

PROJECT PHOENIX
RESTORE QUDAS GAS TURBINE
UNITS TO OPERATION
BAGHDAD, IRAQ

SIGIR PA-05-029
JANUARY 31, 2006



SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION

January 31, 2006

MEMORANDUM FOR COMMANDER, GULF REGION DIVISION, U.S. ARMY
CORPS OF ENGINEERS AND DIRECTOR, PROJECT
AND CONTRACTING OFFICE
COMMANDER, JOINT CONTRACTING COMMAND-
IRAQ/AFGHANISTAN
DIRECTOR, IRAQ RECONSTRUCTION MANAGEMENT
OFFICE

SUBJECT: Report on Project Assessment of the Project Phoenix – Restore Qudas Gas
Turbine Units to Operation in Baghdad, Iraq (Report Number SIGIR-
PA-05-029)

We are providing this project assessment report for your information and use. We assessed the in-process construction work being performed at the Project Phoenix – Restore Qudas Gas Turbine Units to Operation in Baghdad, Iraq, to determine its status. This assessment was made to provide you and other interested parties with real-time sustainability information on a relief and reconstruction project underway and in order to enable appropriate action to be taken if warranted. The assessment team included an engineer and an auditor.

We discussed the results of this project assessment with representatives of the Project and Contracting Office, Gulf Region Division of the U.S. Army Corps of Engineers, and Joint Contracting Command-Iraq/Afghanistan, all of whom concurred with our conclusions. This report includes no recommendations that required management comments.

We appreciate the courtesies extended to our staff. This letter does not require a formal response. If you have any questions please contact Mr. Brian Flynn at (703) 343-9149 or brian.flynn@iraq.centcom.mil or Mr. Michael Stanka, P.E., at (703) 343-9149 or michael.stanka@iraq.centcom.mil.

A handwritten signature in black ink that reads "Stuart W. Bowen, Jr.".

Stuart W. Bowen, Jr.
Inspector General

Special Inspector General for Iraq Reconstruction

SIGIR PA-05-029

January 31, 2006

Project Phoenix - Restore Qudas Gas Turbine Units to Operation, Baghdad, Iraq

Synopsis

Introduction. This project assessment was initiated as part of our continuing assessments of selected sector reconstruction activities for the Electrical Sector. The overall objective was to determine whether selected sector reconstruction contractors complied with the terms of their contract or task orders in regards to sustainability issues. This project assessment was conducted in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included a professional engineer and an auditor.

Project Assessment Objectives. The objective of this project assessment was to provide relief and reconstruction sustainability project information to interested parties in order to enable appropriate action, when warranted. Specifically, we determined whether:

1. Consumables (i.e., fuel, lubricating oil, chemical additives, etc.) quantity and quality were consistent with original objectives;
2. Maintenance manuals were on hand and being used;
3. Preventative maintenance was implemented;
4. Spare parts were addressed, obtained, and on site; and
5. Adequate training was accomplished.

Conclusions. The objective of task order 0006, project EG-049 was primarily to "rescue" Frame 9E Units 3 and 4 and LM-6000 Units 5 through 8 at Qudas and put them into commission to produce electricity for the Iraqi grid. The project has sustainability components embedded, although they did not fully address sustainability requirements for commissioning and operating a power plant. The following provides a summary of our conclusions.

1. Although improving the supply and quality of consumable products such as fuel, which was not an objective of EG-049, the supply of fuel, the quality of fuel, and the lack of natural gas at Qudas is not consistent with an efficient and effective combustion turbine operation. The proposal to capture "flared" natural gas from the East Baghdad Gas Plant as a partial fuel source for the LM-6000s remains unfunded at this time. Further, the current method for delivering diesel fuel to the LM-6000s cannot sustain long term continuous operations.
2. Maintenance manuals for the Frame 9E units and the LM-6000 were on hand. The LM-6000 manuals were located in the two control room facilities adjacent to each unit. Alternatively, Frame 9E manuals were located in a cabinet at the Qudas administration building conference room, not readily available for the operators' use.

3. Preventative maintenance was not performed nor was documentation available to demonstrate the presence of a preventive maintenance program. Instead, maintenance on the LM-6000s and Frame 9E units was reactive rather than preventive.
4. Functional parts and emergency spare parts were not part of EG-049. Spare parts were addressed in EG-051. To date, \$2,089,826 has been expended for emergency spare parts and \$2,572,904 expended for functional spares. However, based on the information provided to us by the Project and Contracting Office (PCO), there appears to be no comprehensive system to identify the type and quantities of functional and emergency spare parts that have been procured for Qudas nor is there a recommended emergency spare parts list that could be utilized in the future by the Ministry of Electricity (MoE).
5. Training was conducted during the contract period and included on site training provided by BTEC Turbines LP (BTEC), from 23 May to 9 June 2005 and a subsequent course in the period 4 to 13 July 2005. These training sessions focused on the operation and maintenance of the LM-6000 units.

Future Initiatives.

Request for Proposal W914NS-05-R-2079: In a major effort to advance sustainability of Iraq's power generation capability, PCO has issued a request for proposal for the development, implementation, and sustainment of an effective Operations and Maintenance (O&M) plan in coordination with the MoE. This contract, when awarded, is intended to enhance production and long term reliability and availability at the MoE's power stations.

