APPENDIX

APPENDICES FOR CHAPTER 1

Appendix1-1 Contrast of the ToR in Minutes and the Reports (1/3)

ToR (Annex I) in Minutes 17th Sept. 2009	ToR in Minutes 3rd March 2010	Draft Final Report
4.1 Review of Basic Information and Current Conditions The Study shall evaluate basic information and current conditions associated with the proposed rehabilitation by following means:		
a) Data Collection and Review To collect and review the necessary data such as schematics and data at the time of construction for Morupule Power Station, remnant life review of the Power Station, the latest power generation plan of the Power Station and other relevant document/information of national energy policy on coal, power demand in the region and electricity supply;	Collection and Confirmation of Related Data and Information	- Chapter 2 Basic Data and Information - Chapter 3 Baseline Survey of Power Station
b) Preliminary Site Survey To conduct site survey on the existing power station to review the current of the power plant and coal supply system such as belt conveyer system from coal mine, storage yard, ash handling system up to the ash pond and water treatment plant facilities.	Investigation of Existing Facilities/ Equipment Diagnosis During Operation/ Equipment Diagnosis during outage	- Chapter 4 Equipment Diagnosis
4.2 Design of Rehabilitation of Morupule Power Station with Environmental Mitigation Facilities/Devises		
(1) Site Investigation Works The Study shall carry out the following site Investigation works:		
a) Preparation of Site Investigation Works To determine the scope of site investigation works necessary for basic layout plan of newly introduced equipment/machinery of the power station and environment mitigation facilities.	Investigation of Existing Facilities	- Inception Report submitted 1st March 2011. - Chapter 1 Introduction/ Clause 1.3 Basic Policy of the Study
b) Land Survey To review existing ground survey works necessary for preparation of land development plan and layouts for the rehabilitation of the power station including coal storage yard and ash pond and environmental mitigation facilities/devises.	Investigation of Existing Facilities	- Chapter 5 Natural Condition and Civil Design /Sub-clause 5.5.4 Topographic Survey - Appendix 5-14
c) Soil Foundation Investigation To review existing soil foundation investigation works necessary for studies of foundation and civil works for newly introduced buildings, equipments/machineries, environmental mitigation facilities/devise and other auxiliary facilities required for the proposed power station	Investigation of Existing Facilities	- Chapter 5 Natural Condition and Civil Design/ Sub-clause 5.5.3 Soil Investigation - Appendix 5-13

Appendix1-1 Contrast of the ToR in Minutes and the Reports (2/3)

ToR (Annex I) in Minutes 17th Sept. 2009	ToR in Minutes 3rd March 2010	Draft Final Report
d) Hydrological Investigation To review existing hydrological investigation works necessary for studies of ground water and/or river near the power station for determining location of water intake and discharge structures of water for the power station and catalytic system for environmental mitigation facilities/devices.	Investigation of Existing Facilities	- Chapter 5 Natural Condition and Civil Design/ Sub-clause 5.1.1 Hydrology
(2) Preliminary Design of Morupule Power Station Rehabilitation		
a) Determination of Technical Specifications To determine the configuration, technical specifications and the layout plan of following main equipment/machineries (only major items are listed below) - Mechanical Equipment Boiler/ Turbine - Electrical Equipments Circuit Breakers /Transformers /Generators - Paje Well fields infrastructure and piping - Water Treatment Plant equipment - Coal Plant Equipment and conveyor belts - Ash plant and conveying systems - Environmental Mitigation Facilities/Devises Electrostatic Precipitator/ De-nox System Facility/ Flue Gas Desulphurization System	Basic Design of the Equipment to be rehabilitated	- Chapter 7 Rehabilitation Scenarios - Chapter 10 Basic Design for the Rehabilitation - Chapter8 Pollution Abatement
b) Basic Design To conduct basic design for determination of performance specifications for mechanical equipments, electrical equipments, cooling system, fuel supply facilities, environmental mitigation facilities/devises and facilities necessary for power evacuation stipulated 4-2(2)a).	Basic Design of the Equipment to be rehabilitated	- Chapter 10 Basic Design for the Rehabilitation - Chapter 8 Pollution Abatement
(3) Implementation Schedule The Study shall prepare Implementation Schedule for the Project.	Basic Design of the Equipment to be rehabilitated	- Chapter 11 Implementation Plan/ Sub-clause 11.1.1 Project Implementation Schedule
(4) Cost Estimation The Study shall carry out cost estimation for the rehabilitation program and environmental mitigation facilities/devices.		- Chapter 11 Implementation Plan - Clause 11.2 Estimation of Project Cost
(5) Procurement The Study shall carry out procurement planning including procurement packages of newly introduced equipments and machineries.		- Chapter 11 Implementation Plan/ Sub-clause 11.1.2 Plan of Procurement
(6) Operation and Maintenance System	None	- Chapter 3 Baseline Survey of Power

Appendix1-1 Contrast of the ToR in Minutes and the Reports (3/3)

ToR (Annex I) in Minutes 17th Sept. 2009	ToR in Minutes 3rd March 2010	Draft Final Report
The study shall analyze the current situation of the operation and maintenance of the power station and identify relevant issues in order to propose alternative operation and maintenance system, including training course curriculum and programs.		Station /Clause 3.4 Operation Management &/ Clause 3.5 Maintenance Management - Chapter 12 Conclusion and Recommendation/ Clause 12.4 Recommendations Prior to Starting Rehabilitation
(7) Economic and Financial Analysis The Study shall carry out evaluation of economic and financial viabilities of the rehabilitation program by the economic and financial analysis such as FIRR, EIRR.	Economical and Financial Analyses and Setting Key Performance Indicators	- Chapter 9 Economical and Financial Analysis
(8) Operation and Effect Indicators The Study shall prepare the Operation and Effect Indicators to measure the benefit derived from the rehabilitation program.	None	- Chapter 9 Economical and Financial Analysis - Sub-clause 9.2.1 Rehabilitation Scenarios and Benefit Indicator
4-3 Environmental and social Considerations In compliance with environmental law and regulations stipulated in Botswana and of JICA Guidelines for Environmental and Social Considerations, the Study will review environmental law regulations stipulated in Botswana as well as the monitoring and enforcement systems thereof. It will then prepare Environmental Impact Assessment such as environmental protections measures, environmental management and monitoring plan and conducting stakeholder meetings and information disclosure.	Environment and Social Consideration	- Chapter 6 Environment and Social Consideration
4-4 Seminar The Study shall conduct seminars for obtaining consensus among participating stakeholders on the plan and outcome of the project with respect to technical, economic, financial and social and environmental aspects.		- 1st Seminar for Inception report: 1st March 2011 - 2nd Seminar for Interim Report: 1st August 2011 - 3rd Seminar for Draft Final: 14th and 17th October 2011

Appendix 1-2 Comments on the 3rd Seminar for Explanation of Draft Final Report held on 14th and 17th October 2011 (1/4)

