

6.1.3. List of Participants

6.1.3.1. List of Participants (7/13,14)



ATTENDANCE LIST
SEMINAR

"TECHNOLOGY TRANSFER RELATING TO THERMAL POWER STATION"
"THE STUDY ON THE IMPROVEMENT MEASURES FOR ELECTRIC POWER
GENERATION FACILITIES FOR JAVA - BALI REGION"

by
JICA Study Team

Day / Date : Thursday - Friday / 13 - 14 July 2006
Waktu : 09.30 WIB - 17.00 WIB
Tempat : R. Rapat Lt. 5
PT. INDONESIA POWER

No.	Name	Company	Signature
1	Ulfung Purwono	KEPP Semarang	[Signature]
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4	Widji Slamet	UDP Semarang	[Signature]
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7	Sayuti	LEN	[Signature]
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No.	Name	Company	Signature
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39	M. Miyazawa	JICA Study Team	[Signature]
40	N. Haruki	JICA Study Team	[Signature]
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6.1.3.2. List of Participants (7/24)

Attendant List [1 / 2]

Title of Meeting: TECHNOLOGY TRANSFER RELATING RLA OF "THE STUDY ON THE IMPROVEMENT MEASURES FOR ELECTRIC POWER GENERATION FACILITIES IN JAVA-BALI REGION IN THE REPUBLIC OF INDONESIA"			
Date: 2006/7/24	Place: Indonesia Power Head Office		
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ADI FIRMANO	Neogy's	PT PJB	[Signature]
WALUYO S	---	PLN LITBANG	[Signature]
FIRMAN	---	PLN LITBANG	[Signature]

Attendant List [2 / 2]

Title of Meeting: TECHNOLOGY TRANSFER RELATING RLA OF "THE STUDY ON THE IMPROVEMENT MEASURES FOR ELECTRIC POWER GENERATION FACILITIES IN JAVA-BALI REGION IN THE REPUBLIC OF INDONESIA"			
Date: 2006/7/24	Place: Indonesia Power Head Office		
Name	Position	Unit & Organization	Signature
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MANUSIHUT. S	---	PTH. KP	[Signature]
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ZARIALA	---	PJB MTW	[Signature]
Dan. Nardi.	---	PJB MTW	[Signature]
Yon.	---	PJB MTW	[Signature]
Indra Dewi	---	PJB MKA	[Signature]
Arman E	---	PJB MKA	[Signature]
Kazunori INOUE	Hydro B	JICA Team	[Signature]
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J. Azuma	RLA Hydro	JICA Team	[Signature]
Y. Matsuda	Team leader	JICA study Team	[Signature]

6.1.3.3. List of Participants (7/11, 12)

Attendant List [1 / 1]

Title of Meeting: TECHNOLOGY TRANSFER RELATING RLA OF THE STUDY ON THE IMPROVEMENT MEASURES FOR ELECTRIC POWER GENERATION FACILITIES IN JAVA-BALI REGION IN THE REPUBLIC OF INDONESIA			
Date: 2006/7/11 -12	Place: Muara Karang thermal power station		
Name	Position	Unit & Organization	Signature
Sutikno	M. Teh.	PJB.	[Signature]
Agus Suliyantoko	UP Gresik	PJB.	[Signature]
Lusyadi S	UP. MKA	PJB	[Signature]
M. Arum	UP. MKA	PJB	[Signature]
ARMEN. R	UP MKA	PJB	[Signature]
U. Sumardi	up MKA	PJB	[Signature]
Arif. H.	UP MKA	PJB	[Signature]
Arman E.	UP MKA	PJB	[Signature]
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YUSUF	---	---	[Signature]
Y. Matsuda	Team Leader	JICA study Team	[Signature]
Y. Murata	Team Staff	---	[Signature]
M. Miyazawa	Thermal A JICA Team	JICA study Team	[Signature]
H. Haruki	RLA Turbine JICA Team	JICA Study Team	[Signature]
T. Matsuno	RLA Boiler JICA Team	JICA Study Team	[Signature]

