

DOURA POWER STATION
UNITS 5 AND 6
BAGHDAD, IRAQ

SUSTAINMENT ASSESSMENT

SIGIR PA-07-103
JULY 18, 2007



SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION

July 18, 2007

MEMORANDUM FOR COMMANDER, JOINT CONTRACTING COMMAND-
IRAQ/AFGHANISTAN
COMMANDER, GULF REGION DIVISION-PROJECT AND
CONTRACTING OFFICE, U.S. ARMY CORPS OF
ENGINEERS
DIRECTOR, IRAQ TRANSITION ASSISTANCE OFFICE
MISSION DIRECTOR-IRAQ, U.S. AGENCY FOR
INTERNATIONAL DEVELOPMENT

SUBJECT: Report on Sustainment Assessment of Doura Power Station Units 5 and 6,
Baghdad, Iraq (Report Number SIGIR PA-07-103)

The Office of the Special Inspector General for Iraq Reconstruction is conducting a series of assessments to evaluate the current condition of completed projects subsequent to their transition to the Government of Iraq to determine whether the projects are likely to remain operational.

We are providing this report for your information and use. It addresses the current status of Doura Power Station Units 5 and 6, Baghdad, Iraq, and the likelihood of whether the power station units will remain operational after scheduled start-up in the near future. The assessment was made to provide you and other interested parties with real-time information in order to enable appropriate action to be taken, if warranted.

Although this report does contain negative findings, we did not include any recommendations for corrective action because plans to restart Units 5 and 6 and continue an operations and maintenance program targeted at mentoring and working with the Ministry of Electricity seem practical and well-fitted for the case at hand. Accordingly, management comments were not requested.

We appreciate the courtesies extended to our staff. If you have any questions, please contact Mr. Brian Flynn at brian.flynn@iraq.centcom.mil or at DSN 318-343-9244. For public or congressional queries concerning this report, please contact SIGIR Congressional and Public Affairs at publicaffairs@sigir.mil or at (703) 428-1100.

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Special Inspector General for Iraq Reconstruction

SIGIR PA-07-103

July 18, 2007

Doura Power Station Units 5 and 6 Baghdad, Iraq

Synopsis

Introduction. SIGIR initiated this project assessment as part of our continuing assessments of selected Iraq Relief and Reconstruction Fund reconstruction activities. The overall objective of this assessment was to determine whether the project was operating at the capacity stated in the original contract or task order objective. We conducted this limited scope assessment in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included an engineer/inspector and an auditor/inspector.

The objective of the initial task order for the Doura Power Station Units 5 and 6 required the contractor to fully rehabilitate two of the four steam turbines at the Doura Power Plant that had been poorly maintained and not used for several years prior to the overthrow of Saddam Hussein in 2003. Rated at 160 megawatts each, rehabilitating and sustaining Units 5 and 6 were critical parts of the United States government's overall effort to increase electricity production in Iraq.

Assessment Objectives. The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action to be taken, when warranted. To accomplish the overall objective, we determined whether the project was operating at full capacity when observed by Special Inspector General for Iraq Reconstruction inspectors on 10 June 2007 and whether sustainability for full-capacity operations was adequately planned and likely to continue.

Conclusions. United States government contractors had previously completed Statement of Work requirements to rehabilitate Doura Power Plant Units 5 and 6; however, neither unit was operational when we observed them on 10 June 2007 for reasons and subsequent events beyond the direct control of the United States government and its contractors. Specifically, operational control was under the authority of the Ministry of Electricity when Unit 5, commissioned in April 2006, experienced catastrophic failures in August 2006 and April 2007. Both times, Unit 5 shut down because of exciter flashover which was the result of repeated "hard tripping"¹ caused by power surges. However, most hard tripping could have been avoided if Ministry of Electricity operational procedures would have allowed plant operators to isolate the generator unit and protect it from frequent deterioration of the incoming 132-kilovolt line to the Doura switchyard. Unit 5 tripped approximately 100 times during the 12 months that preceded the final Unit 5 failure in April 2007.

At the time of our site visit, Unit 6 had not been operational since rehabilitation. This occurred primarily because in August 2006 the exciter was removed from Unit 6 as it neared operational status and was placed into Unit 5 to expedite restarting Unit 5 after its catastrophic failure. Prior to its failure in August 2006, Unit 5 had been operational for

¹ Tripping is the interruption or disconnection of an electrical circuit.

approximately 4 months. Ministry of Electricity officials decided to swap the exciter from Unit 6 to Unit 5 to minimize outage time and quickly restore electric power to the Baghdad grid. As a result, much-needed electricity was not available to the Baghdad grid. However, Doura Power Plant Unit 5 should be operational by mid-July 2007 and Unit 6 by early August 2007. The rehabilitation and start-up plans of the Gulf Region Division of the United States Army Corps of Engineers appeared on track as of 16 June 2007.

Sustainable operations at full capacity cannot be reasonably assured unless the Ministry of Electricity operation and maintenance practices change and improve. To date, the Ministry of Electricity has operated ineffectively and insufficiently maintained equipment. For example, the accumulation of simple dust and oil film in the rotor-end windings and rectifier wheel areas of the exciter facilitated a short circuit and flashover, which resulted in the complete failure of Unit 5 in April 2007. Based on our site inspection we concluded:

- a. The Ministry of Electricity should implement operational procedures to effectively manage power generation and distribution as an integrated activity. To prevent system-wide imbalance and deterioration of the incoming 132-kilovolt lines, the Ministry of Electricity should ensure that bypassing and intentional overriding of automatic controls throughout the generation and distribution systems are not allowed.
- b. A formal maintenance program should be implemented by the Ministry of Electricity that includes procedures to inspect equipment, schedule necessary non-emergency maintenance, and expedite critical repairs. In addition, the Ministry of Electricity should authorize plant-level managers and plant engineers to perform emergency maintenance or repairs to prevent large scale system failure.
- c. Ministry of Electricity officials should ensure that unauthorized tapping of electricity directly from the power plant is discontinued and all existing ad-hoc cable taps throughout the facility are removed as part of an overall program to manage and control electricity generation and distribution.