Comments by Botswana Side Remarks: (P??) are pages in distributed PPT presentation documents	JICA Study Team Reply	Final Report
1. What is the breakdown of investment costs in each of the Scenarios in (P29)?	Costs breakdown for all scenarios are attached in Appendix 9-1 of the Report. Details of direct construction cost for Scenario 1 and Scenario 2a will be supplemented in Appendix-11.	Already incorporated. Supplemented in Appendix 11-1 to 11-3.
2. Net capacity of Morupule A P/S after rehabilitation is indicated as 100 MW in (P6, P7 and P21), while calculation on (P34) indicates otherwise.	Original data obtained from MMEWR indicated Net capacity of 100 MW after rehabilitation. The team expects net capacity of 116 MW, which is after 12% reduction of station usage.	Capacity figures in figure 7-1 & 7-2 in page 7-11 were corrected to 116MW.
3. Isn't the 12% of station usage figure going to change because of the new FGD?	As shown in Figure 3-2 in page 3-2, station usage power were 11.3% to 11.6% in FY 2004 and 2005 when the plant availability rates were more than 80%. As the power usage of an equipment to be newly installed (FGD) will be estimated at less than 0.5%. 12% is the rate with FGD power consumption already considered.	Solved
4. Is the loss of residual value of the existing ESP, which will incur when dismantling and disposing, considered in the cost calculation?	Although the loss of residual value of will be recorded on BPC's profit-loss statement, it will not affect the project cash flow analysis, because it does not require direct cash disbursement. It will be worthwhile mentioning about the effect of dismantling to profit-loss statement of BPC.	Explanation supplemented in 9.3.3
5. What will be the impact of the rehabilitation on the employees? Is the fixed cost that should be paid to the employees even during the rehabilitation considered in the calculations? Is the number of employees going to change? Does the cost of employment remain the same?	C.f. 9.3.2 Running Cost (Operation and Maintenance Cost) of the main report. Assumption is that some of the staffs will be transferred to Morupule B, P/S and some to shared infrastructural functions. Statement that the rehabilitated P/S can be operated under 60% of the current manpower, and that the reduction in the number of staffs will strengthen the financial viability of the project should be included in the report. Costs of the staffs to be paid even during the rehabilitation (shut down) period are taken into consideration as O&M costs in project financial analysis. Redundancies are not assumed. Cost per staff is assumed to remain the same. Possibility of improving the financial viability of Scenarios 2b by avoiding the payment of staff costs during the shut-down period will be explained qualitatively in Chapter 9	Statements supplemented in 9.3.2 (1) Possibility of further improvement by avoiding the payment to staffs during the shut-down period supplemented in 9.8.

Appendix 1-2 Comments on the 3rd Seminar for Explanation of Draft Final Report held on 14th and 17th October 2011 (2/4)

Comments by Botswana Side Remarks: (P??) are pages in distributed PPT presentation documents	JICA Study Team Reply	Final Report
6. What are the factors taken into account when determining the O&M cost for each of the scenarios?	Breakdown of O&M cost is as on (P35), or more precisely, Table 9-7 in page 9-10 of the main report.	Solved
7. Operational period at 80% availability for Scenario 3 is indicated as 25 years in (P20), and 20 years in (P29).	Duration of required availability for Scenario 3 in (P29) should be corrected as 25 years.	Solved
8. Why does the cost of goods remain the same under all the Scenarios? Isn't the operating cost for scenario 1 higher than the others?	O&M cost for Scenario 1 is higher than the others. Differences that may exist for Scenario 1 are all reflected in Maintenance cost items.	Solved
9. What is the Contingency Value? Is it the cost of avoiding the use of the diesel power plant?	The term is more commonly used as "contingent value" signifying a value which a consumer would be willing to pay if the product/service were not to be available from the source.	Corrected to "contingent value" and further explanation of relation between marginal costs is explained in 9.4.2.
10. SAPP unit sales - How does it compare to the marginal cost of Morupule A- (P39)?	Comparison between the unit selling price and the unit cost of power generation will be worthwhile.	Supplemented both in texts and tables in 9.4.2 (3), 9.5.1 and 9.5.2
11. ODA- Is it strictly government to government?	Payments are sometimes made against NGOs and private companies. However, the recipient is always the government. As for Japanese ODA loan, loan agreement is signed directly with the central government or with if it were to be with other public bodies, under guarantee from the financial authority. JST will have to acknowledge that the option of direct loan agreement between the Japanese government and BPC may not be practical at this point in time from both liquidity and governance perspectives.	These discussions may not necessarily be included in the main text of the Final Report.
12. Does the Japanese ODA loan which is assumed to be employed for this project have constraints on procurement?	The type of Japanese ODA loan in this study is an untied loan, open for international procurement.	Solved
13. Why does a slight difference in settings between 2a and 2b result in a significant difference as seen on (P45)?	The biggest advantage of Scenario 2b against 2a is that operation in scenario 2b starts one year earlier than that of 2a. Revenue during the first years count significantly on the result of analysis based on discounted cash flow (DCF) method.	Solved
14. What will be the alternative power source during the shut down period for rehabilitation?	Imported power or additional diesel generation from Orapa diesel power station as stated in (P21).	Solved
15. Shouldn't the cost of electricity procurement from alternative sources be included in project financial analysis?	Yes, it will be more accurate if it will be included.	Supplemented in 9.3.2 (2) and reflected in results of all calculations.
16. If cost-benefit ratio (CBR) changes, does NPV also change?	Yes	Solved

Appendix 1-2 Comments on the 3rd Seminar for Explanation of Draft Final Report held on 14th and 17th October 2011 (3/4)

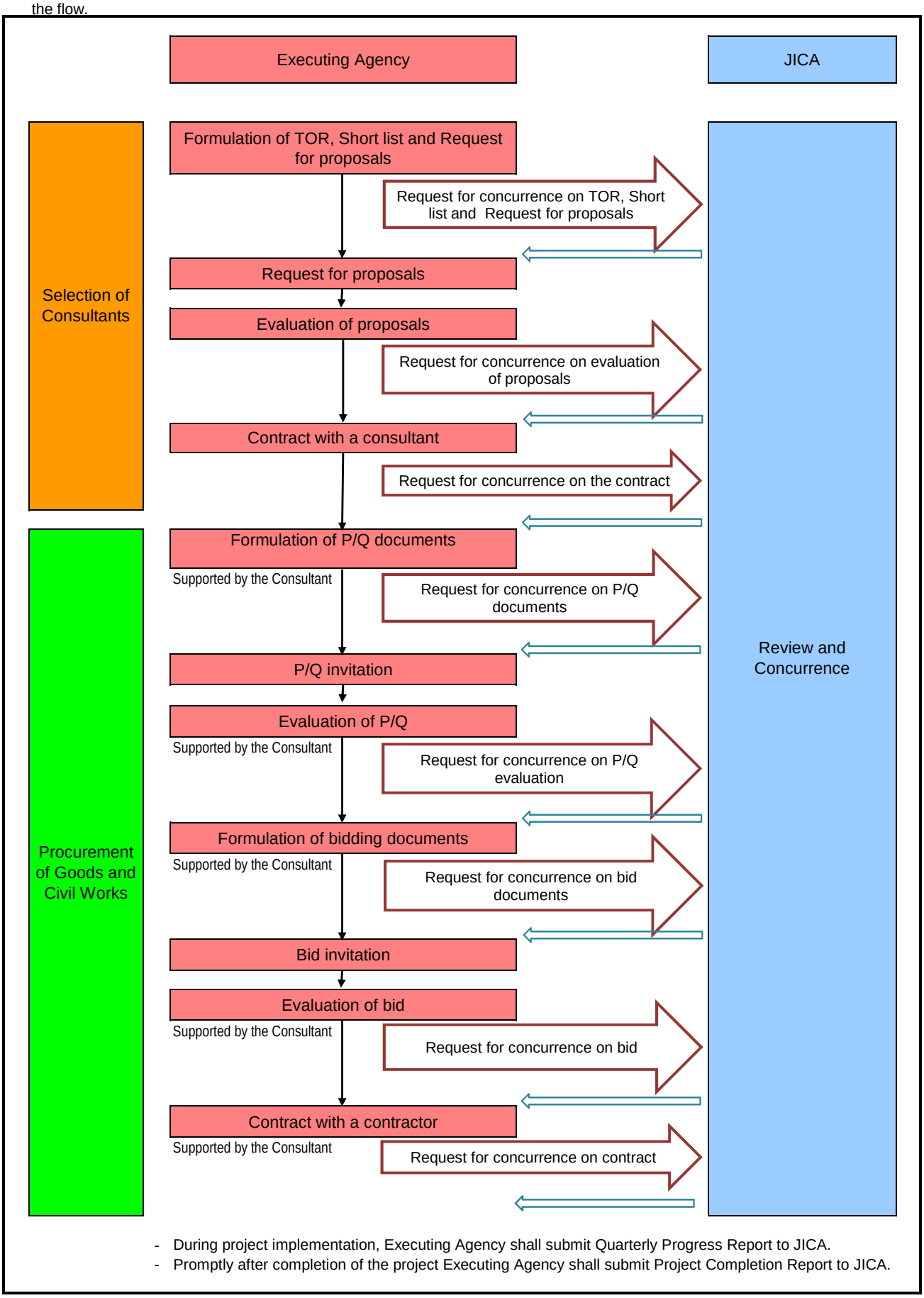
Comments by Botswana Side Remarks: (P??) are pages in distributed PPT presentation documents	JICA Study Team Reply	Final Report
17. Findings of economic and financial analyses (P46) should be addressing to specific issues.	Findings may also refer to the tariff structure review that is currently taking place at MMEWR. Statement on why BPC financial model assumptions were utilised as future tariffs instead of those in the governmental tariff study should be explained in the report. Possibility of further cost cutting due to introduction of competitive environment for the contractors.	Supplemented in 9.8 Explanation supplemented in 9.5.1
18. Can't the pollution abatement costs be recovered through CDM?	The only factor that can be counted as mitigation measure is the improvement in energy efficiency, which is minimal in scale. Application of CDM is economically unlikely in this project. Reduction of SO_2 and NOx emissions is irrelevant to GHG reduction.	Supplemented in 9.4.1
19. Do you have referential documents of the same projects that you have done which are similar to Morupule "A" Power Station? If yes, what were the benefits, duration and costs?	Cases of support for coal fired P/S, especially for rehabilitation is uncommon among ODA project studies, and therefore not available.	Solved
20. Will we have to comply with the World Bank standard as shown on (P54) in all of the rehabilitation scenarios?	DWMPC will establish new regulated value for pollution control within 3 years. The project costs were estimated assuming the replacement of ESP to fabric filter for reducing dust (PM10) to fewer than 50mg/Nm^3. If we were to tolerate the emission up to 100mg/Nm3, existing ESP can be used with the Wet Type FGD. Then, the pollution abatement cost will be reduced by USD 14.7 million, from current USD 49.7 million down to USD 35 million. Financial sensitivity analysis for Scenario 2b with reduced abatement cost may be carried out and explained. JST recommends that the standard case for financial analysis should be based on more expensive option of replacing ESP by fabric filter, and to have economical case as an option in the sensitivity analysis.	Financial analysis and explanations for the case of existing ESP + wet type FGD is supplemented in Section 9.7.3 (2)
21. Why is implementation schedule only referring to scenario 2b? Although 2b is a recommended scenario, it should not be the only possible solution. The same goes to (P7) and (P21) of the presentation material in that it discards scenario 1 and 3.	Implementation schedule for scenario 2a is shown in Table 11-1 in page 11-1 of the main report. As for Scenario 1, implementation schedule will be reduced by only 2 months against scenario 2a, which is stated in 11.1.1 in page 11-1 of the main report.	Solved

