



COMPLETION REPORT FOR PROJECT:

Summary

Participating UN Organisation:

United Nations Development Programme

Cluster:

E – Infrastructure Rehabilitation

Project No. and Project Title:

Project No. E4-10 - 41699
Rehabilitation of Unit 1 of Mussaib TPS – Stage I

Project Location/Region/Province:

Mussaib District, Babil Governorate, Iraq

Reporting Period:

22 Nov. 2004 – Dec. 2006

Report no:

Final (7)

Counterpart organisations / implementing partners:

Client Counterparts: Ministry of Electricity (MoE), Baghdad; General Directorate for Electricity Production (GDEP) – Euphrates Region, Hilla; Mussaib Generating Station

Implementing Partners: Hitachi Ltd. (Japan), Babcock-Hitachi KK (Japan), Hyundai Engineering & Construction Co. (Korea).

Project cost:

\$15,510,982

Abbreviations and acronyms:**Project Duration:**

24 months
(22 Nov. 2004 – Dec. 2006 - Latest equipment delivery to site is in Nov. 2006)

I. Purpose

Main objectives and outcomes expected as per approved Project/Programme document:

Development Goal

Ensure the supply of reliable and safe electricity to Central Iraq to permit operation of essential humanitarian services

Immediate Objectives:

1. The generating capacity, availability, reliability and efficiency of Mussaib Thermal Power Station (Unit No.1) increased.
2. Parts, materials and components, dedicated to future maintenance and repairs, received or targeted for Stage II procurement.
3. Plant operations and maintenance management and staff able to conduct condition assessment of thermal power generating units, and to maintain MoE thermal units in accordance with international standards.

Output 1:

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

Output 2:

Comprehensive set of selected and essential spare parts supplied to Mussaib TPS, which will be available in stock for emergency repairs and routine maintenance – in order to maintain Unit 1 future generation reliability.

Output 3:

Core Team of plant staff proficient in thermal unit condition assessments and able, in turn, to train other junior technical personnel (engineers and technicians) to enlarge MoE in-house capabilities to conduct unit condition assessment.

Reference to how the programme/project relates to the UN Assistance Strategy to Iraq 2006 - 2008 and how it aims to support international and national development goals (revised National Development Strategy Dead Sea July 2005) including the Millennium Development Goals and other goals as pertinent:

The project is in line with the UNDP Needs Assessment Report of October 2003.

The project is within the list of 727 projects presented by Iraqi Authorities in Abu Dhabi in 2003.

Project Stages I & II approved by Iraq's Ministry of Electricity on 22 Nov. '04

Improvement of the electricity situation in Central Iraq and increased reliability of Mussaib Station is part of the UN Strategy for Assistance to Iraq in 2004/05

Project addresses the Millennium Development Goals

Project Management arrangements

- **Programme/project implementation and supervision arrangements; indicate in-country and region based capacity of organisation utilised ;**

Due to the prevailing security situation and restrictions placed on the movement of UN staff over the majority of Iraq, local contractors, team of engineers and architects was chosen to implement the project

The implementation works were monitored regularly. This ensured that the sub-contractors for various technical works comply with the scope, work plan and Bill of Quantities as contracted.

In addition, UNDP's technical team were fully engaged in advising and guiding the contractors

throughout the implementation phase. The implementing agents were paid by UNDP in arrears based on predetermined milestones, which were independently verified by UNDP's Consultant upon receipt of payment request invoices from the contractor. Payments were subject to the progress of works and the submission of all supporting documentation by the contractor and independent consultants including monthly progress reports, before, during and after with photographs of the works and on-site cameras, etc.

- **Main international and national implementing partners involved, their specific roles and responsibilities in project implementation and their interaction with the agency;**

International: Hitachi Ltd, Japan (main contractor to UNDP and supplier of I&C equipment), Babcock-Hitachi KK, Japan (supplier of boiler equipment), Hyundai Egg. & Construction Co, Korea (procurement of equipment for Balance of Plant & Common Facilities).

National (Iraqi): MoE Unit 1 Assessment Team (preparation of boiler for inspection and assessment tasks addressing all of Unit 1 as well as overall plant equipment affecting Unit 1), Al-Rook Co. (boiler inspection and condition assessment). Both are contractors to Hitachi Ltd.

Satellite-based Telecom Systems Design/Supplier: Mitsa Co., Cyprus (supplier of telecom systems for videoconferencing and equipment examination via mobile camera to observe plant equipment from outside Iraq during its assessment / rehabilitation and to communicate with Mussaib Station).