PCO Sustainability for Iraq Power Plants: Currently in the development stages, the PCO Electrical Sector is leading an effort to put together comprehensive bid documents to complete the routine maintenance for 10 Iraq power plants. Routine maintenance will include: hot gas path inspections, combustion inspections, aero-derivative turbine change outs, functional parts identification and procurement to support the combustion turbine overhauls, and to maintain an on-hand strategic spare reserve. The current budget that has been put forward by the Electrical Sector at PCO is \$340 million. Within this initiative, there is also an emphasis to have the MoE more involved particularly with the funding of some of the requirements. PCO, the Department of State's Iraq Reconstruction Management Office (IRMO), and U.S. Aid for International Development (USAID) are considering strategies for additional cost sharing arrangements by the MoE. For example, one possibility is to have the MoE purchase the required parts with its budget.

Recommendations. The Director, Iraq Reconstruction Management Office; Commander, Gulf Region Division; Commander, Joint Contracting Command-Iraq/Afghanistan (JCC-I/A) should coordinate and:

1. Continue to pursue funding for the sustainability of the Iraq power plants initiative.
2. Seek and advocate funding and implementation of the natural gas recovery assessment.

Management Comments. The Principal Assistant responsible for Contracting, JCC-I/A, concurred with our conclusions and recommendations and provided the following comments.

1. “GRD/PCO is continuing to pursue funding for the initiative. JCC-I/A currently has one sustainability project nearing award; solicitations for four projects are currently advertised; and one project is being prepared for solicitation. GRD/PCO will be able to fund the current projects. However, it is waiting funding from the Ambassador’s deferred program to become available for additional projects under the sustainability program.”
2. “Concur in part. The original plan was to use Fluor-AMEC; however, funds were taken out of the program to fund the Ambassador’s program. It appears that some money is being returned from the Ambassador and the requirement has been taken over by the Oil Sector.”

Evaluation of Management comments. Management comments addressed the issues raised in our conclusions and actions planned and taken should correct the deficiencies.

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Introduction

Objective of the Project Assessment

The objective of this project assessment was to provide real-time sustainability information on the completed relief and reconstruction project at the East Baghdad Electrical Plant to interested parties in order to enable appropriate action, when warranted. Specifically, we determined whether:

1. Consumables quantity and quality were consistent with original objectives;
2. Maintenance manuals were on hand and being used;
3. Preventative maintenance was implemented;
4. Spare parts were addressed, obtained, and on site; and
5. Adequate training was accomplished.

Pre-Site Assessment Background

Contract, Task Order, and Costs

“Project Phoenix - Restore Qudas Gas Turbine Units to Operation” was completed under Contract W914NS-04-D-0003, Task Order 0006, Project Number EG-049, Sub-contract Line Item Number 0001AF, Project Identification No. GBAKC 111. Contract W914NS-04-D-0003, dated 11 March 2004, is an indefinite delivery/indefinite quantity, design-build, cost-plus award fee contract with a \$500 million ceiling. The contract was made between the Coalition Provisional Authority (CPA) and FluorAMEC, LLC, a limited liability company.

There are ten modifications to the original contract.

- Modification 01, dated 03 August 2004, incorporated the Resident Management System instruction manual and critical data into the contract. No additional funding was added at this time.
- Modification 02, dated 11 August 2004, added FAR Clause 52.226-1, *Utilization of Indian Organizations and Indian-Owned Economic Enterprises* and added special contract requirements for customs levy exemption. No additional funding was added at this time.
- Modification 03, was not executed.
- Modification 04, dated 20 October 2004, reflected administrative changes to the contract. No additional funding was added at this time.
- Modification 05, dated 01 December 2004, reflected administrative changes to the contract. No additional funding was added at this time.
- Modification 06, dated 11 February 2005, was issued to reflect changes in definitization and reporting requirements, and clarifications to the contract. No additional funding was added at this time.

- Modification 07, dated 01 April 2005, was issued to reflect other changes in definitization and reporting requirements, and clarifications to the contract. No additional funding was added at this time.
- Modification 08, dated 16 April 2005, replaced the changes in definitization and reporting requirements contained in Modifications 06 and 07. No additional funding was added at this time.
- Modification 09, dated 01 October 2005, incorporated the prompt payment clause, deleted an Arabic deliverables requirement, clarified and defined life support services, and clarified invoicing procedures. No additional funding was added at this time.
- Modification 10, dated 25 October 2005, transferred government furnished property to the contractor. No additional funding was added at this time.

Task Order 0006 when issued to FluorAMEC, LLC, was un-definitized. FluorAMEC, LLC was directed by a notice to proceed, dated 18 December 2004, for a not to exceed amount of \$28,574,647, to provide a site assessment (Project EG-049) of seven (7) Electrical Power Generation Plants constructed or renovated previously under earlier Development Fund for Iraq (DFI) contracts. In addition, Task Order 0006, Project EG-049, Contract Line Item Number (CLIN) 0001 required FluorAMEC, LLC to correct deficiencies and commission the seven plants into operation. Sub-contract Line Item Number 0001AF, Project Identification No. GBAKC 111 under Task Order 0006, Project EG-049, required FluorAMEC, LLC to inspect, evaluate, restore, and start up four (4) General Electric (GE) LM-6000 Combustion Gas Turbines at the Qudas Power Plant located in Baghdad, Iraq.

There were seven modifications associated with Task Order 0006.