Recommendations and Management Comments. The Gulf Region Division's plans explained below should correct the deficiencies contained in this report. Specifically, the Gulf Region Division's plans to restart Units 5 and 6 and continue an operation and maintenance program targeted at mentoring and working with the Ministry of Electricity seem practical and well-fitted for the case at hand. Specific goals of the operation and maintenance contract to develop a local training program designed to provide classroom and on-the-job training for a large number of working level personnel and requirements to develop standard operating procedures for operators and maintainers should improve the effectiveness of the operations and maintenance program. Further, Provincial Reconstruction Team activities that focus on training mid-level government workers should reinforce the Gulf Region Division's plans. Accordingly, this report did not include any recommendations for corrective action and management comments were not requested. However, U.S. Army Corps of Engineers, Gulf Region Division, did review the draft and offered no additional information and had no comments.

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Introduction

Objective of the Project Assessment

The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action to be taken, when warranted. Specifically, we determined whether the completed project was operating at the capacity stated in the original contract or task order objective. To accomplish this, we determined if the project was at full capability or capacity when accepted by the U.S. government (USG), when it was transferred to Iraqi operators, and when observed by the Special Inspector General for Iraq Reconstruction (SIGIR) assessment team. In addition, we determined if sustainability for full capacity operations was adequately planned and likely to continue.

Background

Electricity is a critical component of the Iraqi economy because every job in every industry and the national capacity to produce oil is dependent upon electricity. A robust supply of electricity helps boost economic expansion.² Demand continues to outpace supply which has caused key reconstruction goals for Iraq's electricity sector not to be achieved. In 2004, the U.S. program goal to improve peak generation capacity to 6,000 megawatts (MW) per day by the end of June 2004 was established by the Coalition Provisional Authority (CPA). Peak generation capacity for 2006 averaged only 4,280 MW per day. In March 2006, the Department of State set a goal to achieve 12 hours of power per day nationwide as well as in Baghdad. The Government Accountability Office (GAO) reported that hours of power per day in 2006 averaged 11 nationwide and 5.9 in Baghdad. As of 28 February 2007, GAO reported the average hours of power nationwide and in Baghdad had declined to 8.6 and 5.1 respectively.³ Similarly, the Brookings Institute reported that as of 15 May 2007 average hours of power per day nationwide had risen to 10.9 while average hours of power per day in Baghdad had fallen to 5.6.

Short falls were not the result of the USG Electricity Sector reconstruction program. In April 2003, Congress created the first of two Iraq Relief and Reconstruction Funds (IRRF). For all practical purposes, IRRF was the primary source of Electricity Sector reconstruction funding. Specifically, Public Law (P.L.) 108-11 appropriated \$2.475 billion referred to as IRRF 1. In November 2003, P.L. 108-106 appropriated \$18.4 billion referred to as IRRF 2. While IRRF 1 was primarily managed by the United States Agency for International Development (USAID), the Department of Defense (DoD) was the primary manager of IRRF 2 funds. Electricity Sector apportionments of IRRF 1 and 2 appropriations exceeded \$4.5 billion. However, the estimated cost for electrical system rehabilitation and reconstruction, new investment, and operations and maintenance (O&M) for calendar years 2004 through 2007 was estimated to be approximately \$12.6 billion based on the United Nations/World Bank's "Joint Iraq Needs Assessment" dated October 2003. Based on the United States Department of Energy, Energy Information Administration, \$20 billion will be needed to meet Iraq's electrical capacity needs through 2010. Therefore, the \$4.5 billion apportioned via IRRF 1 and IRRF 2 was to jump start the system with an intent that the Government of Iraq would take over reconstruction efforts which included capital projects in addition to O&M. U.S. appropriations were never intended to meet all Iraqi needs.

² [The Electricity Sector Program](http://www.rebuilding-iraq.net) USACE PCO website www.rebuilding-iraq.net 22 May 2007.

³ United States Government Accountability Office Report, GAO-07-677, May 2007, pages 27 and 28.



DigitalGlobe 2007©

Aerial Image 1. Doura Power Plant

Looking towards the future, “...the United States Government’s success in rebuilding the infrastructure in Iraq will be measured in terms of whether the completed facilities function and produce the services as planned over the long term. To meet this need, the USG and the Government of Iraq have turned their focus towards Sustainability. Sustainability means that the Iraqis manage, operate, and maintain the new or refurbished facilities, systems, and equipment upon handover, without additional support from the USG or other coalition partners”. “Capacity Development (CD) is one of the pre-requisites for Sustainability and encompasses a wide range of activities that range from the highest level of Iraqi government structure and policy to training of operations and maintenance staff at a newly constructed facility. CD is one of the basic tools being used by the U.S. Army Corps of Engineers’ Gulf Region Division (GRD) to transfer knowledge, skills, and abilities to the Iraqi workers at various infrastructure facilities. This process is a critical step in preparing the Iraqis to assume control of completed infrastructure”⁴.

This assessment did not address the electric sector as a whole or all reconstruction activities applicable to the Doura Power Station (Aerial Image 1). Rather, this assessment addressed the current status and sustainability of Doura Units 5 and 6.