Adaptation to Local Security Conditions in Iraq: Use of an Audio/Video/Telecom (AVT) satellite-linked system to communicate lives with Mussaib Station staff and observe condition of equipment. The AVT system together with training of Iraqi specialists and periodic meetings in Amman & Cyprus is designed to eliminate the need of having international staff inside Iraq.

- **Indicate extent of cooperation with relevant line ministry**
UNDP designed project with MoE involvement in the earliest stages.

- **Specific delivery mechanisms utilised**

The project was delivered through a DEX modality, and specific tasks were implemented by contractors selected through a bidding process. (See above for details.)

- **Indicate intra cluster cooperation and goods/services other agencies supplied/ common services utilised;**

Intra-cluster cooperation was used during the design of the project within Cluster E. For implementation however, there was no significant inter-agency collaboration to in this specialized area (power generation equipment rehabilitation)

- **Details on arrangements for procuring and transporting programme/project inputs, to ensure local appropriateness and acceptability, as well as security and value-for-money under the circumstances – attach as annex 3 final list of contracts awarded;**

The procurement method used was international competitive bidding. The tenders were managed by UNDP-Iraq's very experienced procurement office, which demonstrated performance over the last few years and is a major asset on which this project has already built on and from which it benefited. In case too few competitors respond or are eligible for the task at hand, waiver may be sought to contract without competitive bidding.

- **Systems for programme/project monitoring (including financial tracking and accounting audit), quality control (including lesson learning, and corrections), and impact assessment; methods for data collection and monitoring**

II. Resources

Total approved budget and summary of resources used for the programme/project from the UNDG Iraq Trust Fund and non-Trust Fund resources where applicable:

See detailed financial report in annex 2

III. Results

An assessment of the extent to which the programme/project component / programme/project is progressing in relation to the outcomes and outputs expected:

Improved Generation: Improved electricity delivery in terms of stability of Mussaib unit 1. Enhanced power generation is expected at the completion of the rehabilitation works and in particular during the 2008 peak electricity demand season (Summer) in Iraq.

Supply of Equipment: equipment delivery milestones for 2005/06 (4 shipments in excess of 82 tons) were met. Thorough assessment of Unit 1 during an unscheduled shutdown (cold assessment) and while in operation (hot assessment) to identify equipment requiring rehabilitation or replacement (to be implemented in Stage II of the project) completed.

Capacity development: High impact (21 Iraqi specialists were trained in thermal unit operation, maintenance and particularly in techniques for technical assessments in Japan & Korea; 4 Iraqi staff were trained on AVT system assembly and operation). Asset Management and Inventory control is yet another area in which the Iraq engineers / persons working in Stores and operation are being exposed to latest techniques as guided by UNDP.

See detailed logical framework analysis in annex 1

Main activities undertaken and achievements/impact:

Equipment supply and Assets management

-- A contract between UNDP and Hitachi was executed on 11 May '05 for the provision of goods and services under Stage I. The contract encompasses the supply of equipment (in particular pressure parts components for the boiler and delivery of equipment to the site). The services component of the contract includes training of MoE staff, monitoring of the Unit 1 assessment work by Hitachi/Hyundai specialists temporarily based in Amman, plus non destructive examination of plant components and other site services

-- Project kick-off and team organizational meetings were held in Amman with participation by Mussaib Power Station, GDEP/Euphrates, MoE/Baghdad, Hitachi, Hyundai, Al-Rook and UNDP. The project Stage I schedule, tasks and plans for deployment or resources were reviewed in detail. Initial plans for the project Stage II were also discussed.

-- A Japanese agent (OMIC PMD JP) was contracted on 20 October '05 to conduct Pre-Shipment Inspection of power plant equipment being shipped by Hitachi to MoE under the UNDP project. Pre-Shipment Inspection of equipment being sent by Hitachi as Lots # 1 and 3 took place at Kure and Omika Works and Kobe Port (Japan) on October/November '05 and January '06. Shipment #1 comprising some 7 containers plus 3 boxes arrived at Mussaib Station 28 Dec '05.

-- The combined shipment #2 & #3 reached Al-Mussaib Station on 15 March. The convoy had suffered an attack shortly after the Iraqi border. Although one vehicle was damaged and had to be replaced, there was no damage to the shipment. Payment on receipt of shipping documents was released as per contract.