- Modification 01, dated 19 January 2005, changed the schedule of supplies/ services of Sub-contract Line Item Number 0001AF, Project Identification Number GBAKC-111 by adding the inspection, evaluation, restoration, and startup of Qudas Units 3 & 4, which are two GE Frame 9E Combustion Gas Turbines. There was no additional funding added at this time.
- Modification 02, dated 07 May 2005, changed the not to exceed amount in Task Order 0006 for CLIN 0001 from \$28,574,647 to \$65,331,000 because of additional requirements identified during comprehensive site assessments at each plant location. There were no specific changes to Sub-contract Line Item Number 0001AF, Project Identification Number GBAKC-111.
- Modification 03, dated 19 June 2005, changed the not to exceed amount in Task Order 0006 for CLIN 0001 from \$65,331,000 to \$83,080,811 because of additional requirements for power plants in Baiji, Ninawa, Mosul, and Al Basrah. There were no changes to Sub-contract Line Item Number 0001AF, Project Identification Number GBAKC-111.
- Modification 04, dated 16 July 2005, added CLIN 0002 and CLIN 0003 to Task Order 0006 as Project EG-051. CLIN 0002 required the contractor to provide and procure emergency spare parts (not to exceed \$2,000,000) as identified, coordinated, and approved by the Government. CLIN 0003 required the contractor to provide and procure functional spare parts (not to exceed

- \$8,909,091) as identified, coordinated, and approved by the Government. The total not to exceed amount for Task Order 0006 was increased from \$83,080,811 to \$93,989,902.
- Modification 05, dated 17 September 2005, revised CLINs 0002 and 0003 in Task Order 0006, Project EG-051. The not to exceed amount for CLIN 0002 was changed from \$2,000,000 to \$3,000,000. The not to exceed amount in CLIN 0003 was changed from \$8,909,091 to \$12,445,455. The total not to exceed amount for Task Order 0006 was increased from \$93,989,902 to \$98,526,266.
 - Modification 06 dated 22 October 2005, added CLIN 0004 to Task Order 0006, Project EG-049. CLIN 0004 required the contractor to assess and provide rough order of magnitude (ROM) estimates for the possible redesign and refurbishment of the East Baghdad Gas Plant systems to increase the crude oil fuel production from 12,000 barrels per day to 18,000 barrels per day of heavy oil production and provide 18 million standard cubic feet per day (MMSCF/D) of natural gas. The East Baghdad Gas Plant is located approximately one kilometer from Qudas and provides crude oil through a pipeline to Qudas for its Frame 9E units. The East Baghdad Plant also produces natural gas as a by-product, which is currently vented and flared to the atmosphere. CLIN 0004 also required the contractor to perform a ROM estimate for providing additional refurbishment services on ancillary systems and controls to increase the Qudas Plant's reliability. The not to exceed amount for CLIN 0004 was \$408,511. In order to cover the costs of CLIN 0004, the total amount for CLIN 0001 on Task Order 0006, Project EG-049, was decreased by \$408,511, from a not to exceed amount of \$83,080,811 to \$82,672,300.
 - Modification 07, dated 19 November 2005, changed CLIN 0002 (emergency spare parts procurement) as revised by Modification 05 to include freight costs. The not to exceed amount for CLIN 0002 remained as \$3,000,000. CLIN 0003 (functional spare parts procurement) as revised by Modification 05, was changed to show the inclusion of freight costs, and the not to exceed amount was changed from \$12,445,455 to a not to exceed amount of \$20,500,000. The total not to exceed amount for Task Order 0006 was increased from \$98,526,266 to \$106,580,811.
 - Modification 08, dated 21 November 2005, increased the not to exceed amount on CLIN 0001 from \$82,672,300 to \$91,729,921. The total not to exceed amount for Task Order 0006 was increased from \$106,580,811 to \$115,638,432.

To summarize, Task Order 0006 consists of two projects, EG-049 and EG-051. Project EG-049 (CLIN 0001) was for the inspection, evaluation, restoration, and startup of seven power plants constructed or refurbished under previous DFI contracts. CLIN 0004, also part of project EG-049, was to provide ROM estimates for improving the fuel delivery to Qudas from the East Baghdad Gas Plant and for improving ancillary systems at Qudas. Project EG-051 (CLINs 0002 and 0003) was for the procurement of emergency spare parts and functional spare parts.

Although contracting actions include seven power plants under a single task order project (EG-049), this assessment addresses only sustainability issues associated with the

“Restore Qudas Gas Turbine Units to Operation” portion (Sub-contract Line Item Number 0001AF, Project Identification No. GBAKC 111) of Task Order 0006. Further, due to the extreme fluidity of the scopes of work associated with Task Order 0006, Sub-contract Line Item Number 0001AF, Project Identification No. GBAKC 111 remained undefinitized through the entire project period. According to the PCO database, “Restore Qudas Gas Turbine Units to Operation” started 24 March 2005 and finished 23 October 2005. As of 29 October 2005, the PCO database listed the actual cost for this project at \$11,390,750. The FluorAMEC cost report, dated 2 December 2005, shows total actual cost at \$12,685,332.

