United Nations Development Programme

برنـــامـج الأمـــم المـــتحدة الإنـمـــائي

Iraq
العراق

Rehabilitation of Mussayib Power Station Phase I

UNDP Project No. 41699

FINAL REPORT

Funded by Government of Japan

March 2008

United Nations Development Programme
برنامج الأمم المتحدة الإنمائي

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UNDP PROJECT No 41699 - E4-10

Rehabilitation of Unit 1 at Mussaib Thermal Power Station

Stage I

Funded by Government of Japan

FINAL REPORT

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Al Mussaib Powerstation

1 SUMMARY

As part of the efforts of Government of Japan for the reconstruction of the electricity sector in Iraq, in late 2004, UNDP received a grant (USD 48.51m) for the Rehabilitation of Unit 1 of Mussaib Thermal Powerstation in Babyl Governorate.

Unit 1 was built in 1987 by Hyundai Engineering as main contractor but shut down over nearly 8 years after it had been severely affected by a rocket attack during the first Gulf war in 1990. It was restarted in 1997 but poor maintenance in the following years due to lack of spare parts (Iraq was under sanctions) contributed even more to the degradation of the unit.

At the end of the 2003 conflict, the power station was in a very poor condition and needed to be rehabilitated urgently. In the mean time, in order to be able to conduct this and future rehabilitations on similar equipment, the Ministry of Electricity needed to upgrade the know-how of its staff.

In view of the poor condition of Mussaib Unit 1 and the complexity of the rehabilitation it was decided to split the Rehabilitation Project into two Stages. Stage I Budget of US$15,510,982 was dedicated in December 2004.

The present report relate achievements of Stage I while Stage II is ongoing and will realize further benefits of the works completed under Stage I.

Detailed background information is reported in Annex 2 in Section 8

2 PROJECT OBJECTIVES

The following outputs where expected from this project:

Output 1:
Unit 1 of Mussaib Thermal Power Station demonstrating increased generating capacity and reliability.

Output 2:
Set of selected essential spare parts supplied to Mussaib Thermal Power Station for emergency repairs and routine maintenance, in order to sustain the increased generation.

Output 3:
A substantial number (20) of trained plant engineers, who will be able to assess problems and maintain the power plant at higher levels of performance and also in turn would be able to train other junior technical personnel (engineers and technicians).

2.1 Narrative Analysis of Achievements

Achievements on Output 1:
As focus was put on the provision of replacement parts, this Stage I of the rehabilitation saw no major overhaul performance and no achievement of significant gain in generation capacity (See Output 2). The bulk of projected improvement in reliability and stability of output is linked to the completion of Stage II rehabilitation works, which is expected for completion in 2009. Full impact of stage I will be realized at that time, when all the benefits become tangible.

Achievements on Output 2:
Approximately 300 tons of essential spare parts for nearly USD 10 million have been supplied to Mussaib Thermal Power Station. These spare parts will be implemented by the Power station staff and thus improve the reliability of the unit.

Achievements on Output 3:
21 (slightly more than the 20 planned) power station engineers underwent overseas training on power plant operation and technical condition assessment.
They later performed the technical assessment with the remote assistance of Hitachi engineers located in Amman in order to determine the optimal sets of parts and repair work needed. A substantial final assessment report (reproduced in part in Annex 1) was issued, determining the replacement parts needed for the comprehensive rehabilitation of Unit 1.
The training also refreshed the knowledge of these engineers on important operation and maintenance procedures. It enabled them to operate Unit 1 of Mussaib Power Station according to the manufacturer's guidelines and procedures, thereby reducing the frequency of breakdown and improving the durability of the equipment.

2.2 Impact, Sustainability and Follow-Up Arrangements

A far reaching impact on Mussaib Thermal Powerstation in particular and on MoE in general is the impact of the training undergone by 21 engineers from Mussaib. This training allowed these engineers to conduct structured and systematical technical assessments on their own. They will also be able to train junior MoE engineers on these procedures.
In general these engineers will be able to operate Unit 1 of Mussaib Powerstation according to the manufacturer's guidelines and procedures for extended Remaining Useful Life (RUL)
Stage II is going to further improve the reliability since more selected boilers parts will be forwarded to site and implemented.

3 PROJECT IMPLEMENTATION PERFORMANCE

3.1 Evolution of Risk Situation

During the implementation of Stage I the security situation worsened. Coalition forces have installed troops inside the Mussaib power station and restricted the use of mobile phones, walkie-talkies and cameras (exceptionally allowed for the technical Assessment). In addition long-lasting security checks were imposed at the entrance gate. These constraints greatly reduced the flexibility and the practicality of remotely -controlled implementation and slowed the project progress.

Regarding the transport of equipment, material and parts to the power station the security situation has dramatically deteriorated between shipment No 1 and 4. First coalition forces did not supply escorts for transport convoys anymore. Private security forces had to be engaged by the contractor. The convoy of shipments No 2 & 3 has been attacked shortly after the border grossing and one vehicle was shot out of order. Fortunately nobody was injured and the material remained intact. Shipment No 4 had to be temporarily stored for 2 months in Kuwait in order to obtain security clearance for its transport to Mussaib.

3.2 Effectiveness of Implementation Strategy

Although these developments did not impede the project totally, they did slow down deliveries and overall implementation. The implementation strategy adopted was designed to be resilient to these uncertainties. This approach proved to be a success, minimizing delay and plowing resolutely forward.

3.3 Lessons Learned

For future assessments it is important to define and supply (prior to the beginning of the assessment) parts and consumables necessary for the Assessment and inspection of machines and equipments.
If emergency parts are to be delivered in such a case an important work has to be completed to select these parts and to set priorities taking the real needs and the budgetary limits into account. This needs to be done in very close relationship with the power station personnel and specialized contractors.
In order to respect the budgetary limitations the power station personnel need to be sensitized to the fact that technical priorities must be set in the selection of parts.

4 MANAGEMENT ARRANGEMENTS PERFORMANCE

4.1 Effectiveness of Management Arrangements

The organization of the UNDP management had remained unchanged during the project duration. It had consisted of an international Project Manager and a Project Assistant with good knowledge of the power plant.

4.2 Lessons Learned

The organization of UNDP staff had proved to be well adapted to the project size and the content. The presence of more national engineers in different fields of expertise during the assessment would have been profitable to a faster conclusion.

5 FINANCIAL REPORT

5.1 Detailed Expenditures

Components	Amount USD
Personnel	369,143.51
Travel	117,787.49
Contracts	14,234,199.48
Miscellaneous	32,179.18
Administration – GMS	748,417.11
Security	9,255.24
Total	**15,510,982.00**

5.2 Financial Summary

Total Funded **= USD 15,510,982.00**

Total Actual Disbursement **= USD 15,510,982.00**

Balance **= USD 0**

Lessons Learned

In the presence of a project that can experience delays, there is a tendency to under-budget staff costs: although the project does not directly incur additional expenses because of the delays, full follow up is needed for the time of the delays and budgeting must take into account the possibility of extended staff needs caused by delays in project completion.

Note: the amounts shown above will be confirmed by final accounting documents and the project will financially closed

6 PROJECT CLOSURE

6.1 Certificate of Completion, Handover Procedures & Asset Transfer

Project activities have been completed successfully and the Ministry of Electricity is using equipment delivered during the course of the project. All assets in the project were received by Mussaib power station.

Annex section 7.1 reproduces (i) the certificate of final completion delivered to the main contractor (ii) the handover letter transferring ownership of project assets to Mussaib counterparts.

6.2 Recommendation for Operational Closure

All activities were completed satisfactorily. This project is therefore recommended for operational closure.