- 1) Technology Transfer on Boiler Part 1: Introduction of Compound creep damage and Corrosion fatigue
 - 2) Technology Transfer on Boiler Part 2: Introduction of Extreme Value Statistical Analysis Method
 - 3) Technology Transfer on Boiler : Higher Efficient Inspection Method for Tube Thickness Measurement
- (2) Technical paper relating to Compound creep damage and Corrosion fatigue
 - 1) Introduction of Compound creep damage and Corrosion fatigue
 - (3) Technical paper relating to Extreme Value Statistical Analysis Method
 - 1) Introduction of Extreme Value Statistical Analysis Method
 - (4) Thesis Relating to Extreme Value Statistical Analysis Method
 - 1) Corrosion life evaluation based on extreme value distribution analysis
 - (5) Exercise - Use of Probability Paper
 - 1) Introduction of Extreme Value Statistical Analysis Method
< Exercise - Use of Probability Paper >
 - (6) PRACTICE PROBLEM Relating to Extreme Value Statistical Analysis Method
 - 1) Introduction of Extreme Value Statistical Analysis Method
< PRACTICE PROBLEM PAPER >
 - (7) Exercise for example. 1 ANSWER
 - 1) Introduction of Extreme Value Statistical Analysis Method
< Exercise for example 1 ANSWER >
 - (8) ANSWER to PRACTICE PROBLEM Relating to Extreme Value Statistical Analysis Method
 - 1) Introduction of Extreme Value Statistical Analysis Method < ANSWER PAPER >

6.1.4.3. Generator Related

- (1) Introduction of On-line Partial Discharge Monitor for Turbine Generators
 - 1) Introduction of On-line Partial Discharge Monitor for Turbine Generators

6.2. Hydropower Station

6.2.1. Background

In the course of the 1st Field Work, the JICA Study Team visited four hydropower stations, such as Saguling, Cirata, Sutami, Soedirman, and PLN LITBANG, and confirmed the current achievement of Remaining Life Assessment for hydropower stations in Indonesia, especially possibility of non-destructive examination method and possibility of electrical insulation examination for a generator stator in order to reflect technology transfer. Furthermore, Remaining Life Assessment relating to casing stay vane, runner and generator coil, which will be included in technology transfer provisionally were introduced to hydropower stations and PLN LITBANG in parallel with the investigation of needs.

The results of investigation are as follows:

(1) Current Achievement of RLA

1) Saguling Hydropower Station

Non-destructive examination for a runner and a casing, and electrical insulation examination for a generator coil have not been conducted as well as RLA. A runner was repaired by welding according to need in the course of periodic inspection, but the amount of welding volume has not been managed.

2) Soedirman Hydropower Station

Non-destructive examination for a runner and a casing has not been conducted. Electrical insulation examination has been conducted by measuring insulation resistance and $\tan \delta$ at the timing of periodic inspection. A runner was repaired by welding according to need in the course of periodic inspection and dimension control has been carried out, but the amount of welding volume has not been managed. Technology transfer of RLA was strongly requested by the power station staff because they already recognized the necessity of conducting RLA but they didn't know how to conduct.

3) Cirata Hydropower Station

Non-destructive examination for a runner and a casing has not been conducted. Electrical insulation examination has been conducted by measuring insulation resistance by them and measuring $\tan \delta$ by LITBANG at the timing of periodic inspection. Partial discharge monitoring has not been conducted because they have no device. RLA has not been conducted.

4) Sutami Hydropower Station

Non-destructive examination for a runner and a casing has not been conducted. Electrical insulation examination has been conducted by measuring insulation

resistance at the timing of periodic inspection. A runner was repaired by welding according to need in the course of periodic inspection and dimension control has been carried out, but the amount of welding volume has not been managed. Japanese manufacturer carried out site investigation for a runner, a generator and a control panel in 2004. In the course of the site investigation, non-destructive examination for a runner and electrical insulation examination for a generator coil were conducted. Based on the electrical insulation examination results, RLA was carried out by the manufacturer.

(2) Current Achievement of RLA by LITBANG

LITBANG has already Remaining Life Assessment technology for a thermal power station but not for a hydropower station. And LITBANG showed their interest in RLA for a hydropower station and hoped for technology transfer relating to RLA for a hydropower station.