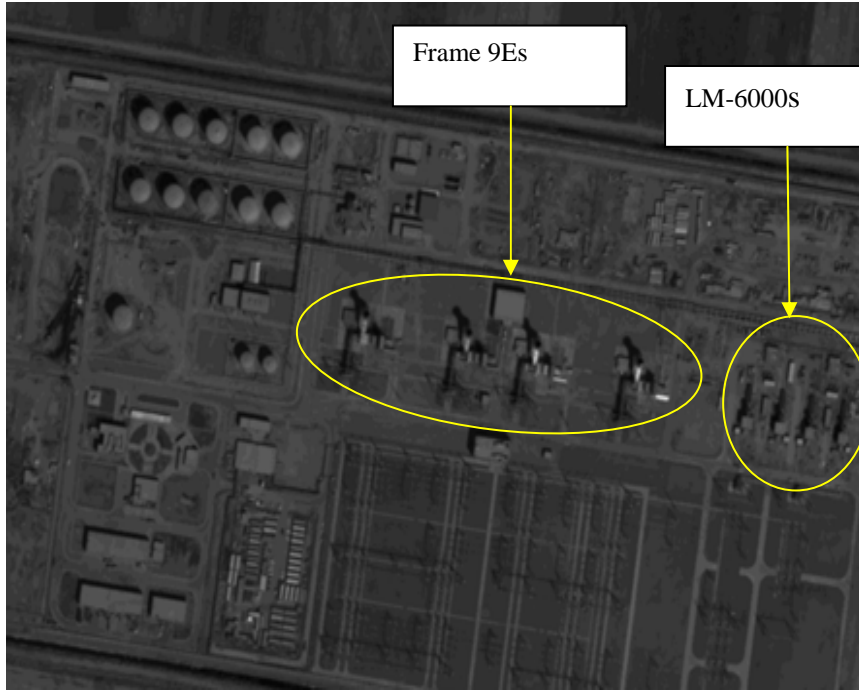
Project Objective

The 19 January 2005, Scope of Work for Sub-contract Line Item Number 0001AF, Project Identification No. GBAKC 111 stated: “The project will allow for the inspection, evaluation, restoration, and startup of Qudas Units 3 & 4, two (2) GE Frame 9E Combustion Gas Turbines, and will facilitate an increase in net electrical output. Additionally, inspection and evaluation of the four (4) GE LM-6000 units shall be conducted to determine the feasibility of placing these machines into service, as well.”

The specific project objectives were to complete the conversion of the two installed GE Frame 9E units (3 & 4) to crude oil firing, determine the cause of failure of the Unit 4 exciter, implement corrective measures, commission the units, and turn over the operating units to the PCO/MoE. The objectives associated with the four GE LM-6000 units included evaluating the four aero-derivative gas combustion turbine units, developing a cost estimate and restoration plan, completing the work necessary to restore and commission the units, and turn over the operating units to the PCO/MoE.

Description of the Facility (prior to the start of Project Phoenix)

The description of the facility (prior to the start of Project Phoenix) was based on information from the initial scope of work, and from the information provided by PCO on the original DFI contract managed by the U.S. Army Corps of Engineers-Gulf Region Division (USACE GRD). The Qudas Power Plant is located in a relatively rural area approximately 25 kilometers north of Baghdad, east of the Tigris River. Topography of the site is generally level in grade. The Qudas Power Plant at the start of Project Phoenix consisted of four GE Frame 9E combustion gas turbine units and four GE LM-6000 aero derivative combustion gas turbine units (see Site Photo 1 for plant layout).



Site Photo 1. Site Layout for Qudas Power Plant

Each Frame 9E unit (Site Photo 2) has the capability to produce 123 megawatts of electricity. The Frame 9E units are designed to run on crude oil and diesel fuel oil (hereafter referred to as diesel). Each LM-6000 unit (Site Photo 3) has a rated capacity of 43 megawatts. The LM-6000 units are designed to run on diesel and natural gas. Electricity produced from all of the eight generators is connected to the MoE's 400kV electrical grid at the plant's switchyard.



Site Photo 2. Frame 9E Unit at Qudas Power Plant



Site Photo 3. LM-6000 Unit at Qudas Power Plant

Frame 9E Units 3 and 4, and the four LM-6000 units at Qudas were originally installed under DFI funding through a USACE GRD administered contract with Fluor Intercontinental, Inc. However, subsequent to the demobilization of the contractor by USACE GRD, an inspection in January 2005 noted that only two of the Frame 9E units were operational and connected to the electrical grid. The four LM-6000's were not operational or producing electricity. At that January 2005 inspection, the inspection team noted that Frame 9E Units 1 and 2 were running on crude oil and producing 90-100 megawatts each. After the inspection revealed problems with Frame 9E Units 3 and 4, modification 01 to Task Order 0006 was issued on 19 January 2005 adding the inspection, evaluation, restoration, and start-up of these units to the scope of work for Task Order 0006, (Sub-contract Line Item Number 0001AF, Project Identification No. GBAKC 111).

Scope of Work of the Task Order

Task Order 0006's Scope of Work, dated 18 December 04, required FluorAMEC, LLC to complete a detailed assessment of each generation unit at the seven power plant sites including Qudas, followed by an analysis of the information obtained from the assessment. Then the analysis was to be summarized in a report that would provide complete documentation of each plant assessment, including a ROM cost estimate and a proposal for corrective measures with a time schedule. FluorAMEC, LLC provided two reports to PCO. The first technical report, submitted in January 2005, included an initial assessment of the problems at the seven sites and a ROM for corrective action at each site. The Qudas portion of the ROM cost estimate was approximately \$2.8 million.

The second technical report was submitted by FluorAMEC, LLC in April 2005. This report provided a more in-depth analysis of the problems at each plant. The report contained a detailed proposal and cost estimates for correcting the problems at Qudas and

the six other power plant sites. The estimated cost for the Qudas plant rehabilitation was about \$15.3 million.

The scope of work for the “Restore Qudas Gas Turbine Units to Operation” portion of Task Order 0006, CLIN 0001 as detailed in FluorAMEC LLC’s April 2005 report, included requirements to:

- Mobilize field teams, obtain necessary tools and reference information (drawings, manuals, reference software, etc).
- Survey each of the six gas turbine units to verify its condition and identify any additional concerns.
- Re-commission Units 3, 4, 5, 6, 7, and 8, principally utilizing GE with the support of the FluorAMEC LLC field and home office teams.
- Commission, start up, and synchronize Unit(s) and Balance of Plant.
- Provide recommended commissioning spare parts list and one (1) year operational spare parts list.
- Conduct trial run of fourteen days, including training/coaching of 20 operations personnel in startup, shutdown, troubleshooting, and nozzle/filter change out.
- Provide necessary documentation including startup report, shutdown checklist, and training material/manuals.
- Comply with GE standard quality assurance procedures.
- Manufacture, ship, install, and commission a new exciter for Frame 9E Unit 4.
- Analyze existing Frame 9E Unit 4 exciter and ship to France for a root cause analysis of the failure.