Appendix 1-2 Comments on the 3rd Seminar for Explanation of Draft Final Report held on 14th and 17th October 2011 (4/4)

Comments by Botswana Side Remarks: (P??) are pages in distributed PPT presentation documents	JICA Study Team Reply	Final Report
22. Why are we specific to the World Bank Standards?	Botswana Standards are being revised and will be benchmarked against World Bank standards	Solved
23. Is EIA necessary for the rehabilitation project?	EIA is not required for the project,, as stated in 6.3.4 (2) page 6-12 of the main report quoted below. "(2) Environmental Management Plan While the EIAA is regulating as stated above, the act was not existing when the Morupule "A" Power Station was constructed in 1986. Therefore, the EIA was not implemented for the plant construction. Then, BPC developed an EMP in August 2010 in accordance with the guidance of the DEA in November 2008 for the continuous operation of the existing Morupule "A" Power Station. The EMP was approved by the DEA in September 2010. The DEA stated that BPC will not be required to provide an additional study for the rehabilitation because the approved EMP involves some factors of the rehabilitation work."	Solved Evidenced e-mail communication with DEA (Department of Environmental Affaires) under MEWT (Ministry of Environmental Wildlife and Tourism) is attached in Appendix 6-14.
24. When the report will be submitted?	As per description in the Minutes of Meeting singed on 3rd March 2011; ✓ JST will despatch 20 copies of the final report by courier within 2 weeks from the receipt of comments from BPC; ✓ BPC agrees to submit their additional comments, if any ,by Friday 21st October, earlier than the initially agreed 27th October 2011, which was the day 2weeks after the receipt of the Draft on 13th. ✓ Finalised report should therefore be despatched by 7th November 2011, addressed to JICA Botswana Office.	BPC will receive the finalised report by the end of November.

Appendix 1-3 General JICA Procurement Procedure Flow Chart

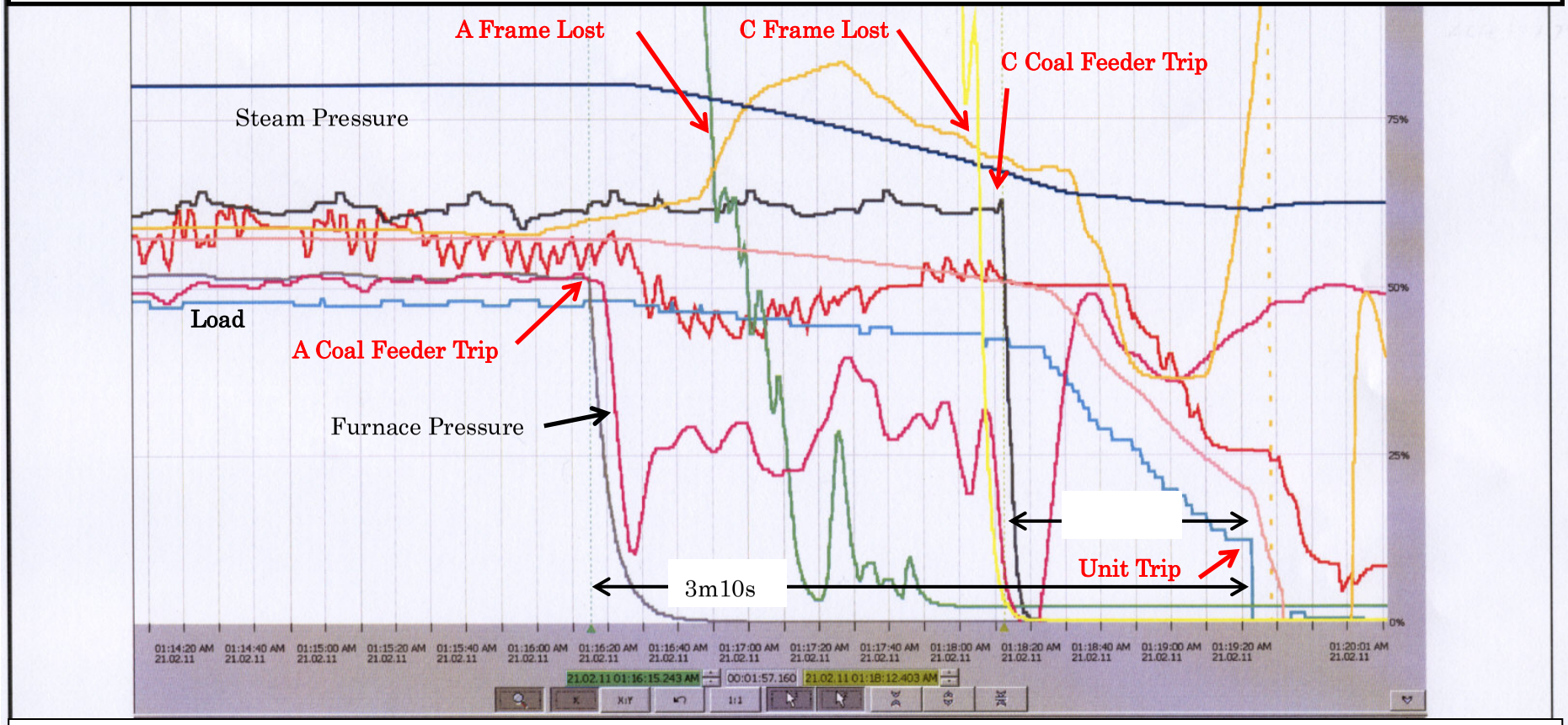
The flow is general, the actual procedure will be confirmed among JICA and the executing agency may not necessarily follow the flow.