(3) Conclusion

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

Since all of the above topics requires the relevant measurement and testing devices, the technology transfer by using devices were not planned and the introduction of the relevant papers were planned firstly. Once the relevant devices will be available in Indonesia in the future, the technology transfer to be conducted by the Study Team helps them brush up their technical capacities to the degree of conducting the testing and judgment by themselves. To achieve the above purpose, the relevant results of measuring and testing done by the

KANSAI Electric Power Co., Inc. and the latest papers were to be collected.

However, PDM (On-line Partial Discharge Monitoring) was determined to be demonstrated as one of the facility assessments for a generator stator coil in response to Indonesia's request raised in the 2nd Workshop.

6.2.2. Technology Transfer

6.2.2.1. Content of Technology Transfer

In the 4th Field Work, the technology transfer relating to the following three topics for hydropower stations and the PDM demonstration at Cirata Hydropower station were conducted.

(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 $\tan \delta$ 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.

6.2.2.2. Schedule for Technology Transfer

(1) Technology Transfer for Hydropower Station

Please refer to Section 6.1.2.2 (2)

(2) Demonstration of On-line Partial Discharge Monitoring

Demonstration of PDM was conducted at Cirata Hydropower Station including the

explanation of the device.

- 1) Date : July 26, 2006
- 2) The number of participants : 32 people
- 3) Place : Cirata Hydropower Station
- 4) Demonstration result

The demonstration of PDM was conducted at the generator unit 6. The demonstration resulted in observation of some creeping discharge at coil-end portion. The periodic monitoring for the deterioration of insulator was recommended.

6.2.2.3. General Overview of Technology Transfer

(1) RLA Technology Transfer for Hydropower Station

1) The number of participants

34 people (please refer to Section 6.2.3.1)

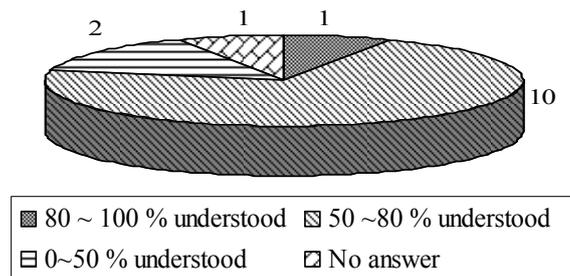
2) Validity of technology transfer

Many relevant staff participated in the technology transfer seminar. Many comments and questions arisen in the seminar indicated that they were much interested in RLA relating to a generator and all respondents to a questionnaire showed their high level of interest in fact. 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.

<i>Results of Questionnaire Survey on Technology Transfer Seminar relating to Remaining Life Assessment for Hydro and Generator</i>			
1. Technology Transfer relating to Hydro and Generator N=14			
1.1	Topics in the Seminar		
	Were you interested in the topics presented in the Seminar?	Yes (14)	No (0)
	If your answer is "No", what a kind of topic are you expecting? Please write your expecting topics in the following columns.		
	a)		
	b)		
1.2	Understanding of topics		
	Could you understand the content of topics in the Seminar? Please mark.		
	80 ~ 100 % understood (1)	50 ~80 % understood (10)	0~50 % understood (2)
1.3	Contribution toward your work		
	Are the topics useful for your work?	Yes (13)	No (0)

Level of Understanding for Technology Transfer

Topics in the Seminar	Hydro, Generator
Date	2006/7/24
80 ~ 100 % understood	1
50 ~80 % understood	10
0~50 % understood	2
No answer	1
Number of collected questionnaires	14



(2) Demonstration of PDM

1) The number of participants

32 people (Please refer to Section 6.1.3.2)

2) Validity of technology transfer

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.

Photos of Technology Transfer (Hydropower Station)



Cirata Hydropower Station



7/26 Demonstration of PDM at Cirata Unit 6 Generator



7/25 Confirmation of Terminal Box at Cirata Unit 6 Generator



7/25 Confirmation of Temperature 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	<ul style="list-style-type: none"> - 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"	<ul style="list-style-type: none"> - 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.	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Implementation of preventive/ predictive maintenance to avoid the same kind of serious accidents occurred in 2004 in 	High