Project Design and Specifications Relevant to Sustainability

There were a number of key aspects that needed to be addressed in order to assess sustainability. They include:

- The availability of consumables such as fuel, lubricating oil, and chemical additives to keep the plant operational;
- Spare parts inventory management;
- Presence and utilization of O&M manuals;
- Implementation of preventive maintenance and a monitoring system; and
- Presence and effectiveness of a formal training program; including on-the-job training.

There were a number of references to sustainability and its specific components within the contract and task order.

Section 2.1.1.2 of contract W914NS-04-D-0003 statement of work addresses sustainability indirectly by requiring the contractor to be capable of supporting work to include spare parts, warranty service, and O&M training.

More specifically, Section 2.9.1 of the contract requires the contractor to provide O&M manuals, preventive maintenance plans, approved spare parts lists, and illustrated parts guides of all installed building or systems components.

Section 2.10 of the contract requires the contractor to develop preventive maintenance plans in accordance with the manufacturer's recommendations and upload them into the PCO asset management system.

Section 2.10.1 states: *"The Contractor will be responsible for proper training and capacity strengthening of Iraqi maintenance staff, operational testing, development and upload of required maintenance job plans, and ninety (90) days of on call operational oversight and technical assistance in executing the operations and maintenance program."* Further, Section 2.12 requires the contractor to provide training to the Iraqi workforce on the operations and maintenance of all infrastructure facility components.

Regarding spare parts, Section 2.10.2 states: *"The contractor will provide all materials required to accomplish regularly scheduled maintenance tasks and operations for six months."* This section also explains that other spare parts requirements could also be defined in individual task orders.

Task Order 0006 also highlights sustainability. The opening paragraph of Section 00020, states that the objective of the task order is to restore 487 megawatts of electrical generating capacity to the Iraqi grid and sustain the operation of power. Section 4.7 of the Task Order requires the contractor to provide plant operation, maintenance and training services as necessary to support continuous operation of the facility after commissioning. Section 4.9 requires the contractor to consult with Sector Project Contracting Office (SPCO) to help determine specific spare parts needs.

Although not part of Project EG-049, modifications 05 (and followed by 07) of Task Order 0006 established two new contract line items, CLIN 002 and CLIN 0003 for emergency spare parts (not to exceed \$3 million) and functional parts (not to exceed \$20.5 million) respectively. Emergency spare parts as delineated in the modification are the material component parts identified by SPCO to be provided and warehoused for use at a later time for emergency repairs. Functional parts are the material component parts required to be installed to meet the requirements of the scope of work for a functional end product.

Site Sustainability Assessment

On 17 November and 1 December 2005, we performed onsite assessments at the Qudas Power Plant in Baghdad, Iraq. Prior to our second site visit, we interviewed the PCO Electrical Sector Deputy Manager, PCO Electrical Sector staff, and the Iraq Reconstruction Management Office (IRMO) Electrical Power Generation consultant. The site visits included an assessment of the plant operations, a review of onsite O&M manuals, and preventive maintenance practices. On the first site visit, Frame 9E Units 1, 2, and 4 were operating; however, Frame 9E Unit 3 and all four LM-6000s were not

operational. On the second site visit, all four Frame 9E Units were operating, but the four LM-6000s were not operational.

Consumables (Fuel and additives)

FluorAMEC's technical report submitted in April 2005 highlighted several problems relating to fuel oil supply and quality. At the time of the initial Qudas Plant inspection in December 2004, Frame 9E Units 3 and 4 were shut down because of the lack of diesel to run the turbine. Further, LM-6000 Units 7 and 8 were shut down due to lack of diesel and Units 5 and 6 were not operating because of excessive carbon buildup in the fuel nozzles. There are three issues associated with fuel at Qudas: the supply of fuel, the quality of fuel, and the lack of natural gas.

Fuel Supply – According to a 22 April 2005 Defense Support Office report which evaluated Iraq's Electricity Sector, there is no national fuel strategy. Thus, refined fuel such as diesel is in short supply. Lack of refining capacity has limited the production of diesel in Iraq. The Ministry of Oil supplies the fuel used in Iraqi power plants. The Defense Support Office reports that the Ministry of Electricity is being supplied with about one third of its diesel needs. Further, at Qudas, the LM-6000s fuel supply is provided by trucks delivering diesel on a daily basis (Site Photo 4). There is no dedicated supply of fuel via pipeline for the LM-6000s.



Site Photo 4. Diesel Trucks Delivering Fuel to Qudas Power Plant

In addition to diesel, natural gas production in Iraq is very limited. However, at Iraq's crude oil production sites, natural gas that is dissolved within the crude oil is being flared into the atmosphere after it is separated at the plant from the crude oil. This provides a potential opportunity for this gas to be recovered, processed, and used as fuel at Qudas. The East Baghdad Gas Plant is a crude oil production facility and supplies crude oil to Qudas via pipeline. The Plant, located about one kilometer away from Qudas, disposes of the natural gas through the flaring process. Site Photo 5 below shows the flaring process at the East Baghdad facility. Since natural gas is a cleaner burning fuel, using it instead of crude oil or diesel would reduce maintenance costs and outages associated with the LM-6000 combustion turbines at Qudas. Modification 06, dated 22 October 2005, adding CLIN 0004 to Task Order 0006

requires FluorAMEC, LLC to assess this issue. The required assessment and ROM estimate will consider the feasibility and costs of redesigning and refurbishing the East Baghdad Gas Plant systems to provide 18 million standard cubic feet per day (MMSCF/D) of natural gas to Qudas. Each LM-6000 requires 9 MMSCF/D to operate; therefore, the natural gas obtained from the East Baghdad facility could supply the daily fuel requirements for two of the four LM-6000s. FluorAMEC's assessment shows that, for an investment of approximately \$45 million, recovered natural gas from East Baghdad could be utilized as the fuel source for two LM-6000 Units.