-- Detailed inspection and inventory of the equipment of lot 1, 2, 3 and 4 took place at Mussaib as per guidelines provided by UNDP

Capacity Building

-- A group of 21 staff from MoE received 3-week training in Japan and Korea on unit condition assessment, improved maintenance practices and enhanced thermal unit operation. The training was conducted at Hitachi Kure Works (topics related to mechanical systems of steam units), Hitachi Omika Works (topics related electronic components of Instrumentation & Controls of steam units), Korea Power Learning Institute (Simulator training on boiler start-up, turbine engagement, synchronizing to grid, etc). In addition, they visited the Pyungtaek TPS (Korean Station similar to Mussaib) and received training on water treatment, T/G maintenance and Non-destructive evaluation testing.

-- A team of four staff from MoE attended training in Amman on the satellite-linked audio/video/teleconferencing system (AVT system) deployed at the Station for monitoring the assessment and rehabilitation works. The training was provided by MITSA International, the supplier of the AVT system.

Assessments

-- Cold assessment of Unit 1 (examination of equipment with unit on outage) started on 15 August '05 as a result of Unit 1 unexpected outage (due to turbine malfunction) and lasted two weeks. MoE stated that some 200 MoE staff and Iraqi contractors were involved in work at assessment peak time. Hot assessment of Unit 1 (calibration of operational data while unit is operating) was conducted on 14 September '05. The outstanding cold assessment tasks (remaining from the cold assessment period with the unit at standstill) were completed with the unit back in operation. The comprehensive Cold and Hot Assessment tasks amount to the first detailed assessment of Unit 1 condition since its construction in 1987.

-- Unit 1 overall assessment results were reviewed with MoE, Hitachi/Hyundai in Amman on 25-29 Sept. '05. The comprehensive technical data (gathered at the Station via data collection forms or observation sheets as brief field data/reports) plus equipment pictures obtained during the Cold Assessment -- all e-mailed to the contractor, were reviewed by Hitachi/Hyundai, MoE and UNDP specialists. An Interim Assessment Report was generated on this basis.

-- The Unit 1 assessment data obtained in August '05 and reviewed at the September '05 meeting included a large amount of data and constitutes a unique technical database for Unit 1: Boiler (over 130 field inspection data sheets & 366 pictures) , Instrumentation & Controls (9 field data sheets), Balance of Plant (92 reports on major equipment & 71 pictures), Electrical System (14 field data sheets & 18 pictures), and Common Facilities (195 reports on equipment/systems & 71 pictures).

Implementation constraints, lessons learned from addressing these and knowledge gained from assessments, evaluations and studies that have taken place during the project:

Constraints:

- (1) Difficulties in getting access to the unit for cold assessment (i.e. condition assessment while the unit is not operating). This was due to the shifting of target dates for access to the unit because of the need to operate the unit whenever possible. Mussaib Unit 1 (currently operating at 200-220 MW) represents roughly 4.5 % of the estimated available capacity in Iraq of 4500 MW). This resulted in having to adopt a more flexible approach in our planning and implementation of the project.
- (2) Difficulties in implementing inspection of Shipment # 1 at the Station for MoE issuance of an Acceptance Report. This resulted in the UNDP plan to use the AVT mobile camera for future inspection (jointly with MoE staff) of shipments that have arrived at the Station.
- (3) Difficulties in entering shipments into Iraq because of security conditions

Lessons Learned: Improve availability of spare parts to be used during equipment assessment
Explore other routes of transport which could be safer, keeping in view the past experience.
Although the equipment of lot 4 has to be stored in Kuwait for about one month, as security clearance on route to Mussaib was not accorded by the survey team of the transport company, the equipment finally arrived at the destination safely.

Key partnerships and inter-agency collaboration, impact on results:

Intra-cluster cooperation was used during the design of the project within Cluster E. For implementation however, there was no significant inter-agency collaboration to in this specialized area (power generation equipment rehabilitation)

Highlights and cross cutting issues pertinent to the results on, e.g., Gender desegregation, policy engagement and participation of the public:

Employment creation during the assessment and rehabilitation periods and policy dialogue constitute a cross-cutting benefit of the project.

Policy dialogue: High-impact continuous dialogue on project issues with senior management at MoE, GDEP and Mussaib Station during Stage I project planning and unit assessment was achieved.

Employment creation: Temporary impact during unit assessment activities (3 from Al-Rook and 50 - 200 personnel from Mussaib Station over a period of 2-4 weeks).

IV. Follow up actions and sustainability

Priority actions that should be supported/implemented following completion of project to build on achievements and partnerships rectify shortcomings encountered and use the lessons learned during the project with strong emphasis on achieving sustainability of the outcomes:

The station management has started use of spare parts for routine and breakdown maintenance. The consumption of spare parts is being facilitated by the forms provided by UNDP, ensuring straightforward impact monitoring.