To whom	Recommendation	Purpose/Effectiveness	Impact
		Japan which killed five maintenance staff.	
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	Commis- sioning	Installed Capacity	(Max) Available Capacity as of November 2005	Available Capacity Total	Manufacturer	Power Generation	Gross Capacity Factor	Station Use (PS + SCUST - TRAFD)	Gross Heat Rate		Service Factor (SF)	Stand by (RSB)	Number of Changes in 2004		Outages in 2004 by PS		Fuel Consumption in 2004					
										Boiler	Turbine / Runner			Generator	MW/year	%	Efficiency	Hours	%	Planned	Unplanned	Planned	Unplanned
Surabaya	1 TU	400.0	400.0	400.0	400.0	MHI	2,014,863	0.74	164,175	6.3	2,477	34.7	7,539	85.8	33	1	10	705	507	379.4	2,486	12,620.34	
	2 TU	400.0	400.0	400.0	400.0	MHI	2,113,298	0.69	143,084	6.8	2,363	36.4	7,829	89.1	286	1	12	0	668	31,860	4,933	947,391	
	3 TU	400.0	400.0	400.0	400.0	MHI	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	12,107.92
	4 TU	400.0	400.0	400.0	400.0	MHI	2,638,923	0.75	166,620	6.5	2,388	36.1	7,557	86.0	69	1	4	0	676	481	24,860	822	1,225,349
	5 TU	600.0	600.0	600.0	600.0	MHI	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
Tanjung Priuk	6 TU	600.0	600.0	600.0	600.0	MHI	4,990,616	0.78	193,679	4.7	2,344	36.7	7,870	89.6	56	1	2	1	809	36	0	881	1,906,138
	7 TU	600.0	600.0	600.0	600.0	MHI	4,510,888	0.86	208,006	4.6	2,304	37.3	8,617	98.1	158	1	0	0	8	0	8	483	2,086,743
	3 TU	500.0	450.0	450.0	450.0	MHI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4 TU	500.0	2005.12	450.0	450.0	MHI	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
	BL1.1 GT	131.4	1994.09	125.0	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
	BL1.2 GT	131.4	1994.09	125.0	125.0		887,426	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
	BL1.3 GT	131.4	1994.10	125.0	125.0		1,083,249	0.56	2,629	0.3	2,955	29.1	7,126	81.1	0	0	3	1	0	3	0	17,701	7,997,034
BL1.4 ST	203.5	1994.10	134.7	1,201.0	ABB	709,580	0.61	24,995	3.5	2,955	29.1	7,126	81.1	0	4	5	1	1,543	116	0	10,948	10,427,885	
BL2.1 GT	125.0	1994.02	125.0	125.0		888,297	0.77	23,178	2.6	2,902	29.6	8,289	94.4	8	4	1	4	23	14	0	141,830	5,572,103	
BL2.2 GT	125.0	1994.02	125.0	125.0		896,215	0.78	4,447	0.3	3,032	28.4	8,555	97.4	0	2	4	1	215	15	0	10,948	10,427,885	
BL2.3 GT	115.0	1994.03	160.0	160.0		1,186,409	0.66	3,413	0.3	3,413	0.3	8,779	99.9	0	0	3	1	0	5	0	494	0	
BL2.4 ST	203.5	1994.12	180.0	180.0		986	0.00	31	3.3	4,476	19.2	56	0.6	52	1	0	0	8,682	0	0	3,887	0	
1 GT	26.0	1976.09	18.0	18.0		7,662	0.01	284	3.7	4,339	19.8	411	4.7	4,584	2	5	0	3,526	293	0	3,887	0	
3 GT	26.0	1976.02	18.0	18.0		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	
1 TU	50.0	1978.10	45.0	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	85,902	0	0	
2 TU	50.0	1978.10	45.0	45.0		1,125,718	0.64	71,549	6.8	2,387	36.0	7,983	90.9	36	1	2	1	622	143	290,179	0	0	