Site Photo 5. Natural Gas Flared at East Baghdad Facility in Vicinity of Qudas

Quality of Fuel – The crude oil used in the Frame 9E combustion turbines is supplied by the East Baghdad Gas Plant. The crude oil is low grade and is shipped via pipeline to Qudas without any pre-treatment or refining. There is a fuel testing laboratory at Qudas and the crude oil is tested once a day or when the fuel supply is changed to another storage tank. Fuel is stored in one of six 5,000 m³ storage tanks. The crude oil supplied from the East Baghdad Gas Plant has very high concentrations of vanadium. Vanadium, a metallic element, is an oil-soluble impurity in crude oil and is generally associated with high sulfur content petroleum. Vanadium will deposit on tubing and turbine blades and related equipment, causing decreases in production capability and plant efficiency. As a result, the plant operators add a vanadium inhibitor to counteract the effects. The inhibitor is supplied in drums (Site Photo 6) and is injected into the fuel line at the Frame 9E fuel pre-heater skid. It is estimated that approximately 8 drums of inhibitor are needed for every 24 hours of continuous operation of one Frame 9E.

The diesel supplied to the plant can also be of questionable quality. Fuel is tested for every delivery truck. The main impurities in the diesel are lead, vanadium, and biological contaminants. The fuel is run through a centrifuge to reduce the levels of these harmful contaminants prior to being supplied to the LM-6000s.



Site Photo 6. Vanadium Inhibitor Drums Adjacent to Frame 9E

The use of crude oil in the Frame 9Es increases the level and frequency of maintenance required. General Electric's publication titled "Heavy-duty Gas Turbine Operating and Maintenance Considerations" (2004), addresses the effects of fuel types burned in gas turbines. With heavier fuels such as crude oil, the operating time between major overhauls of the turbine's combustion unit is reduced by a factor of two to three as compared with natural gas. Although diesel is not as deleterious as crude oil, major overhauls of the combustion components are needed 1.5 times as frequently as with natural gas.

Vanadium Inhibitor – As noted earlier, the fuel quality at Qudas necessitates significant usage of vanadium inhibitor (8 drums for every 24 hours of operation one Frame 9E unit). Further, the estimated cost of vanadium inhibitor (Site Photo 6), including shipping, is about \$2,000 per drum.

Operations and Maintenance Manuals

The O&M manuals were originally submitted on the previous contract administered by GRD. Task Order 0006, CLIN 0001, did not require FluorAMEC to develop O&M documentation or submittals on the Frame 9E or LM-6000 combustion units. During the two site visits, we found that the O&M manuals for the Frame 9E units were located in a cabinet at the Qudas administration building conference room. They were not available in the individual control rooms for the operators to readily use. Alternatively, the O&M manuals for the LM-6000 units were readily available and located in the two control room facilities adjacent to each unit.

Preventive Maintenance

Preventive maintenance is necessary to ensure equipment reliability and operations with minimal down times. Preventive maintenance typically involves a planned and controlled program of systematic inspection, adjustment, lubrication, and replacement of the unit's components. An effective preventive maintenance program will extend

the service life of equipment and reduce life cycle costs along with increasing operational efficiency.

We did not observe any preventive maintenance activities nor was there any documentation available to demonstrate the presence of a preventive maintenance program during the site visits. The O&M manuals for the combustion turbines spell out requirements for preventive maintenance. According to PCO and FluorAMEC engineers, only reactionary maintenance is being done. For example, filters are changed when an alarm goes off. There are over 140 vendors that have provided preventative maintenance instructions on various items such as filters, dampers, coolers, heat exchangers, low voltage motors, and valves that are a part of the LM-6000 units. There is no indication that the preventive maintenance on these components as recommended by the manufacturers is being regularly conducted. Further, as stated by FluorAMEC engineers, the lack of preventative maintenance could decrease the life of an LM-6000 unit by 50 percent.

Spare Parts

As noted earlier, spare parts procurement and management was under Project EG-051, a separate project within Task Order 0006. Project EG-051 contained two contract line items, CLIN 0002 - emergency spare parts and CLIN 0003 – functional spares. According to the 2 December 05 Weekly Cost report submitted to PCO by FluorAMEC, there has been \$2,089,826 expended for emergency spare parts and \$2,572,904 expended for functional spares.

During the commissioning process of the Frame 9Es and LM-6000s at the Qudas Plant, emergency spare parts and functional parts were identified by PCO with input from FluorAMEC. Functional parts are essential to commission the units. Emergency spare parts are spares on hand and are warehoused at Qudas. We received from PCO multiple spreadsheets and listings of spare parts for Qudas. However, based on the information provided to us by PCO, there appears to be no comprehensive system to identify the type and quantities of functional and emergency spare parts that have been procured for Qudas; nor is there a recommended emergency spare parts list that could be utilized in the future by the Ministry of Electricity.