- During project implementation, Executing Agency shall submit Quarterly Progress Report to JICA.
- Promptly after completion of the project Executing Agency shall submit Project Completion Report to JICA.

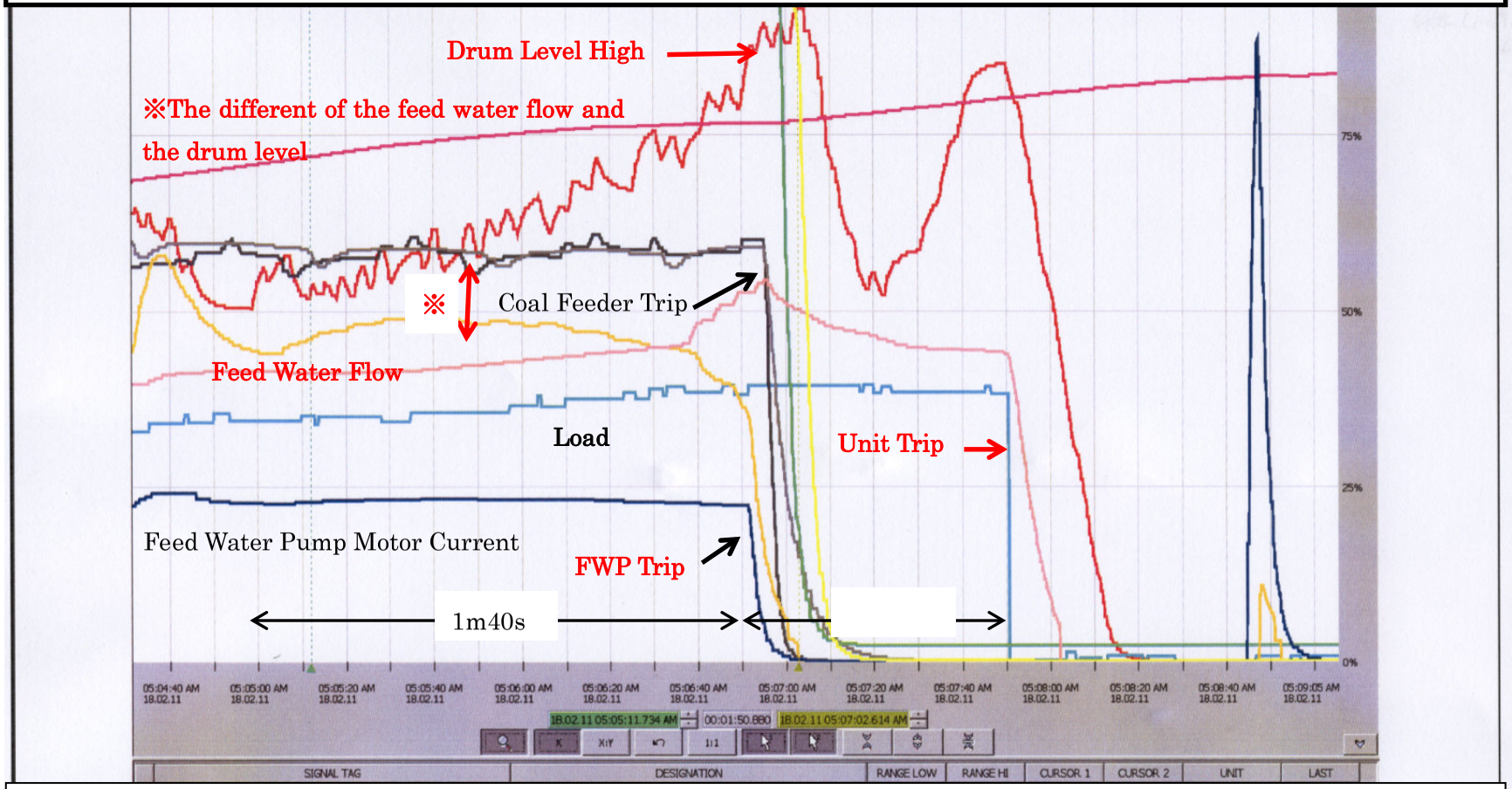
APPENDICES FOR CHAPTER 3

Appendix 3-1 Frame Failure Trip (21. 02. 2011)



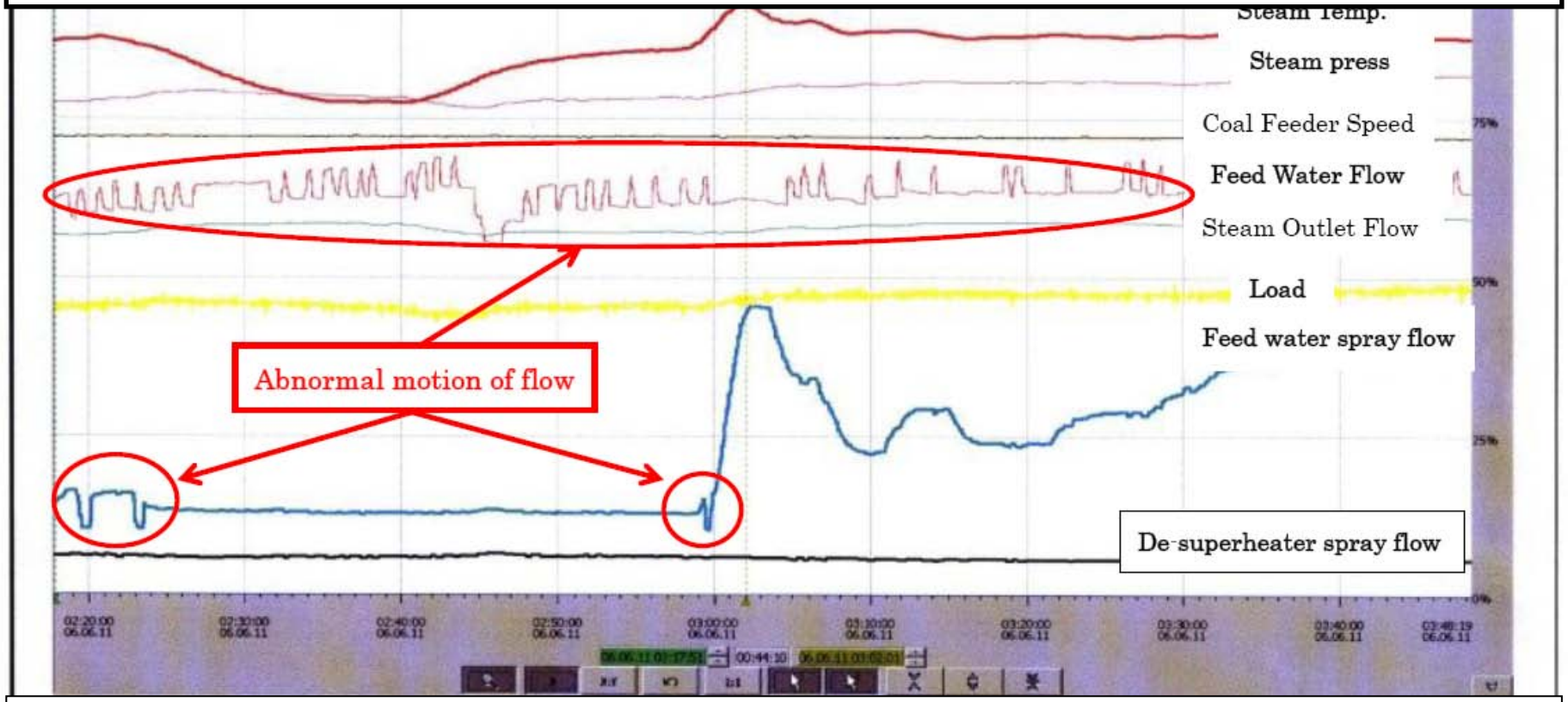
At first, the A coal Feeder tripped on some reason, next the frame detector detected the frame lost and finally the unit trip took place.

