, the cooling water doesn't need. If not, the cooling water need, so some impact to the surrounding environment will be anticipated.
Coastal Zone	D	B	If the air-cooled condenser is installed, the thermal effluent will not discharge, so no impact to the surrounding aquatic organisms will be anticipated. If not, since the thermal effluent will discharge, some impact to the surrounding aquatic organisms will be anticipated.
Flora, Fauna and Biodiversity	D	B	The site of the power station will be expanded. There is the national park and mangrove habitat near the site. Therefore, the additional site must avoid their place.
Meteorology	D	D	Since additional facilities will be not large in scale, no influence will be anticipated.
Landscape	D	C	The site of the power station will be expanded. Therefore, some impact to the scenery will be anticipated.
Global Warming	D	D	Since CO_2 emissions will increase by additional facilities in small scale, minor impact will be anticipated.
Air Pollution	C	D	Since the temperature of exhaust gas will change, the ground-level concentration of air pollutants will change. However, since the low NOx combustion technology has been introduced, increase of the ground-level concentration of air pollutants may be not significant. However, during construction, air pollution from construction machines will be anticipated.
Water Pollution	C	B	If the air-cooled condenser is installed, the thermal effluent will not discharge, so no impact to the surrounding environment will be anticipated. If not, since the thermal effluent will discharge, some impact to the surrounding environment will be anticipated. Water pollution from operating the construction machines is anticipated during construction.
Soil Contamination	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Waste	C	D	Since fuel consumption will not increase, the equipment, such as oil separator will not expand. During construction, since the number of the worker increase, waste will increase.
Noise and Vibration	C	C	Since facilities will be added to the existing power station on its site, some impact to the surrounding environment will be anticipated. However, its impact has been already evaluated. According to it, the impact is only in the limited range. During construction, noise and vibration by construction machines will be anticipated.
Ground Subsidence	D	D	The low NOx combustion technology (using groundwater) has been introduced in the existing gas turbine. Since fuel consumption will not increase, the volume of use of groundwater will not increase.
Offensive Odor	D	D	No source of bad odors will be added.
Bottom sediment	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Accident	C	D	Since additional facilities will be small in scale, the risk of accidents will not increase. However, during construction, there is a possibility that the risk of accidents increase.

Mention of marks on the “Rating” in the table as follow

A : significant impact to the environment will be anticipated
B ; minor impact to the environment will be anticipated
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Con: Construction phase
Ope: Operation phase

Table 4.1-15(1) Scoping Results of the Improvement Plan in UBP Semarang

Criteria	Rating		Reasons
	Con	Ope	
Involuntary Resettlement	D	D	Since facilities will be added to the Tambak Lorok power station on its site, no local residents will ask relocation.
Local economy such as livelihood, etc.	C	C	If the number of staff member of the power plant is decreased, some impact to the surrounding residents whose livelihood depends on Sunyaragi and Cilacap power stations will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Land use and utilization of local resources	C	D	Although facilities will be added to the Tambak Lorok power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Social institution such as social infrastructure and local decision making institution	C	D	Although facilities will be added to the Tambak Lorok power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Existing social infrastructures and services	C	C	Since several units in Sunyaragi and Cilacap power stations will shut down, some impact to the surrounding residents whose livelihood depends on those power stations will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
The poor, indigenous and ethnic people	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Misdistribution of benefit and damage	C	C	Since several units in Sunyaragi and Cilacap power stations will shut down, some impact to the surrounding residents whose livelihood depends on those power stations will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Cultural heritage	D	D	Although facilities will be added to the Tambak Lorok power station on its site, no impact to the surrounding environment will be anticipated.
Local conflict of interest	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Water Usage or Water Rights and Rights of Common	D	B	Since the output of the new steam turbine will be larger than the output of the existing 2 turbines, the intake volume of cooling water on the whole of UBP Semarang may be increased. Therefore, some impact to the surrounding environment will be anticipated.
Sanitation	C	D	Although the increasing and decreasing of staff members is unknown, no increase in the sewage volume will be anticipated. However, during construction, since the number of the worker increase, the increase of sewage will be anticipated.
Hazards (Risk) Infectious diseases such as HIV/AIDS	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, there is a possibility that the risk of infectious diseases increases.
Topography and Geographical features	D	D	Since additional facilities will not be large in scale, no impact will be anticipated.
Soil Erosion	D	C	Since ground subsidence around the Tambak Lorok power station has been reported, the impact will depend on the type of the additional facilities.
Groundwater	C	D	If groundwater use for sanitation during construction, minor impact to groundwater will be anticipated
Hydrological Situation	D	B	Since the output of the new steam turbine will be larger than the output of the existing 2 turbines, the intake volume of cooling water on the whole of UBP Semarang may be increased. Therefore, some impact to the surrounding environment will be anticipated.
Coastal Zone	D	B	Since the output of the new steam turbine will be larger than the output of the existing 2 turbines, the volume of the thermal effluent on the whole of UBP Semarang may be increased. Therefore, some impact to the surrounding aquatic organisms will be anticipated.
Flora, Fauna and Biodiversity	D	D	Although facilities will be added to the Tambak Lorok power station on its site, no impact to the surrounding environment will be anticipated.
Meteorology	D	D	Since additional facilities will be not large in scale, no influence will be anticipated.
Landscape	D	C	Although facilities will be added to the Tambak Lorok power station on its site, minor impact to the scenery will be anticipated. It is necessary to consider the scenery of the vacant lots after Sunyaragi and Cilacap power stations will shut down.
Global Warming	D	D	CO2 emissions will increase by additional facilities in small scale. Moreover, since several units in Sunyaragi and Cilacap power stations will shut down, the volume of CO2 emissions on the whole of UBP Semarang will be decreased.
Air Pollution	C	B	Since the output of new steam turbine is larger than the output of the existing 2 turbines, the amount of gas emission on the whole of UBP Semarang will be increased. During construction, air pollution from operating construction machines is anticipated.
Water Pollution	C	B	Since the output of the new steam turbine will be larger than the output of the existing 2 turbines, the volume of the thermal effluent on the whole of UBP Semarang may be increased. Therefore, some impact to the surrounding environment will be anticipated. During construction, water pollution from operating construction machines is anticipated.
Soil Contamination	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Waste	C	C	The methods to dispose the stopped units should be considered. During construction, since the number of the worker increase, there is a possibility that waste will increase.
Noise and Vibration	C	C	Since facilities will be added to the Tambak Lorok power station on its site, some impact to the surrounding environment will be anticipated. However, since several units in Sunyaragi and Cilacap power stations will shut down, noise and vibration form Sunyaragi and Cilacap power stations will disappear. During construction, noise and vibration by construction machines will be anticipated.
Ground Subsidence	D	C	Since ground subsidence around the Tambak Lorok power station has been reported, the impact will depend on the type of the additional facilities.
Offensive Odor	D	D	No source of bad odors will be added.
Bottom sediment	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Accident	C	D	Since additional facilities will be small in scale, the risk of accidents will not increase. However, during construction, there is a possibility that the risk of accidents increase.

Mention of marks on the "Rating" in the table as follow

A : significant impact to the environment will be anticipated
B ; minor impact to the environment will be anticipated
C : impact to the environment may or may not occur right now
D ; no environmental impact will be anticipated (no problem)
Con: Construction phase
Ope: Operation phase

Table 4.1-15(2) Scoping Results of the Improvement Plan in UBP Perak Grati

Criteria	Rating		Reasons
	Con	Ope	
Involuntary Resettlement	D	D	Since facilities will be added to the Grati power station on its site, no local residents will ask relocation.
Local economy such as livelihood, etc.	C	C	If the number of staff member of the power plant is decreased, some impact to the surrounding residents whose livelihood depends on Perak power station will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Land use and utilization of local resources	C	D	Although facilities will be added to the Grati power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Social institution such as social infrastructure and local decision making institution	C	D	Although facilities will be added to the Grati power station on its site, no impact to the surrounding environment will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Existing social infrastructures and services	C	C	Since several units in Perak power station will shut down, some impact to the surrounding residents whose livelihood depends on Perak power station will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
The poor, indigenous and ethnic people	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Misdistribution of benefit and damage	C	C	Since several units in Perak power station will shut down, some impact to the surrounding residents whose livelihood depends on Perak power station will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Cultural heritage	D	D	Although facilities will be added to the Grati power station on its site, no impact to the surrounding environment will be anticipated.
Local conflict of interest	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the surrounding residents are conservative, there is a possibility that conflict between the residents and the workers happens.
Water Usage or Water Rights and Rights of Common	D	D	Even if the intake volume of cooling water on the whole of UBP Perak Grati increase, the impact has been already evaluated. According to it, the impact is only in the limited range.
Sanitation	C	D	Although the increasing and decreasing of staff members is unknown, no increase in the sewage volume will be anticipated. However, during construction, since the number of the worker increase, the increase of sewage will be anticipated.
Hazards (Risk) Infectious diseases such as HIV/AIDS	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, there is a possibility that the risk of infectious diseases increases.
Topography and Geographical features	D	D	Since additional facilities will not be large in scale, no impact will be anticipated.
Soil Erosion	D	D	Although facilities will be added to the Grati power station on its site, no impact will be anticipated.
Groundwater	C	D	If groundwater use for sanitation during construction, minor impact to groundwater will be anticipated
Hydrological Situation	D	D	Even if the intake volume of cooling water on the whole of UBP Perak Grati increase, the impact has been already evaluated. According to it, the impact is only in the limited range.
Coastal Zone	D	D	Even if the volume of the thermal effluent on the whole of UBP Perak Grati increase, the impact has been already evaluated. According to it, the impact is only in the limited range.
Flora, Fauna and Biodiversity	D	D	Although facilities will be added to the existing power station on its site, no impact to the surrounding environment will be anticipated.
Meteorology	D	D	Since additional facilities will be not large in scale, no influence will be anticipated.
Landscape	D	C	Although facilities will be added to the Grati power station on its site, minor impact to the scenery will be anticipated. It is necessary to consider the scenery of the vacant lots after Perak power station will shut down.
Global Warming	D	D	Since fuel consumption in Grati power station is not increased, the amount of CO2 emission is not increased. Moreover, since several units in Perak power station will shut down, the volume of CO2 emissions on the whole of UBP Perak Grati will be decreased.
Air Pollution	C	D	Since fuel consumption will not increase, the value of air pollutants will not increase. Moreover, since several units in Perak power station will shut down, the value of air pollutants on the whole of UBP Perak Grati will be decreased. However, during construction, air pollution by construction machines will be anticipated.
Water Pollution	C	D	Even if the volume of the thermal effluent on the whole of UBP Perak Grati increase, the impact has been already evaluated. According to it, the impact is only in the limited range. However, during construction, water pollution from operating construction machines will be anticipated.
Soil Contamination	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Waste	C	C	The methods to dispose the stopped units should be considered. During construction, since the number of the worker increase, there is a possibility that waste will increase.
Noise and Vibration	C	C	Since facilities will be added to the Grati power station on its site, some impact to the surrounding environment will be anticipated. However, since several units in Perak power station will shut down, noise and vibration form Perak power station will disappear. During construction, noise and vibration by construction machines will be anticipated.
Ground Subsidence	D	D	Since additional facilities will be small in scale, no impact will be anticipated.
Offensive Odor	D	D	No source of bad odors will be added.
Bottom sediment	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Accident	C	D	Since additional facilities will be small in scale, the risk of accidents will not increase. However, during construction, there is a possibility that the risk of accidents increase.

Mention of marks on the “Rating” in the table as follow

A : significant impact to the environment will be anticipated
B ; minor impact to the environment will be anticipated
C : impact to the environment may or may not occur right now
D ; no environmental impact will be anticipated (no problem)
Con: Construction phase
Ope: Operation phase

Table 4.1-15(3) Scoping Results of the Improvement Plan in UBP Bali

Criteria	Rating		Reasons
	Con	Ope	
Involuntary Resettlement	D	C	The site of the Gilimanuk power station will be expanded. There are some houses near the site. Therefore, the additional site must be avoided the place.
Local economy such as livelihood, etc.	C	C	Since Pesanggaran power plant will shut down, the impact to the surrounding residents whose livelihood depends on Pesanggaran power station will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Land use and utilization of local resources	C	C	The site of the Gilimanuk power station will be expanded. There are some houses and the national park near the site. Therefore, the additional site must be avoided their place. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Social institution such as social infrastructure and local decision making institution	C	C	The site of the Gilimanuk power station will be expanded. There are some houses and the national park near the site. Therefore, the additional site must be avoided their place. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Existing social infrastructures and services	C	C	The site of the Gilimanuk power station will be expanded. There are some houses and the national park near the site. Therefore, the additional site must be avoided their place. Since Pesanggaran power plant will shut down, the impact to the surrounding residents whose livelihood depends on Pesanggaran power station will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
The poor, indigenous and ethnic people	C	D	Although the increasing and decreasing of staff members is unknown no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Misdistribution of benefit and damage	C	C	Although the increasing and decreasing of staff members is unknown no impact to the surrounding residents will be anticipated. However, since the Bali native and the people from Jawa live near the power plant, there is a possibility that the profit and damage unfairly distribute between them. Moreover, since Pesanggaran power plant will shut down, the impact to the surrounding residents whose livelihood depends on Pesanggaran power station will be anticipated. During construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Cultural heritage	D	D	The site of the Gilimanuk power station will be expanded. However, there are not historical monuments around the site.
Local conflict of interests	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, some impact to the surrounding residents will be anticipated.
Water Usage or Water Rights and Rights of Common	D	B	As for the Gilimanuk power station, if the air-cooled condenser is installed, the cooling water will not need. If not, since the cooling water will need, some impact to the surrounding residents will be anticipated.
Sanitation	C	D	Although the increasing and decreasing of staff members is unknown, no increase of sewage will be anticipated. However, during construction, since the number of the worker increase, the increase of sewage will be anticipated.
Hazards (Risk) Infectious diseases such as HIV/AIDS	C	D	Although the increasing and decreasing of staff members is unknown, no impact to the surrounding residents will be anticipated. However, during construction, since the number of the worker increase, there is a possibility that the risk of infectious diseases increases.
Topography and Geographical features	D	D	Since additional facilities will not be large in scale, no impact will be anticipated.
Soil Erosion	D	C	The site of the Gilimanuk power station will be expanded. Therefore there is a possibility that the risk of the soil erosion increase in the additional site.
Groundwater	C	D	As for the Gilimanuk power station, the low NOx combustion technology (using groundwater) has been introduced in the existing gas turbine. Since fuel consumption will not increase, the volume of use of groundwater will not increase. However, if groundwater use for sanitation during construction, some impact to groundwater will be anticipated
Hydrological Situation	D	B	As for the Gilimanuk power station, if the air-cooled condenser is installed, the cooling water doesn't need. If not, the cooling water need, so some impact to the surrounding environment will be anticipated.
Coastal Zone	D	B	As for the Gilimanuk power station, if the air-cooled condenser is installed, the thermal effluent will not discharge, so no impact to the surrounding aquatic organisms will be anticipated. If not, since the thermal effluent will discharge, some impact to the surrounding aquatic organisms will be anticipated.
Flora, Fauna and Biodiversity	D	B	The site of the Gilimanuk power station will be expanded. There is the national park and mangrove habitat near the site. Therefore, the additional site must avoid their place.
Meteorology	D	D	Since additional facilities will be not large in scale, no influence will be anticipated.
Landscape	D	C	The site of the Gilimanuk power station will be expanded. Therefore, some impact to the scenery will be anticipated. It is necessary to consider the scenery of the vacant lots after Pesanggaran power station will shut down.
Global Warming	D	D	CO_2 emissions will increase by additional facilities in small scale. Moreover, since several units in Pesanggaran power station will shut down, the volume of CO2 emissions on the whole of UBP Bali will be decreased.
Air Pollution	C	D	As for the Gilimanuk power station, since the temperature of exhaust gas will change, the ground-level concentration of air pollutants will change. However, since the low NOx combustion technology has been introduced, increase of the ground-level concentration of air pollutants may be not significant. Moreover, since several units in Pesanggaran power station will shut down, air pollutants by Pesanggaran power station will disappear. However, during construction, air pollution from construction machines will be anticipated.

Criteria	Rating		Reasons
	Con	Ope	
Water Pollution	C	B	As for the Gilimanuk power station, if the air-cooled condenser is installed, the thermal effluent will not discharge, so no impact to the surrounding environment will be anticipated. If not, since the thermal effluent will discharge, some impact to the surrounding environment will be anticipated. Water pollution from operating the construction machines is anticipated during construction.
Soil Contamination	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Waste	C	D	As for the Gilimanuk power station, since fuel consumption will not increase, the equipment, such as oil separator will not expand. The methods to dispose the stopped units in the Pesanggaran power station should be considered. During construction, since the number of the worker increase, there is a possibility that waste will increase.
Noise and Vibration	C	C	Since facilities will be added to the Gilimanuk power station on its site, some impact to the surrounding environment will be anticipated. However, since several units in Pesanggaran power stations will shut down, noise and vibration from Pesanggaran power stations will disappear. During construction, noise and vibration by construction machines will be anticipated.
Ground Subsidence	D	D	As for the Gilimanuk power station, the low NOx combustion technology (using groundwater) has been introduced in the existing gas turbine. Since fuel consumption will not increase, the volume of use of groundwater will not increase.
Offensive Odor	D	D	No source of bad odors will be added.
Bottom sediment	D	D	Since no additional fuel tanks will be added, the risk of oil leakage will be not anticipated.
Accident	C	D	As for the Gilimanuk power station, since additional facilities will be small in scale, the risk of accidents will not increase. Since several units in Pesanggaran power stations will shut down, the risk of accidents will disappear. However, during construction, there is a possibility that the risk of accidents increase.

Mention of marks on the "Rating" in the table as follow

A : significant impact to the environment will be anticipated
B ; minor impact to the environment will be anticipated
C : impact to the environment may or may not occur right now
D ; no environmental impact will be anticipated (no problem)
Con: Construction phase
Ope: Operation phase

4.2. <u>Hydropower Stations</u>

4.2.1. Technical Study

Based on the review and analysis as mentioned in Section 3, the following rehabilitation, modification and repowering plans are proposed tentatively as shown in the following table.