Site Photo 7 shows one side of the warehouse used for spare parts storage. At Qudas, the warehouse inventory system is maintained through retention of shipping and receiving documents kept in binders in the warehouse manager's office. It is a paper-based system, but PCO currently has two individuals who are working with the Qudas warehouse staff to develop a spreadsheet-based Parts Inventory System and Inventory Control System.



Site Photo 7. Spare Parts Storage

Training

Training conducted during the contract period included onsite training provided by BTEC Turbines LP (BTEC), from 23 May to 9 June 2005 and a subsequent course from 4 to 13 July 2005. These training sessions focused on the operation and maintenance of the LM-6000 units. The initial course, beginning in May, was for plant operators and provided basic information on the equipment in the LM-6000 gas turbine generator plant and its operational requirements. The training included the following topics:

- Gas generator fundamentals (i.e., combustion system, bearing assembly, etc.).
- Turbine auxiliary systems (lube oil cooling system, air inlet system, and system operating parameters).
- Generator and basic protection.
- Gas turbine operations (pre-start, startup, operational checks).
- Systems Review.

According to BTEC's training report, emphasis was placed on utilizing O&M manuals, initiating technical discussions, and the corrective action decision process. The use of the vendor's technical manuals was also covered and additional time was devoted to explain how to research and troubleshoot problems using the manuals.

BTEC's training report noted that the technical competency of the operators attending the training appeared to be high. However, the training provider from BTEC observed that developing routine maintenance seemed to present problems for all the operators. The training provider also stated in his report that the problems are due to: "The lack of clearly defined procedures within the vendor's documentation and the need for developing advanced tools and processes."

Each employee attending the training received an instruction manual from BTEC. Training records indicate that 28 operators from Qudas were on the class roster for the training during the 23 May to 9 June 2005 session. Our review of the training

records disclosed that 15 of 28 (55 percent) employees attended class 19 percent of the time or less during 23 May to 9 June 2005.

BTEC provided another class on the LM-6000 operations in July 2005 in two identical training sessions; these two, 5-day sessions (July 4-8 and 9-13) provided classroom and hands-on training which covered the unit's communications modules and their interface to the control systems. Twelve people attended this training and 10 of 12 (83 percent) employees attended every day of the five-day training session.

BTEC's training report for the 4-13 July 2005 training listed one problem observed dealing with spare parts. The report notes an ongoing problem with plant personnel being unable to locate spare parts under the current warehousing structure at Qudas.

BTEC's training report for the July sessions also reports that the training providers remained an additional 10 days to assist with the startup of the LM-6000s and provide operational support. Further, during this period, the Qudas operators were given additional training covering the starting up and shutting down of the gas turbines, operation of the fuel oil treatment plants, and how to determine the importance of alarms that occur during normal operation of the turbines.

In addition to formal training, GE provided on-the-job training to Iraqi plant operation shift leaders during the commissioning of the LM-6000s.

Regarding Frame 9Es, there were no records or information provided to substantiate any training took place for the Qudas Plant operators on the operation and maintenance of these units.

Future Sustainability Efforts

There are currently two PCO led sustainability initiatives for Iraq's power plants.

Operations and Maintenance Request for Proposal W914NS-05-R-2079

In a major effort to advance sustainability of Iraq's power generation capability, PCO has issued a request for proposal for the development, implementation, and sustainment of an effective Operations and Maintenance plan in coordination with the MoE. This contract, when awarded, is intended to enhance production and long term reliability and availability at the MoE's power stations. The scope of work focuses on six functional areas:

1. **Power Plant Support** -- This includes embedded contractor teams at seven power plant sites. Their mission is to assist MoE operators in plant sustainment activities such as development and implementation of O&M procedures, development and implementation of O&M reports, providing an overall spare parts plan and inventory control, and implementation of on-the-job training activities.

2. **Resident Technical Support for the MoE** -- This includes an embedded contractor management team to work at the MoE offices in Baghdad to provide general coordination of the O&M contractual obligations and to assist the MoE in establishing an efficient and reliable generation system.
3. **Engineering Support** -- This includes an engineering support team capable of providing support to the field teams and the MoE in the areas of:
 - a. Root cause analysis
 - b. Performance evaluations
 - c. Plant upgrades
 - d. Maintenance support
 - e. Design review
 - f. Heat balances and performance models
4. **Maintenance Support** -- This includes at least one central maintenance team which can be dispatched on demand to plants throughout Iraq to support the onsite maintenance staff and provide specialized technical inspections and maintenance.
5. **Central Monitoring** -- This will include a contractor team to staff a National Dispatch Center (i.e., central monitoring facility for Iraq's combustion turbine power stations).
6. **Mobile Technical Support** -- This includes a one-time, 60-day training program for six (6) MoE personnel, who will then operate two mobile training vehicles and provide onsite training by traveling to various MoE power plants. The two vehicles will be equipped to serve as mobile training centers dedicated to basic instrument calibration and controls training.

The contract, when awarded, will be for one base year, plus two option years. The intention within the contract is to utilize host nationals as much as possible to comprise the teams defined in these six functions. The team members will provide mentoring to the MoE staff who then will gradually take over the day to day O&M activities. The level of contractor effort can be reduced as the skill levels of the MoE operators and engineers become further developed.

PCO Sustainability Initiative for Iraq Power Plants

Currently in the development stages, PCO Electrical Sector is leading an effort to put together comprehensive bid documents to complete the routine maintenance for 10 Iraq power plants. Routine maintenance will include: hot gas path inspections, combustion inspections, aero-derivative turbine change outs, functional parts identification and procurement to support the combustion turbine overhauls, and maintain an on-hand strategic spare reserve. The current budget that has been put forward by the Electrical Sector at PCO is \$340 million. Within this initiative, there is also an emphasis to have the MoE more involved, particularly with the funding of some of the requirements. PCO, IRMO and USAID are considering strategies for

additional cost sharing arrangements by the MoE. For example, one possibility is to have the MoE purchase the required parts with their budget.