Appendix 3-2 Drum Level High Trip (18. 02. 2011)



At first, the drum water level rose, but the feed water supply flow did not decrease. So the drum water level continued higher. Finally the feed water pump trip by the drum level extra high, the C coal feeder trip (the boiler trip), finally the unit trip took place.

Appendix 3-3 Stream Temperature Control on Unit No.1 Boiler



The feed water flow was behaved in step response, and the feed water spray flow was behaved in step response occasionally, because those normally shall behave continuously, The de-super-heater spray flow was not behaved for the change of the stream temperature. These were abnormal phenomena,

APPENDIX FOR CHAPTER 4

ALSTOM

THERMAL POWER
THERMAL SERVICES

MORUPULE POWER STATION

UNIT-3 SITE OBSERVATIONS REPORT

MORUPULE PS – PALAPYE BOTSWANA

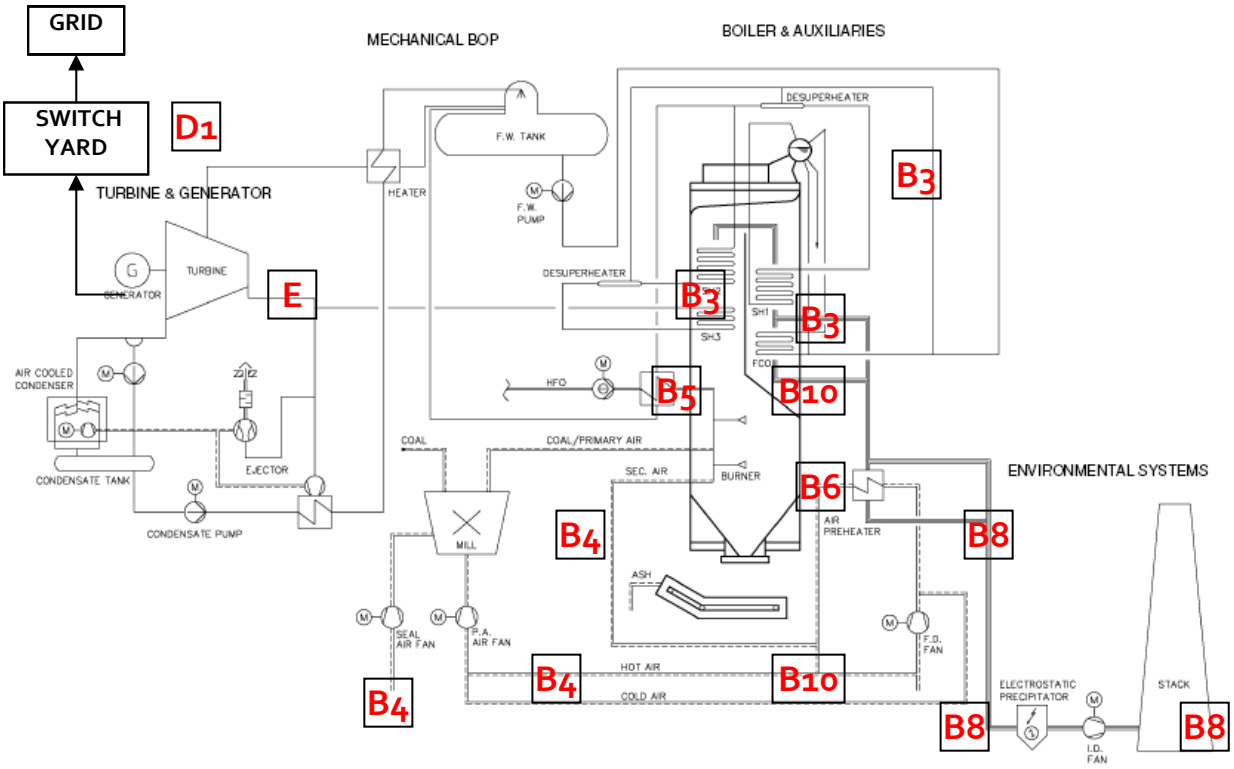
4 x 33 MW

REV	ETABLI *ESTABLISHED*	VERIFIE *CHECKED*	APPROUVE *APPROVED*	DATE	MODIFICATIONS
A3	TH	HOU	YG	2011-07-28	First issue Rev.3
B1	TH	HOU	YG	2011-09-13	Second issue Rev.1

Reference : CGP10100 Rev.C Amendment-1/PB-4256007	Status DFR	Rev B1	

A. INTRODUCTION

The red marks refer to chapter numbers.



A.1 CONTEXT

These observations have been done in two steps:

- **First step with the machine running and in electrical production.**
- **Second step with the machine stopped for inspection (outage).**

The MORUPULE plant includes 4 coal fire boilers units of 33 MW each.

The goal of the observation was to estimate the condition of the following parts of unit 3 during operation and during a long outage: boiler, turbine and BOP Electricity.

The unit 3 has been inspected as a reference, for the rehabilitation work of all units.

During our site observations in March the unit never run more than 23MW, due to one mill being out of service. Consequently, the HFO was in service most of the time. The unit also experienced a few boiler trips.

During our site observations in April, unit 3 was stopped and all access doors opened.

Scaffolding was erected inside the furnace for access to pressure parts and burners. Mill A was stripped out for maintenance and mill B partially dismantled. The turbine has been opened some days after BOPE and Boiler team arrival. Our turbine specialist couldn't stay for schedule reason during all turbine works.

A.2 ABBREVIATION AND DEFINITION

No abbreviation and special wordings.

- **AH :** Air Heater
- **BPC : BOTSWANA POWER CORPORATION**
- **BOP E :** Balance Of Plant Electrical
- **BOP M :** Balance Of Plant Mechanical
- **Contractor :** ALSTOM Power
- **PC :** Pulverized Coal
- **C&I:** Control and Instrumentation
- **DE :** Driven End
- **DPT :** Dye Penetrant Test
- **Employer :** Morupule power plant owner
- **ESP :** Electro Static Precipitator
- **FD fan :** Forced Draught fan
- **HFO :** Heavy Fuel Oil
- **HTS :** High Temperature Superheater
- **ID fan :** Induced Draught fan
- **MPI : magnetic particle inspection**
- **NDE :** Non Driven End
- **NDT :** Non Destructive Test
- **OMM :** Operation and Maintenance Manual
- **OEM :** Original Equipment Manufacturer
- **PA fan :** Primary Air fan
- **PPE :** Personal Protective Equipment
- **P&ID :** Process and Instrumentation Diagram
- **US test or UT :** Ultra Sonic test
- **WSB:** Wall Sootblower