Table 4.2-1 Proposed Rehabilitation Modification and Repowering Plans

Power Station	No.	Proposed Plans
Saguling	1)	Replacement of the generator and bearing cooler's tube material to anti-corrosion type.
	2)	Replacement of control electronic parts for automatic voltage control system
	3)	Replacement of control electronic parts for governor
	4)	Replacement of monitoring panel in control room
Cirata	1)	Modification of cooling water system from opened type to closed type including cleaning and lining of embedded pipe
	2)	Replacement of monitoring panel and control computer system for power station
Soedirman	1)	Replacement of control electronic parts for automatic voltage control system
	2)	Replacement of control electronic parts for governor
	3)	Replacement of control electronic parts for power station computer system.
Sutami	1)	Replacement of 154 kV Circuit Breaker
	2)	Relocation of generator oil cooler from inside the generator housing to outside of generator housing. Or modification of cooling water system from opened type to closed type.

4.2.2. Economic Financial Analysis

Rehabilitation/modification and repowering plans relating to the existing hydropower stations proposed by the JICA Study Team are rehabilitation/modification plans only as mentioned in Section 4.2.1. The main purpose of rehabilitation/modification plan is to improve the reliability of operation, in other words, to reduce the forced outage caused or might be caused by deterioration and /or defect of power generation facilities. However, from the economic and financial viewpoint, it is very difficult to estimate the benefit (improvement of reliability) in money term because the extent to which the improvement of reliability will be achieved by rehabilitation/modification plans is unforeseeable.

Based on the above reason, the utilization of JBIC export credit for rehabilitation/ modification plans is proposed here as mentioned in Section 2.5 instead of economic and financial analyses.

In the meeting with JBIC Jakarta Office on June 7, 2006, the JBIC informed of the following assistance policy for the future in Indonesia.

a) Development of PLTP (Geothermal Power Station)
b) Development and reinforcement of Transmission Line in outer islands
c) Promotion of rehabilitation/modification and repowering plans for the existing power stations in Java-Bali region

4.2.3. Environmental and Social Consideration

Rehabilitation/modification and repowering plans relating to existing hydropower stations proposed by the Study Team are shown in Section 4.2.1. As shown in Section 4.2.1, no repowering plan is proposed. Rehabilitation/modification plans including replacement of facilities are not required AMDAL because the relevant engineering woks are envisaged to be small-scale and not to affect the serious impact on the environmental aspects.

And there seems to be no environmental and social consideration issue relating to improvement measures for operation and maintenance for the existing hydropower stations as well as thermal power stations.

5. Improvement Measures relating to Operation, Maintenance and Inspection

5.1. Toward Improvement of Operation Performance

(1) Maintenance Optimization Program (MOP)

Besides the development of performance indicators, PJB has developed Maintenance Optimization Program (MOP) with assistance of PT. MTS (Maintenance Total Solution) Indonesia and applied to Gresik power station firstly. Figure 5.1-2 shows the flowchart of MOP.

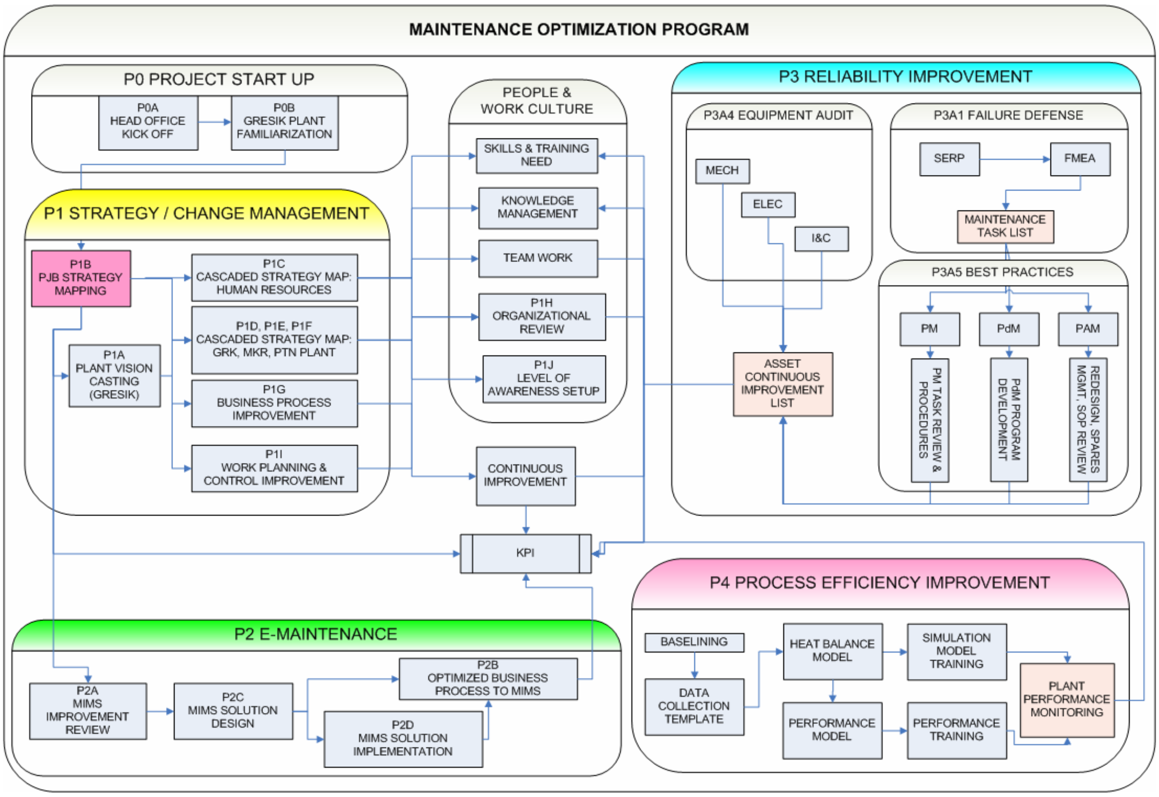


Figure 5.1-2 Flowchart of Maintenance Optimization Program at PJB

Each power station tackles the scheme of Improvement of Operation and Maintenance Performance.

5.2. Thermal Power Station

Based on the current status and tasks in the operation and maintenance management of the existing thermal power generation facilities under Section 3.2, the following improvements from operation and maintenance aspects are recommended to achieve effective power supply.

< 1. Improvements to prevent routine accidents and troubles >

(1) Measures to promptly cope with unexpected accidents:

<Operational aspect>

① Education and training of troubleshooting of the unit utilizing a compact type simulator (new installation), which is also useful for the development of instructors and maintenance personnel.

② Education and training of troubleshooting of the unit, by modifying the existing onsite simulators.

< Maintenance aspect >

① Establishment of material management system utilizing IT to promptly cope with accidents, etc. by IT utilizing.

(2) Measures to prevent deterioration of facilities: Promotion of Predictive and Preventive Maintenance.

① Enhancement of CBM (Condition based Monitoring).
Expansion of not only the exclusive diagnosing technique but the definition of CBM.

② Promotion of facility assessment to prevent serious accidents.

A. Conduct trials of pipe thickness inspection work for power generation at a typical unit of a typical power station.

B. Reinforcement of efforts to perform equipment-based maintenance to cope with increasing unexpected troubles due to deterioration of the equipment.

(3) Improvements of education and training of Indonesia Power and PJB

① Improvements of education of newcomers

② Prevention of lessons gained from accidents and troubles from fading with time, prevention of recurrence of similar accidents and passing on of skills to next generation

③Implementation of OJT on quality and safety management in Japan

(4) Arrangement in order and expansion of technical base jobs to ensure quality and safe.
－Preparation of Manuals and development of Data Base－

(5) Promotion of information sharing.
Holding information exchange meetings on operation and maintenance management.

< 2. Improvements of Scheduled Inspection Work from operational aspect >

(1) Restructuring of scheduled inspection system and establishment of (Draft) guideline for implementation procedure.

(2) Improvements toward reduction of the work period to rationalize the scheduled inspection work.

(1) Measures to promptly cope with unexpected accidents

< Operational aspect >

① Education and training of troubleshooting of the unit utilizing a compact type simulator (new installation), which is also useful for the development of instructors and maintenance personnel

It is recommended that simulated training with a training simulator (a conventional and combined type of a typical unit) be provided to cope with an emergency of the unit as it is most effective in improving skills of operators in “normal starts and stops of the unit” and “troubleshooting of the unit.”

Outline of the Recommended Training Simulator

A compact type simulator in which the operation training effects can be expected from the simplified desk panel and not only training by an instructor can be provided but also selection of an effective training menu can be made without an instructor.

1) Standard specifications:

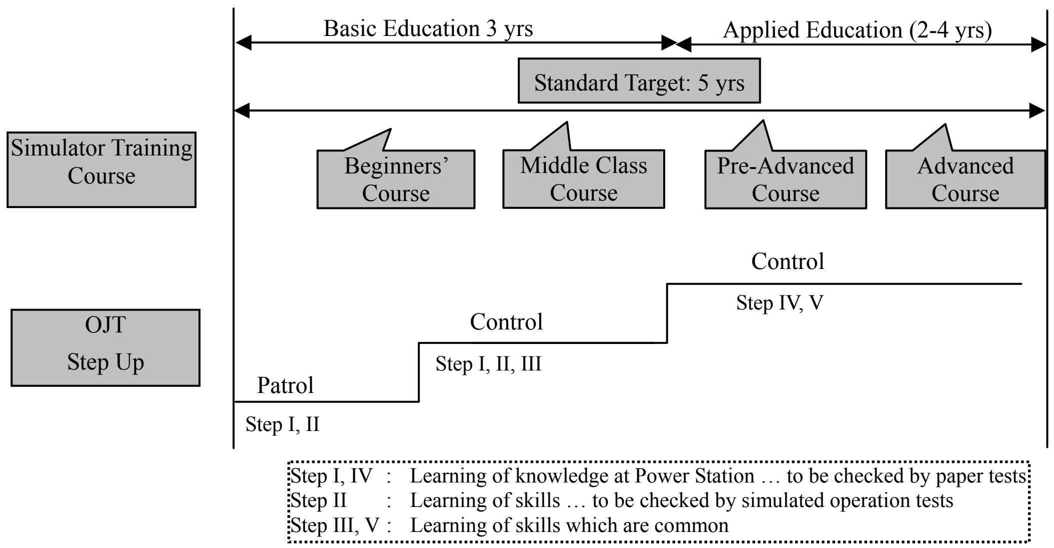
・Model accuracy:	static property errors	:less than 0.5%
	dynamic property errors	:less than 2% (main process)
		:less than 10% (other process)
・Number of malfunctions		:200 pieces

2) Merits of introducing operation training simulator
- Operation can be easily learned individually or by group
- Operators’ skills can be improved through simulated operation assuming various troubles such as machinery failure and system fluctuation.
- Maintenance personnel’s understanding of maintenance technique can be increased through training of the control logic changes and control parameter adjustments.

Simulation Training Course: Learning of Knowledge & Technique in Standard Target of 5 Years

- Beginners' course : Learning of start-up/Shutdown of normal units. Learning of easy troubleshooting.
- Middle class course : Learning of exact troubleshooting for frequently occurring accidents and troubles of facilities.
- Advanced course : Learning of exact troubleshooting for unexpectedly occurring accidents and troubles of facilities.

Image of Upgrading of High School Graduates



(2) Measures against deterioration of facilities: Promotion of Predictive and Preventive Maintenance

1) Enhancement of CBM (Condition Based Monitoring).

The inspection of equipment which is less important is conducted on the basis of CBM; however, it is important for us to tackle equipment maintenance and management in an attempt to expand the definition of CBM which covers not only exclusive diagnosing technique but also routine inspection.

Expansion of the definition of CBM which covers not only exclusive diagnosing technique but also routine inspection.

1. Utilization of five senses at the time of routine inspection by operators
2. Early detection of abnormality by regular functional confirmation tests and issuing of alarms.

↓

Test Items of Security Devices conducted by the Japanese Electric Power Companies (once a month)

Electricity-related	1. Seal oil back up activation tests and ANN tests 2. Stator cooling water pump automatic start tests
Main turbine-related	1. Main steam stop valve stem free tests 2. Governor valve stem free tests 3. Reheating valve stem free tests 4. Main turbine security device tests (central remote control) 5. Main turbine's main oil pump discharge pressure low trip tests 6. Condenser vacuum low trip tests 7. Main turbine shaft bearing oil pressure low trip tests 8. Main turbine thrust protection device activation tests 9. EH oil pump automatic start tests 10. Main turbine suction oil pump (SOP) automatic start tests 11. Main turbine turning oil pump (TOP) automatic start tests 12. Main turbine emergency oil pump (EOP) automatic start tests 13. Bleeder check valve activation tests
BFP-T-related	1. BFP-T High and low pressure steam stop valve stem free tests 2. BFP-T Security device tests ① Thrust protection system activation tests ② Emergency trip system activation tests ③ Shaft bearing pressure low trip tests ④ Main oil pump automatic start tests ⑤ Emergency oil pump automatic start tests

2) Promotion of facility assessment to prevent serious accidents

a. Conduct trials of pipe thickness inspection work for power generation at a typical unit of a typical power station

In August 2004, a pipeline breakage accident (a condenser pipe and a drain pipe of feed water heater) occurred due to reduction of pipe thickness caused by erosion and corrosion at two Japanese power stations, which resulted in a socially major problem.

As a result of the pipeline thickness inspection at each power station of electric companies, IPP and private power stations soon after these accidents, many pipelines which did not meet TSR* (Thickness Shell Requirement) were found.

* "TSR" is the thickness required to maintain pipeline strength which is obtained by calculation.

IP and PJB are recommended to establish a pipeline management policy of thermal power facilities as well as pipeline inspection plans and conduct trials of the following contents at early stages in a typical unit of a typical power station because there seems to be the possibility of occurrence of the same accident in Indonesia as well as Japan.

Contents of Inspection

1. Facilities subject to investigation:
   Thermal power generation facilities using steam turbines with output of 1 MW or more.

2. Pipelines subject to investigation:
   Pipelines made of materials which have a potential to suffer thickness reduction caused by water and steam.
   Each pipeline of the following:
   ①Main steam system ②Reheat steam system ③Condenser system
   ④Feed water system ⑤Bleeder system ⑥Drain system

3. Portions subject to investigation (See Figure 5.2-1) :
   Portions which have a potential for thickness reduction due to erosion and corrosion.
   ①Control valve downstream ②Glove type check valve downstream ③Elbow ④T pipe
   ⑤Orifice downstream ⑥Swing type check valve downstream ⑦Reducer ⑧Bent pipe
   ⑨Glove type valve downstream

4. Inspection (test) method
   Inspection (test) method should be the following:
   ①Thickness measurement method with ultrasonic waves pulse reflection
   ②Test method by radioactive penetration image inspection
   ③Screening test method using pulse vortex
   ④Test method utilizing potential difference
   ⑤Test method with three-dimensional ultrasonic inspection