Previous Contracts

Key electricity sector projects throughout Iraq were included in basic contract EEE-C-00-03-00018-00 issued on 17 April 2003 by USAID and valued at \$1.03 billion (IRRF 1 authorization) with Bechtel National Inc., San Francisco, California. In addition, electricity sector reconstruction work continued via a second USAID basic contract SPU-C-00-04-00001-00 with Bechtel awarded on 4 January 2004 and valued at \$1.82 billion (IRRF 2 authorization). Job Orders (JO) approved and issued by the USG were used to carry out specific reconstruction activities. Among others, two JOs were particularly relevant to Doura Power Plant rehabilitation and long term operability. Specifically, JO-03-037-08 in the amount of \$90.8 million was approved and included provisions to rehabilitate Doura Power Plant Units 5 and 6. In addition, JO-04-503-03 in the amount of \$80 million was approved and included provisions to provide Ministry of Electricity (MOE) personnel O&M assistance and training.

Doura Power Plant Rehabilitation Units 5 & 6⁵ (JO-03-037): “Under this \$90.8 million project, Bechtel was tasked with the rehabilitation of two of the four steam turbines at the Doura Power Plant, one of the main power plants supplying electricity for the Baghdad area. Although the two turbines being rehabilitated had a designed output rating of 160 MW each, they had been poorly maintained and had not been in use for several years. Work under this project began on August 1, 2003 and was originally planned to be completed by April 30, 2004. The project’s completion date, however, has been amended several times to account for additional work determined to be necessary during the course of the project, resulting in an expanded scope of work. As of January 31, 2005, the approved project completion date was May 1, 2005—a year beyond the original completion date. Due to implementation delays, however, the project was not expected to be completed by

⁴ Capacity Development: Critical Infrastructure Sustainability, Iraq Reconstruction Report 30 Apr 2007, Assist. Sec. of the Army (ASA) for Acquisition, Logistics and Technology (ALT), www.rebuilding-iraq.net

⁵ Direct quote from USAID, AUDIT REPORT NO. E-267-05-003-P dated June 29, 2005

this date either or by the date the contract under which this project was funded was set to expire (June 30, 2005)”.

“One of the problems behind the delays has been the fact that this project was integrated with other projects and activities being carried out concurrently by the ME and another (non-USAID) contractor, with the latter two responsible for upgrading some of the many systems supporting the two turbines being rehabilitated. As a result, the completion of the project by Bechtel, which required that the rehabilitated turbines be placed back into operation, depended on both the ME and its contractor completing their respective areas of work. However, according to the Mission, the U.S Army Corps Of Engineers (USACE) and Bechtel staff, the ME has not been effectively managing and coordinating this process to ensure that the work on these other areas, to be carried out by either the ME staff or its contractor, was being completed in a timely manner. This, in turn, has hampered Bechtel’s efforts to complete its work.”

During our assessment we confirmed that GRD Electric Sector officials concurred with the above quote from USAID, Audit Report No. E-267-05-003-P, regarding rehabilitation of Doura Power Plant Units 5 and 6 via JO-03-037.

Power Plant Maintenance Program⁶ (JO-04-503): *“As part of this \$80 million project, Bechtel was providing approximately 60,000 hours of O&M technical and management training for 239 ME staff who were divided into tiers corresponding to their management level with (i) 5 senior ME staff receiving instruction in leadership and strategy at an industry training center in the U.S.; (ii) 36 plant managers receiving management training at a U.S. university; (iii) 83 senior power plant staff receiving train-the-trainer instruction in the area of combustion plant and thermal plant operations at a university in Jordan; and (iv) 115 plant operators and technicians receiving technical training, also in Jordan, covering different aspects of power plant operations, including safety, maintenance, instrument calibration and control systems. **The project also allocated funding to provide targeted O&M assistance to ME staff at the Doura Power Plant.** Under this activity, a resident technical support team was assigned to the plant to provide coaching, mentoring, on-the-job training and general operating support to plant staff to assist them in carrying out the necessary work to facilitate the startup of the two turbines at the plant currently being rehabilitated by Bechtel”.*

In its June 2005 report, USAID’s Office of the Inspector General summarized that:

*“USAID’s newly refurbished infrastructure in the electrical power sector is currently **at risk of sustaining damage as a result of improper O&M practices.** Based on reports of damage frequently occurring to existing (non-USAID) equipment—all resulting from poor O&M procedures—it is difficult to imagine that USAID’s infrastructure projects will be spared a similar fate after they are turned over to the ME. Unfortunately, the problems and challenges involved are numerous and complex and exist at both the power plant and the ministry level. And until these problems are effectively addressed and result in significant improvements in the O&M practices at the power plants, reports of damaged equipment and infrastructure will continue”.*

⁶ Direct quote from USAID, AUDIT REPORT NO. E-267-05-003-P dated June 29, 2005

Current Operations and Maintenance Contract

As a key follow-on to USG efforts to rehabilitate Units 5 and 6 (JO-03-037), sustain operations (JO-04-053), and in response to solicitation W914NS-05-R-2079, Amendment 0005, cost-plus-fixed-fee letter contract no. W91GXY-06-C-0066 dated 5 July 2006 between Washington International, Inc. (WII) and The Department of the Army was executed to provide support for the GRD's Project and Contracting Office (PCO) in coordination with the MOE to help develop, implement, and sustain an effective O&M plan. The final definitized value of the current O&M contract was approximately \$81.3 million⁷ with a 5 July 2006 through 4 July 2007 period of performance. In addition, the contract included a provision to extend the term of the contract out as far as a total of 3 years and 6 months. However, the USG did not exercise the right to extend the term of the contract with WII. Accordingly, the USG had initiated normal processes to select a new O&M contractor during the timeframe of this sustainment assessment. Overall contract administration was the responsibility of the Joint Contracting Command Iraq/Afghanistan (JCCI/A), Electricity Sector, Baghdad, Iraq.