At present, the entire sustainability initiative is unfunded.

Conclusions

The objective of task order 0006, project EG-049 was primarily to “rescue” Frame 9E units 3 and 4 and LM-6000 units 5 through 8 at Qudas and put them into commission to produce electricity for the Iraqi grid. The project has sustainability components embedded although they did not fully address sustainability requirements for commissioning and operating a power plant. The following provides a summary of our conclusions.

1. Although improving the supply and quality of consumable products such as fuel, which was not an objective of EG-049, the supply of fuel, the quality of fuel, and the lack of natural gas at Qudas is not consistent with efficient and effective combustion turbine operation. The proposal to capture “flared” natural gas for the East Baghdad Gas Plant as a partial fuel source for the LM-6000s remains unfunded at this time. Further, the current method for delivering fuel to the LM-6000s cannot sustain long term continuous operations.
2. Maintenance manuals for the Frame 9E units and the LM-6000 units were on hand. The LM-6000 manuals were located in the two control room facilities adjacent to each unit. Alternatively, Frame 9E manuals were located in a cabinet at the Qudas administration building conference room not readily available for the operators’ use.
3. Preventative maintenance was not performed nor was documentation available to demonstrate the presence of a preventive maintenance program. Instead, maintenance on the LM-6000s and Frame 9E units was reactive, not preventive.
4. Functional parts and emergency spare parts were not part of EG-049. Spare parts were addressed in EG-051. To date, \$2,089,826 has been expended for emergency spare parts and \$2,572,904 expended for functional spares. However, based on the information provided to us by PCO, there appears to be no comprehensive system to identify the type and quantities of functional and emergency spare parts that have been procured for Qudas; nor is there a recommended emergency spare parts list that could be utilized in the future by the MoE.
5. Training was conducted during the contract period and included onsite training provided by BTEC Turbines LP (BTEC), from 23 May to 9 June 2005 and a subsequent course in the period from 4 to 13 July 2005. These training sessions focused on the operation and maintenance of the LM-6000 units. There were no records of training being conducted for the Frame 9E units.

Recommendations

The Director, Iraq Reconstruction Management Office; Commander, Gulf Region Division; and the Commander, Joint Contracting Command-Iraq/Afghanistan (JCC-I/A) should coordinate and:

1. Continue to pursue funding for the sustainability of the Iraq power plants initiative.
2. Seek and advocate funding and implementation of the natural gas recovery assessment.

Management Comments

The Principal Assistant responsible for Contracting, JCC-I/A, concurred with our conclusions and recommendations and provided the following comments.

1. "GRD/PCO is continuing to pursue funding for the initiative. JCC-I/A currently has one sustainability project nearing award; solicitations for four projects are currently advertised; and one project is being prepared for solicitation. GRD/PCO will be able to fund the current projects. However, it is waiting funding from the Ambassador's deferred program to become available for additional projects under the sustainability program."
2. "Concur in part. The original plan was to use Fluor-AMEC; however, funds were taken out of the program to fund the Ambassador's program. It appears that some money is being returned from the Ambassador and the requirement has been taken over by the Oil Sector."

Evaluation of Management Comments

Management comments addressed the issues raised in our conclusions and actions planned and taken should correct the deficiencies.

Appendix A. Scope and Methodology

We performed this project assessment from November through December 2005 in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included a professional engineer and auditor.

In performing this Project Assessment, we:

- Reviewed contract documentation, including the Scope of Work, contract, contract modifications, daily, weekly and monthly cost reports;
- Reviewed the design package (manufacturer drawings and specifications) and all available sustainability documentation;
- Interviewed PCO project manger and project engineers, and the contractor's field manager and project engineers; and
- Conducted an onsite assessment at the Qudas Electrical Power plant and documented results.

Appendix B. Acronyms

BTEC	BTEC Turbines LP
CLIN	Contract Line Item Number
CPA	Coalition Provisional Authority
DFI	Development Fund for Iraq
Frame 9E	Combustion Gas Turbine Engine (123 megawatts capability)
GE	General Electric
GRD	Gulf Region Division
IRMO	Iraq Reconstruction Management Office
LM-6000	Combustion Gas Turbine Engine (43 megawatts capability)
MoE	Ministry of Electricity
MMSCF/D	Million Standard Cubic Feet per Day
O&M	Operation and Maintenance
PCO	Project and Contracting Office
ROM	Rough Order of Magnitude
SPCO	Sector Project Contracting Office
USACE	U.S. Army Corps of Engineers
USAID	U.S. Agency for International Development

Appendix C. Report Distribution

Department of State

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Senior Advisor to the Secretary and Coordinator for Iraq

U.S. Ambassador to Iraq

Director, Iraq Reconstruction Management Office

Inspector General, Department of State

Department of Defense

Deputy Secretary of Defense

Director, Defense Reconstruction Support Office

Under Secretary of Defense (Comptroller)/Chief Financial Officer

Deputy Chief Financial Officer

Deputy Comptroller (Program/Budget)

Inspector General, Department of Defense

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)

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Commanding General, Joint Contracting Command – Iraq/Afghanistan

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House Committee on Government Reform
 Subcommittee on Government Efficiency and Financial Management
 Subcommittee on National Security, Emerging Threats and International Relations

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 include:

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