A.3 MEASUREMENT MATERIAL REFERENCES

Instrument	Qty	Manufacturer Made in	Type	Serial N°	Comment Certificate
BOILER					
Ultrasonic thickness measurer & probe	2	GE Inspection Technologies Germany	DM4DL & DA 412	01TWDF	Calibration on site, using reference shims 15--1160 15--8760
Combustion analyzer + probe	1	KIMO France	KIGAZ 302 LV4	140691	N°15-8651 0001
Tube thickness	1	GE Inspection Technologies	DM4	01TWD9	Calibration on site, using reference shims
Vibration pen	1	SKF USA	CMVP 50	000489	N°15-8649 0001
Digital thermometer and probe	1	KIMO	TK 100	MAT0800374	N°15-8665 0006
INSTRUMENTATION					
Multifunction calibrator	1	GE Sensing France	DPI 610 400 bar	2974/99-04	N°15-8637 0002
Multifunction calibrator	1	GE Sensing France	DPI 610 20 bar	216/97-11	N°15-0085 0005
BALANCE OF PLANT ELECTRICAL					

Event recorder	1	PROGRAMMA Italy	TM 1600/16	3502396	No calibration (recorder)
Micro ohmmeter	1	PROGRAMMA Italy	MOM 600A	5061592	15-0746 0035
Discharger bench	1	TORKEL Germany	860 Multi	85011780	No calibration required
Multimeter	2	FLUKE China	FL 87	99000293 99000292	15-0992 0012 15-0992 0013
Clamp multimeter	2	FLUKE China	FL 15	219728UMV 119252ABH	15-0065 0037 15-0065 0122
Single phase relay testing unit	1	PROGRAMMA Italy	SVERKER 760	3504140	No calibration required
Megohm meter	1	CHAUVIN ARNOUX France	CA 6547	109821AAH	15-1073 0005
Ground tester	1	LEM USA	UNILAP GEO X	A188506211	15-0045 0007
Digital thermometer	1	COMARK USA	KM 43	57172/14	15-1106 0004

A.4 OBSERVATIONS CONCLUSION

Colour code for below tables :

- Replacement: complete renew, with original or different design.
- Add: install new equipment which was not designed originally.
- Overhaul: general disassembly, check and reassembly of the equipment.
- Repair: partial modification / fix the malfunction
- Check: equipment, data, calibration inspection/checking.
- Cleaning: clean the equipment, area or place.
- Other: special operation (eg. hydro test, or acid cleaning).
- ***Bold type and lean : related to Security***

A.4.1 Boiler

Boiler System or Equipment	Conclusion	Minimal work to be performed to regain suitable availability of the unit	Larger scope of work to allow the unit to be operated in acceptable condition for the next 15 years
Operation	- Due to limited load, present boiler operation involves HFO being in service most of the time.		
Pressure parts **§B.3**	- Global condition is satisfactory and corresponds to the 80.000 hours of operating time (10 years about).	- Some waterwall and superheater tubes to be changed due to excessive wear. - Carry out further NDT investigation on HTS2 outlet header. - Repair identified defects. - Repair the damaged and unavailable sootblowers. - Carry out an acid cleaning of water walls tubes. **§ B14.7.3**	- Replace HTS2 outlet header. - Tube erosion: a) To solve the tube erosion effect, review the sootblowing procedure and check the pressure on each sootblower. b) Add protecting shells on the eroded tubes c) Replace 8 sootblowers (refer to § B10 list). Overhaul all other sootblowing equipment. d) Replace 2 elbows (low thickness) on economizer and 4 tubes on water wall close to burners **A1** e) Replace alls valves equal or lower than 2” (general remark)

Fuel systems: Coal mills, feeders, coal burners. **§B.4**	- The mills are in good condition, except for the oil stations and specifically on mill C (oil bath overheating) - Numerous hang-up on feeder raw coal inlet (lower part of coal bunkers). - Important erosion in all Pulverized coal pipes elbows	- Replace the mills sealing air fan suction filters. ***-Repair the damaged PC pipe elbows*** - Replace the missing flame detector. Hydro test on oil station coolers	- ***Replace all PC pipe elbows (new design with antiwear material).*** - Add an anti plugging system on each raw coal bunker(pneumatic or vibration system) - Overhaul of mill oil stations
HFO preparation and burners. **§B.5 & B.6**	- HFO pumping station: filters and instrumentation, many leaks or spillage. - HFO preparation: atomizing steam unavailable - Individual burner skid:	- ***General cleaning.*** - ***HFO leaks repair.*** - Replace all missing igniters. - ***Replace all missing flame detectors.***	- Replace the complete pumping station. - Replace the HFO and atomizing steam station (at 11m level). - Replace all burners guns and burner skids (For lifetime extension reasons) and flexible pipes. - Based on our experience, also replace the complete HFO preparation skid.
Air – flue gas system **§B.8**	- Many expansion joints are worn or damaged. - Slight corrosion in ID fan - AH by-pass duct corroded section at 40m level.	- In the short term (considering 7 years remaining lifetime), replace all expansion joints. - Readjust the control damper.	- Replace all expansion joints. - If ID fan corrosion increases repair casing (to be checked regularly). - Overhaul the primary air fans. - Check the FD fan and PA fans bearings condition. - Replace AH by-pass duct corroded section. - Clean the air heater.

Burner sealing **§B.7**	- Burner sealing air fans: belts damaged and close to rupture.	- Replace all the tension belts (consumable).	
Miscellaneous **§B.11**	- Chemical sampling: some instruments are out of order.	- Replace damaged or missing instruments. - Recalibrate (if possible) the instruments showing a wrong indication or not available in control room.	- Renew the analysis skid for more accurate and complete data (all items to be supplied from same supplier)
Miscellaneous **§B.12**	- Ash extractor : Bottom and slope damaged. Main gasket old and partly damaged. Filling and water level control out of order.	- Ash extractor main gasket to be repaired where damaged.	- Ash extractor main gasket to be replaced. - Filling and water level control system to be replaced. - Bottom and slope sheets to be replaced.
Miscellaneous **§B.12**	- Bottom ash handling: damaged idler rollers. - Flying ash handling: many leaks, some gaskets in bad condition. - Actuator handles missing.	Fix the leakages (gasket/flanges)	- All casing and conveyor system to silo to be replaced. - Leakage to be fixed (gasket replacement).
Miscellaneous	- General Cleaning	Level 0.00m (in priority and regular needs): - PA and sealing air fan - ID and FD fans - ***HFO pumping station*** - ***Coal mills*** - Ash and slag extractors - Flue gas ducts - ***Boiler burners up to level 18m.***	

A.4.2 Instrumentation

A.4.2.1 Boiler part

A very big cleaning is necessary in this boiler in sucking out with industrial vacuum cleaner all fly ashes and ash laying down on all equipments.
Then a secondary cleaning is necessary with clean rag, soft brush and small vacuum cleaner on the electrical consumers (motorized valves, instrumentation, panel).

The steel pipe protection of all the thermocouples is too short and doesn't protect in a right way the T° probe.

Cable must have mechanical protection in order to avoid risk of damage.

Individual cable mechanical protection must be installed every where it is possible in order to protect the cables in a right way.

All instrumentation have to be changed for :

- Damage
- Aging

System or Equipment	Minimal work to be performed to regains suitable availability of the unit	Larger scope of work to allow the unit to be operated in acceptable condition for the next 10 to 15 years
Boiler Instrumentation §C1	***Essential instrument to be rep***laced, i.e approximately 25% of the total instrumentation. Main cleaning in cable boxes and panels to be done. Insure the electrical continuity and information going up to the DCS and control room. General check on main cable tray network. Cleaning where necessary. General check on instrumentation pipe up to pipe boss, supports and rack.	***All instrumentation to be replaced and tested.*** Individual cable conduits to be installed. All cable gland to be replaced in order to fit to cables. Cables to be replaced (approximately 50%) between main cable tray and instrument or electrical consumers). Cable box and panels to rehabilitate (included the sealing door or cover gaskets). Heat tracing system to be replaced up to the fuel oil station. All inlet/outlet (loop checking) to be done Motorized valves, motors and other electrical consumers to be tested.