5. Inspection period:
   While the unit is shutdown during the scheduled inspection work period.

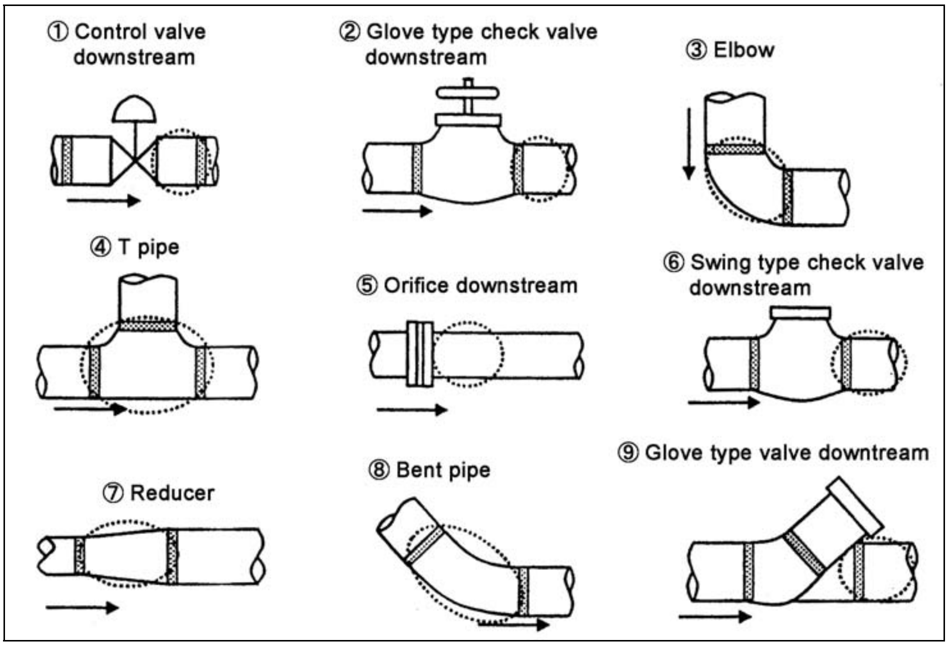


Figure 5.2-1 Measurement Points

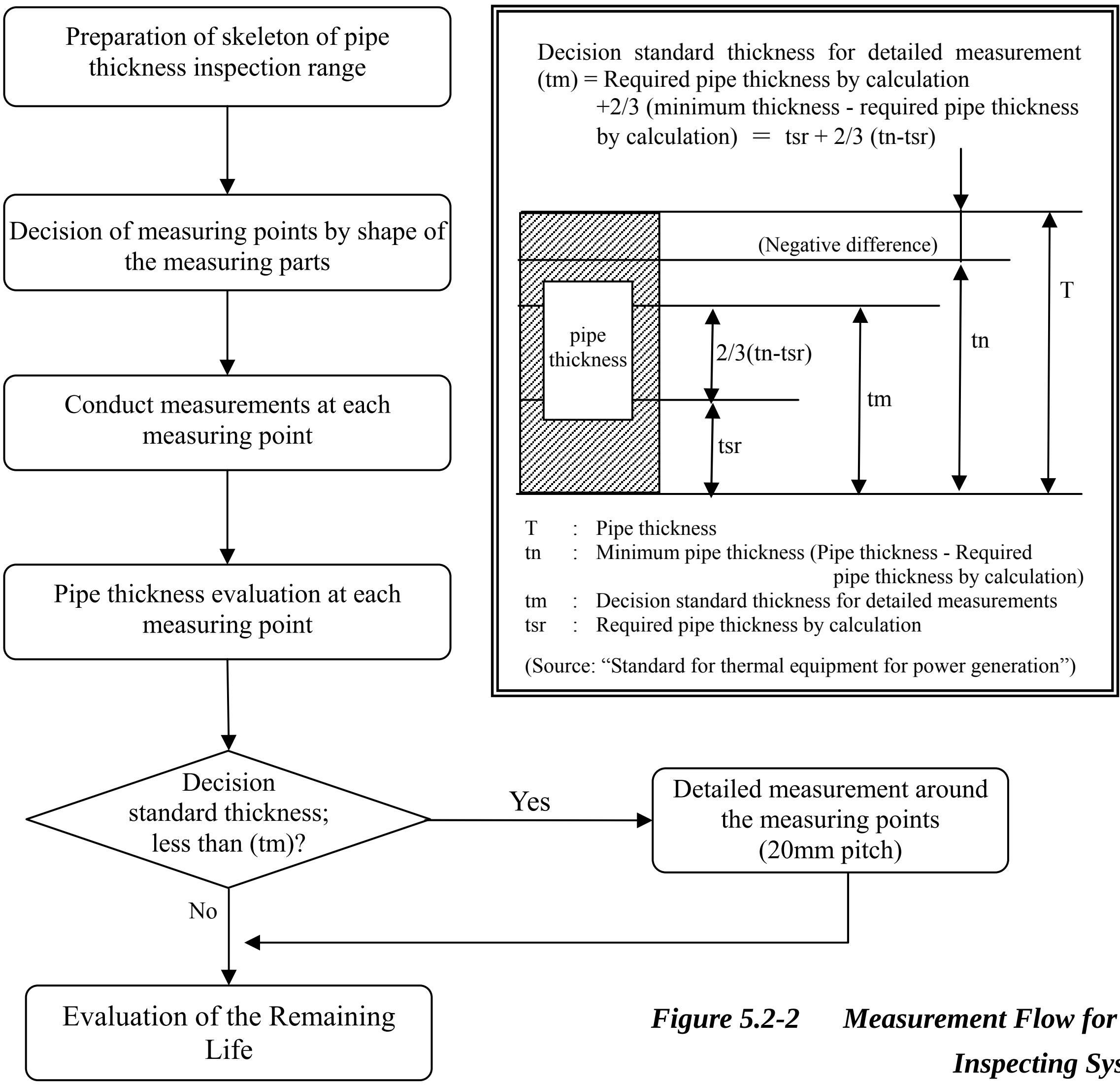


Figure 5.2-2 Measurement Flow for Key Inspecting System

(3) Improvements of education and training at IP and PJB

① Prevention of lessons gained from accidents and troubles from fading with time, prevention of recurrence of similar accidents and passing on of skills to next generation －Preparation of cases of troubles and entry of Data Base－

A. "A collection of unexpected or unusual trouble cases" - Min. 20 cases

For example,

- A trip due to boiler "low drum level"
- Steam turbine trip while turbines are gaining speed
- Steam Adjusting Valve spring tightening bolts, etc.
- Inability to start units due to BCP trip while the units are being started up

B. "A collection of damage cases of equipment suffering aged deterioration" - Min. 20 cases

For example,

- Corrosion on exterior surface of pipeline
- Expansion damage (HRSG exhaust gas damper)
- Tube rupture due to surface corrosion
- System shutdown due to malfunction of sequencer, etc.

C. "A collection of facility trouble cases due to human errors" - Min. 20 cases

For example,

- Emergency shutdown of boilers due to erroneous operation of DCS (Digital Control System)
- Erroneous activation of Gland Steam Pressure Adjusting Valve due to erroneous connection of the signal wires
- Delay in startup due to failure of steam turbine startup conditions
- Lowering of condenser vacuum

② Implementation of OJT on quality and safety control in Japan

Purpose	:	To acquire through OJT the actual status of quality and safety control in scheduled inspection work of the Japanese electric power companies in order to enhance skills of maintenance personnel in quality and safety control and make horizontal development of such skills in Indonesia.
Number of participants	:	4 to 5 persons (Supervisor class in charge of boilers, turbines, generators, instrumentation and electricity)
Implementing Place	:	Existing coal-fired or gas-fired thermal power station and such a power station under construction
Duration	:	about 6 months × 2 times or so

(4) Improvement Plans of Scheduled Inspection Work from Operational Aspect

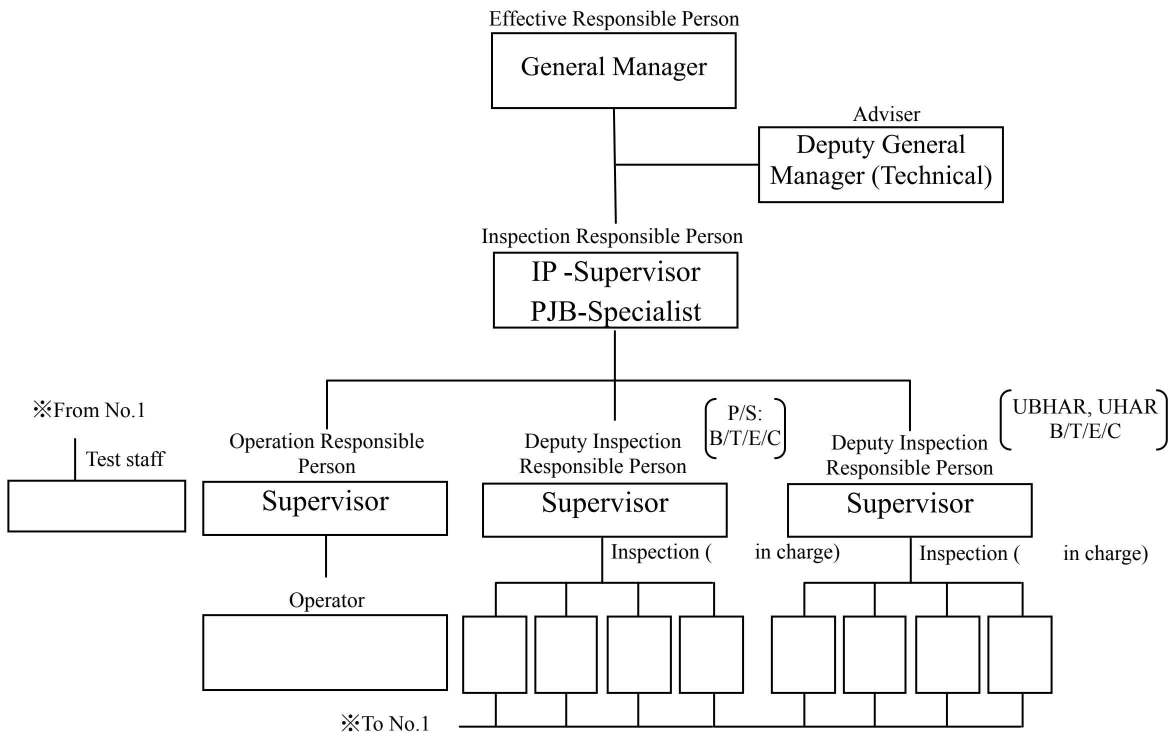
1) Restructuring of scheduled inspection work and establishment of (Draft) guideline for implementation procedure

It is recommended that in order to prevent repetition of similar accidents due to overlooking, etc. during scheduled inspection and improve security and quality of power generation facilities, the Scheduled Inspection System specifying sharing of roles on user side be structured and the Guideline for Implementation Procedure be established to smoothly implement jobs.

① System for scheduled inspection and sharing of roles

A. Inspection System

The inspection system for scheduled inspection shall be as follows:



B. Sharing of Roles

The sharing of roles played by members involved in the scheduled inspection between the Power Station and Maintenance Business Division (UBHAR & UHAR) shall be as shown in Table 5.2-2 "Sharing of Roles".

③ Implementation Procedure for Scheduled Inspection

The sequence of the jobs from the start of scheduled inspection through its completion and the implementation procedure for each job are as follows:

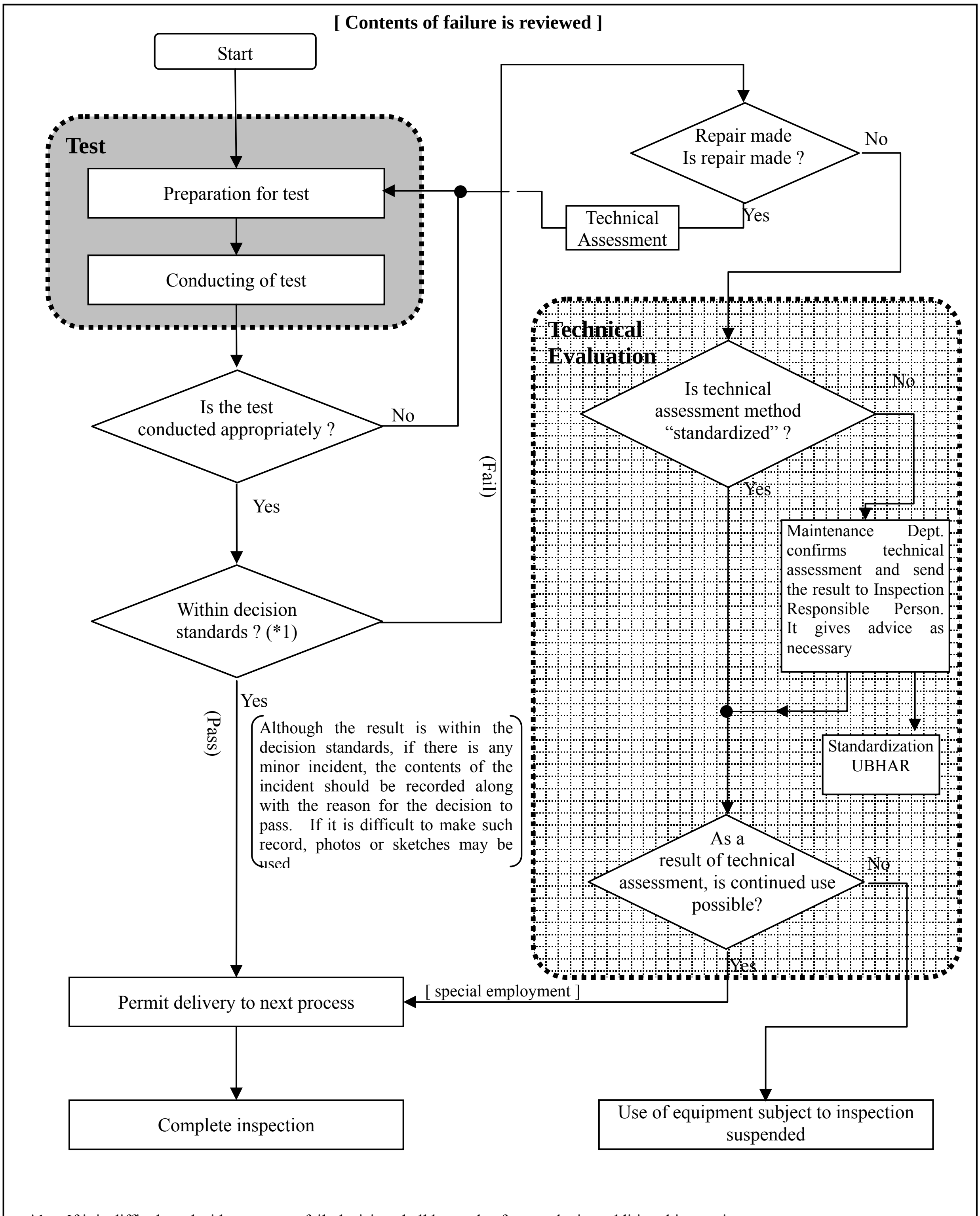
Table 5.2-1 Implementation Procedure of Scheduled Inspection

1. Inspection procedure	The inspection procedure shall be as per Figure 5.2-3 "Flow of Inspection Procedure".
2. Preparation for test and inspection	(1) Inspector shall confirm the following prior to the test a. Confirmation of inspection and measurement Inspection and measurement device and testing device shall be calibrated and inspected at intervals specified by the "Guideline for measurement control device management" or before they are used and confirmation shall be made of required accuracy. b. Confirmation of qualification The inspector shall make prior confirmation by a copy of Requirement Certificate or Work Engagement Career that the testing personnel have required qualification for the implementation of tests, and report to the inspector in charge. (2) Inspector in charge shall confirm the following before inspection a. Establishment of system for operating inspection and test operating inspection Operator in charge shall describe the names of Operator in charge and Operator and the day when he confirmed the operator's qualification in Operating Inspection and Test Operating Inspection System Table (in arbitrary format). Inspector in charge shall confirm that the required items are described before the operating inspection and test operating inspection.
3. Implementation of tests	(1) Implementation procedure of tests Inspector shall confirm that tests are conducted by Test Staff in accordance with Inspection Manual by witnessing the tests each time of the tests. The items to be confirmed shall be as follows: a. Test method b. Qualified person is conducting the tests c. Parts where the tests are conducted d. Inspection device used (2) Handling of inspection device Inspector and Test Staff shall handle the inspection device in accordance with the manufacturer's handling instruction book.
4. Test records	(1) Record of test results prepared by Test Staff a. Inspector shall instruct Test Staff to prepare test records and request him to promptly submit them. b. Inspector shall confirm the test records submitted by Test Staff and confirm that there is no problem with the test results. (2) Operating inspection and test records of test operating inspection Inspector shall output and print necessary data for inspection. If the data cannot be output or printed, the data shall be collected. In this case, the data collection may be entrusted with Assistant Inspector.
5. Conducting of tests	(1) Scope of inspection In accordance with each Inspection Manual. (2) Inspection method employed by Inspector a. Inspector shall make a decision to pass or fail of the test results in light of the grading standards by witnessing on site or examining the test records. The date of inspection shall be the date when Inspector made the decision to pass or fail. (a) The kinds of inspection in which the acceptability is decided by witnessing on site shall be visual inspection, appearance inspection, penetration test inspection, condenser leak inspection, operating inspection, and test operating inspection. However, as for the operating inspection of Gas Detector, the decision to pass or fail can be made by examining the test records. (b) Regarding inspection other than those referred to in above (a), the decision to pass or fail can be made by examining the test records. (c) In case inspection is made in factory, the decision to pass or fail can be made by examining the test records after obtaining confirmation by Inspection Responsible Person of the inspection manual prepared by the delivering maker meeting our requirements. (The inspection manual shall be limited to the one specified in advance.) b. In case it is difficult to make a decision to pass or fail by visual inspection, etc., additional inspection such as PT inspection or technical evaluation confirming the soundness shall be conducted to make the decision to pass or fail. Meanwhile, in case the decision is made to pass or fail by technical evaluation, the approval date of such technical evaluation results shall be the date of inspection. c. In case repairs are made based on the inspection results, re-inspection shall be conducted and an additional inspection conducted as necessary. d. In case inspection other than those specified in the Inspection Manual is conducted, inspection manual shall be prepared and approval of Executive Responsible Person shall be obtained. (3) Witness by Inspection Responsible Person and Deputy Inspection Responsible Person Deputy Inspection Responsible Person shall, in principle, witness on site the decision making on acceptance by Inspector and give appropriate instructions to Inspector and manage him.

6. Inspection records	(1) Recording of Inspection results a. Inspector shall use "Inspection records" to describe necessary matters and prepare inspection records. Nothing shall be transcribed from the test records into the inspection records except minimum requirements. In case re-inspection is conducted or blank space of the inspection record format is insufficient due to additional inspection, inspection records shall be newly prepared. Each time inspection is conducted, the inspection results shall be confirmed by Deputy Inspection Responsible Person. b. Deputy Inspection Responsible Person shall confirm that Inspector prepares appropriate records each time inspection is conducted and sign the inspection records. He shall also confirm completion of the inspection of all the facility items (name of inspection in the inspection records) and obtain approval of Inspection Responsible Person. c. Inspection Responsible Person shall approve of the inspection records and conduct document registration and post in the scheduled inspection record data base inspection cover sheet, test records of operating inspection and test run inspection as well as inspection system table for operating inspection and test runs. (2) Attachment to Inspection records a. Materials used to make a decision to pass or fail shall be attached to the inspection records. The original test records prepared by the test staff shall be attached. b. Description or supplement of the inspection results shall be attached. c. As for operating inspection and test run inspection, the original of the test records and the actual records of inspection system including Operation Responsible Person and Operator shall be attached. In case it is difficult to make a decision to pass or fail in light of the judgment standards, a list of the test records may be prepared. In that case, the original of the test records shall always be attached.
7. Measures against failure	If Inspector decides that any item does not meet the requirement, the most appropriate measures shall be studied and described in the intra-office prompt report and confirmation of Inspection Responsible Person shall be obtained. (1) In case repair is made After gaining approval from Inspection Responsible Person, retest shall be conducted after the repair or replacement and the series of actions taken shall be recorded in the inspection records. (2) In case repair is not made a. Technical evaluation (a) If technical evaluation method is specified in the intra-office standards, technical evaluation shall be conducted in accordance with such standards. (b) If there is no prescription in the intra-office standards, Inspection Responsible Person shall coordinate with the maker's recommendations, operation records, etc, and if necessary, coordinate with the related parts and report to Executive Responsible Person on the result of the technical evaluation. b. Special Employment If, as a result of the technical evaluation, Inspector decides that safe and stable operations can be continued until the next inspection, and Inspection Responsible Person approves of it, then it can be treated as Special Employment. The date when the special employment is approved shall be the date of inspection.
8. Delivery to next process	If Inspection Responsible Person approves as "pass" or as "Special employment" in making a decision to pass or fail, the delivery to the next process is permissible. If Deputy Inspection Responsible Person approves any item as "pass," he is allowed to give permission to the assembly or restoration.
9. Inspection process management	Inspection Responsible Person shall prepare "Inspection Process Management Table" after receiving reports from Deputy Inspection Responsible Person and grasp each inspection process. After completion of the inspection, he shall make an interim report to Executive Responsible Person in general interlocking timing. (Such a report can be eliminated if the scheduled inspection does not include the general interlocking.) After making reports upon completion of the inspection, he shall post it on "Inspection Process Management Table" in Scheduled Inspection Record Data Base."
10. Completion of scheduled inspection	When Inspection Responsible Person confirms the completion of all the scheduled inspections, the inspections shall be completed.