With no financial obligation pending and activities completed within the set budget, financial closure will also follow the issue of this final review, after specific accounting buffer period are met.

7 ANNEX 1: IMPLEMENTATION DETAILS

7.1 Certificate of completion and assets handover

United Nations Development Programme

Iraq

Contract No. IRQ - P/AM097/05

Rehabilitation of unit No.1 at Mussaib Power Station in Babyl Governorate, Iraq (Stage I)

Between the United Nations Development Programme (UNDP)
and
Hitachi Ltd. Tokyo (Japan) - (the Contractor)

CERTIFICATE OF FINAL COMPLETION

In accordance with the agreement between the Contractor and the UNDP, the Engineer on behalf of the UNDP hereby certifies that on the basis of an verification jointly carried out with UNDP, the "Works" is at this date namely 17 of November 2007 (hereinafter referred to as the "agreed date" of final completion) have been finally completed by the Contractor.

The agreed date of final completion shall be regarded as the date of final completion for all purposes whatsoever, duties and obligations of the Contractor under the terms and conditions of the Contract.

for UNDP RCP unit:

Name: Herald Kehl

Title: Technical Advisor

Signature:

Date: 10 December 2007

Acknowledgement by Contractor

Name: Fumio Komamura

Title: Manager / HITACHI

Signed by:

Date: 10 December 2007

for UNDP Procurement unit:

Name: NAHID KHAN

Title: PROCUREMENT SPECIALIST

Signature:

Date: 10/12/07

Originals To:

(1) The Contractor
(2) Crisis Prevention and Recovery Unit, UNDP Iraq,
(3) Procurement Unit - UNDP, Iraq

United Nations Development Programme
برنامج الأمم المتحدة الإنمائي

Iraq

العراق

28 February 2007

To: General Directorate of Electricity Production / Middle Euphrates

Attn.: Director General Mr. Wafi Mnadi

Subject: UNDP Mussaib Unit 1 Rehabilitation Project, Stage I

UNDP is pleased to inform you that the Warehouse reception of the spare parts supplied under Stage I contract is now completed. Consequently the parts are at your disposal for their implementation in unit No.1.

In order to keep an adequate record of the parts stored in Mussaib warehouse UNDP requests MoE to apply the following procedures:

1) Monthly report to UNDP through the "Balance sheets" for parts being used for unit No. 1.
2) A complete inventory at the end of each year until all supplied parts have been cleared from Warehouse and the remaining balance is 0 (zero).
3) Request for approval to UNDP prior of using parts for other units than unit No.1 of Mussaib TPS.

In case you need assistance for the implementation of parts, please send a written request for assistance to UNDP. UNDP will request Hitachi to supply the necessary assistance.

Best Regards

Steve Vilonel

Harald Kehl

7.2 Supplies to the site

During Stage I the following Equipments, Parts, Tools and Office equipment have been supplied to Mussaib Power Station.
In total nearly 300 t of goods, equipments and parts have been forwarded to Mussaib in 3 major transports
Transport No 1: - 7 containers and several boxes, approximately 82 t,
Transport No 2: - 2 containers, approximately 30 t,
Transport No 3: - 8 containers and several boxes, nearly 180 t

Transport No3: one convoy is crossing the Kuwaiti/Iraqi border

– **Mussaib Unit 1, Stage I Parts list**

No.	Equipment name	Parts Name	Unit	Q'ty
4	Air Heater	Low temperature elements	set	2
		Seal Plates (shaft seal, radial seal , circumferential seal)	set	2
		Inspection lamp with switch	pcs	2
8	Pressure gauge	Water & steam line in Ku0-160-577G	pcs	11
		Auxiliary steam line	pcs	3
		Washing water line in Ku2-224-439G	pcs	7
		Chemical injection system in Ku2-224-432D	pcs	8
		Seal and aspirating air in Ku0-160-531C	pcs	14
		Burner front (oil)	pcs	16
		Burner front (steam)	pcs	16
		Burner seal air, FDCF discharge	pcs	2
		Burner aspirating air ,atomizing air	pcs	2
		Burner atomizing steam	pcs	2
12	Soot blower	Complete rack type soot blower	set	12
15	Chemical Injection Pump	Gland packing	pcs	8
20	Burner	Burner sprayer plate	pcs	16
		Burner Cap nut	pcs	16
		Burner joint washer	pcs	32
		Single Solenoid valve for start up burner	pcs	96
		Double Solenoid valve for start up burner	pcs	76
23	Local Control valve	TV-102A, TV-102B, TV-103A, PV-111A, PV-161A, PV-161B, PV-107A, LV-107A, LV-107B, TV-064A Diaphragm	pcs	10
		Gland Packing (included in 23-1)	pcs	10
		O-ring (included in 23-1)	pcs	10
		Positionner	pcs	10
		Air relay	pcs	10
		E/P Converter	pcs	10
		Solenoid Valves for control valves & control drives	pcs	25
		Limit switch for control valve and control drive	pcs	70
		Position transmitter for control valve (Non Explosion Proof)	pcs	3
		Position transmitter for control drive (Non Explosion Proof)	pcs	10
		Position transmitter for control drive (Explosion Proof)	pcs	8
24	Local Controller	Complete set of controller(PC)	pcs	4
		Complete set of controller(TC)	pcs	1

		Completes et of contr oller(LC)	pcs	2
		Air regulator (included in 24-1)	pcs	7
		Pressure gauge(0-2bar,0-10bar) (included in 24-1)	pcs	14
26	Temperature switch	Completes et of temperature switch	pcs	8
		Fan mot or bearing temperature		
		Fan bearing temperature	pcs	8
31	Furnace ITV	Lens tube Optical mode LT 500HA HITACHI	sets	2
		Explosion proof Camera Housing (Hooding Middle TIE-64 Water cooled) HITACHI	sets	2
	for Drum Level monitor	Camera Housing Model PH 2UB (Rain proof construction Air cooled) HITACHI	sets	2
32	Limit switch	Type VCX-5101 (5A, 250 VAC, Explosion proof 4 contact) YAMATAKE	pcs	100
		Type VCX-5103 (5A, 20VAC, Explosion proof 4 contact) YAMATAKE	pcs	100
35	Exciter Transformer	Ignition transformer (YEW)	pcs	16
40	Expansion Joint	EXPJ for GRF outlet (Metal)	pcs	2
		EXPJ for GRF outlet (Non-Metal)	pcs	2
41	Chemical Injection pump	Phosphate injection pump for Drum	pcs	2
		Motor for above (1.5kw)	pcs	2
		Phosphate injection pump for STM Converter	pcs	2
		Motor for above (0.4kw)	pcs	2
		Hydrazine injection pump for Deaerator	pcs	2
		Motor for above (0.4kw)	pcs	2
		Hydrazine injection pump for STM Converter	pcs	2
		Motor for above (0.4kw)	pcs	2
42	Field Instrument	Press Transmitter	pcs	5
		Level Transmitter (included in 42-2)	pcs	1
		Tank level transmitter (included in 42-2)	pcs	1
		Flow Transmitter (included in 42-2)	pcs	2
		Press. indicating controller (included in 42-2)	pcs	1
		Press. Switch (included in 42-2)(included in 42-2)	pcs	6
		Press. Gauge (included in 42-2)	pcs	2
		Level Switch (included in 42-2)	pcs	3
		Level Controller (included in 42-2)(included in 42-2)	pcs	1
		Thermocouple, etc (included in 42-2)	pcs	7
		Temp. indicating controller (included in 42-2)	pcs	4
		Temp. Gauge with Switch (included in 42-2)	pcs	4
		Flow Sight Glass (included in 42-2)	pcs	1
		Tank Level Gauge (included in 42-2)	pcs	1
		Condenser Leak Monitor (Conductivity transmitter and cell) (included in 42-2)	pcs	1
43	Boiler Additional Parts	Parts for burner solenoid valve rack	pcs	32
		Air Filter		
		Air Regulator	pcs	32
		Soot blower for AH (complete set)	sets	2
		Shaft seal plate for two GRF	sets	4
		Parts for inspection hole	pcs	8
		Glass		
		Refractory for 8 holes	set	1
		Gasket for Drum manhole	pcs	10
45	Local Control &Analyzer Panel	Sampling rack & Analyzer Panel	set	1
		Conductivity monitor (included in 45-1)	sets	7
		PH analyzer (included in 45-1)	sets	5
		Silica analyzer (included in 45-1)	set	1
		DO2 analyzer (included in 45-1)	set	1
		Flow meter, cooler, thermometer, cation, , valve, etc (included in 45-1)	set	1
27	Drum level gauge	Electrode type Level indicator	set	1
		Isolation valves and tubes for Electrode type Level Indicator	pcs	2
Inst		Displacement Level Transmitter Deaerator	pcs	1
Inst		Displacement Level Transmitter Condenser	pcs	1
Inst		- Ph meters for water treatment	pcs	1
Inst		- D/P Indicating switch	pcs	1
Mech		Fuel oil station sump pump	pcs	2
		baffle wall tube	set	1
		Economizer	set	1