A.4.2.2 Turbine hall part

Instrumentation	Bad condition, need to be changed
Piping and valves	Very dirty, cleaning need to be done
Overall condition	Very dirty

All instruments need maintenance and calibration tests

All cables must be checked again and the cable end done again in accordance with the norms.

Individual cable mechanical protection must be installed everywhere it is possible in order to protect the cables in a right way.

Cabling in grouping box and panels must be checked again.

General cleaning must be done especially in the three way valves in order to check: Position, leak, tightening.

Complete I/O tests to be perform.

System or Equipment	**Minimal work to be performed to regains suitable availability of the unit**	**Larger scope of work to allow the unit to be operated in acceptable condition for the next 10 to 15 years**
Instrumentation in turbine hall §C2	All temperature probes to be changed. General check in control cabinet and grouping boxes	All instrumentation to be changed. To rehabilitate the grouping box and panels. Cable tray network to be covered. Cable gland to fit to cables. Instrumentation to be tested. I/O checks.

A.4.3 Electrical balance of plant

A.4.3.1 Conclusions

System or Equipment	Minimal work to be performed to regains suitable availability of the unit	Larger scope of work to allow the unit to be operated in acceptable condition for the next 10 to 15 years
D.1 HV 220KV Switchyard	To adjust the earth blades in order to get an acceptable contact when closed. (earth switch) Replacement of the Surge Arrester porcelain phase "A".	To replace and to maintain a good amount of spare parts in order to replace any defective electrical apparatus. To repair and make working the interlocking devices. (earth switch) ***Replacement in a near future of the three batteries***
D.2 12KV to 6.6KV power supply equipments	Main and Unit transformer oil checks.	**Fire protection efficiency to be investigate, to adjust the water sprays**.
12KV to 6.6KV cable boxes	12KV and 6.6KV cables water tightening to be repair when entering in cable boxes.	To repair all cable glands and make them fitting well with each cable. **To insure the water tightness**
Main transformer / 12KV cable links	***Links between the main transformer bushing and the 12KV cables to be protected against falling object.*** ***Link steel structure support to be fixed properly on the concrete slab (to add concrete plot under the fixation).***	***Replacement of the system by connecting the cables directly to the transformer bushings***.
Transformers fire detection & protection	***Fire detection efficiency to be investigate, to add few detectors.***	***To make the water deluge valve operating automatically.*** ***To adjust properly the fire piping water distribution on both transformers in order to spray in a good condition the transformer when needed.*** ***To fix properly the piping support on the ground.*** ***To install fire piping protection on the top of the transformer conservators.*** ***To install a fire detection system on the top of the transformer conservators.*** ***To adjust properly the fire nozzle in order to spray efficiently.*** ***To add water pressure system (C02 bottles)*** ***To install appropriate gutter for oil and water evacuation.***

FCB	***FCB bus bar contact to be repair.***	***To replace the two FCB compressors.***
D.3 Electrical distribution panels		For all distribution panels To replace and to maintain a good amount of spare parts in order to replace any defective electrical apparatus.
	To replace the 220VDC batteries A&B.	***To paint with anti acid paint the battery set floor and walls, to protect the cell links by plastic covers, to withdraw the Air Conditioning, to replace appropriate exhaust pipe on top of each battery set, to verify and replace if needed the exhaust fan, to install a new door (instead of wooden door to install a steel door) boiler side, to install closed to the entry door a new and suitable individual protection need when entering in batteries room, to add eyes cleaner, shower, to investigate the floor sloop and water/acid evacuation system, to replace the lighting system, plugs and all apparatus for an explosion proof equipments, to have in spare parts (4) battery cells of each voltage, to install large wooden steps for the 220VDC batteries, to add few wooden grating around the battery set.***
Cables (inside electrical building only)	To repair mechanical protection up to 2 meters on vertical floor penetration.	General investigation on cable terminal blocks.
Cable tray network (turbine hall)	To replace and install new individual cable conduit in order to protect the cables as closed as possible from the electrical consumer (instrumentation especially).	To design and replace new individual cable conduit in order to protect the cables as closed as possible from the electrical consumer (instrumentation especially), to give priority for a roof distribution instead of a floor or wall distribution.
D.4 Main Black Start Diesel Generating set	***Perform a major overhaul of the Diesel Engine and of the Generator.*** ***Replace the exhaust pipe.*** ***Replace the Engine control System.***	
D.8 Fire protection inside electrical buildings	To investigate the system conformity.	***To modify the fire protection system with more fire nozzle and gas pressure system (CO2).***
D.9 Fire wall in floor and wall opening	***To repair and seal with the same product the wall and floor cable penetration in order to minimize the possibility of fire progression (for***	***To replace all the fire wall and floor penetration with fire proof products under the international standards (for all walls and floors opening).***

	all walls and floors opening).	
D.10 Boiler auxiliaries - General for PAF, ID, FD, ESP, FGMD	General cleaning and general electrical investigation. Cable supports to be repaired properly.	***Cable box and cable panels to be rehabilitate and electrical I/O checks.*** ***Cable individual support to be repair in accordance with the need.*** ***Main cable tray to be protected by cover (modification).*** ***Cable glands to fit properly to cables (modification).*** ***Instrumentation to be replaced.*** ***Cables to be replaced (approximately 50%) between main cable tray and instrument or electrical consumers).*** Cable tie to be replaced.
D.10.1 Bunker bay	Boiler transformers oil leak repair (if any).	***All boiler transformer oil replacement and tested.***
D.10.2 Sample room	General electrical investigation.	***Roof and floor cable penetration to be replaced with suitable product.*** ***Anti acid paint coat to be done on floor and walls, replacement.*** ***Individual protecting equipment to be replaced and storage in the entry of room.***
D.13 Auxiliaries **D.13.1** Fuel system	***To suck out the existing stain oil located all around the equipments, repair.***	***To design and change the complete oil plant as:*** ***New unloading truck area.*** ***Heat tracing new system to put in place.*** ***System to collect oil leak and running over (see point 5 § D 15.2.4).*** ***Pipe new insulation.*** ***Cable box and cables to be replaced.***
D.13.2 Water demin… system	***Global system investigation.***	***System to collect acid/water leak and running over (see point 6 § D 15.2.4).*** ***Anti acid paint coat on concrete slab.*** ***Cable box and cables to be replaced.***
D.14 Diesel AVR and engine control system	***To replace the engine control system.***	

A.4.3.2 Extra recommendation

220KV Switchyard and building

The 220KV apparatus interlock system and link with the power plant units is perfectible.

A good UNIT interlock system has to be put in place.

220KV Interlock apparatus locked by key (as the one used in the 6.6KV room) with adapted stainless steel sealed box equipped with electrical contact look adapted to the need.

Main and unit transformer areas

The concrete transformer slabs are flat and with no real water evacuation.

Just two gutters as been installed in the unit transformer area and a small gutter in the main transformer area.

In case of oil leak due to (safety valve release, explosion involving a fire), there is no way to evacuate properly and quickly the oil.

After witnessed the fire protection test on the unit 2, we mention a high level of water inside the transformer areas during few minutes.

Consequently and in case of explosion oil in fire will run around the transformers during few minutes burning all equipments.

We suggest to protect the transformers in a better way in installing a large and deep gutter around the transformer slabs with an efficient slop up to an oil/water separator.

Gutter will have to be covered by grating hot deep galvanized.

Transformer fire detection system is not really adapted to the need:

- no detector on top of transformer body's
- no detector on top of conservators
- for the detectors installed on the fire piping they are too far from the transformer body and accessories

We recommend to install more fire detectors and to adjust the actual fire piping distribution in accordance with the need.

The original main transformer has been changed for an other (smaller size), the fire protection piping haven't been modified accordingly. It has to be done.