Table 5.2-2 Sharing of Roles

Title	Contents of duty
Executive Responsible Person / General Manager of Power Station	He shall exercise control over jobs on security at the power station. If Deputy Superintendent is posted, he can have him assist his duty.
Inspection Responsible Person: (Representatives of Maintenance Divisions at P/S IP: Supervisor Senior PJB: Specialist)	・He shall be responsible for appropriate implementation of scheduled inspections. ・He shall prepare Inspection Manual and establish inspection system. ・He shall post inspectors who have knowledge and experience required to conduct scheduled inspections. On the basis that he shall be familiar and comply with the procedure necessary for inspection, he shall conduct inspection having sufficient contact and cooperation with parties concerned, and give appropriate instructions and make management of inspectors under his control performing their duty. ・If there is any failure, he shall take measures in accordance with the guideline. ・He shall confirm that there is no imperfection in the inspection records and attachment and if he finds any imperfection, he shall correct it. ・He shall be authorized to give permission to the delivery to next process. ・He shall conduct process management of scheduled inspections.
Deputy Inspection Responsible Person: ・IP/PJB Power Station: Supervisor (B/T/E/C) ・UBHAR/UHAR ; Supervisor (B/T/E/C)	・When Inspection Responsible Person is absent, he shall perform superior's duty on his behalf. ・If it is difficult for him to abide by the procedure necessary for the inspection in performing his duty, he shall seek Inspection Responsible Person's judgment and take necessary measures. ・He shall confirm that there is no imperfection in the inspection records and attachment, and if finds any imperfection, he shall correct it. ・He is authorized to give permission to the assembly or restoration. ・He shall grasp the inspection status and periodically report to Inspection Responsible Person. ・Deputy Inspection Responsible Official who has qualification necessary for inspection can perform Inspector's duty.
Inspector (Maintenance Div.) ・IP/PJB Power Station: Technician Senior (B/T/E/C) ・UBHAR/UHAR ; Technician Senior (B/T/E/C)	・On the basis of compliance with the procedure necessary for inspection, he shall conduct scheduled inspections. ・If he finds it difficult to abide by the procedure necessary for inspection, he shall seek Inspection Responsible Person's judgment and take necessary measures. ・He shall decide to pass or fail in light of the judgment standards. ・If he finds it difficult to decide to pass or fail, he shall seek guidance or advice from Deputy Inspection Responsible Person, Inspection Responsible Person or BT Chief Technician. ・If any decision goes beyond the decision standards, he shall review the contents of measures to be taken in case of failure and after obtaining approval from Inspection Responsible Person, he shall take measures against failure.
Operation Responsible Person (IP/PJB)	・He shall select Operators necessary for inspection and give instructions on operations. ・If he finds any malfunction, he shall report to Inspection Responsible Person.
Operator (IP/PJB)	・He shall perform operations under the instructions given by Operation Responsible Person. ・If he finds any malfunction, he shall report to Inspection Responsible Person.



*1 : If it is difficult to decide to pass or fail, decision shall be made after conducing additional inspection.
(Example: Since an incident of a crack was suspected in visual inspection, penetration test was conducted as additional inspection).

Figure 5.2-3 Flow of Inspection Procedure

(5) Improvements toward reduction of the work period to rationalize the scheduled inspection work

The work period reduction items are employed in Japan at each work process of the scheduled precision inspection of boilers and turbines. We investigated whether or not each power station of Indonesian Power/PT PJB also performed such work process reduction items in the form of questionnaire.

The results are shown in Table 5.2-3. Since these work period reduction items seem to greatly contribute to ensuring high operation performance of the equipment and reduction of the operation and maintenance and repair costs, IP and PJB are recommended to re-review the items of the shortening methods for scheduled inspection at each power station.

Table 5.2-3 Scheduled inspection shortening method (questionnaire result summary sheet)

○:Finishing[adoption] ×;un-adopting
－: No response

(Boiler)

	shortening method	Suralaya	Tanjung Priok	Semarang	Perak	Muara Tawar	Gresik	Grati	Paiton
1	Boiler forced cooling	×	×	○	×	×	○	×	×
2	Enlargement of a manhole	×	○	×	×	○	×	○	○
3	Adoption of the scaffold in a lifting furnace	○	×	×	×	○	○	×	×
4	An improvement and increase of a mechanic tool	○	○	×	－	○	○	○	○
5	Increase of welding equipment	○	○	×	×	○	○	×	○
6	Foundation of the scaffold work in a furnace	○	○	○	－	○	×	×	×
7	Adoption of the scaffold in a sky station (gondola type) furnace	○	○	×	×	○	○	－	○
9	Adoption of vacuum car, such as an ash handling system	×	－	－	－	－	－	－	×
10	An improvement and of the polish methods, such as a pipe and a tube	○	○	×	－	○	○	○	○

(Turbine)

	shortening method	Suralaya	Tanjung Priok	Semarang	Perak	Pesang -garan	Pemaron	Gilima-nuk	Muara Tawar	Gresik	Grati	Paiton
1	Forced cooling of a gas/ steam turbine	×	×	×	×	×	×	○	○	×	×	×
2	Encapsulation of casing keeping-warm material	○	○	×	×	○	○	○	○	×	○	○
3	Adoption of a mass bolt heater	○	○	○	－	○	○	○	×	○	○	○
4	Increase of welding equipment	○	×	－	－	－	－	－	○	○	×	○
5	Adoption of a high frequency bolt heater	○	○	○	－	×	×	×	○	○	○	○
7	Encapsulation of main steam entrance pipe flange part keeping-warm material	○	○	×	×	－	－	－	○	×	○	○
8	The crane for accessories disassembly	○	○	○	×	○	○	○	○	○	○	○
9	Hydraulic coupling bolt	○	○	○	－	○	○	○	○	×	○	○
10	Adoption of turbine casing jack rise equipment	○	○	○	－	○	○	○	○	×	○	○
11	Adoption of turbine rotor slewing mechanism	○	○	○	－	○	○	○	○	×	○	○
12	Foundation of a diaphragm storage stand	○	○	○	－	○	○	○	○	×	○	○
13	Adoption of in-line type oil flushing equipment	○	×	×	×	×	×	×	×	○	○	○
14	Adoption of additional oil flushing equipment	○	×	○	×	○	○	○	×	○	○	○

5.3. Hydropower Stations

Based on the review and analysis as mentioned in Section 3, common issues to be studied for each power station are as follows at the moment. And selections of the items to be applied are recommended.

(1) Periodical Personnel Exchange between Operation Staff and Maintenance Staff

Number of operation staff and maintenance staff seems to be enough at the all power stations. However, the periodical personnel exchange between operation staff and maintenance staff is seldom carried out basically. The periodical personnel exchange is advisable in view of further upgrading the existing skill of the relevant staff.

(2) Flexible operation of scheduled periodical inspection

The periodical inspection in Indonesia consists of "Annual Inspection (AI)", "General Inspection (GI)" and "Major Overhaul (MO)" basically and a certain inspection is conducted for almost every year in keeping with the schedule. However, considering the current frequency level of accidents, the flexible operation of scheduled periodical inspection including the extension of interval is advisable like Soedirman, which once simplified Annual Inspection (AI) to 6-month maintenance inspection and reduced the inspection duration to 30 hours for an example.

Concerning the Major Overhaul, MO is scheduled to conduct for every 40,000 hours basically. However, MO has not been carried out up to now at Soedirman power station because the operation has been in good condition even though the first commercial operation was about twenty (20) years ago (1998.11). If the unit operation is in good condition, non Major Overhaul is advisable.

(3) Better operation and maintenance work

Indication of the equipment name or machine's abbreviation number is quite important to prevent miss operation and/or miss judgment. Therefore it is desirable to indicate above mentioned indications for safety work.

For the meters, pressure gauges, level gauges, indication of standard value or normal range is desirable if possible.

Description of the criteria is important in the recording sheets for easier judgment during maintenance work.

Measurement and recording of the unit operation sequence time (for instance "preparation finished, inlet valve full open, start the machine, excitation, in parallel", and vice versa) during starting and stopping is one of the useful check to judge the machine condition.

The machine's temperature is recorded closely at this moment for every power station however long term trend management is advised to continue closely for bearing temperature, stator winding temperature, generator cooling air temperature, etc.

Concerning the machine temperature management, comparison is quite important for actual gathered data and design data and/or commissioning test data.

In case that abnormal data is found out, urgent confirmation of machine condition and measurement system condition are needed. Also description of its cause is important to the recording sheets for the reference at long afterward maintenance. And it's important the calibration of the detector if necessary.

(4) Better inspection work

It is considered, overhaul of the machine is not necessary only the reason that operation hours of the unit reach the scheduled period. (and also economical point of view)

Except the special case, it is considered that inspection of the bearing pad surface is not necessary at AI.

Detail description of repair work is desirable in the report for the reference at long afterward.

Polarity index (PI) test and Tan (δ) test are useful for the evaluation of stator winding. Therefore it desired that both of test is carried out during general inspection. (according to the periodical inspection reports, these tests ware carried out some cases completely and some cases incompletely.)

It is desirable to add the some performance test items after inspection.

Measurement of relation between guide vane opening and output is advised to confirm turbine performance.

During GI, carrying out the load rejection test is desirable to confirm the governor performance if it is permitted both of the power grid side and power station facility side.

Any performance record is not described in the some periodical inspection report. Test result is important not only to confirm the machine performance but also to compare the previous time record. Therefore description of the performance test record is advised in the report.

5.4. Regulations related to Power Utilities Companies in Japan

This section introduces the related laws and regulations on Power Utilities Companies in Japan, especially on operation and maintenance, in order to serve MEMR, a control authority of Indonesia power sector, for her reference toward the improvement of her supervision and instruction.

Power utilities companies in Japan run their business in compliance with the following regulations and rules set by METI (Ministry of Economy, Trade and Industry).

(1) Electricity Utilities Industry Law (National Law : enacted in 1964, revised in 2005)

(2) Enforcement Order for Electricity Utilities Industry Law (Ministerial Decree: enacted in 1965, revised finally in 1996)

(3) Rules for Enforcement of Electricity Utilities Industry Law (Ministerial Decree: enacted in 1965, revised finally in 2006)

(4) Ministerial Decree for Technical Standards on
- (a) Electrical Facilities (enacted in 1965, revised finally in 2006)
- (b) Thermal Power Facilities (enacted in 1965, revised finally in 2006)
- (c) Hydropower Facilities (enacted in 1965, revised finally in 2006)

(5) Regulation on Electricity Related Accident Report (Ministerial Decree: enacted in 1965, revised finally in 2004)

(1) Electricity Utilities Industry Law

1) Conformance to Technical Standard (Clauses 39 & 40)
2) Establishment of Independent Safety Rule (Clause 42)
3) Chief Engineer (Clause 43)

(2) Enforcement Order for Electricity Utilities Industry Law

1) Collection of Report (Clause 8)

(a) The Minister of METI can let the Electric Power Supplier report the following issues:
- Issues relating to management of electric power supply business
- Issues relating to engineering work, operation and maintenance in connection with security of power utility facilities
- Issues relating to financial status
- Issues relating to management of research services

The control authority can get any information or data relating to electric power supply business according to need.

(3) Rules for Enforcement of Electricity Utilities Industry Law

The Ministerial Decree of "Rules for Enforcement of Electricity Utilities Industry Law" gives the more detailed clauses to practice the "Electricity Utilities Industry Law".

(4) Regulation on Electricity Related Accident Report[10]

The regulation defines the accidents to be reported to the head of Regional Bureaus of Economy, Trade and Industry or the Minister of METI including the definition of accidents.

1) Definition of accidents (Clauses 1-3, 4, 5)

2) Accident Report (Clause 3-2)

(a) Electric power supplier shall report to the personnel specified in the following table, when the following accidents occur.

Table 5.4-1 Regulated Electricity related Accident Report

	Accidents	Reporting to whom
1	Accident causing injury or death due to the electrical shock or miss-operation of the power facilities or non-operation of the power facilities only for the cases of death, or hospital stay for curing.	The head of Regional Bureaus of Economy, Trade and Industry
2	Fire accident (Concerning the facilities, only for the case of more than 50 % loss by fire. Relating item 1 above and following items 3 to 5 are exclusive.)	The head of Regional Bureaus of Economy, Trade and Industry
3	Accident causing damage for their use relating to public properties and community facilities, such as a road, a park, a school, other facilities and causing serious social impact due to the accident of damage or miss-operation of power facilities or non-operation of power facilities (Relating to item 2 above is exclusive)	The head of Regional Bureaus of Economy, Trade and Industry
4	Accident of damage for main power facilities belonging to followings (Relating item 1 above and following items 8 to 10 are exclusive) 1) Hydropower station of which power output is less than 900,000 kW 2) Steam driving power or powers consisting of two (2) driving power units and more including a steam in a thermal power station, and power facilities which use a gas turbine with 1,000 kW and more or internal-combustion power with 10,000 kW and more as drive power 3) Steam driving power or powers consisting of two (2) driving power units and more including a steam in a thermal power, of which power output is less than 1,000 kW (Boiler related is exclusive) 4) Fuel battery power station (Omission) 5) Solar battery power station (Omission) 6) Wind power station (Omission) 7) Substations with 170,000 V and over to less than 300,000 V 8) Transmission line with 170,000 V and over to less than 300,000 V 9) Omission	The head of Regional Bureaus of Economy, Trade and Industry
5	Accident of damage for main power facilities belonging to followings (Relating to items 1 & 3 above and following items 8 to 10 are exclusive) 1) Hydropower station of which power output is 900,000 kW and over 2) Substation with 300,000 V and over, or substation of which capacity is 300,000 kVA and over, or which has a frequency converter with 300,000 kW output and over, or which has a rectifier with 100,000 kW and over 3) Transmission line with 300,000 V and over (170,000 V and over for direct currency line)	The Minister of METI

[10] MEMR has no Ministerial Decree corresponding to "Regulation on Electricity Related Accident Report", although an investigation prior to the commencement of commercial operation is obligated by the decree.

	Accidents	Reporting to whom
6	Accident of delivery failure of which delivery failure output is 7,000 kW more and 70,000 kW less and its delivery failure time is more than one (1) hours, or of which delivery failure output is 70,000 kW more and 100,000 kW less and its delivery failure time is more than ten (10) minutes (Relating to item 3 above and following item 8 are exclusive)	The head of Regional Bureaus of Economy, Trade and Industry
7	Accident of delivery failure of which delivery failure output is 100,000 kV and over, and its delivery failure time is ten (10) minutes and more (Relating to item 3 above and following item 9 are exclusive)	The Minister of METI
8	Accident causing other electricity power suppliers the delivery failure of which delivery failure output is 7,000 kW and over and less than 70,000 kW and their delivery failure time is one (1) hour and more, or of which delivery failure output is 100,000 kW and over, and their delivery failure time is ten (10) minutes and more due to the accident of damage or miss-operation of power facilities or non-operation of power facilities (Relating to item 3 above is exclusive)	The head of Regional Bureaus of Economy, Trade and Industry
9	Accident causing other electricity power suppliers the delivery failure of which delivery failure output is 100,000 kW and over, and their delivery failure time is ten (10) minutes and more (Relating to item 3 above is exclusive)	The Minister of METI
10	Omission	
11	Omission	
12	Accident caused by the abnormal discharge passing through a spillway of a dam (Relating to item 3 above is exclusive)	The head of Regional Bureaus of Economy, Trade and Industry

5.5. Guideline and Management Plan for Thermal Power Station

(1) Organization

A. The system for the operation, maintenance/Inspection management of the thermal power stations (hereinafter “Organization”) shall have clear description of the responsibility, authority and mutual relationships of the following departments (including the employees) and shall be documented.

① Department which manages the jobs on the operation and maintenance and safety management.

② Department which implements the jobs on the operation and maintenance and safety management.

③ Department which verifies the validity of the jobs on the operation and maintenance and safety management.

(Remarks) “Safety management” means to make prior evaluation of safety when the condition of use such as for the modification of boilers, etc. and to utilize information on malfunctions and incidents inside and out of the company for the operation and maintenance management.

(2) Standards for the operation management and routine inspection

A. Table 5.5-1 of Boilers/Turbines, etc. Proper standards specifying operation management items shall be established and the operation management shall be implemented based on the standards and the results shall be recorded and kept.

B. Table 5.5-2 of Boilers/Turbines, etc. Proper standards specifying routine inspection of equipment, inspection points, inspection items, inspection method, standards for adequacy, etc. shall be established and the routine inspection shall be conducted based on the standards and the results shall be recorded and kept.

Table 5.5-1 Items for Operation Management

Equipment	Items for Operation Management	Remarks
Boilers	・Steam pressure & temperature at outlet of Superheater & Resuperheater	1
	・Boiler vaporization volume or feed water flow rate	
	・Drum water level	2
	・Drum pressure	2
	・Quality of boiler water and feed water	
	・Fuel used	
	・Spray water quantity of superheater and reheater or steam temperature before and after spraying	2
	・Boiler efficiency	3
Steam turbines	・Output of the generators	
	・Steam pressure and temperature upstream of Main Steam Stop Valve and upstream of Re-heater Stop Valve	
	・Steam turbine speed	2
	・Steam turbine exhaust pressure	
	・Steam turbine extraction pressure and temperature	2
	・Oil pressure at inlet of steam turbine bearings	2
	・Temperature of steam turbine bearings & oil temperature at outlet of bearings	2
	・Characteristics of lubricating oil	
	・Steam turbine control hydraulic pressure	2
	・Opening of steam regulating valve	2
	・Vibration of steam turbines	2
	・Steam turbine efficiency	3
	・Expansion and difference in expansion of shaft and casing (only for those with 2 or more casings)	2
Gas turbines	・Output of generators	4
	・Gas turbine speed	5
	・Discharge pressure of Gas turbine air compressor	2
	・Gas temperature at gas turbine inlet	6
	・Oil pressure at gas turbine shaft inlet	2
	・Gas turbine shaft temperature or oil temperature at gas turbine shaft outlet	2
	・Characteristics of lubricant oil	
	・Gas turbine control fluid temperature	2
	・Vibrations of gas turbines	2
	・Gas turbine air compressor inlet air temperature	7
	・Fuel used	
	・Gas turbine efficiency	8

Note 1: In the case of the unit system, the pressure and temperature may be covered by those upstream of Main Steam Stop Valve and upstream of Reheating Steam Stop Valve.