Statement of Work

The primary purpose of the O&M contractor was to coordinate with the MOE to make its O&M organization fully functional and develop effective daily operation while simultaneously performing effective O&M services. While the main service requirement focused on the O&M of the generation assets, some managerial and maintenance support was required by the PCO regarding the transmission and distribution systems. The contractor was required to coordinate services with the MOE and provide proactive support as generally outlined within the Statement of Work (SOW) in order to transform the MOE's performance to the highest achievable level and instill international standards and industrial best practices. The contract included provisions for a nationwide O&M plan including manning 8 sites, engineering support, emergency maintenance support, critical spare parts support, and other key components. The program was not established to operate and maintain plants. Rather, to mentor the MOE staff and provide the tools to properly allow the MOE to operate and maintain the utility system. The Doura Power Station was one component of the O&M program.

The services provided by the contractor were O&M support in coordination with the MOE to enhance production and long term reliability/availability of electricity. While maintaining prudent engineering and operating practices, contractor services were to be performed in consideration of MOE's commercial requirements and other variables such as fuel supply and seasonal demand.

The SOW required the following O&M services:

Function 1 – In Power Plant Support

The contractor was required to provide support teams to assist MOE operators in their duties 7 days per week 12 hours per day.

Function 2 - Resident Advisers at the MOE Offices

The contractor was required to provide a team of Local Nationals (LNs) to reside at the MOE offices in Baghdad to facilitate general coordination of the

⁷ The O&M contract was nationwide and included Doura, Khor-Zubair, Al-Qudas, Baghdad South, Baiji, Kirkuk, Nassiriyah, and Musayib. In that this assessment was not intended to review or disclose detailed financial information, we did not determine the amount allocable to Doura activities.

O&M contractual obligations and to assist the MOE in establishing an efficient and reliable generation system.

Function 3 - Engineering Support

The contractor was required to provide an engineering support team of specialists capable of providing support to the field teams and the MOE.

Function 4 - Maintenance Support

The contractor was required to provide central mobile maintenance teams which could be dispatched to sites throughout Iraq to support the on-site maintenance staff and provide specialized services 7 days per week 12 hours per day.

Function 5 - Central Monitoring

The contractor was required to provide a team of personnel (engineers/operators) to staff a National Dispatch Center in Baghdad (central monitoring facility) which was under construction during the timeframe of the O&M contract.

Function 6 - Mobile Calibration Vehicles

The contractor was required to provide a one-time 60-day training program for six MOE personnel who in turn would travel to various MOE power plants and act as traveling trainers under the on-the-job (OJT) training program. The 60-day training program was designed to convey skill-sets to traveling trainers so that the trainers could train the Instrument and Controls staff of the power plants on calibrating instruments, trouble shooting, record keeping, basic control theory, and control systems.

Pre-Rehabilitation Conditions and Security Issues

GRD Electricity Sector managers familiar with the pre-rehabilitation condition of the Doura Power Station told inspectors that the facility had not been properly maintained for several years and many sub-systems necessary for efficient plant operations were completely or nearly non-functional. GRD Electricity Sector managers told inspectors that they were at times surprised that Iraqi maintainers could keep the plant running in its current state of disrepair. In its Report to Congress dated 30 January 2006, SIGIR reported that the Doura Power Station, like others in Iraq, was in “great need” of repair before Bechtel commenced rehabilitation of Units 5 and 6 in September 2004. In addition, SIGIR reported in its 30 April 2006 Report to Congress that the lifespan of a generator in Iraq was 10-25% the lifespan of properly maintained equipment. In short, it is reasonable to assume that the challenges levied on the USG and its contractors to reverse years of institutional behavior of questionable O&M practices on the part of the MOE were daunting at times.

Security issues have impacted reconstruction efforts in the electrical sector. SIGIR inspectors coordinated with GRD Electricity Sector officials to ensure that enough detail was provided to demonstrate the negative impact security issues have had on reconstruction. GRD Electricity Sector security officials provided a substantial number of examples of acts of violence against personnel directly involved in the reconstruction or operation of the Doura Power Station. Accordingly, violence at Doura has hampered the effectiveness of USG reconstruction efforts.

Site Assessment

With the assistance of GRD Electricity Sector personnel, SIGIR conducted a site visit on 10 June 2007 and observed the current condition of Units 5 and 6 and other related equipment and systems required to start-up and continue operation. Inspectors conducted detailed discussions with on-site GRD Electricity Sector engineers, who provided day to day technical supervision and implementation management of GRD's plan to bring Units 5 and 6 on-line. GRD Electricity Sector managers also provided inspectors with sufficient follow-up information and detailed explanations in response to specific inquiries from SIGIR.

General Observations

While the rehabilitation of Units 5 and 6 was reported substantially⁸ complete as of 15 June 2005, Units 5 and 6 were not operational at the time of SIGIR's site visit. This occurred because a series of subsequent events beyond the direct control of GRD precluded timely start-up or sustained operation of Units 5 and 6. Under the direct operational control of the Minister of Electricity, Unit 5, commissioned in April 2006, experienced catastrophic failure in mid-August 2006 and again on 28 April 2007.

At the time of our site visit, Unit 6 was not fully operational since it was reported substantially complete in June 2005. This was because a critical generator component (exciter⁹) was removed from Unit 6 and placed into Unit 5 in late August 2006 to expedite Unit 5's restart. Prior to failure in August 2006, Unit 5 was operational for approximately 4 months. At that time, MOE officials decided to swap the exciter rehabilitated from Unit 6 to Unit 5 to minimize outage time and quickly restore electric power output to the Baghdad grid¹⁰. Following the exciter swap, Unit 5 was restarted and remained operational until a second failure occurred in April 2007.

The exciter removed from Unit 5 in August 2006 was not shipped to Germany for repairs until December 2006. The repair company (Siemens) reported the damage was extensive and advised GRD that repairs would take approximately 14 months. Therefore, the exciter would not be ready for installation until approximately February 2008.