Concerning the 20KV cables distribution on the top of the main transformer unit 3, we strongly recommend to install a mechanical protection on the top of theses links in case of object who may fall down provoking short circuit between phases and explosion.

General instrumentation

All the instrumentation of the unit 3 must be dismantled, checked on local laboratory and changed. We suggest to replace all instruments.

General cabling included the boiler

1 - CABLE DISTRIBUTION

The cable distribution made by cable ladder, cable tray and individual conduit don't follow anymore the safety requirement.

The cable ladder and tray work must be protected by cover especially in boiler area after cleaning.

Fly ashes and coal are covering the cables and may damaged the cable outlet enclosure.

Few cables got already their enclosure synthetic rubber very hard due to weather and polluted product contact.

Some of them must be replaced in adding cable junction boxes directly on the main cable tray distribution (closed to the electrical consumers) with new short cable lengths.

An important part of the cable conduits are bent, too short and don't protect the cable properly as per the need i.e. closed to the electrical apparatus.

We suggest to use the opportunity of instrumentation change in order to :

- Make new cable conduits in order to protect your cables as closed as possible from the electrical consumer
- Install new cable junction boxes (if needed)
- Pull and do the cable connection to electrical consumers

2 - CABLE GLAND & CABLE END

The cable end in electrical rooms are generally done in a right way.

For the consumers located in all parts of the power plant we mention at 90% a non conformity of cable gland size.

Effectively, most of the time the cable glands are too big and the cable not really tightened in a right way.

The result is critical as far as the cable not tightened slip from the cable gland and the internal wiring become visible from the outside part of the cable gland.

We suggest to change all cable glands not properly sized in order to insure a real seal and tight pressure on the cable.

3 - COMPRESSORS, DIESEL GENERATOR

All compressor and diesel generators need rehabilitation.

Special care must be taken for the equipments

4 - ELECTRICAL SPARE PARTS

We have notified an important need of spare parts for the electrical system.

Spare parts are vital (breaker, relays etc.) for the good operation of your power plant.

The need is an "URGENT" matter.

We suggest to send us an official list of the need. An additional study can be done with this list to define spare availability according to the installation obsolescence.

5 - FUEL OIL STATION

Fuel oil station need a real truck unloading area with roof protection.
This area made by flat concrete slab must be clearly defined.
Around this area a gutter part of the slab must collect the eventual leak through a big oil pit installed in one extremity and in the lowest point.
The oil pit and gutters will have to be covered by an hot deep galvanized grating.

Oil discharge area must be open air and equipped with an earth pit in order to connect the truck when oil unloading operation.

The same type of installation must be done around the local pumping and treatment stations.
Gutter part of the slab must collect the eventual leak through a big oil pit installed in one extremity and in the lowest point.

6 – DEMINERALIZING PLANT

We have notified especially in the acid treatment plant lack of safety and equipments not adapted to the work.
The main work to be done consist of anti acid paint work and support insulation from the polluted area (acid treatment).
We suggest you for this particular area to dismantle the entire system, to install large gutter around the main slab protected by grating (plastic or hot deep galvanized).
In the gutter lowest part to install a big pit in order to clean with efficiency the main slab and to recuperate all water / acid liquid.
The slab and gutters must be anti acid painted included the wall, tank and pipe supports insulated from the main slab by concrete blocks anti acid painted.
Fixation of equipments must be stainless steel type.
Tanks must be stainless steel or anti acid plastic type.

A.4.4 Turbine

Additive legend for turbine items :
Minimum recommendations : as written in Siemens report

System or Equipment	Minimal work to be performed to regains suitable availability of the unit	Larger scope of work to allow the unit to be operated in acceptable condition for the next 10 to 15 years
§ E.2.1 Turbine rotor (Turbine shaft)	SPG 403 report = Option 1 (100%) - General dressing, polishing and cleaning - Replace main oil pump drive gear Hand dress reaction blades row 1 to 14 - Remove debris from blade throats of stage 15 & 16 and dress the blades - Dress blades stages 17 to 33 to remove burrs Rotor geometrical checking High speed balancing	SPG 403 report = Option 2 ?? (detail drawing needed) Same as “minimal works” with reaction blades replacement (row 1 to 30)
Turbine casing	Visual control of the horizontal joint plane. Adjust interfaces with front and rear pedestals (vertical keys) with realignment Careful checking when reassembly (interfaces with casing palm supports). Pay attention to external pipes connection / Ensure that weight applying on P1 and P2 bearing blocks are well balanced (comparison between left side and right side) Quality of thermal insulation	Same as left + Checking of the horizontal joint deformation (if any) between lower and upper casing Replacement of all studs (100%)
§ E.2.2 Bearings	N°1 white metal lining replacement and machining + DPT + Dimensional controls after machining Cleaning and visual inspection of the oil seals	Retrofit possibility by replacement of a combined mono-block “thrust-bearing / bearing“ by 2 separate pieces (spare parts strategy) : after internal further investigations not possible with rotor as existing.

System or Equipment	Minimal work to be performed to regains suitable availability of the unit	Larger scope of work to allow the unit to be operated in acceptable condition for the next 10 to 15 years
§ E.2.3 Blade carriers	SPG 404 report = Option 1 Cleaning and dressing Replacement of stationary blades rows 15 & 16 Stage 33 blades to be dressed and blended	Same as “minimal works” with replacement of stationary blades row 1 to 30)
§ E.2.5 Stop valve	Refer to MP-U3-AD-0012 report : - New Bushes and new spindle valve to be installed with clearance checking - Blue checking between new valve head with associated seat (+ lapping if required) For relay = refer to MP-U3-AD-007 report Steam Strainer and thermal insulation checking ***Cleaning (see § E.1.3.1)***	
§ E.2.5 Governor valves	Refer to MP-U3-AD-0012 report : - New Bushes and new spindle valve to be installed with clearance checking - Blue checking between new valve head with associated seat (+ lapping if required) For relay = refer to MP-U3-AD-007 report SPG 402 report = Replacement of one governor valve seat (Top, right side) : ***Cleaning (see § E.1.3.1)***	
§ E.2.4 Glands	Geometrical and dimensional controls Replacement of springs	Geometrical and dimensional controls Replacement of segments Replacement of springs

System or Equipment	Minimal work to be performed to regains suitable availability of the unit	Larger scope of work to allow the unit to be operated in acceptable condition for the next 10 to 15 years
§ E.2.1.4 Turning gear	Replacement of gears damaged. Note: status on other components of turning gear device is highly suggested . Note : a complete checking of logic sequence is required	Depending upon occurrence of damage discovered on this system for units 1,2 & 3, a retrofit study could be opportune
Lube Oil System	Refer to MP-U3-AD-005 report Main oil pump drive gear to be replaced Teeth gear to be replaced New main oil pump drive shaft bearings to be replaced Main oil pump to be replaced with spare + Replacement of filters cartridges Periodic Oil analysis : add analysis of contamination by solid particles (particles size and quantity)	Draining of the oil Cleaning of the oil tank Dimensional control of the components Clearances checking Oil coolers cleaning Oil coolers pressure test Piping lube oil flushing Replacement of filters
§ E.1.3 Instrumentation	Replacement of the defective instrumentation (see § E.1.3.1 and § E.1.3.2) Correct adjustment/calibration of all Eddy current probes with specific care for axial probes (thrust wear and differential expansion with identification of zero reference and “+”, “- “ displacement signs) Check identification and transmission of values to DCS Closing of all Junction boxes	Required to change the instrumentation which could be considered as obsolete or defective with improvement/replacement of cable trays
§ E.1.3.6 Turbine drains	Thermal insulation to improve (refer to « on load » analysis report)	
§ E.1.3.5 Gland steam condenser	Damaged Heat insulation to replace (refer to « on load » analysis report – Picture in § E.1.8)	