Total Cost for these Equipments and Parts ***(including transport):*** **US $ 10,727,674**

– **Special tools for Boiler and Machinery Assessment sent to Mussaib:**

Item No.	Description	Unit	Qty
1	Hydraulic Test pump	Pc	1
2	Field Balancing Unit " Smart Balancer"	Pc	3
3	Fiberglass Endoscope	Pc	1
4	Infrared Thermometers	Pc	3
5	Laser Speed Tachometer with Accessories	PC	2
6	Vernier Caliber	PC	10
7	Feeler Gauge	PC	10

Total costs for these Special Tools and Machinery: **US $ 69,822**

– **Additional assessment equipment**

To facilitate the Assessment various office equipments (photocopiers, desktop and lap top computers including office software, printers, walkie talkies, cameras, printers) for a total value of US $ 20,478 have been forwarded to Mussaib.

7.3 Documentation of the overseas training

7.3.1 Training

21 Power station engineers of all required expertise were selected out of 25 candidates and have been send overseas to Hitachi and Hyundai premises for a detailed 3 weeks training in power plant:
- Operation
- Maintenance
- Technical Assessment

The Training took place in three different places: Kure, Japan for Boiler- and other Mechanical engineers, Omika, Japan for Instrument and Control Engineers and Seoul, Korea for the whole group.

UNDP had organized kick off and de-briefing meetings with the trainees in Amman.

At the de-briefing meeting the trainees had to submit an Evaluation of the training. The general result of this evaluation was satisfactory.

7.3.2 Lessons Learned

The training would have been of a higher quality level if Interpreters would have been present. The language skills of trainers and trainees are representing a supplementary difficulty for easy mutual understanding and smooth ongoing of the training.

7.4 Documentation of the technical Assessment

The Assessment was performed in two separate phases:

1 Cold Assessment: the unit 1 was stopped and the equipments to be assessed were partially dismantled. 440 assessment report sheets were issued and 520 photos were transmitted, giving a detailed account of the state of the unit.

2 Hot Assessment: the unit was in operation and performance data, vibration measurements, etc. were recorded and collected. The hot assessment was reported by the means of some 20 data sheets.

7.4.1 Cold Assessment

The cold assessment was performed from August 15th and had to be finished by August 29th on MoE's request. The Assessment of the remaining equipment (redundant equipment) was completed by September 25th.
The assessment results were commonly reviewed and analyzed by MoE, Hitachi, Hyundai and UNDP during an Amman meeting between September 25th and September 29th.

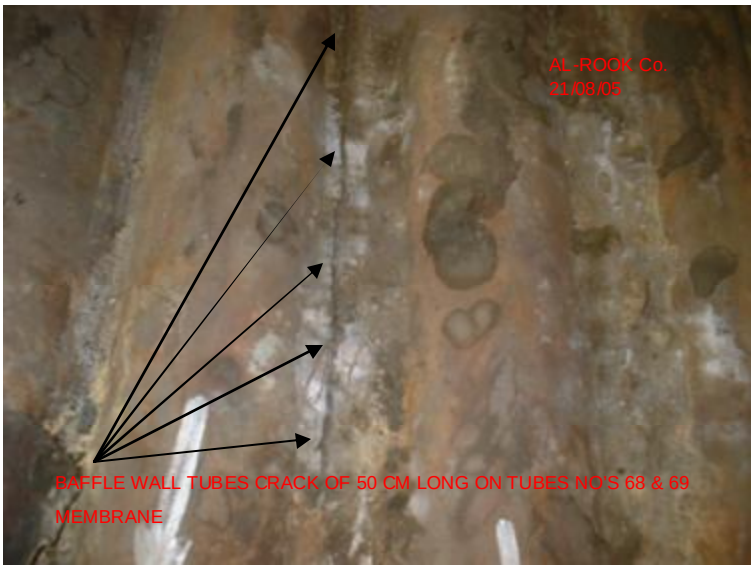
7.4.1.1 Assessment of Boiler tubes

The assessment of boiler tubes was performed in 5 different ways:

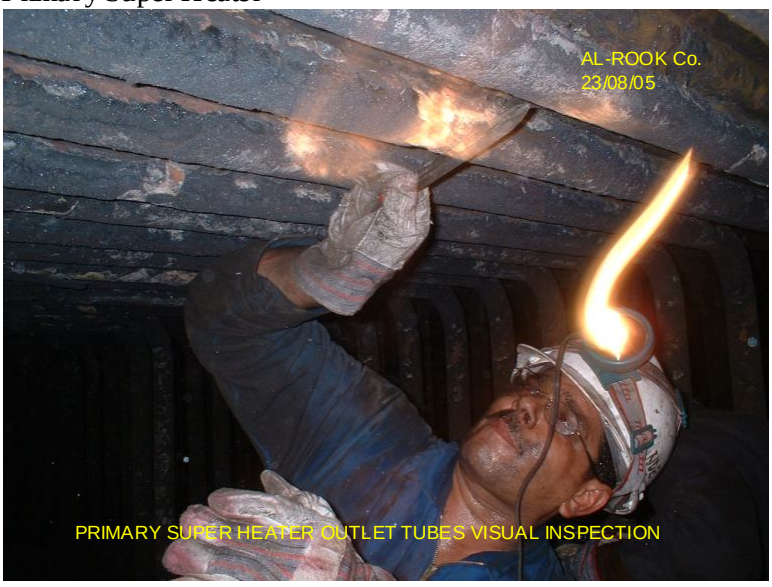
- Visual inspection ,
- Ultrasonic UT-Flaw detection
- Hardness test,
- Dye penetration test.
- Endoscopic tube inspection

These assessment techniques are illustrated in the following pages. Some defects were detected and immediately repaired according to Hitachi's instructions.