As a result, GRD assumed responsibility and control from MOE and implemented a plan to facilitate the re-starting of Unit 5 and the first start-up of Unit 6 since rehabilitation. Following the April 2007 failure of the exciter swapped in August 2006 from Unit 6 to Unit 5, GRD Electricity Sector officials coordinated local repair of the damaged exciter. SIGIR observed that the repaired exciter was in-house on 10 June 2007, pending installation into Unit 6. In addition, GRD officials ordered a new mobile exciter from Siemens to off-set the impact of a future 14 month turn around repair period.

GRD officials confirmed that delivery of the new mobile exciter was scheduled for 23 June 2007 and estimated that Unit 5 should be operational by mid-July 2007 and Unit 6 by early August 2007. At the time of our site visit, preparations for the installation of

⁸ Based on USAID information provided to SIGIR on 21 April 2007.

⁹ An exciter is the component that supplies the generator's rotor with excitation current in order to induce larger voltage and current in the generator's stator windings that are connected to the load or high voltage lines. Without an exciter and excitation, a generator will take electricity from the grid rather than supply electricity to the grid.

¹⁰ Grid or power grid is the interconnected system or network of high voltage electricity distribution lines and power stations.

necessary components into Units 5 and 6 were completed. The exciter, which was out for repairs, could be kept as a backup.

Based on GRD engineers' assessment Unit 5 shutdowns or catastrophic failures in August 2006 and April 2007 were caused by exciter flashover¹¹. However, a number of questionable O&M practices also contributed to the exciter flashover.

Operations and Maintenance

While on site and in response to SIGIR follow-up inquiries and questions related to operational and maintenance (O&M) practices, SIGIR determined several factors led to the problems at the Doura Power Station. They include: maintenance staff, parts procurement, formal maintenance program, questionable maintenance practices, house loads, generator overload, ad-hoc cable taps, and the switchyard.

Maintenance Staff. Many workers were untrained¹² and overall worker absenteeism was high. GRD Electricity Sector managers estimated that of the staff members: 1 out of 10 are well-trained workers from the Saddam era, 5 out of 10 are poorly-trained Saddam era carry-overs, and 4 out of 10 have been recently hired and have not been properly trained. The Saddam era group of employees seems prone to jury-rigging equipment for short term operational gain while ignoring the long term benefits of a preventative maintenance program. This group of employees has practiced a make it work "now" concept without regard to equipment stress or increased risk of future large scale equipment failure. However, GRD Electricity Sector managers felt this group of employees could benefit most from O&M OJT and likely be convinced that preventative maintenance practices would result in more power to the grid by lessening the frequency of shutdown situations or equipment failure. GRD Electricity Sector managers stated that absenteeism and turnover rates are high within the recently hired group of workers. As such, the contributions of this group of workers have been minimal.

Parts Procurement. The Doura plant manager has a small budget to purchase consumable and small parts that generally fall under or fit into a routine maintenance category. However, the Doura plant manager does not have sufficient budget resources or authority to approve and purchase higher cost parts or system components often needed in an emergency repair situation. Purchase requests for parts or components have to flow through the centralized MOE bureaucracy that requires multiple levels of approval. As a result, the procedures in place have generally been too slow and have not been an effective way to obtain parts needed in emergency situations. Accordingly, the current O&M contract between the USG and WII includes provisions for a Critical Parts Program. When the Doura plant manager encounters an emergency repair situation and a more costly critical part is needed, the plant manager can coordinate with GRD Electricity Sector managers to have a purchase request approved and the needed part(s) obtained in an expedited manner.

Formal Maintenance Program. GRD Electricity Sector managers stated that a formal maintenance program or work order driven preventative maintenance system

¹¹ Flashover is an event that occurs when an "arc" or "spark" is generated from a conductive material. Often such an event is caused by a short circuit between two conductive materials with inadequate or damaged insulation.

¹² The next or forthcoming O&M contract will include expanded training requirements and establish a local classroom and OJT program designed to train thousands of working level MOE personnel.

for routine and emergency maintenance or equipment change-out has not been implemented by the MOE or the current and past Doura plant managers. However, a work order system has recently been effectively implemented at another Baghdad area power plant. Accordingly, GRD Electricity Sector managers hope to convince the current Doura plant manager by demonstrating the benefits of a work order system where plant equipment is routinely inspected; needed maintenance is identified, prioritized and scheduled; and work progress and task completion are documented. While on site, SIGIR observed that no equipment or system components were tagged and identified as pending scheduled maintenance.

The lack of required maintenance on river water intake screens is an example of the negative effect of not having implemented a proper or formal maintenance program at the Doura Power Plant. Routine non-technical cleaning of the screens was not scheduled. These cleanings are needed to avoid high torque situations on the main water pump. Instead, the maintainers removed the screens designed to collect debris at the water source. As a result, the pump pushed unscreened debris through, resulting in the cooler equipment tubing being plugged, damaged, and rendered substantially less efficient (Site Photos 1 and 2). When a cooling system is not 100% efficient, chances of heat related follow-on damage to equipment or mechanical system components is greatly increased.

Questionable Maintenance Practices. GRD Electricity Sector managers stated that questionable maintenance practices were contributing factors to the Unit 5 failures in August 2006 and April 2007. The exciter's heat exchanger and the plant's closed cooling water system had not been properly maintained. Accordingly, the exciter's cooling system and the plant's closed cooling water system were not functional. As a result, high water temperature in the exciter's heat exchanger and high operating temperature in the exciter rotor occurred. Temperatures exceeded the designed operating range. While exciter cooling air temperature should have been below 45° C (Celsius), Unit 5's exciter cooling air temperatures at the time of the failures was in the range of 50-60 ° C. The excessive heat weakened the rotor's insulation and damaged the insulating paint in the exciter's end winding area resulting in the exciter being prone to flashover.