Unit assessment information obtained in Stage I for decisions on equipment priorities for Unit 1 within the price negotiations with the main contractor (Hitachi) for Stage II of the project (including the supply of equipment with long-lead and short-lead delivery periods as well as for services for the installation of the equipment).

Stage 2 (ongoing) is a critical follow up activity to Stage 1 and will bring most obvious power generation benefits

Indication of major adjustments in the strategies, targets or key outcomes and outputs:

None

Estimated Budget required (Budget required for any necessary follow up action):

No funding shortfalls based on the original scope of the project have been experienced.
If confirmed by the accounting department, the slight overspending will be covered by UNDP.

Annex 1 Key Performance Indicators – Log Frame Matrix

Objectives	Measurable indicators	Means of verification	Outcomes
<p>Development Objective</p> <p>To respond to the humanitarian needs of war-affected Iraqi people through ensuring reliable and safe electricity supply to permit the operation of essential humanitarian services and addressing human development priorities, and daily needs.</p>	<p>Availability of a reliable and secure electricity supply to all consumer categories but especially for essential humanitarian needs and community services that impact the quality of daily life.</p>	<p>Monitoring decrease of power shortages to gauge improvement in wellbeing and economic development of people in Iraq attributable to the increment of power from Unit 1 rehabilitation.</p>	<p>Due to failure of pipelines, power stations transmission lines, the overall availability of power in Iraq has decreased. However, successful operations such as this project's assessments and supply of spare parts, the life of generation assets is being extended and contributes to mitigating failures elsewhere.</p> <p>Unit 1 at Mussaib will contribute increased power to the grid only after end of phase 2 of the the rehabilitation.</p>
<p>Immediate Objectives:</p> <p>1. The generating capacity, availability, reliability and efficiency of Mussaib Thermal Power Station (Unit No.1) increased.</p> <p>2. Root causes that are resulting in Unit 1 running under operational stress (e.g. inoperative sensors) identified and corrected or targeted to be addressed in Stage II.</p> <p>3. Parts, materials and components, dedicated to future maintenance and repairs received or targeted for Stage II procurement.</p> <p>4. Plant operations and maintenance management and staff able to conduct condition assessment of thermal power generating units, and to maintain MoE thermal units in accordance with international</p>	<p>1. Energy recording instruments indicating an increase of generation output from Unit 1 after its rehabilitation. Generating unit performance monitoring data indicating improvement in selected parameters.</p> <p>2. Post-rehabilitation assessment of monitoring instrumentation and sensors found to be not operating or malfunctioning that were repaired or replaced.</p> <p>3. Parts, materials and components required for future maintenance and emergency repairs procured in Stage I.</p> <p>4. Ability of the plant staff to undertake the condition assessment of a large thermal unit, its repair and maintenance works in accordance with</p>	<p>1. Verification of power output from Unit 1 made by Mussaib TPS and NDC (National Dispatch Center) staff in close cooperation with MoE and UNDP engineers, plus consultants and contractors.</p> <p>2. Post rehabilitation audit of inoperative or malfunctioning monitoring instrumentation and sensors found in Unit 1.</p> <p>3. Post rehabilitation audit of goods received in Stage I targeted for use in future maintenance and repairs.</p> <p>4. Assessment by UNDP engineers and contractor specialists on the level of skills acquired by MoE staff for thermal unit condition</p>	<p>Availability and stability of Unit 1. has increased. Full results on power output and complete measurements will be realized with the implementation of Stage II</p> <p>The hot and cold assessments have provided the information necessary for full diagnosis.</p> <p>All spare parts under phase I have been delivered. Inventory is monitored regularly and spare consumption is expected to reach [TBA]% in [TBA].</p> <p>MoE management understood the possibility to run Assessments in other Power stations or units whilst relying on the skills and the knowledge of the engineers that have undergone the specific training und</p>