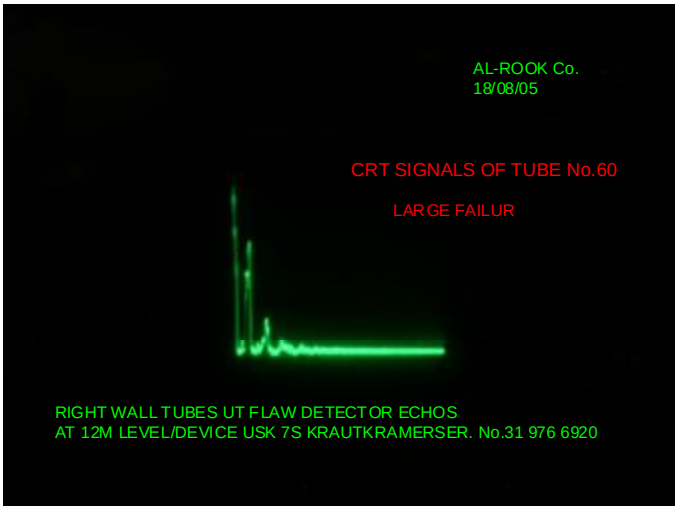
Visual Inspection:

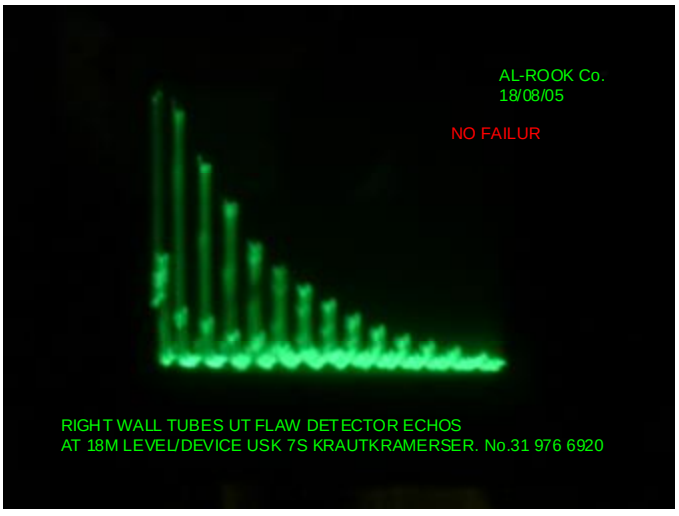


Primary Super Heater

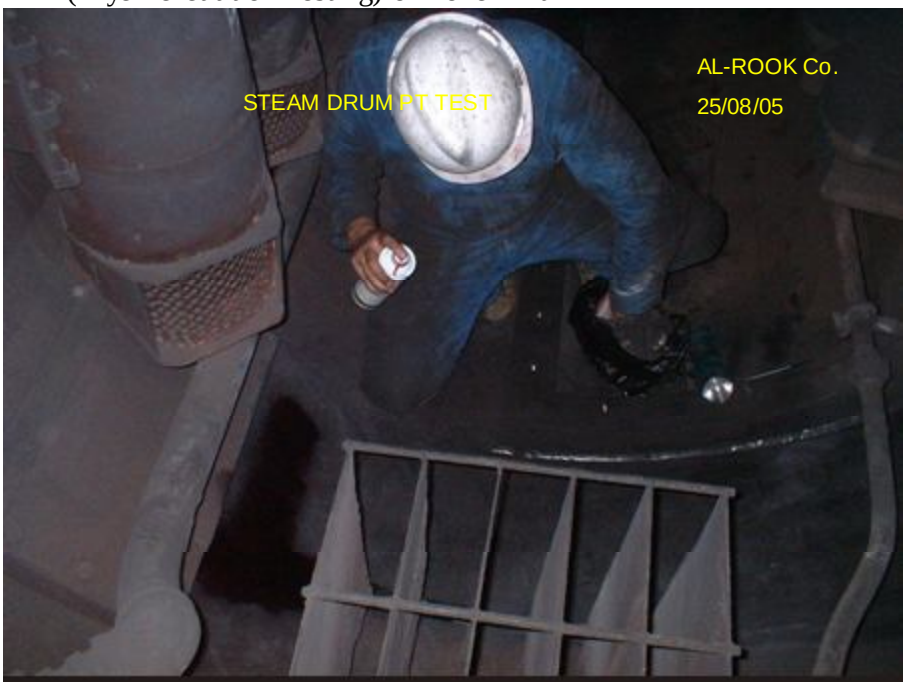


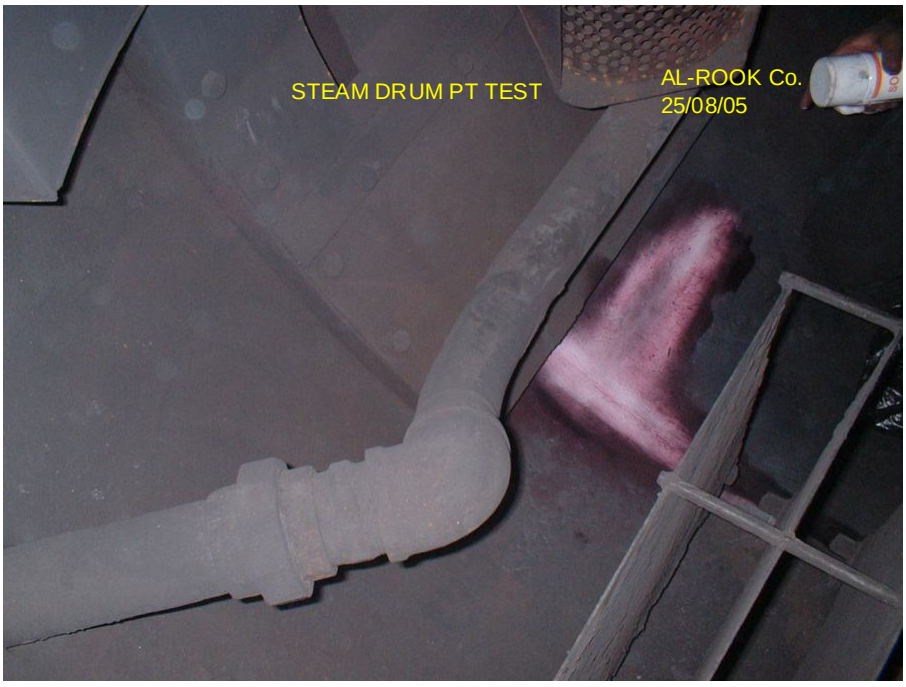
UT Flaw Detection:





DPT (Dye Penetration Testing) of Boiler Drum



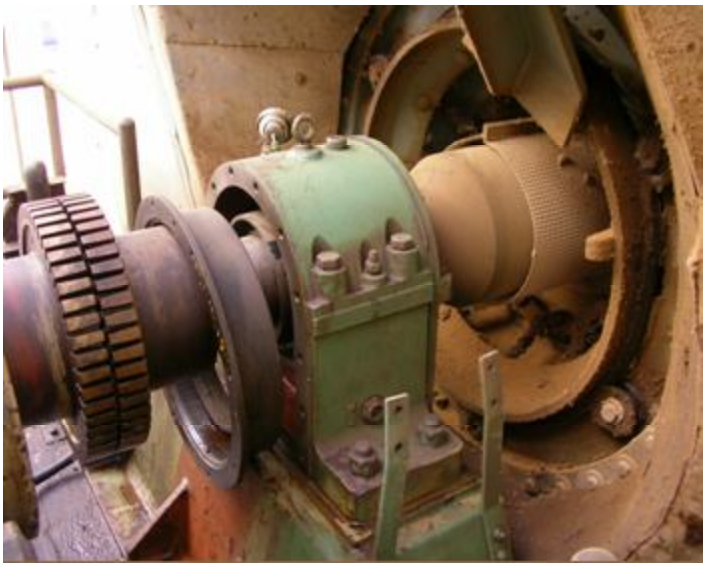


Hardness measurement:

Endoscopic boiler tube inspection

7.4.1.2 Assessment of rotating machines

Rotating machines were partially dismantled and inspected. During the hot Assessment vibration measurements were taken.