Note 2: Recording of the data is not always required. However, any abnormality in light of the operation management standards shall be recorded.

Note 3: In the case of the unit system, the boiler efficiency may be covered by the general efficiency of the unit.

Note 4: The data may be covered by generation power output.

Note 5: In the case of free turbine type gas turbine, the data shall be gas generator speed and output turbine speed. Although recording is not always required, any abnormality in light of the operation management standards shall be recorded.

Note 6: The data may be covered by gas temperature at the gas turbine outlet.

Note 7: In the case of indoor equipment, the temperature may be air temperature at air intake of power generation plant, and in the case of outdoor equipment, it may be ambient temperature. Although recording is not always required, any abnormality in light of the operation management standards shall be recorded.

No.8: The efficiency may be covered by the general efficiency.

Table 5.5-2 Routine Inspection Items

Equipment	Routine Inspection Item
Boiler safety valve	・Steam leaks from valve seats
Main pipeline	・Abnormality of hangers ・Leaks of steam and gas from pipeline ・Vibration of pipeline
Boiler or furnace	・Combustion status ・Abnormality inside the furnace
HRSG	・Damage to boiler body or tubes ・Drum two-tone water level, steam leaks, damage to glass
Steam turbines	・Vibration, abnormal noise ・Steam leaks from casing ・Loosening of bolts & nuts ・Vibration, abnormal noise, species, superheating and waste oil of bearings
Main heat exchanger, etc.	・Steam leaks ・Water level
Gas turbines	・Vibration, abnormal noise, superheating and other abnormality ・Leaks of gas, lubricant oil, etc. ・Abnormality of scaffolding, supporting metal fittings, and loosening of bolts & nuts ・Vibration, abnormal noise superheating and waste oil condition of bearings
Gas turbine air compressor	・Vibration, abnormal noise and other abnormality ・Leaks of lubricant oil ・Abnormality of scaffolding, supporting metal fittings, and loosening of bolts & nuts ・Vibration, abnormal noise superheating and waste oil condition of bearings
Generators	・Vibration, abnormal noise, offensive smell ・Leakage of hydrogen gas ・Quantity and temperature of waste oil from bearings, bubbling condition ・Vibration of CT bushing and phase separating bus bar, leak from water leakage alarm ・Wear condition, vibration of the brush, superheating and connecting condition of lead lines
Main revolver (excluding Steam turbines, Gas turbines and Gas turbine air compressors)	・Vibration, abnormal noise and temperature increase of the body ・Steam and gas leaks from glands ・Oil temperature, oil surface and oil leaks from bearings
Main valves	・Vibration, abnormal noise of valves ・Leaks of steam, gas, etc. from valve glands, valve seats ・Abnormality of activating source
Main transformer	・Superheating, offensive smell, buzzing and discoloring condition ・Conservator oil surface, discoloring condition of breather silica gel
Electric equipment	・Abnormality of display lights on operation panels, monitoring panels, distribution panel switching device, Switch-on condition of alarm display ・Superheating, offensive odor and discoloring and terminal tightening condition ・Vibration, abnormal noise, offensive smell of motor transformer, illumination transformer
Instruments	・Damage condition of indicators and recorders, etc. ・Damage condition and any difference by comparison between indicated values and standard values on instruments such as indicators and recorders ・Condition of ink loss from recorders and of chart processing ・Indicated value on , leaks from detector

(3) Cultivation of Human Resources for the Operation and Maintenance Management

< Human Resources Training Method for Each Function to Establish Strong Thermal Power >

(Operating personnel)

Trainee of Basics (Recording and management of learning career)	Trainee of Application: Application I (Recording and management of learning career)	Trainee of Application: Application II (Recording of learning career)
Descriptions of Thermal technological text + Skills required to perform jobs (inspection, maneuvering, monitoring, control, etc.)	Skills necessary to perform jobs (operation, monitoring, control, etc.) • Learning of knowledge: Paper tests • Learning of technical aspects: Simulator advanced course	Skills necessary for jobs (operation, monitoring, control, etc.)

(Maintenance personnel)

Trainee of Basics (Recording and management of learning career)	Trainee of Application: Application I (Recording and management of learning career)	Trainee of Application: Application II (Recording of learning career)
Descriptions of thermal technological text (Technical knowledge on equipment structure, principle, characteristics, etc.) + Skill to grasp points of attention in job implementation	Skill to grasp points of attention in job implementation (A series of maintenance jobs including work plans and implementation, measures against trouble.) Detailing of contents • Learning and grasping of points of attention: Oral test for each item	Skill to grasp points of attention in job implementation (A series of maintenance jobs including work plans and implementation, measures against trouble)

(Engineering, Environment・Planning personnel)

Trainee of Basics (Recording and management of learning career)	Trainee of Application: Application I (Recording and management of learning career)	Trainee of Application: Application II (Recording of learning career)
Descriptions of thermal technological text (Technical knowledge necessary to perform jobs) + Skill to grasp points of attention in job implementation	–	Skill to grasp points of attention in job implementation (Improvement of unit performance, environmental improvement work, water supply, oil management, etc.)

5.6. Guideline and Management Plan for Hydropower Station

(1) Items for operation job

Regarding the operation job for hydro power station, the main daily affairs are as ① start/ stop, open/close etc. of the facilities, ② supervision of the machines, ③ daily patrol check of the facilities, ④ open/close and locking of the electrical switches, valves, protection relays, etc. for maintenance work

① During operation of the facilities, preventing the miss operation is the most important. Therefore, operation of the main machines such as unit start/stop, open/close of main circuit breakers and disconnecting switches are usually carried out by operation staff under the chief engineer's supervision and instruction step by step.
And the operation job such as open/close the valves, start/stop the auxiliary equipment and locking the relays are permissible in case that the job is in accordance with the approved operation procedure.

② Regarding the supervision of the facilities, careful watching for meters is required at any time. And daily trainings are important to recover from the abnormal condition quickly.

③ Regarding the daily patrol check of the facilities, not only the visual check but also the five senses check are important. Also for easier detecting the abnormal condition of the equipment, the daily check sheet had better include the indication of normal/allowable ranges of the relevant meters and detectors, etc. and/or description of the criteria.
The patrol route is carefully considered to prevent the facilities from missing the inspection and for easier patrol.

④ Before starting the inspection work or repairing work, perfect lock of the related switches, valves, protection relays, and so on are very important in view of safety work of maintenance staffs and the prevention of the bad influence to the power grid.
For these purposes, it is quite important that locking job is carried out based on the approved operation procedure. And it is the same manner during the restoration.
To prevent any miss operation, it is desirable to attach the indicators and/or tags nearby such as machine's abbreviation number, each equipment name, valve number, valve open/close condition, flow direction and classification of fluid on the pipes.

(2) Items for Maintenance Job

Regarding the maintenance job for hydro power station, the main affairs are as ① planning, action and evaluation of periodical inspections such as weekly, monthly, yearly and reflection of the inspection result on the next inspection plan, ② in case of trouble or incident, recovering, investigation of the causes and study on prevention of recurrence, ③ examination and management of setting values of protection relays, ④ management of design drawings and calculation sheets, instruction documents, commissioning test records and periodical inspection reports, etc.

① For the planning of the inspection schedule and items, it is very important that inspection frequency is decided under consideration of reliability and level of importance of each facility. And the inspection sheet is proposed to include the criterion measure/average level in order to judge whether the machine condition is normal or abnormal at a glance.
Regarding the yearly inspections such as Annual Inspection and General Inspection, these are relatively large scale inspections, therefore it is important that inspection items is decided in advance under the close consideration of previous inspection results. In case that the items which were judged as "good", it is better to reconsider the extension of the inspection period.
Especially concerning Major Overhaul, it is large scale inspection and gives influence to the power grid reliability and also economical viewpoint, therefore it is quite important that the timing of the M.O is considered closely actual machine condition.
It is not necessary to carry out M.O only by the reason that unit operating hours reach the planned M.O timing.
In the inspection report, detail description of repaired work and operation test results are especially desired for serving subsequent inspections.

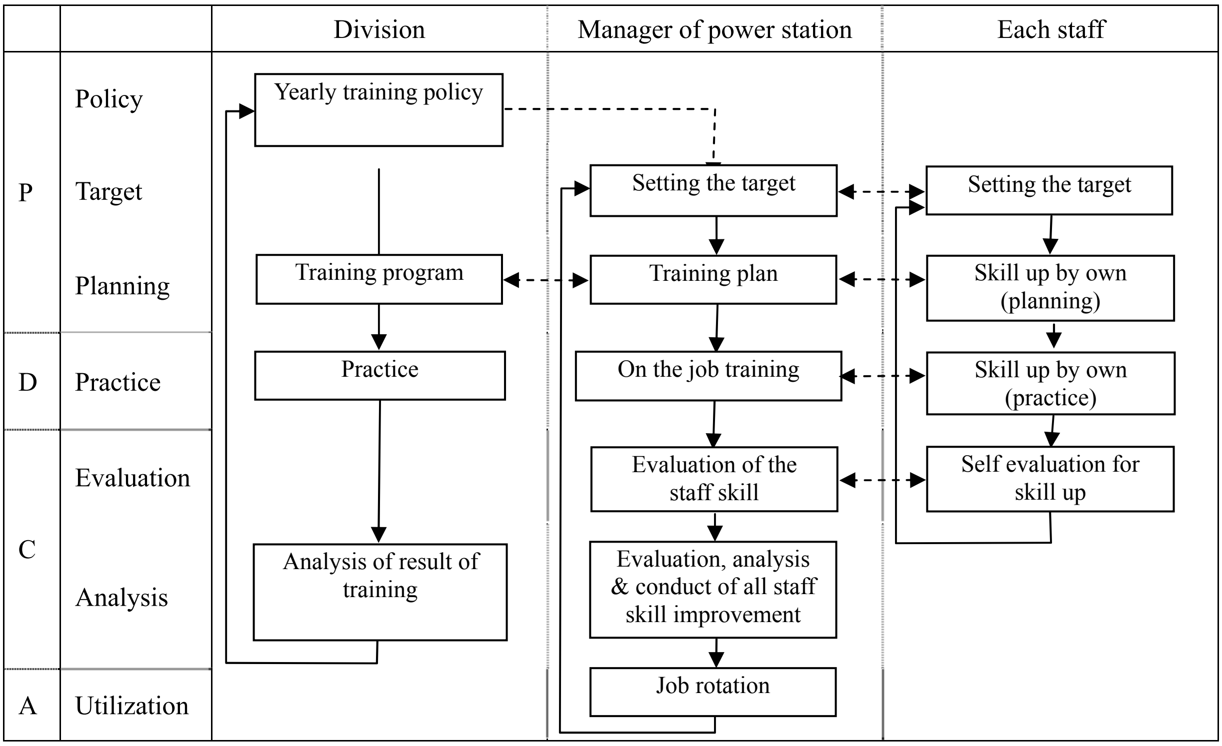
② In case of trouble or incident, of course quick recover is very important and it is also important to investigate it's cause closely and to prevent recurrence of same trouble.

③ Regarding the protection relays, review of setting values are needed sometime according to changing the power grid condition and/or changing machine's operation condition. Therefore, it is important to prepare rule of the calculation method of protection relays.

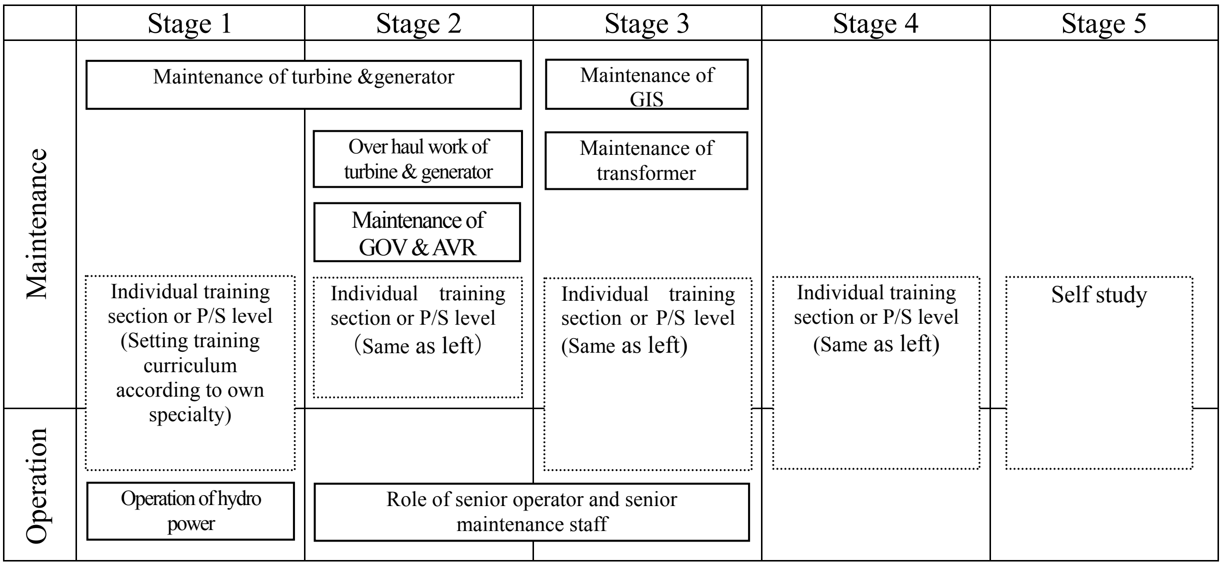
④ Drawings, calculation sheets, instruction documents, erection records and test records during the construction period, periodical inspection reports, and so on are quite important for good maintenance. Therefore preparation the managing method is important to prevent any missing the materials.

(3) Items for Training

System of Yearly Staff Training Policy



Contents of Training for Each Skill Level



6. Technology Transfer

6.1. Thermal Power Station

(1) Background

Based on the above investigation, the following issues are confirmed for RLA.

1) LITBANG, PLN's research institute, has already RLA technology for a boiler.
2) RLA for a turbine and a generator has been carried out by manufacturers and LITBANG hopes for technology transfer of RLA regarding a turbine and a boiler.
3) Since some power stations have already exceeded the design life time, the execution of RLA is required.

Considering the deterioration of facilities, rehabilitation/modification works in the past and effectiveness of RLA technology for Indonesia side addition to the above confirmation, the contents of technology transfer for a boiler, a turbine and a generator had been set by the Study Team and consensus was obtained in the 2nd Workshop.

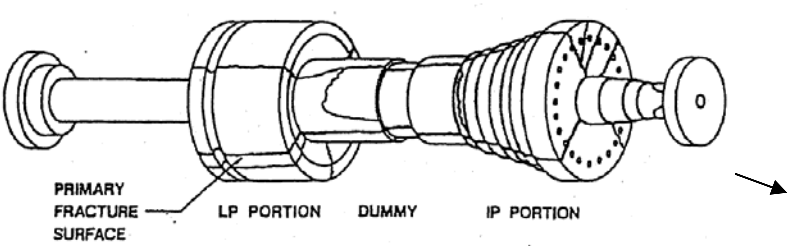
(2) Technology Transfer

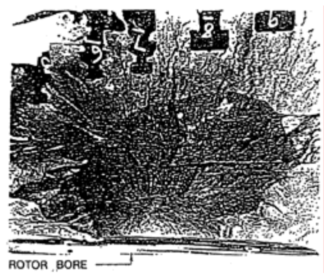
1) Turbine

1. Thermal Power Station
   RLA has been conducted by turbine manufacturers.
2. LITBANG
   LITBANG hopes for technology transfer of RLA

Deterioration of turbine might be caused by various factors, such as creep, fatigue and embrittlement etc.

→ Among the above factors, deterioration by embrittlement is important because turbine failure by embrittlement causes the serious damage.





Example of burst of turbine rotor due to embrittlement

(USA Gallatin #2 1974)

Turbine rotors manufactured in 1970s have more embrittlement components, such as P, Sn, Sb, As, and S, than those manufactured in 1980s. Therefore, attention shall be paid to those turbine rotors. Power stations which have the turbine rotors manufactured in 1970s are as follows;

- Perak : Units 3, 4 (1978)
- Tambak Lorok : Units 1, 2 (1978)
- Gresik : Units 1, 2 (1981)

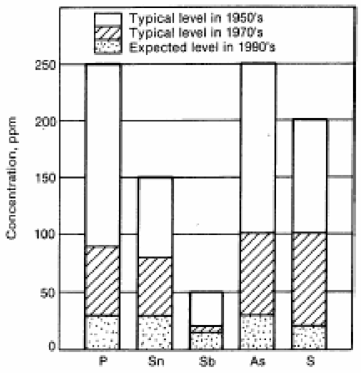


Fig. 6.37. Trends in impurity levels in Cr-Mo-V rotor steels (Ref 20).

Based on the above reasons, Non-destructive Evaluation of Temper Embrittlement in Cr-Mo-V Rotor (Measuring method of embrittlement rate by corroding gain boundary on the surface) was introduced. Method, content and characteristics of RLA in Japan was explained.

2) Boiler

1. Achievement of RLA
   RLA has been conducted by LITBANG.
2. Current Status of Boiler
   Many unit trips occur due to boiler tube leak and some of leaked tubes are still with the design life time.

1

The above phenomenon could be interpreted as the phenomenon has happened due to not only the single factor such as creep damage or fatigue or corrosion damage but also compound damage consisting of these damages. Therefore, the following compound damage mechanism and evaluation method are introduced.