Site Photo 1. Condenser clogged with debris (Photo courtesy of GRD Electricity Sector)

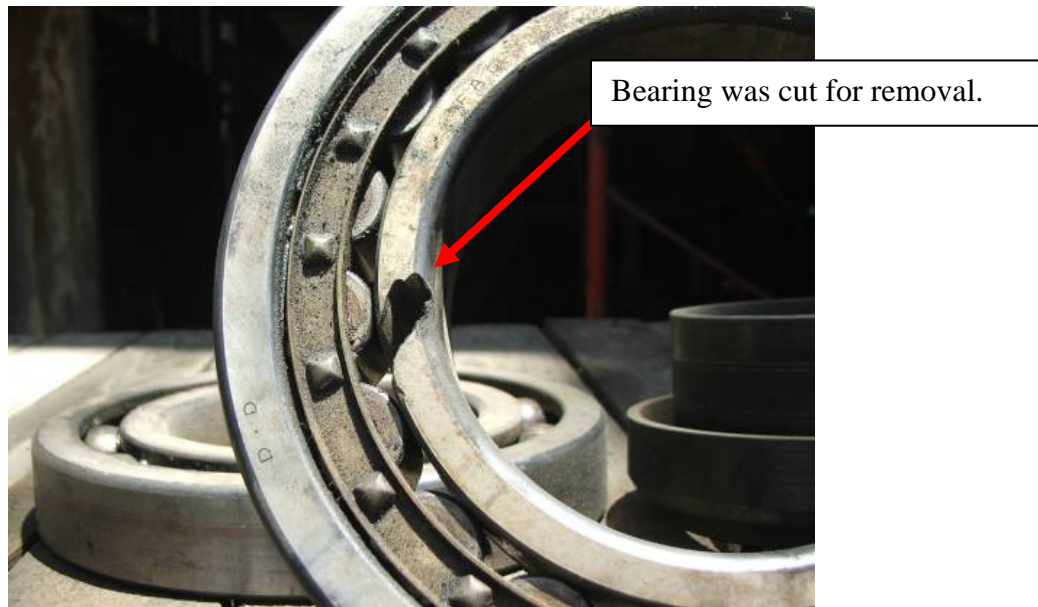


Site Photo 2. Condenser cleaning and repair. (Photo courtesy of GRD Electricity Sector)

In addition, ineffective general maintenance of the exciter resulted in an oil and dust accumulation in the rotor end windings and rectifier wheel areas. The film of oil, dust, and mud created short circuit paths between the end winding connectors of the exciter. When combined with other operational problems, a short circuit (flashover) occurred and the exciter was rendered inoperable when the rotor windings were damaged. SIGIR observed a large bearing that failed and damaged the shaft on a piece of component equipment because of inadequate lubrication. One of the resident Electricity Sector managers agreed that lubrication is a key component of any effective preventative maintenance program. In this case, the bearing ran nearly dry and generated so much heat that it had to be cut for mechanics to remove the bearing from the rotating shaft (Site Photos 3 and 4).



Site Photo 3. Inadequate lubrication caused bearings to fail. (10 June 2007)



Site Photo 4. Mechanics had to cut bearing before removal. (10 June 2007)

House Loads. GRD Electricity Sector managers explained the negative effect of frequent dropping of the incoming 132 kilovolt (kV) line to the Doura switchyard that supplies Unit 5 house loads while the turbine generator is on-line. When the 132 kV grid deteriorates, all house load controls trip from loss of power (feed water pumps, fuel pumps, fans, etc) which eventually causes a boiler and turbine trip. Such “hard trips” cause excessive stress on the equipment. During such a series of trips, the generator and exciter rotors experience a sudden loss of excitation and synchronization resulting in unbalanced current induction on the surface of the rotor. Excessive heat generated in the rotor during such an event reduces the life of the rotor windings and deteriorates the insulating paints on the shaft and end winding area of the exciter. GRD Electricity Sector managers stated that such events have been documented and that Unit 5 tripped approximately 100 times during the 12 months that preceded the final Unit 5 failure in April 2007.

In addition, configuration and operating practices related to house loads were incorrect before each of the Unit 5 failures. When the generator was synchronized to the grid, the operator should have switched or transferred the house load to the generator power. Such a procedure would have avoided hard tripping of the generator when the external 132 kV line dropped because the house loads powered by the generator would have remained on. However, the protective load transfer procedure was not performed because the transfer switch equipment had been disabled to maximize generator MW output to the grid at the risk of hard tripping the generator whenever the incoming 132 kV line dropped. In short, Unit 5 always tripped when the 132 kV grid dropped because the exciter was designed only to control and regulate generator voltage. It was not designed to ramp up/down the MW output. While generator voltage was usually stable, or fluctuated within +/- 5% regardless of the MW, generator power output control should have been regulated by the plant central control system, which was designed to adjust the boiler-turbine in order to maintain the desired MW output.

Generator Overload. GRD Electricity Sector managers explained that plant operators always communicated with the central dispatch by phone before and after the plant was synchronized to the grid. A shift engineer responsible for most operating decisions and operator supervision had to obtain permission from the plant manager before a unit could be intentionally shut down. GRD Electricity Sector managers have witnessed numerous occasions when Unit 5 experienced an overload after other power stations within the Baghdad grid tripped, shut down, or transmission line interdictions occurred. Usually, Unit 5 tripped because an under-frequency (too much load caused the turbine to slow down) condition. While the condition of the line protection systems for outgoing lines from Doura is not known, it appears there were neither sufficient provisions nor effective control systems to protect generators within the grid from a cascading trip situation caused by a grid overload. Accordingly, a protection system used to sense an overload within the grid will be installed to immediately trip a generator breaker and isolate Doura Units 5 and 6 from the grid before an overload can affect the generator. As such, units could operate in an island mode until grid problems are corrected. Then the operator could re-synchronize the generator to the grid without experiencing a forced shutdown.