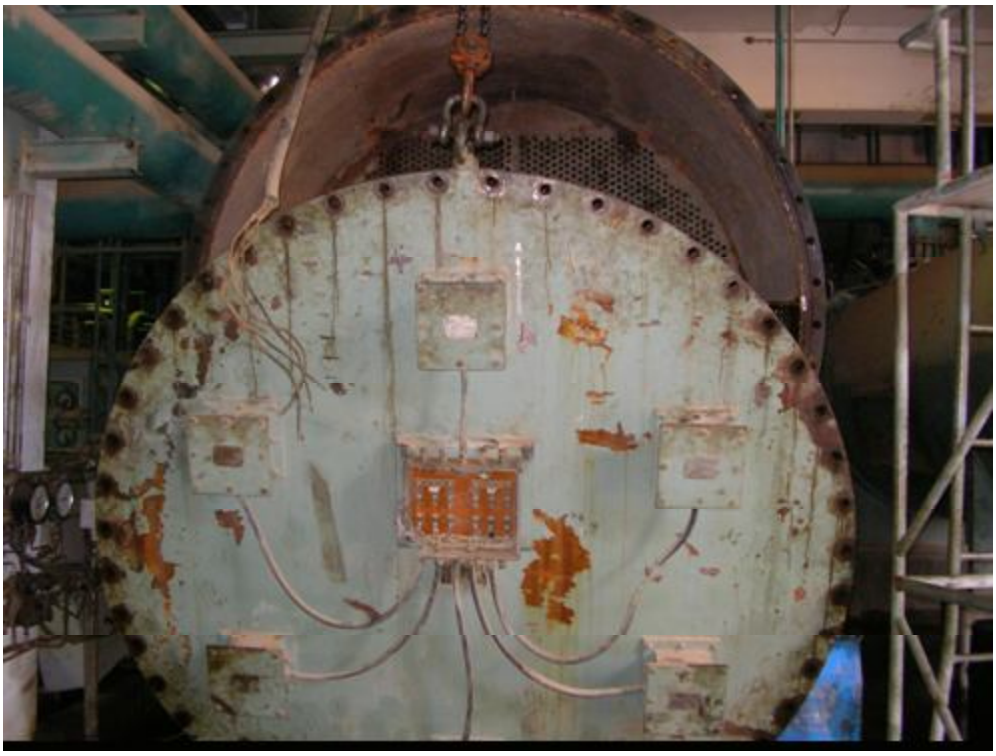


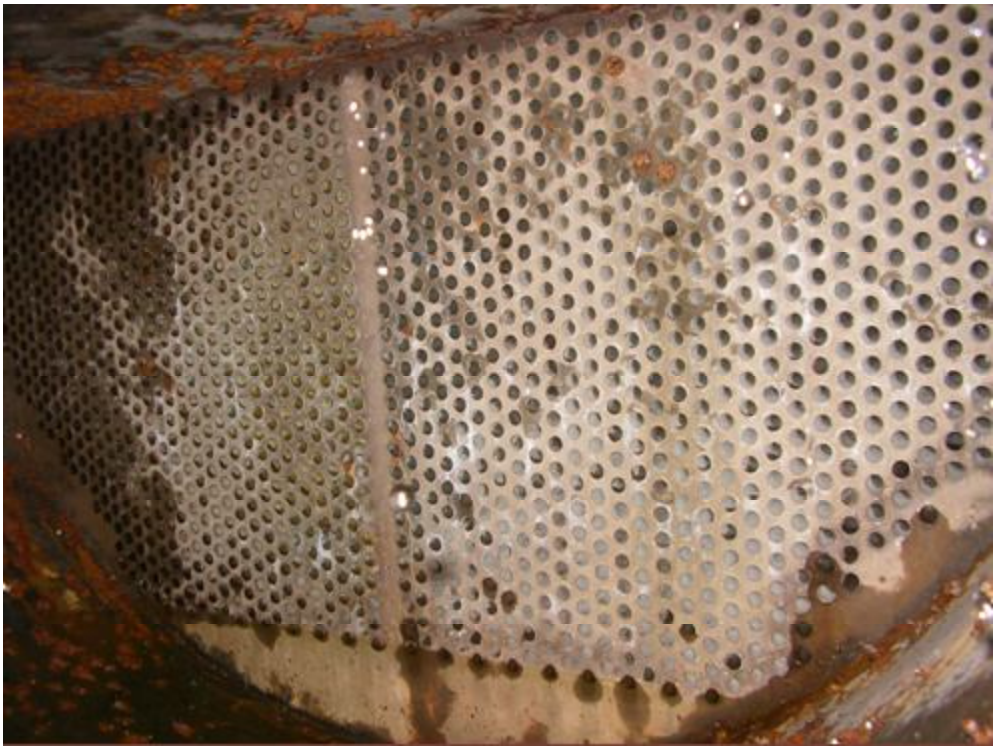
7.4.1.3 Assessment of Air heater

The Air Heater was internally inspected for damages and minor repair works were carried out.

7.4.1.4 Assessment of Heat exchangers

Heat exchangers were visually inspected and cleaned. Minor repair works carried out whenever possible.





7.3.2 Hot Assessment

The hot assessment was carried out on 14 September. Initially it was planned to take 4 measurements, but the time became too short and the 4rth measurement could not be done.

Example of a recorded sheet:

BOILER OPERATION DATA (1 / 6) **BY-XMU-A-02**

REPUBLIC OF IRAQ
STATE ORGANIZATION OF ELECTRICITY
AL-MUSSAIB POWER STATION
UNIT NO.: 1 Fuel: Oil
GENERATOR OUT PUT: 200 MW, 50 HZ

Date : Time | Month: September | Year: 2005
COMPANY NAME:
PERSON IN CHARGE:
LOAD SETTING: AFC DFC AIR MAN.