1) Compound creep damage
2) Corrosion fatigue damage

2

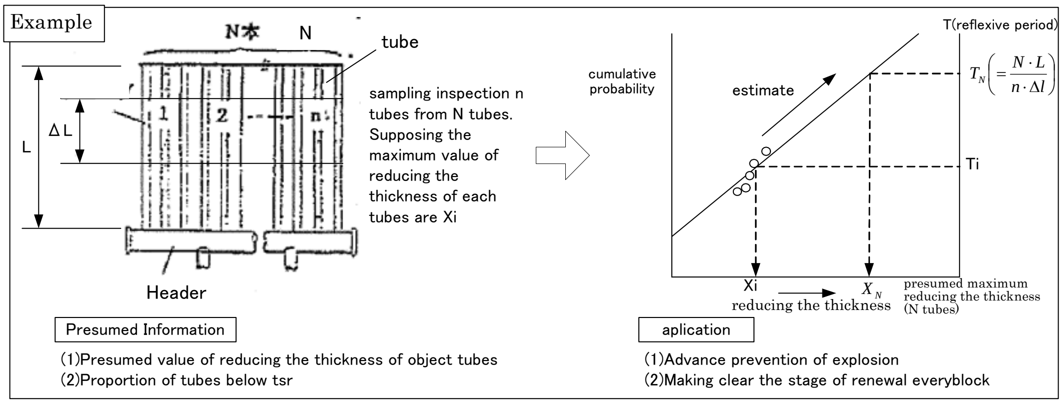
When the evaluation of compound damage for boiler tubes is conducted, it is necessary to know the current tube condition such as degree of corrosion and steam oxidation scale thickness at inner tube. Therefore, more easy-to-use and more accuracy inspection devices are introduced.

Boiler Inspection Device

1) Corrosion fatigue detecting MT device
2) Steam oxidation scale thickness measuring device
3) Coil deep space inspection device

3

Measurement of pitting corrosion is sometimes forced to be conducted within the limited duration in the course of periodic inspection of a boiler and or some measurement points require a scaffold to access the points. One of the alternatives to avoid such restrictions is Extreme Value Statistical Analysis Method, which can estimate the maximum pitting depth and the minimum tube thickness statistically for the objective portion by the limited tube thickness data sampled at periodic inspection. Extreme Value Statistical Analysis Method, of which concept is shown in the following figure, was introduced.



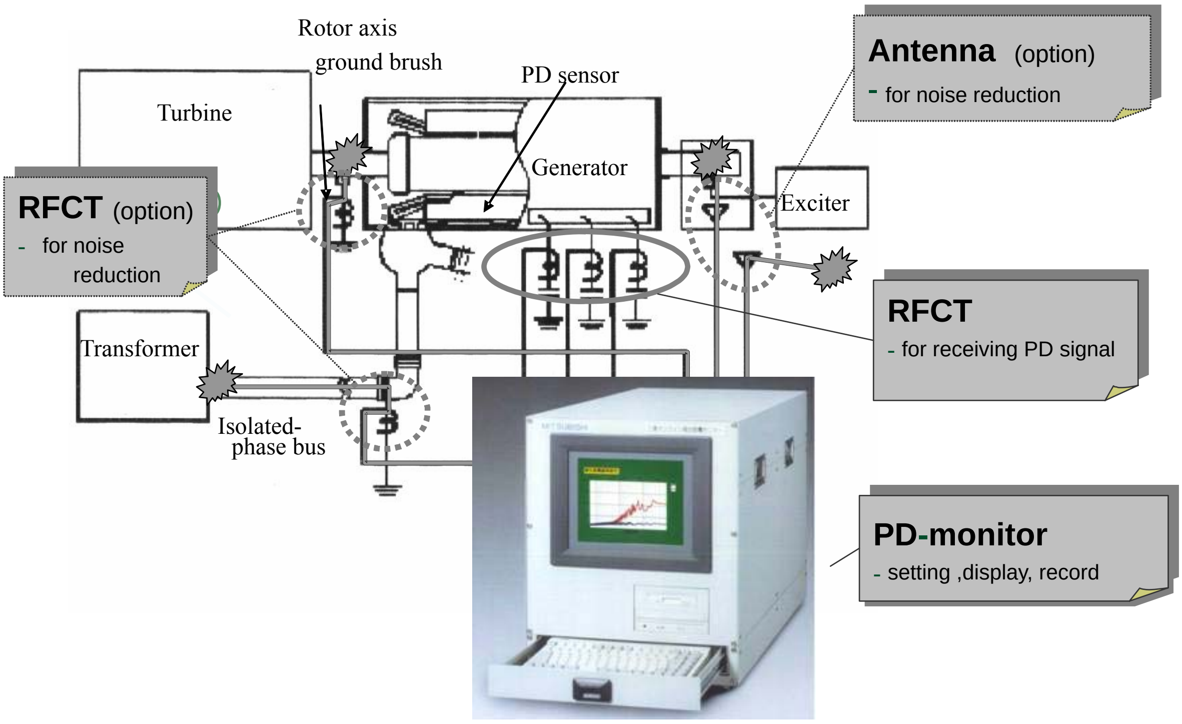
3) Generator

Defects of a power generation body are mainly cased by the deterioration of insulator, although defects are caused by many factors.

Concerning the insulator deterioration, the deterioration of a stator coil has been going on in proportion to operation hours due to electric charge, thermal stresses and low cycle fatigues. Once dielectric breakdown at a stator coil occurs, a power station has to stop the generation promptly and it takes a lot of time and money to restore generally. For the above reasons, the deterioration diagnosis technology for a stator coil is introduced.

Insulator deterioration at a stator coil causes occurrence and enlargement of a void. The more and larger voids occur, the lower dielectric breakdown voltages (BDV) become. Therefore, the degree of insulator deterioration can be estimated by the measurement of dielectric breakdown voltages at an each generator unit. However, since BDV cannot be measured directly for an actual generator, the degree of insulator deterioration can be also estimated by measuring a partial discharge, which has the strong correlativity with BDV.

The monitoring device called as “On-line Partial Discharge Monitor for Turbine Generator”, which can measure a partial discharge without stopping the operation, was introduced.



(3) General Overview

1) RLA general, turbine-related and boiler-related

Almost of all respondents to a questionnaire could understand the content of topics more than 50 %. Especially concerning a turbine-related topics, more than 90 % of respondents could understand the content 50 % and more, even though the topics included heavy subject matters. Concerning a boiler-related, more than 90 % respondents could understand the content 50 % or more, and 20 % of the total respondents could understand the content 80 % or more. Considering these understanding of participants, technology transfer might be assessed as successfully conducted.

2) Generator-related including hydropower station

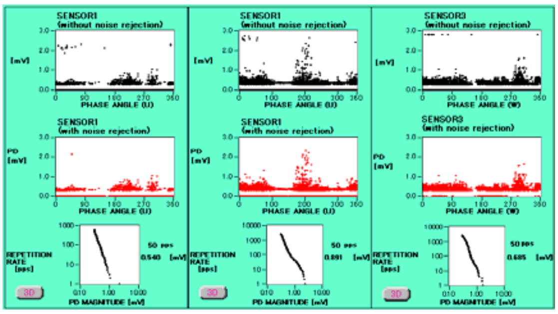
More than half respondents out of the total respondents could understand the content 50 % or more. Considering these understanding of participants, technology transfer for a generator-related might be assessed as successfully conducted as well as a turbine and a boiler.

3) Demonstration

Many relevant people, from IP, PJB and LITBANG participated in the demonstration conducted at Muara Karang power station and "On-line Partial Discharge Monitoring for Turbine Generator" was requested to be demonstrated at Kamonjang Geothermal power station.

7/13,14 Technology Transfer

7/27 Confirmation of Terminal Box at Muara Karaang Unit 1 Generator



7/27 Result of PDM at Muara Karang Unit 1

6.2. Hydropower Station

(1) Background

During the course of the above investigation, RLA by utilization of non-destructive examination and electrical insulation examination has not been conducted for hydropower stations. But the necessity and effect of conducting RLA were well understood and they showed their high interest in RLA. The application of RLA to old hydropower stations are well expected to contribute to prevent serious accidents by preventive maintenance.

Based on the above conditions, technology transfer for RLA, by using non-destructive examination method and electrical insulation examination for a generator stator aiming the establishment of preventive maintenance, is to be conducted. The following three (3) topics for the technology transfer were confirmed by the discussion with the Indonesia side and the Study Team in the 3rd Field Work based on the results of the 1st Field Work.

- Remaining Life Assessment by using non-destructive examination results for a casing and a stay vane
- Remaining Life Assessment by using the management of welding volume for a turbine runner
- Remaining Life Assessment by using the results of electrical insulation examination for a generator stator

(2) Technology Transfer

1) RLA by using the non-destructive examination results for a casing and a stay vane

The RLA is to evaluate the remaining life by firstly modeling the defects resulting from an ultrasonic defecting device as one of the non-destructive method, and by application of fracture mechanism considering the operating stresses and material characteristics secondly. The concrete evaluation method and points to remember were explained by using the actual samples in the technology transfer.

2) RLA by using the management of welding volume for a turbine runner

The RLA is to evaluate the remaining life of a runner by digitalizing the damage, utilizing an evaluation standard, caused by the repair works for a runner, such as welding volume, stress relief, and deformation. The concrete evaluation method and points to remember were explained by using the actual samples in the technology transfer.

3) RLA by using the results of electrical insulation examination for a generator stator coil

The RLA is to evaluate the remaining life of a stator coil by estimating the dielectric strength resulting from the measurements of the maximum partial discharge and tan δ carried out for an electrical insulation examination for a generator stator coil. The concrete evaluation method and points to remember were explained by using the actual samples in the technology transfer.

(3) General Overview

1) RLA Technology Transfer for Hydropower Station

More than half respondents out of the total respondents could understand the content 50 % or more. Considering these understanding of participants, technology transfer for a generator-related might be assessed as successfully conducted.

2) Demonstration of PDM

Many relevant people, from IP, PJB and LITBANG participated in the demonstration conducted at Cirata Hydropower Station. Many questions arose in the demonstration, such as

- Can the remaining life of a stator coil be evaluated by only the measurement of partial discharge?
- Can the concrete defective coil portion be identified by the PDM?
- Please more explanation about the occurrence mechanism of void causing insulation deterioration.
- Please show us the examples of measuring results conducted at power stations in the KANSAI.

－ Do you have some experiences in conducting PDM at hydropower stations in the KANSAI?

－ Is this PDM sold on the market?

The demonstration and explanation hours far exceeded the planned hours due to the above active exchange of views.

7/26 Demonstration of PDM at Cirata Unit 6 Generator

7. Conclusion and Recommendation

In the course of the one-year Study, the Study team visited sixteen (16) power stations, LITBANG, Suralaya Training Center, P3B and local dispatching center in Java-Bali region and collected a lot of relevant data/information in the meetings relating to power generation facilities and O&M. Further more, technology transfer relating to Remaining Life Assessment was also conducted including the demonstration at Cirata hydropower station and Muara Karang thermal power station. Addition to the above activities and studies, three (3) Workshops and three (3) Steering Committees were held and useful comments were made by the participants. Based on the above activities and studies, the following conclusions and recommendations are induced.
Table 7-2 shows the summary of objective power stations in respect to their operation and maintenance performance.

7.1. Conclusion

7.1.1. Thermal Power Stations

(1) The Study Team analyzed the operation performance on June 20, 2005 which caused the serious power supply shortage in Java-Bali region, for the objective power stations. The results of analyses are;

(a) About 25 % of the total installed capacity with 12,660 MW were forced to stop the operation and causing the derating due to planned outages and forced outages.

(b) The derating caused by fuel issues was about 6 %. The 6 % doesn't include shutdown of power station due to the stop of fuel supply.

(2) Concerning the gas and oil related, it is confirmed that MEMR is a regulator and a policy maker, and BPMIGAS (Executive Agency for Upstream Oil and Gas Business Activity) under the direct control of the president is a regulator and a supervisor relating to the gas and oil business.

(3) Development of new coal fired power plants with the total capacity up to 10,000 MW through out Indonesia for the next three years aiming the energy diversification was announced on May 22, 2006 by PLN during the Study Period. According to a newspaper, the development of new coal fired power plant seems more likely to affect the current thermal power stations in some form, especially HSD firing power stations.

(4) The Study Team analyzed accidents and troubles (times and hours) for 75 units among the objective thermal power stations from 2003 to 2005. The results of analysis are;

(a) The number and hours of forced outages show the tendency to increase of forced outage as a whole.

(b) The main cause of forced outages is due to the defect or malfunction of Instrumentation and Control (I & C), which might be caused by maladjustment at the periodic inspection, aged deterioration and sometimes by human errors.

Based on the above analysis, measures for "Improvement to preventive routine accidents and troubles" and "Improvement of scheduled inspection work from operation aspect" are prepared by the Study Team.

(5) It is confirmed that PLN's affiliated companies IP and PJB report their financial status to PLN but don't submit the accident reports to PLN. And it is also confirmed that MEMR, the control authority for the power sector, is not normally engaged with the electricity related accidents except for the case, such as the large area blackout in Java-Bali region which occurred on August 18, 2005 causing the serious social impact and MEMR has been investigating the cause of and responsibility for the blackout.

(6) In respect of maintenance system for a power station, it is confirmed that IP adopts the Maintenance System Based on Location of Facilities and PJB adopts the Maintenance System Based on Category of Maintenance Methods, and both maintenance systems are different.

(7) It is confirmed that currently Suralaya, Muara Karang, Paiton and Saguling power stations are under procedure of JBIC export credit. Addition to the above four (4) plans, it is also confirmed that PLN has intention to carry out further rehabilitation and modification plans for Suralaya unit 3 and unit 4, and Muara Karang PLTU unit 4 and unit 5, which are excluded in the current JBIC export credit due to the limit of PLN budget.

(8) The Study Team proposed the repowering plans for Tambak Lorok, Grati and Gilimanuk power stations to be converted from the existing PLTU/PLTG to PLTGU. Along with the repowering plans, oil reduction plans are also proposed for UBP basis, such as UBP Semarang, UBP Perak/Grati and UBP Bali.

(9) The economic and financial analyses were conducted for the six (6) proposed plans. The economic analysis resulted in good EIRR exceeding the social discount of 12 % under the current high fuel oil prices. However, the financial analysis resulted in pessimistic project FIRR below the opportunity cost of 12 %. Measures to implement the proposed plans are presented by the Study Team.

(10) The Study Team conducted scoping for the six (6) proposed plans from the viewpoint of Environmental and Social Consideration. And a draft KA-ANDAL is prepared by the Study Team.

7.1.2. Hydropower Stations

(1) Regarding four (4) hydropower stations, no derating was observed. Operation and maintenance are well managed.

(2) Some rehabilitation/modification plans for Saguling, Cirata, Soedirman and Sutami were proposed by the Study Team.

(3) The water quality deterioration in the reservoir, due to the inflow of domestic wasted water and factory effluent, is causing the serious damage to the water cooling system at Cirata and Saguling hydropower stations. It is confirmed that Replacement of water cooling piping is under progress at Cirata by PJB own budget or planned at Saguling by JBIC export credit.

(4) It is confirmed that reservoir operation rule for Saguling and Cirata is developed by the Coordination Committee and the generation use of the Citarum River is set at the lowest priority among the utilizations of the Citarum River.

7.1.3. Power Facilities (Transmission Line and Substation)

(1) Construction of southerly 500 kV transmission line with two circuits was completed in June 2006.

(2) It is confirmed that in 500 kV transmission line, only the section which is restricted by system stability is not satisfied with N-1 criteria and as for 500/150 kV transformers, the ratio of transformers whose availability is over 60 % accounts for 90 % or more of the total, and almost of transformers do not meet N-1 criteria.

(3) The Study Team analyzed the accidents relating to transmission lines and transformers. The result is that the number of service interruption due to transmission line is small, but one due to transformer faults has been increasing year by year.

(4) It is confirmed that generators owned by IP and PJB do not carry out governor free operation even though Grid Code regulates all power stations have to be operated with governor free mode. It is also confirmed that generators owned by IPPs and PLN (Muara Tawar) are operated with governor free mode.

7.1.4. Technology Transfer for Remaining Life Assessment (RLA)

(1) It is confirmed that LITBANG, PLN's research institute, has many experiences in RLA for boiler related, while RLA for turbines and generators is conducted by manufacturers, and RLA has not been conducted by Indonesia side for hydropower stations.

(2) Based on the current situation of RLA in Indonesia, technology transfer relating to RLA

including the demonstration at power stations was conducted by the Study Team for the following items mainly.

- Management method by Extreme Value Statistical Analysis for Boiler
- Non-destructive Evaluation of Temper Embrittlement in Cr-Mo-V Rotor
- Remaining Life Assessment by using the none-destructive examination results for a casing and a stay vane
- Demonstration of On-line Partial Discharge Monitoring for Turbine Generator

7.2. Recommendation

The followings are recommendations relating to improvement measures for the electricity generation facilities in Java-Bali Region.