Objectives	Measurable indicators	Means of verification	Outcomes
<p>standards.</p> <p>5. Core team of plant engineers specialized in the practices to ascertain detailed condition assessment of thermal units and application of the latest instrumentation and techniques for diagnosis of remaining useful life of thermal-unit components subjected to cyclic pressure.</p>	<p>standard utility practices and approved work plans</p> <p>5. Core team of plant engineers qualified in unit condition assessment able to train other engineers to conduct condition assessment.</p>	<p>assessment.</p> <p>5. Assessment by UNDP engineers on the level of skills acquired by MoE staff for training MoE engineers on thermal unit maintenance and condition assessment</p>	<p>performed the Assessment of unit 1.</p> <p>UNDP selected 21 engineers out of 25 candidates submitted by MoE. These engineers had the required expertise and experience to be sent for the training and to transmit the acquired knowledge to junior engineers.</p>
<p>Outputs :</p> <p>1. Unit 1 of Mussaib Thermal Power Station rehabilitated and demonstrating increased generating capacity.</p> <p>2. Observation and test data collected from Unit 1 suited for root-cause problem identification related to inadequate monitoring of Unit operational parameters.</p> <p>3. Comprehensive set of selected and essential spare parts supplied to Mussaib TPS, which will be available in stock for emergency repairs and routine maintenance – in order to maintain Unit 1 future generation reliability.</p> <p>4. Twenty (21) plant staff trained in operation and</p>	<p>1. Use of energy Output Recording instrumentation to measure generation from Unit 1 after its rehabilitation. Unit performance monitoring data to assess improvement in selected production parameters.</p> <p>2. Inventory of monitoring instrumentation and sensors in Unit 1 found to be not operating or malfunctioning that were repaired or replaced.</p> <p>3. Warehouse inventories of spare parts delivered in Stage I or targeted for procurement in Stage II.</p> <p>4. Ability of staff to undertake the</p>	<p>1. Improved production and performance from Unit I.</p> <p>2. Number of inoperative instrumentation and sensors repaired or replaced in Stage I.</p> <p>3. Inventory of goods for future maintenance/repairs received in Stage I.</p> <p>4. Proficiency of plant staff trained in</p>	<p>The improvement of Unit 1 performance will only be fully realized and measurable after completion of stage II of this rehabilitation project.</p> <p>During the Assessment 244 Instruments and Sensors were identified being urgently to be replaced and an additional 257 need to be replaced as a next priority.</p> <p>The supplied Parts have been received in Mussaib Warehouse and Inventory lists been established.</p>

Objectives	Measurable indicators	Means of verification	Outcomes
<p>maintenance of thermal units to achieve higher plant performance, reliability and availability.</p> <p>5. Core Team of plant staff proficient in thermal unit condition assessments and able, in turn, to train other junior technical personnel (engineers and technicians) to enlarge MoE in-house capabilities to conduct unit condition assessment.</p>	<p>condition assessment, repair and maintenance of thermal units in accordance with standard utility practices.</p> <p>5. Ability of Core Team dedicated to condition assessment and resources made available by project (e.g. instrumentation) suited to training future specialists in unit condition assessment</p>	<p>operation and maintenance</p> <p>5. Proficiency of plant staff trained in condition assessment</p>	<p>The engineers have undergone a refreshment training on operational issues and a training on recent maintenance techniques</p> <p>The trainees (especially those who were involved in the site Assessment) feel now familiar with the procedures and techniques. They feel confident to train junior personnel.</p>

Annex 2 PROJECT COSTS

CATEGORY	UNDG ITF approved budget	Actual COST	Percentage of Approved	Budget Revision approved (give date)	Percentage of revision
1. Personnel • including staff and consultants	\$336,000	\$369,144	109.86%		
2. Contracts • including companies, professional services, grants	\$14,050,000	\$801,727	5.71%		
3. Training	\$50,000	\$0	0.00%		
4. Transport		\$0			
5. Supplies and commodities		\$153,770	NA		
6. Equipment		\$13,278,702	NA		
7. Travel	\$100,000	\$117,787	117.79%		
8. Security	\$211,864	\$9,255	4.37%		
9. Miscellaneous	\$24,500	\$32,179	131.34%		
10. Agency Management Support	\$738,618	\$748,417	101.33%		
Total Expenditure	\$15,510,982	\$15,510,982	100.00%		

Annex 3 List of contract awards by procurement method

No	Contract description	Procurement Method	Contractor	Amount (US\$)
1	Supply and on site delivery of selected Equipments and Parts, Supply of Training for 21 engineers, Technical Assessment	International Competitive Bidding	Hitachi Ltd, Tokyo	13,313,493.00
2	Pre-Shipment Inspection of four shipments in Japan	Same	OMIKA Ltd, Tokyo	
3	International consultant for Assistance in	Same	Sinclair Knight and Merz, London	92,526.80
4	Supply and commission a VSAT system	Same	MITSA Ltd, Cyprus	233,212.44
5	Supply of an Endoscope	Same	Storz - GmbH, Germany	28,300.00
6	Supply of a Boiler Pressure Test Pump	Same	TCEM - SARL, France	10,323.00
7	Supply of Vibration analyzers	Same	Schenck RoTec -GmbH, Germany	28,299.00