No	DATA Log No	Items to be measured/inspected	unit	Planned	Measured	Measured	Measured	Measured	Remarks
		Water & Steam System		@210MW	210 mw				
1	W001	Deaerator Pressure	bar		4.9	5	5		
2	W010	Deaerator Temperature	°C		160	160	160		
3	W002	BFP discharge Pressure	bar		166	166	166		
4	W011	BFP discharge Temperature	°C		161	161	161		
5	W014	HP Heater outlet Temperature	°C	230.7	164	164	164		
6	B038	Feedwater Flow	t/h	607.5	613	613	613		
7	B005	Eco. Inlet Pressure	bar	173.6	167	167	168		
8	B025	Eco. Inlet WaterTemerature	°C	230.7	167	170	171		
9	B015	Eco. Outlet Water Temperature -A	°C	279	212	212	212		
10	B016	Eco. Outlet Water Temperature -B	°C	279	212	212	213		
11	UCB	Continuous blow down Motor valve opening	%		0	0	0		
12	B001	Drum Pressure	bar	171.6	160	160	160		
13	H027	Drum Temperature	°C	353	350	349	350		
14	B011	Primary Superheater outlet Steam Temperature-A	°C	408	415	415	416		
15	B012	Primary Superheater outlet Steam Temperature-B	°C	408	421	421	421		
16	UCB	SH Spray Flow Control Signal	%						Man. Mode
17	X033	SH Spray Flow Control Valve Position -A	%						to be checked at local
18	X034	SH Spray Flow Control Valve Position -B	%						to be checked at local
19	B034	SH Spray Flow	t/h	36.9	31	32	36		
20	Local	PSH out Aux. Steam Press. Control Valve position	%						to be checked at local
21	B013	SH Attemperator outlet Steam Temperature - A	°C	382	395	394	387		
22	B014	SH Attemperator outlet Steam Temperature - B	°C	382	389	389	389		
23	B002	Secondary Superheater outlet Pressure	bar.g	168	155	155	155		
24	B019	Secondary Superheater outlet Temperature - A	°C	541	557	556	551		
25	B020	Secondary Superheater outlet Temperature - B	°C	541					
26	B021	Main Steam Temperature	°C	540	536	536	533		
27	T001	HP Turbine inlet Pressure	bar.g	168	155	155	155		
28	T022	HP Turbine inlet Temperature - A	°C	538	541	540	537		
29	T023	HP Turbine inlet Temperature - B	°C	538	543	543	539		
30	T024	HP Turbine inlet Temperature	°C	538					
31	T006	HP Turbine inlet Pressure - A	bar.g	168	144	144	144		
32	T007	HP Turbine inlet Pressure - B	bar.g	168					
33	T061	Main Steam Flow	t/h	607.5	638	638	627		
34	T016	HP exhaust Pressure	bar.g		29.6	29.6	29.3		
35	T038	HP exhaust Temperature	°C	309.7	367	368	368		
36	UCB	Reheater Spray Control Signal	%	0					Man. Mode
37	X043	Reheater Spray Flow Control Valve Position	%	0					to be checked at local
38	B035	Reheater Spray Flow	t/h	0					
39	B004	Reheater inlet Pressure	bar.g	26.9	29.3	29	29		
40	B024	Reheater inlet Temperature	°C	309.7	327	327	325		
41	B003	Reheater outlet Pressure	bar.g	25.5	30.1	30	29.8		
42	B022	Reheater outlet Temperature - A	°C	541					
43	B023	Reheater outlet Temperature - B	°C	541	538	538	536		
44	T008	IP Turbine inlet Pressure - A	bar	25.5	32	32	31		
45	T009	IP Turbine inlet Pressure - B	bar	25.5	29	29	29		
46	T026	IP Turbine inlet Temperature - A	°C	538	505	505	505		
47	T027	IP Turbine inlet Temperature - B	°C	538	516	516	513		
48	C001	Condenser Vacuum	mbar		-860	-860	-860		
49	X017	Main Steam Flow	t/h	607.5					
50	X019	Main Steam Pressure	bar.g	168					
51	X030	Superheater outlet Steam Temperature - A	°C	541					

7.5 Assessment results: Rehabilitation recommendations

Below the Hitachi Final Assessment Report is shown partially. In particular are attached the recommended Countermeasures for the Rehabilitation of Unit 1.
For further information please refer to the complete Report.

IRAQ RECONSTRUCTION PROGRAM –UNDP
AL-MUSSAIB THERMAL POWER STATION UNIT-1
EMERGENCY REHABILITATION PROJECT STAGE-1
CONTRACT NO. IRQ-P/AM097/05

UNIT NO.1 BOILER ASSESSMENT REPORT

OCTOBER 2005
HITACHI LTD BABCOCK-HITACHI K.K.
TOKYO - JAPAN

CONTENTS

[…]

4. COUNTERMEASURE
4.1 Summary of Countermeasure

1) Advise to replace water wall panels because of the remarkable internal corrosion caused by improper water conditioning and outside corrosion due to the acid corrosion.
2) Advise to replace all local instruments. No spare parts were supplied since the commencement of commercial operation resulting in the manual operation of all pneumatic control valves and control drives. The instrument air system including air dryer must be replaced because the all pneumatic control devices have been damaged by wet instrument air.
3) Advise to replace flue duct, its expansion joints including the insulation materials around the gas recirculation fans and air heater down stream since severe flue gas leakage have been observed.
The boiler sealing air system has not been working resulting in the clogging of seal air line and draft impulse piping, corrosion of soot blower wall boxes and boiler casing and mal-functioning of the pneumatic instruments.
4) Advise to replace the chemical dosing pump in order to control boiler water conditioning.
The boiler water tube have been suffering severe rupture problem because of this
(Note: Chemical injection pumps with motors were included in the Stage-1 contract)
5) Advise to replace all soot blowers and their control systems soot blowers. Outer tubes, inner tubes and seal boxes were severely corroded by flue gas. (Note: All Racktype soot blowers were included in the Stage-1 contract)
6) Advise to overhaul or replace high pressure drain valves, motorized drain valves and safety valves because those essential valves have not been overhauled since the commencement of commercial operation.

4.2 Recommendation
4.2.1 Boiler Water Walls

1) To replace all Water wall panels around fire box (up to FL+ 25,000).
This includes baffle wall panels and water wall inlet headers.
(Note: Only baffle wall panels were included in the Stage-1 contract)
2) To replace baffle support tubes (1ry Superheater coil support tubes)

4.2.1 Economizer Coils

To replace all coils (Note: All economizer coils were included in the Stage-1 contract)

4.2.2 Primary Superheater Coils

No tube failure was reported, therefore no replacement is planned.

4.2.3 Secondary Superheater Coils

No tube failure was reported, therefore no replacement is planned.

4.2.4 Reheater Coils

No tube failure was reported. The replacement of the second bank coils located convection down stream is subjected to the results of the sample tube analysis.

4.2.5 Steam Coil Air Heater

To replace all condensate recovery pumps in order to correct heat balance around LP heater and condenser.

4.2.8 Regenerative Air Heater

To replace all low temperature elements and seal plates in order to minimize air leakage from airside to gas side so that boiler can be operated with the suitable excess air condition.

(Note: All low temperature elements and seal plates were included in the Stage-1 contract)

4.2.9 Soot Blower

To replace all soot blowers with their control system. All outer tubes and seal boxes are corroded by acidic flue gas due to the mal-functioning of the boiler sealing air system.

(Note: All rack type soot blowers were included in the Stage-1 contract)

4.2.10 Chemical Injection System

To replace all chemical dosing pumps and tank level switches.

(Note: Chemical injection pumps with motors were included in the Stage-1 contract)

4.2.11 Forced Draft Fans and Gas Recirculation Fans

To replace fan bearings with the water-cooled type and re-align fan shaft and bearings.

4.2.12 High Pressure Valves, Safety Valves and Motorized valves

1) To replace all high pressure drain valves which might have erosion problem for their valve seats.

2) To overhaul all safety valves, high pressure valves and high pressure motorized valves.

4.2.13 Local Instruments, Actuators and Monitoring system

1) The design concept of the instrumentation for Al-Mussaib thermal Power Station is a full automatic operation. Due to the mal-functioning of the instrument air-drying system, all pneumatic instruments had become faulty and control drives or burner air cylinders had become sluggish movement.
Therefore we strongly advise to replace all pneumatic instruments, remote drivers and air cylinders.

2) To replace all magnetic solenoid valves, limit switches for the position monitoring and burner actuators.

3) To replace furnace monitoring television and drum level monitoring television.
(Note: Two furnace monitoring TV and two drum level monitoring TV were included in the Stage-1 contract)

4.2.14 Burners

1) No spare parts has been available since commencement of the commercial operation resulting in a flame impingement to the furnace side walls,
We advise to replace a whole burner gun atomizers and burner impellers for all boilers.

2) To replace burner management system, flame monitoring system in order to avoid further failures or incidents.

4.2.14 Duct Expansion Joints, Insulation and Outer Claddings

To replace Air heater outlet gas duct expansion joints (G7 & G8), their insulation materials and outer claddings because they are severely corroded.

4.2.15 Cold Reheat Piping Support

To replace all piping supports, shock absorber, hydraulic snubbers and hanger supports along the HP exhaust to reheater inlet line.

4.2.16 Steam Drum Internals

1) Replace all hydro-clones for four boilers since they should have an erosion corrosion problem.

2) Replace chemical feed pipe in the steam drum since they had repeated clogging problem in the feed pipe.

The boiler rehabilitation plan is listed in the Table 4-2-1 to Table 4-2-4 for reference.