Table 7-1 Recommendations

To whom	Recommendation	Purpose/Effectiveness	Impact
MEMR, BPMIGAS	To address the shortage of fuel oil and gas supply, especially for gas	- Recovery of power output for dual firing thermal power plant - Deaccelerating the aged deterioration to a certain extent	High
MEMR	To establish “Regulation on Electricity Related Accident Report”	- More active involvement of MEMR in operation and maintenance of power stations as the control authority - Statistical processing of electricity related accidents by MEMR to establish necessary policies and/or decrees aiming the reduction of accidents.	High
IP	To conduct Feasibility Study on conversion of Gilimanuk PLTG to PLTGU and the possibility of shutdown of Pesanggaran PLTG #1 & #2 aiming repowering and fuel oil saving.	- A pilot project achieving repowering and fuel oil reduction simultaneously, in other words, an integrated project aiming the promotion of efficiency of the existing thermal power stations. - Improvement of PLN’s financial status by reducing the expensive fuel oil cost	High
PLN	To install simulation system for PLTG and PLTGU addition to the current simulator (PLTU) at Suralaya Training Center	- Strengthening the capability of operation staff for prompt response to a unit trip - Development of human resources of operation staff - Preventing reoccurrences of accidents caused by the same cause	High
IP, PJB, PLN	To utilization of JBIC Export Credit for rehabilitation/modification for the existing power generation facilities	- Recovering of power output to a certain extent - Improvement of reliability of power supply	High
IP, PJB	To conduct pipe thickness inspection work at a typical power station	- Implementation of preventive/ predictive maintenance to avoid the same kind of serious accidents occurred in 2004 in Japan which killed five maintenance staff.	High

To whom	Recommendation	Purpose/Effectiveness	Impact
PLN, MEMR	To dispatch IP's and PJB's staff to Japan to receive education and training for OJT (at least 6 months to one year) at thermal power stations/or at companies engaged in maintenance of thermal power stations.	- Acquiring predictive/preventive maintenance and management system of power stations in Japan, and disseminating to power stations in Indonesia in order to improve the maintenance and management system, if applicable	High
PLN	To compile the electricity related accidents examples by generation type and generation facility basis	- Preventing reoccurrences of accidents caused by the same cause	Intermediate
PJB	To switch their current maintenance system to the Maintenance System Based on Location of Facilities adopted by IP	- Aiming more effective maintenance considering the accelerating of aged deterioration in the future	Intermediate
IP, PJB	To conduct the Remaining Life Assessment for high/intermediate pressure turbine rotors manufactured in 1970s (Gresik #1 & #2: 1978, Perak #3 & #4: 1978 and Tambak Lorok #1 & #2:1981) because turbine rotors in 1970s have the possibility of having more impurity materials which accelerate embrittlement of rotors, if IP and PJB want to use them over the years to come.	- Implementation of predictive and preventive maintenance to avoid a burst of turbine rotor, of which example was introduced in the Technology Transfer Seminar.	Intermediate
IP, PJB	To review and revise IP's and PJB's procedure for scheduled maintenance by referring "Implementation Procedure of Scheduled Maintenance" in Table 5.2-1 and "Sharing of Roles" in Table 5.2-2 which are the know-how adopted in power utility companies in Japan	- Improvement measures toward the effective and efficient procedure for scheduled maintenance	Intermediate
IP, PJB	To conduct the periodic performance test for protective devices	- Improvement of safety shutdown of power stations under the current numerous unit trips - Contributing to sustainability and improvement of technical capabilities of operation staff	Low

Table 7-2 (1/4) Summary of Objective 16 Power Stations relating to Operation and Maintenance

		Power Station	Unit		Capacity	Commi-ssioning	Installed Capacity	(Max.) Available Capacity	Available Capacity Total	Manufacturer			Power Generation	Gross Capacity Factor	Station Use (PS + SUSUT TRAFO)		Gross Heat		Service Hours (SH)	Service Factor (SF)	Stand by (RSH)	Number of Outages in 2004			Outages in 2004 by P/S		Fuel Consumption in 2004			
								as of November 2005		Boiler	Turbine / Runner	Generator	in 2004 (PH = 8,784 Hours)				Rate	Efficiency				Planned	Outgae by P/S	by System	Planned	Outage F.O+M.O	Fuel Type MFO	HSD	NG	Coal
					MW	yy.mm	MW	MW	MW				MWh/year		MWh/year	%	kcal/kWh	%	Hours	%	Hours	No. of times			Hours		KL	KL	MMBTU	Ton
Thermal	Indonesia Power (IP)	Suralaya	1	TU	400.0	1985.04	3,400	400.0	3,400	B&W (Canada)	MHI	MELCO	2,614,863	0.74	164,175	6.3	2,477	34.7	7,539	85.8	33	1	10	0	705	507	37,914	2,486		1,242,034
			2	TU	400.0	1985.06		400.0					2,113,298	0.60	143,084	6.8	2,363	36.4	7,829	89.1	286	1	12	0	0	668	31,860	4,933		947,391
			3	TU	400.0	1989.02		400.0					2,579,479	0.73	159,230	6.2	2,393	35.9	7,581	86.3	77	1	4	0	975	151	13,214	894		1,210,792
			4	TU	400.0	1989.11		400.0					2,638,923	0.75	166,632	6.3	2,383	36.1	7,557	86.0	69	1	4	0	676	481	24,860	823		1,225,349
			5	TU	600.0	1997.06		600.0					4,162,813	0.79	193,280	4.6	2,418	35.6	8,526	97.1	56	1	4	0	190	12	0	946		2,017,561
			6	TU	600.0	1997.09		600.0					4,090,616	0.78	193,679	4.7	2,344	36.7	7,870	89.6	56	1	2	1	809	36	0	881		1,906,130
			7	TU	600.0	1997.12		600.0					4,510,588	0.86	208,006	4.6	2,304	37.3	8,617	98.1	158	0	1	0	0	8	0	483		2,086,743
		Tanjung Priok	3	TU	50.0	(1998)	1347.4	45.0	1,201.0	MHI	MHI	MELCO	0	0	0	-	-	-	0	0.0	0	-	-	-	0	0	0	0	0	
			4	TU	50.0	2005.12		45.0					0	0	0	-	-	-	0	0.0	0	-	-	-	0	0	0	0	0	
			BL1.1	GT	131.4	1994.09		125.0		ABB	ABB	ABB	653,989	0.57	3,981	0.6	3,039	28.3	6,475	73.7	22	4	3	0	2,275	11	0	19,748	7,249,797	
			BL1.2	GT	131.4	1994.09		125.0					762,281	0.66	25,083	3.3	2,919	29.5	7,311	83.2	38	2	6	0	1,410	24	0	83,284	6,234,093	
			BL1.3	GT	131.4	1994.10		125.0					687,426	0.60	23,179	3.4	2,898	29.7	6,401	72.9	33	3	7	0	2,118	232	0	27,997	7,248,972	
			BL1.4	ST	203.5	1994.10		175.0					1,003,749	0.56	2,629	0.3	-	-	8,781	100.0	0	0	3	1	0	3	-			
			BL2.1	GT	131.4	1994.02		125.0					709,580	0.61	24,995	3.5	2,955	29.1	7,126	81.1	0	4	5	1	1,543	116	0	17,701	7,997,034	
			BL2.2	GT	131.4	1994.02		125.0					888,297	0.77	23,178	2.6	2,902	29.6	8,289	94.4	58	4	4	1	423	14	0	141,830	5,572,193	
			BL2.3	GT	131.4	1994.03		115.0					896,215	0.78	4,447	0.5	3,032	28.4	8,555	97.4	0	2	4	1	215	15	0	10,948	10,427,885	
			BL2.4	ST	203.5	1994.12		160.0					1,186,409	0.66	3,413	0.3	-	-	8,779	99.9	0	0	3	1	0	5	-			
			1	GT	26.0	1976.09		18.0		-	WH	WH	936	0.00	31	3.3	4,476	19.2	50	0.6	52	1	0	0	8,682	0	0	494	0	
			3	GT	26.0	1976.02		18.0					7,662	0.03	284	3.7	4,339	19.8	411	4.7	4,554	2	5	0	3,526	293	0	3,887	0	
		Tambak Lorok	1	TU	50.0	1978.09	1334.2	45.0	1260.00	F&W	GE	GE	312,384	0.71	26,273	8.4	2,771	31.0	7,946	90.5	6	1	4	1	664	168	93,504	0	0	
			2	TU	50.0	1978.10		45.0					284,422	0.65	22,231	7.8	2,797	30.7	7,618	86.7	65	1	5	1	1,043	58	85,962	0	0	
			3	TU	200.0	1983.07		200.0		Mitsui-Riley	MHI	MELCO	1,125,718	0.64	71,549	6.4	2,387	36.0	7,983	90.9	36	1	2	1	622	143	290,179	0	0	
			BL1.1	GT	109.7	1993.08		105.0		Austrian - EE	GE	GE	459,188	0.48	5,160	1.1	3,065	28.1	5,734	65.3	2,381	1	6	0	639	30	0	163,286	0	
			BL1.2	GT	109.7	1993.10		105.0					432,692	0.45	7,003	1.6	3,090	27.8	5,455	62.1	2,713	1	5	0	589	27	0	155,117	0	
			BL1.3	GT	109.7	1993.10		105.0					268,251	0.28	8,118	3.0	3,086	27.9	3,512	40.0	4,180	1	4	0	1,068	24	0	96,035	0	
			BL1.4	ST	188.0	1997.11		170.0					568,834	0.34	34,353	6.0	-	-	8,080	92.0	47	1	18	1	574	83	-	-	-	
			BL2.1	GT	109.7	1996.07		105.0					392,896	0.41	3,172	0.8	2,996	28.7	4,921	56.0	3,302	1	4	0	387	175	0	136,563	0	
			BL2.2	GT	109.7	1996.08		105.0					433,395	0.45	2,995	0.7	2,997	28.7	5,241	59.7	3,386	1	1	0	155	2	0	150,693	0	
			BL2.3	GT	109.7	1996.09		105.0					423,611	0.44	2,586	0.6	3,055	28.2	6,079	69.2	2,386	1	3	0	317	2	0	150,101	0	
			BL2.4	ST	188.0	1997.05		170.0					577,928	0.35	50,111	8.7	-	-	8,492	96.7	169	0	12	1	46	77	-	-	-	
		Grati	BL1.1	GT	112.45	1996.10	868.37	100.75	767.5	CMI	MHI	Siemens	186,820	0.19	3,126	1.7	3,292	26.1	2,630	29.9	3,942	1	2	0	476	1,737	0	69,716	0	
			BL1.2	GT	112.45	1996.10		100.75					229,070	0.23	3,377	1.5	3,394	25.3	3,423	39.0	5,139	0	14	0	0	222	0	87,597	0	
			BL1.3	GT	112.45	1996.10		100.75					250,630	0.25	3,902	1.6	3,409	25.2	3,468	39.5	4,611	1	8	0	572	133	0	94,413	0	
			BL1.4	ST	189.50	1997.03		159.58					275,910	0.17	22,234	8.1	-	-	4,050	46.1	2,800	0	10	0	0	1,934	-	-	-	
			BL2 1	GT	113.84	2002.10		101.90		-	MHI	Siemens	142,560	0.14	2,979	2.1	3,659	23.5	2,209	25.1	6,396	1	3	0	106	73	0	55,824	0	
			BL2 2	GT	113.84	2002.10		101.90					105,350	0.11	2,372	2.3	3,399	25.3	1,575	17.9	6,367	1	9	0	114	729	0	39,916	0	
			BL2 3	GT	113.84	2002.10		101.90					117,150	0.12	2,565	2.2	3,423	25.1	1,783	20.3	6,568	1	10	0	88	345	0	44,495	0	
		Perak	1	TU	(25.0)	1964.xx	100.0	Retired in 1996		(F&W)	(GE)	(GE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2	TU	(25.0)	1964.xx		Retired in 1996					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			3	TU	50.0	1978.04		45.00	90	MHI	MHI	MELCO	231,196	0.53	14,912	6.4	3,010	28.6	7,817	89.0	312	0	8	0	0	655	69,118	118	0	
			4	TU	50.0	1978.07		45.00					204,884	0.47	13,900	6.8	3,099	27.8	7,017	79.9	520	0	5	0	0	1,247	61,128	43	0	
		Pesanggaran	1~11	D	5.08 x 4 + 4.14 + 6.77x 2 + 6.52 x 2	1973.02~1989.02	201.27	60.91	170.61	Mirrlees BS, SWD			70,534	0.12	3,848	5.5	2,511	34.2	1,561	17.8	6,951	3.7	1	7	272	1	0	19,106	0	
			1	GT	21.35	1985.02		19.5		-	Alstom	Alstom	54,875	0.29	642	1.2	3,885	22.1	3,131	35.6	5,017	4	2	0	618	18	0	22,996	0	
			2	GT	20.10	1993.05		18.0			GE	GE	35,625	0.20	432	1.2	3,946	21.8	2,067	23.5	6,588	9	1	0	58	71	0	15,163	0	
			3	GT	42.00	1994.07		37.1			WH	WH	269,661	0.73	3,532	1.3	3,408	25.2	8,216	93.5	332	3	2	2	140	9	0	99,111	0	
			4	GT	42.00	1994.07		35.1					232,633	0.63	2,212	1.0	3,395	25.3	7,225	82.3	611	4	5	0	915	33	0	85,197	0	
		Gilimanuk	1	GT	133.8	1997.07	133.8	133.80	133.8	-	ABB	ABB	707,391	0.60	494	0.1	3,310	26.0	8,389	95.5	18	6	4	0	346	31	0	256,854	0	
		Pemaron *coming from T. Priok in 2002.	1	GT	48.8	2004.11	97.6	45.0	90.0	-	GE	GE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			2	GT	48.8	2005.10		45.0					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7-2 (2/4) Summary of Objective 16 Power Stations relating to Operation and Maintenance

Power Station			Unit		Capacity	Commi-ssioning	Installed Capacity	(Max.) Available Capacity	Available Capacity Total	Manufacturer			Power Generation	Gross Capacity Factor	Station Use (PS + SUSUT TRAFO)		Gross Heat Rate	Gross Heat Efficiency	Service Hours (SH)	Service Factor (SF)	Stand by (RSH)	Number of Outages in 2004: Planned	Outage by P/S	Outage by System	Outages in 2004 by P/S: Planned	Outage F.O+M.O	Fuel Consumption in 2004: MFO	HSD	NG	Coal
								as of November 2005		Boiler	Turbine / Runner	Generator	in 2004 (PH = 8,784 Hours)									No. of times			Hours		KL	KL	MMBTU	Ton
					MW	yy.mm	MW	MW	MW				MWh/year		MWh/year	%	kcal/kWh	%	Hours	%	Hours									
Thermal	PJB	Muara Karang	1	TU	100.0	1979.02	1208.4	90.0	1119.0	B&W	MHI	MELCO	604,005	0.69	39,854	6.6	2,822	30.5	8,180	93.1	25	0	8	1	0	579	167,490	87	0	
			2	TU	100.0	1979.02		90.0					558,990	0.64	31,995	5.7	2,849	30.2	7,570	86.2	143	0	12	0	0	1,071	169,065	52	0	
			3	TU	100.0	1979.06		90.0					491,665	0.56	31,234	6.4	2,887	29.8	6,496	74.0	106	?	7	0	1,217	965	149,032	51	0	
			4	TU	200.0	1981.11		190.0		MHI			557,554	0.32	56,433	10.1	2,648	32.5	7,715	87.8	33	0	8	1	0	1,035	165,032	624	4,594,195	
			5	TU	200.0	1982.06		190.0					666,332	0.38	43,731	6.6	2,613	32.9	6,389	72.7	0	?	17	1	1,313	1,082	185,188	1,283	1,427,452	
			BL1.1	GT	107.8	1993.10		103.0		Austrian EE	GE	GE	661,036	0.70	779	0.1	3,256	26.4	7,212	82.1	10	0	12	3	0	1,562	0	0	8,429,573	
			BL1.2	GT	107.8	1993.xx		103.0					366,307	0.39	684	0.2	3,788	22.7	5,780	65.8	36	?	20	2	2,233	736	0	0	5,115,221	
			BL1.3	GT	107.8	1993.xx		103.0					524,762	0.55	745	0.1	3,178	27.1	5,772	65.7	0	?	4	2	988	2,024	0	0	6,593,872	
			BL1.4	ST	185.0	1995.xx		160.0					586,954	0.36	46,361	7.9	-	-	8,131	92.6	0	0	11	3	0	652	-	-	-	
		Gresik	1	TU	100.0	1981.08	2,259.2	95.0	2092.0	IHI	Toshiba	Toshiba	619,317	0.71	36,055	5.8	2,652	32.4	8,771	99.9	0	0	1	0	0	13	167,689	0	0	
			2	TU	100.0	1981.11		95.0					596,256	0.68	34,021	5.7	2,687	32.0	8,339	94.9	0	1	1	0	289	156	103,506	0	0	
			3	TU	200.0	1988.03		200.0					986,821	0.56	61,425	6.2	2,404	35.8	7,790	88.7	0	1	1	1	850	143	168,360	0	2,863,878	
			4	TU	200.0	1988.07		200.0					1,023,177	0.58	64,420	6.3	2,406	35.7	7,953	90.5	0	2	1	1	701	129	191,129	0	2,333,800	
			BL1.1	GT	112.45	1992.03		100.0		MHI	MHI	MELCO	704,690	0.71	4,603	0.7	3,390	25.4	8,361	95.2	6	2	1	1	213	204	0	0	9,480,435	
			BL1.2	GT	112.45	1992.05		100.0					720,790	0.73	4,169	0.6	3,394	25.3	8,524	97.0	19	1	2	2	212	30	0	0	9,708,536	
			BL1.3	GT	112.45	1992.06		100.0					715,810	0.73	4,177	0.6	3,350	25.7	8,443	96.1	18	1	4	1	242	80	0	0	9,514,354	
			BL1.4	ST	188.91	1993.04		170.0					1,292,890	0.78	38,321	3.0	-	-	8,487	96.6	0	1	4	2	283	13	-	-	-	
			BL2.1	GT	112.45	1992.07		100.0					482,250	0.49	3,152	0.7	3,587	24.0	7,447	84.8	233	1	6	0	914	190	0	190,062	172	
			BL2.2	GT	112.45	1992.08		100.0					512,010	0.52	3,749	0.7	3,605	23.9	7,952	90.5	303	1	3	0	211	318	0	199,710	113,461	
			BL2.3	GT	112.45	1992.09		100.0					429,120	0.43	2,790	0.7	3,644	23.6	6,866	78.2	667	3	11	1	960	291	0	171,741	172	
			BL2.4	ST	188.91	1993.08		170.0					859,730	0.52	34,961	4.1	-	-	8,761	99.7	20	0	0	1	0	2	-	-	-	
			BL3.1	GT	112.45	1993.01		105.0					529,900	0.54	3,115	0.6	3,681	23.4	7,905	90.0	243	1	1	1	585	52	0	0	7,740,848	
			BL3.2	GT	112.45	1993.01		105.0					507,950	0.51	2,543	0.5	3,640	23.6	7,458	84.9	455	1	0	1	780	91	0	0	7,338,347	
			BL3.3	GT	112.45	1993.01		105.0					542,070	0.55	4,094	0.8	3,579	24.0	7,709	87.8	190	1	1	1	864	21	0	0	7,698,444	
			BL3.4	ST	188.91	1993.11		180.0					978,140	0.59	34,454	3.5	-	-	7,939	90.4	0	1	2	2	832	12	-	-	-	
			1	GT	20.1	1978.06		17.0		-	Alstom	Alstom	6,949	0.04	165	2.4	4,488	19.2	464	5.3	7,308	0	3	0	0	1,012	0	3,439	0	
			2	GT	20.1	1978.06		17.0			Alstom	Alstom	8,984	0.05	194	2.2	3,863	22.3	520	5.9	7,597	1	6	0	513	153	0	3,820	0	
			3	GT	(20.1)	1984.08		To Sumatra		-	Alstom	Alstom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		* means Gilitimur P/S in Madura	1*	GT	20.1	1999.10		16.5		-	GE		7,830	0.04	218	2.8	4,208	20.4	490	5.6	7,581	1	2	0	570	143	0	3,639	0	
			2*	GT	20.1	1999.11		16.5			GE		9,355	0.05	216	2.3	4,251	20.2	590	6.7	7,866	0	1	0	0	328	0	4,386	0	
		Paiton	1	TU	400.0	1994.04	800.0	400.0	800.0	Combution Eng. USA	Toshiba	Toshiba	2,749,487	0.78	194,828	7.1	2,614	32.9	7,691	87.6	155	1	6	0	662	276	0	1,100		1,396,580
			2	TU	400.0	1993.11		400.0					2,751,948	0.78	191,401	7.0	2,575	33.4	7,762	88.4	106	1	5	0	624	292	0	1,021		1,375,497
		Muara Tawar	BL1.1	GT	145.0	1997.01	950.0	133.8	871.0	ABB	ABB	ABB	654,601	0.51	5,460	0.80	3,202	26.9	6,780	77.2	870	3	3	1	1,032	102	0	225,809	0	
			BL1.2	GT	145.0	1997.03		133.8					635,211	0.50	5,072	0.80	3,173	27.1	6,393	72.8	760	2	5	0	659	971	0	217,263	0	
			BL1.3	GT	145.0	1997.04		133.8					649,435	0.51	5,156	0.80	3,163	27.2	6,613	75.3	999	2	1	1	474	698	0	221,468	0	
			BL1.4	ST	225.0	1997.10		202.0					1,018,431	0.52	81,747	8.00	-	-	8,146	92.7	614	0	4	1	0	23	-	-	-	
			2.1	GT	145.0	1997.03		133.8		-			70,475	0.06	1,171	1.70	3,112	27.6	707	8.0	150	1	0	0	2,147	5,780	0	23,489	0	
			2.2	GT	145.0	1997.06		133.8					102,349	0.08	1,207	1.20	3,295	26.1	1,180	13.4	583	1	3	0	6,551	471	0	36,103	0	
			2.3	GT	(145.0)	Move to Gilimanuk in 1997			-	-	-		-	-	-			-	-	-		-	-	-	-	-	-	-	-	-
Hydro	IP	Saguling	1	-	175.18	1985.10	700.72	175.18	700.72		Toshiba	MELCO	586,933	0.40	5,529	0.3			4,763	54.2	3,862	1	3		154	5				
			2	-	175.18	1985.11		175.18					560,789	0.40					4,773	54.3	3,879	1	5		128	4				
			3	-	175.18	1986.04		175.18					337,063	0.20					2,628	29.9	4,091	1	8		2,020	45				
			4	-	175.18	1986.05		175.18					505,703	0.30					4,184	47.6	2,232	4	5		2,334	34				
		Sudirman (Soedirman)	1	-	60.3	1988.11	180.9	60.3	180.9		BOVING	ASEA	155,354	0.30	982.2	0.6			3,420	38.9	5,235	1	0		129	0				
			2	-	60.3	1988.11		60.3					131,602	0.20	815.6	0.6			2,949	33.6	5,718	1	4		108	9				
			3	-	60.3	1988.11		60.3					150,825	0.30	932.4	0.6			3,342	38.0	5,188	1	3		248	6				
	PJB	Cirata	1	-	126.0	1988.05	1008.0	126.0	1008.0		Voest Appine HG	ELIN	142,472	0.10	5,403 (2005)	0.4 (2005)			1,826	20.8	6,487	2	1		466	5				
			2	-	126.0	1988.02		126.0					139,428	0.10					1,799	20.5	6,209	1	1		775	1				
			3	-	126.0	1988.09		126.0					168,325	0.20					2,100	23.9	5,173	3	3		1,488	23				
			4	-	126.0	1988.08		126.0					119,375	0.10					1,762	20.1	7,022	0	0		0	0				
			5	-	126.0	1997.08		126.0					165,839	0.10					2,300	26.2	6,211	1	0		273	0				
			6	-	126.0	1997.08		126.0					138,285	0.10					1,926	21.9	6,501	1	3		348	9				
			7	-	126.0	1998.04		126.0					133,870	0.10					1,828	20.8	5,923	1	1		1,032	1				
			8	-	126.0	1998.04		126.0					125,308	0.10					1,748	19.9	6,371	1	1		650	15				
		Sutami	1	-	35.0	1973.xx	105.0	35.0	105.0		Toshiba	Toshiba	149,702	0.50	636 (2005)	0.2 (2005)			5,699	64.9	2,965.0		0		120	0				
			2	-	35.0	1973.xx		35.0					170,999	0.60					6,562	74.7	2,126.0		0		96	0				
			3	-	35.0	1973.xx		35.0					130,356	0.40					4,383	49.9	3,657.0		0		744	0				