3 TU	200.0	1983.07	200.0	200.0		459,188	0.48	5,160	1.1	3,065	28.1	5,734	65.3	2,381	0	6	0	639	30	0	163,286	0	
BL1.1 GT	109.7	1993.08	105.0	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	
BL1.2 GT	109.7	1993.10	105.0	105.0		268,251	0.28	81,18	3.0	3,086	27.9	5,512	40.0	4,180	1	4	0	1,068	24	0	96,035	0	
BL1.3 GT	109.7	1993.10	133.2	133.2		568,834	0.34	34,353	6.0	3,086	27.9	5,512	40.0	4,180	1	4	0	1,068	24	0	96,035	0	
BL1.4 ST	188.0	1997.11	170.0	170.0		392,896	0.41	3,172	0.8	2,996	28.7	4,921	56.0	3,322	1	18	1	574	83	0	0	0	
BL2.1 GT	109.7	1996.07	105.0	105.0		433,295	0.45	2,995	0.7	2,997	28.7	5,241	59.7	3,366	1	4	0	387	175	0	136,563	0	
BL2.2 GT	109.7	1996.08	105.0	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	
BL2.3 GT	109.7	1996.09	105.0	105.0		577,928	0.35	50,111	8.7	3,022	26.1	2,600	29.9	3,942	1	2	0	476	1,737	0	69,716	0	
BL2.4 ST	188.0	1997.05	170.0	170.0		186,620	0.19	3,126	1.7	3,292	26.1	2,600	29.9	3,942	1	2	0	476	1,737	0	69,716	0	
BL1.1 GT	112.45	1996.10	100.75	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	
BL1.2 GT	112.45	1996.10	100.75	100.75		250,630	0.25	3,902	1.6	3,499	28.2	3,468	39.5	4,611	1	8	0	572	133	0	94,413	0	
BL1.3 GT	112.45	1996.10	100.75	100.75		275,910	0.17	22,234	8.1	3,086	27.9	5,512	40.0	4,180	1	4	0	1,068	24	0	96,035	0	
BL1.4 ST	189.50	1997.03	868.37	767.5		142,566	0.14	2,978	2.1	3,659	33.5	2,209	25.1	6,396	1	3	0	106	73	0	55,824	0	
BL2.1 GT	101.90	2002.10	101.90	101.90		105,300	0.11	2,372	2.3	3,399	25.3	1,575	17.9	6,347	1	9	0	114	729	0	39,916	0	
BL2.2 GT	113.84	2002.10	101.90	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	
BL2.3 GT	113.84	2002.10	101.90	101.90		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1 TU	(25.0)	1964.xx	100.0	100.0		231,196	0.33	14,912	6.4	3,010	28.6	7,817	89.0	312	0	8	0	655	69,118	118	0	0	
2 TU	(25.0)	1964.xx	100.0	100.0		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	
3 TU	50.0	1978.04	45.00	45.00		70,534	0.12	3,848	5.5	2,511	34.2	1,561	17.8	6,951	3	7	272	1	0	19,106	0		
4 TU	50.0	1978.07	45.00	45.00		54,875	0.29	642	1.2	3,885	22.1	3,131	35.6	5,077	4	2	0	68	18	0	22,996	0	
1-11	D	5,08 x 4 - 4.14 + 6.73 x 2 + 6.53 x 2	193.00-1989.00	60.91	170.61	Maries B5, SWD	35,625	0.20	432	1.2	3,946	21.8	2,067	23.5	6,388	9	1	0	58	71	0	15,163	0
1 GT	21.35	1985.02	201.27	19.5	170.61	Alstom	269,661	0.73	3,532	1.3	3,408	82.16	93.5	332	3	2	2	140	9	0	99,111	0	
2 GT	20.10	1993.05	201.27	18.0	170.61	GE	232,653	0.63	2,212	1.0	3,395	25.3	7,225	82.3	611	4	5	0	915	33	0	85,197	0
3 GT	42.00	1994.07	201.27	37.1	170.61	WH	707,391	0.60	494	0.1	3,310	26.0	8,389	95.5	18	6	4	0	346	31	0	25,6854	0
4 GT	42.00	1994.07	201.27	35.1	170.61	ABB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1 GT	48.8	2004.11	97.6	45.0	90.0	GE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
2 GT	48.8	2005.10	97.6	45.0	90.0	GE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