Ad-hoc Cable Taps. A GRD Electricity Sector manager familiar with Doura Power Station since June 2005 explained that the illegal power cables observed on 10 June 2007 by SIGIR existed in June 2005, but whether they were installed a day or ten years earlier could not be determined. However, GRD Electricity Sector managers explained that there are several tapping points throughout the power station at various electrical panels where electric power moves uncontrolled from the power

plant to the community surrounding the power station. While on site, SIGIR observed the control center for Unit 5 and 6 main oil pumps after it was ruined by a devastating fire on 31 May 2007 (Site Photo 5).

An ad-hoc cable tap caused the fire, which rendered the control center inoperable. As a result, approximately 100 village houses that previously obtained power directly from the ad-hoc cable tap or circuit have been and will be without power until the control center is rebuilt and Unit 5 is re-started and operational. Although discussed with the MOE, GRD Electricity Sector managers stated that they were not certain whether the MOE would authorize disconnecting the ad-hoc cable taps throughout the plant. In the meantime, to prepare for restarting Unit 5, inspectors observed that contractor personnel have been and were attempting to minimally repair the control center (Site Photo 6).

The preferred way to provide power to the “village” would be to have operators at the Iraqi Central Control for Transmission and Substations line up the system so that the "normal" grid power would be available to the Doura village. However, normal power has not been available to the village because all the electricity has been routed to the Baghdad grid and the substation within the grid that serves the Doura village has not been operational.



Site Photo 5. Oil Station control center after May 2007 fire. (Photo courtesy of Electricity Sector)



Site Photo 6. Control center cleanup and repair work in progress.
(Photo courtesy of Electricity Sector)

Switchyard. While operational at the time of our site visit, the switchyard should be overhauled. GRD Electricity Sector managers explained that, in the past, several insulators have been damaged from bullets and shrapnel and that most of the insulators need to be cleaned. The breaker control and protection circuits need to be tested (Site Photo 7). Resident GRD Electricity Sector managers, while working on the Unit 5 and 6 section of the switchyard, observed that several protections and controls have been bypassed and some high voltage breakers would not work remotely or were leaking SF6 insulating gas. Additionally, GRD Electricity Sector managers were not aware of any switchyard control or standard operating procedures (SOP) utilized by the MOE. Nonetheless, the MOE has total control of the switchyard and only allows contractor personnel to work on the Unit 5 and Unit 6 section(s) of the switchyard. Based on discussions with the resident GRD Electricity Sector manager, the switchyard lineup should be changed to ensure that power is distributed evenly from Units 3 through 6 to each outgoing line to avoid overloading any particular line section in the switchyard. At the time of our site visit, the resident GRD Electricity Sector manager stated that such a recommendation would be made in a timely manner before restarting Units 5 and 6.



**Site Photo 7. Unit 5 transformer and 132 kV switchyard is in questionable condition.
(Photo courtesy of Electricity Sector)**

Conclusions

U.S. government contractors previously completed Statement of Work requirements to rehabilitate Doura Power Plant Units 5 and 6; however, neither unit was operational when observed by SIGIR on 10 June 2007, for reasons and subsequent events beyond the direct control of the U. S. government and its contractors. Specifically, operational control was under the authority of the Ministry of Electricity when Unit 5, commissioned in April 2006, experienced catastrophic failures in August 2006 and April 2007. Both times, Unit 5 shut down because of exciter flashover, which was the result of repeated “hard tripping” caused by power surges. However, most hard tripping could have been avoided if Ministry of Electricity operational procedures would have allowed plant operators to isolate the generator unit and protect it from frequent deterioration of the incoming 132-kilovolt line to the Doura switchyard. Unit 5 tripped approximately 100 times during the 12 months that preceded the final Unit 5 failure in April 2007.

At the time of our site visit, Unit 6 had not been operational since rehabilitation. This occurred primarily because in August 2006, the exciter was removed from Unit 6 as it neared operational status and was placed into Unit 5 to expedite restarting Unit 5 after its catastrophic failure. Prior to its failure in August 2006, Unit 5 was operational for approximately 4 months. Ministry of Electricity officials decided to swap the exciter from Unit 6 to Unit 5 to minimize outage time and quickly restore electric power to the Baghdad grid. As a result, much-needed electricity is not available to the Baghdad grid. However, Doura Power Plant Unit 5 should be operational by mid-July 2007 and Unit 6 should be operational by early August 2007. The rehabilitation and start-up plans of the USACE, GRD appeared on track as of 16 June 2007.

Sustainable operations at full capacity cannot be reasonably assured unless the Ministry of Electricity operation and maintenance practices change and improve. To date, the

Ministry of Electricity has operated ineffectively or insufficiently maintained equipment. For example, the accumulation of simple dust and oil film in the rotor-end windings and rectifier wheel areas of the exciter facilitated a short circuit and flashover, which resulted in the complete failure of Unit 5 in April 2007. Based on our site inspection we concluded:

- a. The Ministry of Electricity should implement operational procedures to effectively manage power generation and distribution as an integrated activity. To prevent system-wide imbalance and deterioration of the incoming 132-kilovolt lines, the Ministry of Electricity should ensure that bypassing and intentional overriding of automatic controls throughout the generation and distribution systems are not allowed.
- b. A formal maintenance program should be implemented by the Ministry of Electricity that includes procedures to inspect equipment, schedule necessary non-emergency maintenance, and expedite more critical repairs. In addition, the Ministry of Electricity should authorize plant-level managers and plant engineers to perform emergency maintenance or repairs to prevent large-scale system failure.
- c. Ministry of Electricity officials should ensure that unauthorized tapping of electricity directly from the power plant is discontinued and all existing ad-hoc cable taps throughout the facility are removed as part of an overall program to manage and control electricity generation and distribution.