Ministry of Electricity Republic of Iraq
Al Mussaib Thermal Power Station

15 October 2005

RECOMMENDED REPLACEMENT PART/ EQUIPMENT

Table 4-2-1

No.	Equipment. Parts	Unit-1 Boiler	Remarks
1	Water wall Panel (up to FL+25,000)	Total Replacement (details are as below)	**This item included in the long lead items**
	Front water wall Panels	Total Replacement up to **FL+25,800**	
	Rear water wall Panels	Total Replacement up to **FL+25,400**	
	Right side wall (B) Panels	Total Replacement	Including inlet headers
	Left side wall (A) Panels	Total Replacement	Including inlet headers
	Front Hopper Panels	Total Replacement	Including inlet headers
	Rear Hopper Panels	Total Replacement	Including inlet headers
	1ry SH Support Tubes	Total Replacement (36pieces)	**This item included in the long lead items**
3	Low temperature RH coils	The replacement is subjected to the result of the sample tube analysis	
7	Phosphate distribution Pipe in Steam Drum	Total Replacement from pump discharge to the end of distribution pipe in the steam drum	**This item included in the long lead items**
8	Hydro-clone in steam Drum	Supply four hydro-clones	**This item included in the long lead items**
9	Forced Draft Fan	Replace four bearing housing and bearings. (Note: Fan bearing TIS are included in the Stage 1contract) Replace four inlet vane control mechanism	**This item included in the long lead items** Bearing housing to be water-cooled type
10	Gas Recirculation Fan	Supply four Fan bearing housing and bearings. (Note: Fan bearing TIS are included in the Stage 1contract) Replace four shaft seals.	**These items included in the long lead items** GRF shaft seals are included in Stage1 contract Bearing housing to be water-cooled type
11	Regenerative Air Heater	Supply a main reduction gear, two lubrication oil pumps Replace two reducer gear for AH soot blower	**These items included in the long lead Items.** Low temperature element and seal plates are included in the stage-1 contract.
12	Steam Coil Air Heater	Replace two drain pumps with motor.	
14	Chemical Injection Pumps and control Panel	Replace seven level switches (LSL163AA, LSL163A, LSLL163A, LSL163B, LSLL163B, LSL163C, LSLL163C)	(All pumps with motor were included in Stage 1 contract)

Ministry of Electricity Republic of Iraq
Al Mussaib Thermal Power Station

15 October 2005

RECOMMENDED REPLACEMENT PART/ EQUIPMENT

Table 4-2-2

No.	Equipment. Parts	Unit-1 Boiler	Remarks
15	Safety Valve	Supply a set of lapping tool for various kind of safety valves and a set of compound powder	**This item included in the long lead items**
	Drum Safety Valve	Four safety valves are to be replaced (PSV101AA, AB,BA and BB)	**This item included in the long lead items**
	SH Safety Valve	PSV126B and ERV (PSV126A) together with controller are to be replaced	**This item included in the long lead items**
	RH Safety Valve	**No replacement**	
	Auxiliary Steam Safety Valves	Soot blower safety valve(PSV11A) and a Auxiliary steam safety valve(PSV161B - 150mm) to be replaced.	**This item included in the long lead items**
16	Motorized Valves	①Soot blower steam stop valve(M.128.105),Soot blower drain trap by-pass valve(M128.106) and 1ry SH outlet Auxiliary steam stop valve(M.128.161B) are to be replaced. ②Replace Drum vent valve(M.128.107) 1ry SH vent valve(M.128.113), 2ry SH vent valve (M.128.114),Cold reheat pipe drain valve(M128.8), Auxiliary steam Isolation Valve from CRP (M.128.97) and SAH heating steam from CRP (M.128.100) ③Replace gland packing of SAH heating steam Valve from Aux. Steam header (M.128.101)	**Item ① included in the long lead items**
	Motorized Drain Valve	Replace 9 complete drain valves as follows; Down comer drain valves A, B(M128.108A,B), Continuous blow valve & Emergency blow valve(M128.109A,B),1ry SH inlet & outlet drain valves(M128.110,111), 2ry SH outlet drain valve(M128.112), MSP drain valves A, B(M128.2A,2B),	**This item included in the long lead items**
17	General valves High Pressure Drain Valve	①Replace 9 complete drain valves as follows; Down comer drain valves A, B(65W27316A,B), Continuous blow valve, Emergency blow valve(65W16316S), 1ry SH inlet(80W27316) & outlet drain valves(50x27400),2ry SH outlet drain valve(80W29515), MSP drain valves A, B (65W27515) ②1ry SH outlet Aux. steam pressure control valve By-pass valve(80x27316) and Eco. inlet check valve(350A) ③Supply 381 sets of gland packing & seal ring or gasket as per valve list(KU3-450-982 to 991)	**Items ①, ② included in the long lead items**
19-1	Local instruments (PG,TG)	No supply	81 pressure gauges are included in Stage 1 contract
19-2	Switches(PS,TS,LS)	①Replace six draft switches (PS-109A,B,C, PDSL110A,B PDSH110A) ②Replace 20 pressure switches (PSL-111A, PSL-116A,B,C, PSH-116A, PSH-112A, PSLL-112A,B, PSLL-112C, PSL-110J, K, PSL-114AA,AB,AC,PSH-114AA, PSL-114BA, PSH-114BA, PSH-110A, PSH-114AB, PSLL-110A,) ③Replace five differential switches (PDSH-116A, PDSH-114AA,BA, PDSH-115A, PDSH-113A) ④Replace four Temperature switches (TSH-108AA,AB,BA,BB) for AH lubrication oil temperature ⑤Replace one pressure transmitter (PT-116B) for fuel oil header pressure	

RECOMMENDED REPLACEMENT PART/ EQUIPMENT

Table 4-2-3

No.	Equipment. Parts	Unit-1 Boiler	Remarks
19-3	Control drive, On-Off drive with accessories	Replace all control drives and power cylinders for Air and Gas system ①FDF inlet control drive (FZ-106AB), GRF inlet control drive(FZ-109AA,BA), SAH inlet control Drive (FZ108AA,BA), Wind box inlet control drive(FZ-106AA to DB), ②Remote shut off damper drives(Q250x565S-7pcs, Q160x369S-4pcs, Q50x360-2pcs)	**This Item included in the long lead items**
19-4	Control valve with accessories	Replace ten local control valves (TV-102A & B, TV-103A, PV-111A, PV-161A & B, PV-107A, LV-107A & B, TV-064A) and RH spray shut off valve (FSV-103A)	
19-5	Controller	No supply	Seven controllers are included in stage 1 contract
19-6	Burner Air Cylinders	Replace all burner air cylinders as follows ①Main burner Cylinder (16pcs) ②Oil lighter Cylinder (16pcs) ③Igniter Cylinder (16pcs) ④Air register air cylinder (16pcs) ⑤Speed controller for air cylinders (128pcs) ⑥Oiller for burner cylinders (80pcs)	
19-7	Limit switches	①Replace 16pcs of limit switches for control valves (Type:DTF2-2RN2-J) ②Supply 108pcs of type VCX5101H	100pcs of VCX-5101 and 100pcs of VCX-5103 are included in Stage-1 contract.
19-7	Solenoid valves	①No supply for burners ②Replace following solenoid valve Type 831655(1pc), Type 8321A5(1pc), Type HT8320A108 (6pcs), Type 8321A5(2pcs), Type 8211D4(2pcs), Type MVS803 (13pcs), Type MVD803 (5pcs)	96 single solenoid valves and 76 double solenoid valve are included in the stage-1 contract for start up burners.
21	Burner pulse Igniter	Replace16 sets of ignition system completely(Transformer、Cable、Plug、and Stick)	16 Transformers are included in Stage-1 contract
22	Burner Burner Management System	①Replace 16 burner guns ②Supply 300% of Cap nut, Joint washer, Sprayer plate, Gland Packing, impeller and flexible hoses for oil and steam ③Replace 16 pilot burners ④Replace Burner Management System	②100% of cap nut ,sprayer plate and joint washers are included in Stage-1 contract.
23	Pressure Taps	Replace 8sets of pressure taps and impulse piping for Air Foils	
24	Duct Expansion	Replace G7 and G8 expansion joints at AH outlet gas duct	GRF outlet duct expansion joints are included in Stage-1 contract