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

Power Station	Unit Capacity		Commencing	Already Committed	Rehabilitation, Modification & Repowering Plans as of 2005.12			Final Proposal by JICA STUDY Team	Boiler - Related	Turbine-Related	Others	Remaining Life Assessment & Performance Assessment		
	MW	Yr./unit			Under Preparation and Future Plan	Under Preparation and Future Plan	Under Preparation and Future Plan							
Thermal	Mura Karang	1 TU	100.0	1979.02					-TU #1 Replacement of SH & Economizer tube (04/05)	-GT #1.1 Replacement of 1st stage rotor & backer (04/09)	-TU #2 Replacement of Fuel oil pump bearing (04/02)	Remaining Life Assessment of Boiler #4, #4 & #5 No. 19 BKT/20A, 20B (DQA, LTBANG)		
		2 TU	100.0	1979.02					-TU #1 Replacement of boiler tubes (04/02)					
		3 TU	100.0	1979.06										
		4 TU	200.0	1981.11	Conversion to PLTCU for TU 1-3	Steam turbine, condenser & pumps, generator, exciter and transformers, boiler for TU 4 & TUS (JRC Export Credit)		None						
		5 TU	200.0	1982.06	2-2-3, 4 - 720 MW (JRC Yen Loan)									
		BL1.1 GT	107.8	1993.16										
		BL1.2 GT	107.8	1993.33										
		BL1.3 GT	107.8	1993.33										
		BL1.4 ST	185.0	1995.33										
		1 TU	100.0	1981.08										
		2 TU	100.0	1981.11										
		3 TU	200.0	1988.05										
		4 TU	200.0	1988.05										
BL1.1 GT	112.45	1992.05												
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	1992.08												
BL2.4 ST	188.91	1993.06												
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	20.10	1984.08												
1 GT	20.10	1990.11												
2 GT	20.10	1991.11												
1 TU	400.0	1994.06												
2 TU	400.0	1993.11												
BL1.1 GT	145.0	1997.01												
BL1.2 GT	145.0	1997.05												
BL1.3 GT	145.0	1997.06												
BL1.4 ST	225.0	1997.16												
2.1 GT	145.0	1997.05												
2.2 GT	145.0	1997.06												
2.3 GT	(145.0)	1997.06												
1	175.18	1985.10												
2	175.18	1985.11												
3	175.18	1986.04												
4	175.18	1986.05												
1	60.3	1988.11												
2	60.3	1988.11												
3	60.3	1988.11												
1	126.0	1988.05												
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												
1	35.0	1973.33												
2	35.0	1973.33												
3	35.0	1973.33												
4	35.0	1973.33												

Note: (1) Outage hours = FO(Forced Outage) hours + MO (Maintenance Outage) hours

APPENDIX

1. Thermal Power Station

TH 01	Logsheet (Ground Floor, Boiler Area, Turbine) - Suralaya Power Station
TH 02	Logsheet (Control Room) - Suralaya Power Station
TH 03	Category of Troubles (Muara Tawar)
TH 04	Category of Troubles (Gresik)
TH 05	Category of Troubles (Paiton)
TH 06	Category of Troubles (Perak)
TH 07	Category of Troubles (Tanjung Priok)
TH 08	Category of Troubles (Muara Karang)
TH 09	Category of Troubles (Tambak Lorok)
TH 10	Category of Troubles (Grati)
TH 11	Category of Troubles (Suralaya)
TH 12	Category of Troubles (Pesanggaran)
TH 13	Category of Troubles (Pemaron)
TH 14	Category of Troubles (Gilimanuk)

2. Hydropower Station

HY 01	Location of Saguling and Cirata
HY 02	Location of Soedirman
HY 03	Location of Sutami
HY 04	Single Line Diagram of Saguling
HY 05	Single Line Diagram of Cirata
HY 06	Single Line Diagram of Soedirman
HY 07	Single Line Diagram of Sutami
HY 08	Inspection Plan and Items for Saguling
HY 09	Inspection Plan and Items for Cirata
HY 10	Daily Recorded Log of Cirata
HY 11	Daily Recorded Log of Sutami
HY 12	Temperature Record of Soedirman
HY 13	Organization Chart of Saguling
HY 14	Organization Chart of Cirata
HY 15	Organization Chart of Soedirman
HY 16	Organization Chart of Brantas (Sutami)
HY 17	Explanation of Type of Cooling Water System
HY 18	Example of Closed Type Cooling Water System (KANSAI)
HY 19	General Plan of Rehabilitation for Cooling Water System
HY 20	Schematic Diagram of Closed Type Cooling Water System

3. Technology Transfer Relating to Remaining Life Assessment

TT 01	Thermal Power Station (Boiler-related)
TT 02	Thermal Power Station (Turbine-related)
TT 03	Thermal Power Station (Generator-related)
TT 04	Hydropower Station