Note: (1) Outage hours = F.O(Forced Outage) hours + M.O. (Maintenance Outage) hours

Table 7-2 (3/4) Summary of Objective 16 Power Stations relating to Operation and Maintenance

		Power Station	Unit		Capacity	Commi-ssioning	Rehabilitation, Modification & Repowering Plan as of 2005.12			Main Rehabilitation, Modification and Uprating Works			Remaining Life Assessment & Performance Assessment
					MW	yy.mm	Already Committed	Under Preparation and Future Plan	Final Proposal by JICA STUDY Team	Boiler - Related	Turbine-Related	Others	
Thermal	Indonesia Power (IP)	Suralaya	1	TU	400.0	1985.04		#1 ~ #4 Replacement of secondary superheater & reheater outlet, primary & secondary air heater basket, seal and fan adjustment and HIP turbine. Inspection main condenser, dearator & HP feed water. Rewinding generator stator & roter. Renewal of brushless e	None				Boiler Remaining Life Assessment (BRLA) No. 073.BKIT.007E.2004 Unit -1 UBP SURALAYA (2004, LITBANG) Life Extension for Suralaya, Preliminary Boiler Inspection for Unit 2 (1998.01, Babcock & Wilcox International, Inc.) Suralaya Steam Power Plant Unit-2,
			2	TU	400.0	1985.06							
			3	TU	400.0	1989.02							
			4	TU	400.0	1989.11							
			5	TU	600.0	1997.06							
			6	TU	600.0	1997.09							
			7	TU	600.0	1997.12							
		Tanjung Priok	3	TU	50.0	(1998)	Convertion to PLTGU + 720 MW (JBIC Yen Loan) - Addition of three gas turbines		None	The rehabilitation project for PLTU Unit 3 and 4 (JBIC Yen Loan ; 1991.08 ~ 1994. 09) - Boiler : replacement of Heater, nozzle, and air heater, etc. - Turbine: overhaul of blade, CWP, condenser tube, etc. - Electrical and Control System : overhaul - Moder			
			4	TU	50.0	2005.12							
			BL1.1	GT	131.4	1994.09							
			BL1.2	GT	131.4	1994.09							
			BL1.3	GT	131.4	1994.10							
			BL1.4	ST	203.5	1994.10							
			BL2.1	GT	131.4	1994.02							
			BL2.2	GT	131.4	1994.02							
			BL2.3	GT	131.4	1994.03							
			BL2.4	ST	203.5	1994.12							
			1	GT	26.0	1976.09							
			3	GT	26.0	1976.02							
		Tambak Lorok	1	TU	50.0	1978.09	Semarang Power Plant Rehabilitation and Gasification Project (for Unit 3) (JBIC Yen Loan)		(1) C.C. conversion of PLTU #1 and #2 (1-1-2) (2) New C.C. plant consisting of large GT (1-1-2) and shutdown of the existing Sunyaragi PLTG # 1 to #4 and Cilacap PLTG #1 and #2 (Oil Reduction Plan as UBP Semarang)				Life Time Assessment of Condenser Tube, Boiler Unit 3 A& B (2004.05, PT. Superintending Company of Indonesia Engineering and Transformation (SUCOFINDO)) Remaining Life Assessment Boiler Unit-2 PLTU Tambak Lorok UBP Semarang No. 056.BKIT.097A.2004 (2004.0
			2	TU	50.0	1978.10							
			3	TU	200.0	1983.07							
			BL1.1	GT	109.7	1993.08							
			BL1.2	GT	109.7	1993.10							
			BL1.3	GT	109.7	1993.10							
			BL1.4	ST	188.0	1997.11							
			BL2.1	GT	109.7	1996.07							
			BL2.2	GT	109.7	1996.08							
			BL2.3	GT	109.7	1996.09							
			BL2.4	ST	188.0	1997.05							
		Grati	BL1.1	GT	112.45	1996.10		Development of BL3 for Combined Cycle (PLTGU) by IPP formation	(1) C.C. conversion of PLTG Block 2 (3-3-1) (2) C.C. conversion of PLTG Block 2 (3-3-1) and shutdown of the existing Perak PLTU #3 & #4 (Oil Reduction Plan as UBP Perak/Grati)				
			BL1.2	GT	112.45	1996.10							
			BL1.3	GT	112.45	1996.10							
			BL1.4	ST	189.50	1997.03							
			BL2 1	GT	113.84	2002.10							
			BL2 2	GT	113.84	2002.10							
			BL2 3	GT	113.84	2002.10							
		Perak	1	TU	(25.0)	1964.xx		Conversion to PLGTU by adding one GT and one HRSG to existing TU3 & TU4 (1-1-2)	None				Tanjung Perak Harbor, Surabaya, Indonesia Perak Thermal Plant # 3 & 4 Thermal Performance Test Report (2005. 10. Korea Electric Power Research Institute)
			2	TU	(25.0)	1964.xx							
			3	TU	50.0	1978.04							
			4	TU	50.0	1978.07							
		Pesanggaran	1~11	D	5.08 x 4 + 4.14 + 6.77x 2 + 6.52 x 2 +12.39 x 2	1973.02 ~1989.02		Modernization project for Pesanggaran Power Station (JBIC, 12/28/2005 Advertisement) - New construction of DME (dimethyl ether)-fired combined cycle plant	No Repowering Plan due to environmental conservation of mangrove at seashore				
			1	GT	21.35	1985.02							
			2	GT	20.10	1993.05							
			3	GT	42.00	1994.07							
			4	GT	42.00	1994.07							
		Gilimanuk	1	GT	133.8	1997.07			(1) C.C. conversion of PLTG gas turbine (1-1-1) (2) C.C. conversion of PLTG (1-1-1) and shotdown of existing Pesanggaran PLTG #1 & #2 (UBP Bali)				
		Pemaron *coming from T. Priok in 2002.	1	GT	48.8	2004.11	Conversion to PLTGU + 50 MW, listed in RUKN (IP Own Budget)		None				
			2	GT	48.8	2005.10							

Table 7-2 (4/4) Summary of Objective 16 Power Stations relating to Operation and Maintenance

		Power Station	Unit		Capacity MW	Commi-ssioning yy.mm	Rehabilitation, Modification & Repowering Plan as of 2005.12: Already Committed	Under Preparation and Future Plan	Final Proposal by JICA STUDY Team	Main Rehabilitation, Modification and Uprating Works: Boiler - Related	Turbine-Related	Others	Remaining Life Assessment & Performance Assessment
Thermal	PJB	Muara Karang	1	TU	100.0	1979.02	Conversion to PLTGU for TU 1~3 (2-2-3), + 720 MW (JBIC Yen Loan)	Steam turbine, condenser & pumps, generator, exciter and transformers, boler for TU 4 & TU5 (JBIC Export Credit)	None	+TU #1 Replacement of SH & Economizer tube (04.05) +TU #1 Replacement of Boiler tube (04.02) +TU #3 Replacement of AH element(04.10) +TU #3 Replacement of Boiler wall tube (04.06) +TU #4 Replacement & welding of Economizer tube (04.12) +TU #5 Replacement	+GT #1.1 Replacement of 1st stage nozle & bucker (04.09) +GT #1.2 Replacement of coupling bolts & exiter (00.04)	+TU #3 Replacement of Fuel oil pump bearing (04.02)	Remaining Lfe Assessment of Boiler #4 & #5 No.189.BKIT.421A.2004 (2004, LITBANG)
			2	TU	100.0	1979.02							
			3	TU	100.0	1979.06							
			4	TU	200.0	1981.11							
			5	TU	200.0	1982.06							
			BL1.1	GT	107.8	1993.10							
			BL1.2	GT	107.8	1993.xx							
			BL1.3	GT	107.8	1993.xx							
			BL1.4	ST	185.0	1995.xx							
		Gresik	1	TU	100.0	1981.08		Modification of Control System for Gas Turbine Open Cycle (2006) (PJB Own Budget) Conversion to combined cycle plant for GT1 and GT2 (Expecting JBIC yen loan)	None	The project for rehabilitation of Gresik Steam Power Plant Unit 1 and 2 (Japan's ODA grant ; 1999 ~2000) - Fuel conversion from MFO to Gas for Boilers The project for rehabilitation of Gresik Steam Power Plant Unit 3 and 4 (Japan's ODA grant ; 2005 ~2006) - Fuel conversion from MFO to Gas for Boilers The fuel conversion project for Unit 3 and 4 (JBIC Yen Loan; 1991.05 ~ 1994.08) - Installation of	The project for rehabilitation of Gresik Steam Power Plant Unit 1 and 2 (Japan's ODA grant ; 1999 ~2000) - Efficiency recovery (replacement of turbine blade) The project for rehabilitation of Gresik Steam Power Plant Unit 3 and 4 (Japan's ODA grant ; 2005 ~2006) - Fuel conversion from MFO to Gas for Boilers +GT2.2 Replacement of Nozle No. 10, 11, 15 and 16 (04. 06) +GT1.2 Replacement of Fuel Gas No	+GT1.1 Chemical Cleaning and Re-balancing of Compressor (04.01) +HRSG3.3 Welding at lekage portion in Superheater (03.06)	Laporan Hasil Pengkajian Sisa Umur, Steam Bioler Power Plant Unit I, PT. PJB II UP. GRESIK (2004, PT SURVEYOR INDONESIA) Laporan Hasil Pengkajian Sisa Umur, Steam Bioler Power Plant Unit II, PT. PJB II UP. GRESIK (2004, PT SURVEYOR INDONESIA) Remai
			2	TU	100.0	1981.11							
			3	TU	200.0	1988.03							
			4	TU	200.0	1988.07							
			BL1.1	GT	112.45	1992.03							
			BL1.2	GT	112.45	1992.05							
			BL1.3	GT	112.45	1992.06							
			BL1.4	ST	188.91	1993.04							
			BL2.1	GT	112.45	1992.07							
			BL2.2	GT	112.45	1992.08							
			BL2.3	GT	112.45	1992.09							
			BL2.4	ST	188.91	1993.08							
			BL3.1	GT	112.45	1993.01							
			BL3.2	GT	112.45	1993.01							
			BL3.3	GT	112.45	1993.01							
			BL3.4	ST	188.91	1993.11							
			1	GT	20.10	1978.06							
			2	GT	20.10	1978.06							
			3	GT	(20.1)	1984.08							
		* means Gilitimur P/S in Madura	1*	GT	20.10	1999.10							
			2*	GT	20.10	1999.11							
		Paiton	1	TU	400.0	1994.04		Improve reliability and availability Boiler, Major valve and turbine accessories. Improve efficiency, reliability and life extension of steam turbine. Life Asessment of Generator (JBIC Export Credit)	None				Steam Turbine Inspection Report on Paiton Power Station Unit 1 and 2 (2004.08, Toshiba) Inspection Report Boiler Paiton Unit 1, 2 (2004.07, Toshiba) Boiler Remaining Life Assessment (BRLA) PLU Paiton UNIT 1 (2005.09 LITBANG)
			2	TU	400.0	1993.11							
		Muara Tawar	BL1.1	GT	145.0	1997.01	New construction of BL 5 as PLTGU + 225 MW (JBIC Yen Loan)	Modification of Control Panel System (Integration of each control system) (2006) (PJB Own Budget)	None				
			BL1.2	GT	145.0	1997.03							
			BL1.3	GT	145.0	1997.04							
			BL1.4	ST	225.0	1997.10							
			2.1	GT	145.0	1997.03							
			2.2	GT	145.0	1997.06							
			2.3	GT	(145.0)	Move to Gilimanuk in 1997							
Hydro	IP	Saguling	1	-	175.18	1985.10		Replacement of turbine runner & accessories and governor system (JBIC Export Credit) (2006~) - Replacement to new turbine runner (uprating 2 %) - Replacement of guide valve, govenor system and cooling system	(1)Repalcement of the generator and bearing cooler's tube material to anti corrosin type. (2) Replacement of control electric parts for automatic voltage control system and governor (3) Repalcement of monitoring pannel in control room				
			2	-	175.18	1985.11							
			3	-	175.18	1986.04							
			4	-	175.18	1986.05							
		Sudirman (Soedirman)	1	-	60.3	1988.11			(1) Replacement of control electric parts for automatic voltage control system and governor (2) Replacement of control electric parts for power station computer system				Infrared Thermography Inspection Report using ThermaCAM PM-595 FLIR Systems (2002.11, Donny GUSTIAN)
			2	-	60.3	1988.11							
			3	-	60.3	1988.11							
	PJB	Cirata	1	-	126.0	1988.05		Replacement of embeded pipe cooling system (2006 ~ 07) (PJB Own Budget) Cirata Control Panel system modification (SCADA) (2006 ~ 07) (PJB Own Budget)	(1) Modifcation of cooling water system from opened type to closed type including cleaning and lining of embeded pipe (2) Replacement of monitoring panel and control computer system for power station				
			2	-	126.0	1988.02							
			3	-	126.0	1988.09							
			4	-	126.0	1988.08							
			5	-	126.0	1997.08							
			6	-	126.0	1997.08							
			7	-	126.0	1998.04							
			8	-	126.0	1998.04							
		Sutami	1	-	35.0	1973.xx			(1) Replacement of 154 kV Circuit Breaker (2) Relocation of oil cooler from inside of the generator housing to outside of the generator housing				Site Investigation Report for Present Status of Electro-Mechanical Equipment for Sutami Hydropower Station (2004.12, Nippon Koei Co., Ltd.)
			2	-	35.0	1973.xx							
			3	-	35.0	1973.xx							

Note: (1) Outage hours = F.O(Forced Outage) hours + M.O. (Maintenance Outage) hours