Recommendations

The Gulf Region Division's plans explained below should correct the deficiencies contained in this report. Specifically, the Gulf Region Division's plans to restart Units 5 and 6 and continue an operation and maintenance program targeted at mentoring and working with the Ministry of Electricity seem practical and well-fitted for the case at hand. Specific goals of the operation and maintenance contract to develop a local training program designed to provide classroom and on-the-job training for a large number of worker level personnel and requirements to develop standard operating procedures for operators and maintainers should improve the effectiveness of the operations and maintenance program. Further, Provincial Reconstruction Team activities that focus on training mid-level government workers should reinforce the Gulf Region Division's plans. Accordingly, this report did not include any recommendations for corrective action and management comments were not requested. However, U.S. Army Corps of Engineers, Gulf Region Division, did review the draft and offered no additional information and had no comments.

Appendix A. Scope and Methodology

We performed this project assessment from May through June 2007 in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included an engineer/inspector and an auditor/inspector.

In performing this sustainment assessment we:

- Reviewed solicitation and Statement of Work documentation for the current and forthcoming O&M program;
- Reviewed reports published by other USG oversight agencies that performed work within Generally Accepted Government Auditing Standards in order to obtain reliable historical and background information. Specifically, we discussed historical and background information with USAID Regional Inspector General;
- Conducted field level discussions with GRD Electricity officials and managers located in the International Zone and resident to the Doura Power Station;
- Conducted an on-site assessment on 10 June 2007; and
- Briefed the results of fieldwork and conclusions with appropriate USACE GRD and GRD Electricity Sector officials before distributing a draft report for management comments.

Appendix B. Acronyms

C	Celsius
CD	Capacity Development
CPA	Coalition Provisional Authority
DoD	Department of Defense
GAO	Government Accountability Office
GRD	Gulf Region District
IRRF	Iraq Relief and Reconstruction Fund
JCC-I/A	Joint Contracting Command-Iraq/Afghanistan
JO	Job Order
kV	Kilovolt
LN	Local National
MOE	Ministry of Electricity
MW	Megawatt
OJT	On the Job Training
O&M	Operations and Maintenance
PCO	Project and Contracting Office
SIGIR	Special Inspector General for Iraq Reconstruction
SOP	Standard Operating Procedure
SOW	Statement of Work
USAID	United States Agency for International Development
USACE	United States Army Corps of Engineers
USG	United States Government
WII	Washington International, Inc.

Appendix C. Report Distribution

Department of State

Secretary of State

Senior Advisor to the Secretary and Coordinator for Iraq

Director of U.S. Foreign Assistance/Administrator, U.S. Agency for
International Development

Director, Office of Iraq Reconstruction

Assistant Secretary for Resource Management/Chief Financial Officer,
Bureau of Resource Management

U.S. Ambassador to Iraq

Director, Iraq Transition Assistance Office

Coordinator, Office of Provincial Affairs

Mission Director-Iraq, U.S. Agency for International Development

Inspector General, Department of State

Inspector General, U.S. Agency for International Development

Regional Inspector General-Iraq, U.S. Agency for International Development

Department of Defense

Secretary of Defense

Deputy Secretary of Defense

Under Secretary of Defense (Comptroller)/Chief Financial Officer

Deputy Chief Financial Officer

Deputy Comptroller (Program/Budget)

Deputy Assistant Secretary of Defense-Middle East, Office of Policy/International
Security Affairs

Inspector General, Department of Defense

Director, Defense Contract Audit Agency

Director, Defense Finance and Accounting Service

Director, Defense Contract Management Agency

Department of the Army

Assistant Secretary of the Army for Acquisition, Logistics, and Technology

Principal Deputy to the Assistant Secretary of the Army for Acquisition,
Logistics, and Technology

Deputy Assistant Secretary of the Army (Policy and Procurement)

Commanding General, Joint Contracting Command-Iraq/Afghanistan

Assistant Secretary of the Army for Financial Management and Comptroller

Chief of Engineers and Commander, U.S. Army Corps of Engineers

Commanding General, Gulf Region Division

Chief Financial Officer, U.S. Army Corps of Engineers

Auditor General of the Army

U.S. Central Command

Commanding General, Multi-National Force-Iraq

Commanding General, Multi-National Corps-Iraq

Commanding General, Multi-National Security Transition Command-Iraq

Commander, Joint Area Support Group-Central

Other Federal Government Organizations

Director, Office of Management and Budget
Comptroller General of the United States
Inspector General, Department of the Treasury
Inspector General, Department of Commerce
Inspector General, Department of Health and Human Services
President, Overseas Private Investment Corporation
President, U.S. Institute for Peace

Congressional Committees and Subcommittees, Chairman and Ranking Minority Member

Senate Committee on Appropriations
 Subcommittee on Defense
 Subcommittee on State, Foreign Operations, and Related Programs
Senate Committee on Armed Services
Senate Committee on Foreign Relations
 Subcommittee on International Development and Foreign Assistance, Economic Affairs, and International Environmental Protection
 Subcommittee on International Operations and Organizations, Democracy and Human Rights
 Subcommittee on Near Eastern and South and Central Asian Affairs
Senate Committee on Homeland Security and Governmental Affairs
 Subcommittee on Federal Financial Management, Government Information, Federal Services, and International Security
 Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia
Permanent Subcommittee on Investigations

U.S. House of Representatives

House Committee on Appropriations
 Subcommittee on Defense
 Subcommittee on State, Foreign Operations, and Related Programs
House Committee on Armed Services
House Committee on Oversight and Government Reform
 Subcommittee on Government Management, Organization, and Procurement
 Subcommittee on National Security and Foreign Affairs
House Committee on Foreign Affairs
 Subcommittee on International Organizations, Human Rights, and Oversight
 Subcommittee on the Middle East and South Asia

Appendix D. Project Assessment Team Members

The Office of the Assistant Inspector General for Inspections, Office of the Special Inspector General for Iraq Reconstruction, prepared this report. The principal staff members who contributed to the report were:

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