RECOMMENDED REPLACEMENT PART/ EQUIPMENT

Table 4-2-4

No.	Equipment. Parts	Unit-1 Boiler	Remarks
25	Cold Reheat Pipe Supports	①Support Supply three SH & SA, seven CH, two HS, and one RH。 ②Structures and beams Supply steel structure and beams as indicated in the drawings (KU3-525-679 to 682, KU3-524- 711 to 716, KU3-527-244 and KU3-524-069 to 072)	
		③Supply following H-steels(12m) A piece of H200x200x8/12 A piece of H150x150x7/10 Two pieces of H350x175x7/11 A piece of H400x200x8/13 A piece of H390x300x10/16 A piece of H500x200x10/16 A piece of H300x300x10/15	
26	Drum Level Gauges	Supply a Two color type and two remote type level gauges	
28	Flame Detector	Replace 16 Main burner flame sensors and amplifiers. Replace 16 pilot burner flame sensors and amplifiers.	
29	Boiler Chemical Cleaning Apparatus	Supply boiler chemical cleaning apparatus indicating in the engineering sheet BE-XMU-K-59, KU3-515-024revB and a set of drum level monitor consist of camera and receiver.	
30	Boiler Outer Claddings	Supply a set of boiler outer claddings and deck plates for one boiler	
31	Boiler Insulation Materials	Supply a set of insulation materials for one boiler	
32	Gas Duct Material	Supply a set of corrosion resistance carbon steels for AH out let gas duct to stack	
33	Steam Drum Cyclone Separator	Supply 100 pieces Cyclone separator for one boiler	**This item included in the long lead items**
34	Oil Burner & Pilot Burner Interlock valves	Supply all pneumatic burner inlet valves, purge valves and Oillers ①Burner fuel oil valve (FSV-116AAA to DDA 16pcs) ②Burner purge valve (FSV-112AAB to DDB 16 pcs) ③Burner atomizing steam valve (FSV-112AAA to DDA 16pcs) ④Burner start up oil valve (FSV-114AAC to ADB 8pcs) ⑤Oil igniter valve (FSV-114AAA to DDA 16pcs) ⑥Oil igniter drain valve (FSV-114AAB to DDB 16 pcs) ⑦oil igniter purge valve (FSV-110AAA to DDA 16pcs)	
35	Washing water system	Replace a Washing pump (without motor), a Chemical pump(without motor), four AH washing nozzles, a Tank mixer, a Mixing heater and a temperature controller(TIC064A) Replace three level switches (LSL-064A, LSLL-064B,LSLL-064A)	
13	Thermo-prove	Replace a complete thermo-prove	

8 ANNEX 2: PROJECT PROFILE

8.1 Project Background

During 1997-2003 UN Iraq Programme, in the centre and south of Iraq, the UN observation team based in Baghdad, comprising 13 international electricity sector specialist observers from UNDP and other agencies (plus Iraqi technical and support staff) regularly inspected the overall electric system of Iraq as part of the monitoring and verification role of the Iraqi Programme. During the last two years prior to the war, some 400 visits of Iraq's facilities (including 22 power stations, 7 power-plant construction sites, transmission lines, substations, 15 distribution centres, 4 power-related manufacturing industries, and a number of warehouses for electric goods) were conducted. These activities generated a significant database on the electricity sector infrastructure, its operating track record and principal assets. In addition, the UN team acquired in-depth knowledge on the condition of the physical assets and became well acquainted with the staff responsible for the planning, development, operation and maintenance of these assets.

In the three northern Iraqi governorates, UNDP administered and implemented major infrastructure rehabilitation projects (totaling $700 million) through the Electricity Network Rehabilitation Programme (ENRP). A comprehensive project team was assembled to investigate, plan and implement works to rehabilitate the electricity network. UNDP developed extensive experience in the management and execution of complex engineering projects through its work on the ENRP where its team of 300 national and 70 international employees worked with a local workforce of around 3000.

b. Post war involvement of UNDP in the electricity sector

Following the requirements of Security Council resolutions, UNDP was assigned the lead role in the post-war processing of contracts for the electricity sector of Iraq and, during its tenure successfully processed over $ 1 billion worth of equipment and goods for the electricity sector. In the technical area, UNDP played a key role in the electricity sector Needs Assessment and is currently undertaking the following activities in consultation and collaboration with Iraqi national authorities including the MoE:

- Programs of emergency repairs, replacement and additions to Iraq's basic services including systems for the supply of power to satisfy basic humanitarian and developmental needs in Iraq. This followed the deployment of the United Nations/World Bank rapid assessment teams to determine the specific post-war needs.
- Assistance in the development of a Master Plan for the electrical sector to guide the rehabilitation, strengthening and growth of the network to satisfy electricity demand in the future.

- Rehabilitation of the National Dispatch Centre (i.e. Central Operation Control facility) of the Ministry of Electricity to manage the power system stability and control the power flow in the grid.
- Programs to increase power generation capacity by rehabilitating facilities such as Hartha, Taji, Mosul and Mussaib power stations.

8.2 Project Justification

Currently the electricity supply in the country is adversely affected due to the shortage of generation, limited capacity of damaged transmission lines, and inefficiency of partly obsolete and partly worn out distribution systems. The biggest deficit of the energy occurs in the central part of the country and in the Baghdad area in particular. The central region usually draws power at levels of 900 – 1200 MW from other parts of the country. Due to their size and importance for the Iraqi grid thermal plants are the backbone of generation and thus will help secure long-term operational sustainability. The implementation of Stage I of this project will add needed capacity to the grid.
Completion of the rehabilitation program, including Stages I and II, will maintain the increment of added capacity to the grid for years into the future. The rehabilitation of the Mussaib power plant will satisfy the following needs:

- The project will contribute to the recovery of generation output that is urgently needed, as assessed by numerous reports (World Bank, AID, CPA, UNDP, etc). Unit 1 will be generating more reliable output, as a result of Stage I. This more safer power will help meet the severe need for power observed at times of peak demand. Stage II of this project will firm up the reliability in the supply of this increment of power to users for years into the future.
- Improvement of the electricity situation in Central Iraq as well as increased reliability and generating capacity of the Mussaib Power Plant is part of the UN Strategy for Assistance to Iraq – 2004 (see page 49 of the UN Strategic Plan, IFFI Meeting in Abu Dhabi, 28 February, 2004).
- Without the rehabilitation work (e.g. continuation of Unit operation with inoperative or malfunctioning sensors), the deterioration of Unit 1 will not be arrested and may result in long-term damage of other operating components of the unit in addition to operational outages at anytime. The rehabilitation will bring an extension of the Remaining Useful Life (RUL) of deteriorated components of Unit 1, in particular the boiler, which will be rehabilitated in Stage II. This will contribute to system reliability and assist MoE in meeting the middle to longer-term electricity demand of the nation.
- The project is helping in capacity building of Iraqi engineers in thermal power plant unit condition assessment and maintenance skills. The on-the-job training will acquaint the appropriate plant staff with the latest technology in assessments of equipment condition (RUL) and rehabilitation procedures.