U.S. TRADE AND DEVELOPMENT AGENCY

EXECUTIVE SUMMARY

FINAL REPORT FOR KHOURIBGA COGENERATION PLANT FEASIBILTY STUDY

MARCH 1, 2000

U.S. Firm: Black & Veatch
Main contact name: H.Z. Kennon
Current phone: 913-458-2000
Fax: 913-458-8711

Project Sponsor: OCP
Main contact name: Mr. Driss Msatef
Current phone: 212-2-230-620
Fax: 212-2-990-752

TDA Activity Number: 98-10052A
NTIS: PB2000-105654

1.0 Introduction/Summary

Black & Veatch International (BVI) was retained by Groupe Office Ch6rifien des Phosphates (OCP) to perform a feasibility study for a cogeneration facility at the Phosphate Drying Plant near Khouribga, Morocco. This study has been funded by the United States Trade and Development Agency (USTDA) under Grant No. GH8152318 (Activity No. 98-10052A).

The objective of this study is to establish the technical and financial feasibility of a developed cogeneration **facility at the OCP Khouribga Phosphate** Drying Plant. The study will determine the following for the cogeneration facility:

- Preferred facility generation capacity.
- Appropriate generation technology.
- Economic and reliable conceptual design.
- Estimated costs.
- Realistic implementation plan.
- Project financial viability.

The investigations, analysis, results, and recommendations for this study are documented in this Final Report.

1.1 Phosphate Industry Significance and Expansion Plans

The phosphate mining and fertilizer production are extremely important to the Moroccan economy for the reasons listed below:

- Fertilizer production is one of the largest sources of Moroccan foreign exchange.
- The phosphate mining and fertilizer production industries employ a significant portion of the skilled and semi-skilled labor in Morocco.

Because of its great importance, the government of Morrocco has placed a very high priority on expanding phosphate mining and processing facilities over the next 5 years.

Recognizing this important expansion, OCP intends to increase production at its Khouribga phosphate mining complex. To support this increased production, OCP is considering constructing a cogeneration plant that would supply both electricity and process heat to the complex.

1.2 Project Overview

This Feasibility Study project will review the potential to install a cogeneration electrical power plant to supply both electrical energy and process heat for the phosphate rock production plant at Khouribga. This electrical generation would be used to supply the power plant needs. Excess energy would be supplied to

ONE's electrical power grid. The exhaust heat from the combustion turbine would be used to supply a portion of the heat energy required for the phosphate drying process.

The underlying objective of this cogeneration study is to devise an environmentally and economically sound method of "thermal recycling." In essence, this cogeneration application captures the excess thermal energy contained in the turbine exhaust gas which is often lost "up the stack" in more conventional design applications.

Therefore, OCP solicited USTDA funding for this cogeneration plant feasibility study to investigate the cogeneration possibility, identify the preferred plant configuration option, and determine its financial feasibility. Specific tasks addressed in this study included the following:

- Review the operations of plants and mines at the Khouribga site to gather pertinent production and processing information, as well as data needed to provide a basis for the analysis of the project.
- Evaluate energy requirements for plants and mines and establish electricity prices.
- Develop a purchasing plan for energy.
- Develop feasibility study plans and design basis.
- Prepare plant heat balances.
- Prepare preliminary plant layouts.
- Prepare equipment lists and preliminary specifications.
- Conduct technical and economic studies.
- Develop conceptual design documents.
- Develop capital costs and investment requirements.
- Perform a financial and risk analysis.
- Evaluate a management plan for plant maintenance.
- Prepare and submit final feasibility study report.

1.3 Final Report Outline and Content

This Final Report has been developed to document the execution of these tasks including data collected, conceptual design developed, financial viability, results, and conclusions. This comprehensive review study is being presented in the sections described below:

Section 1.0 Introduction/Summary. This section provides a brief introduction and overview of the project. Section 2.0 Existing Facility Summary/Project Requirements. This section of the report provides details and discussions of the following:

Existing facility

-Existing equipment.

-Existing operating mode.

Section 3.0 Study Plan and Configuration Optimization. This section of the report contains the following:

-Information on the study plan.

-Description of potential cycle configurations.

-Justification for selection of the most appropriate configuration to be used as a basis for the remainder of the study.

- Section 4.0 Conceptual Design Information. This report section provides information on the conceptual design of the preferred configuration option including the following:

- Plant arrangement.

- System descriptions.

- Piping and instrument diagrams.

-Heat balances.

- Section 5.0 Prelimina1y Specifications. This section provides a brief summary of technical and operational specification requirements for major equipment components of the selected configuration.

Section 6.0 Preliminary Planning Information. This report section contains the following:

Preliminary project schedule.

Estimated capital costs.

Estimated operation and maintenance costs.

Section 7.0 Preliminary Financial & Risk Analysis. This section of the report presents the financial pro forma model results for the selected configuration as well as provides a brief discussion of potential project risks.

Section 8.0 Operation and Maintenance (O&M) Plan. This section provides a discussion on the operation and maintenance needs for the power plant including a preliminary O&M manual on the design, plant automation, and local conditions. This section also includes a one year maintenance schedule and spare parts list.

1.4 Conclusions

The technical review performed for this study confirmed that the proposed cogeneration facility is technically feasible. Specific aspects of the project where technical feasibility was confirmed include the following:

- The use of combustoin turbine exhaust gas as a source of supplemental heat for the phosphate dryer combustion chambers.

1.0 Introduction/Summary

- The relocation of an existing Alstom Frame 6B combustion turbine from Tit-Mellil to Beni-Idir.
- The use of large, internally insulated ductwork to distribute exhaust gas to the phosphate dryers without exceeding the exhaust pressure limitations of the Frame 6B combustion turbine.
- Interconnection of the combustion turbine and supporting auxiliaries to the existing plant systems at Beni-ldir listed below:

  -Fuel oil unloading and storage system.

  -Fuel oil supply system.

  -Well water supply system.

  -60 kV substation.

In addition, it was confirmed that the facility will reduce the amount of fuel consumed by the phosphate dryers. However, the economic analysis indicates that unless ONE provides concessions such as sharing the capital cost to construct the facility, furnishing the exhaust gas heat at no charge, or lowering the cost of electricity purchased by OCP, the project will not be economically viable. Without the necessary concessions from ONE, BVI recommends that OCP abandon the Khouribga cogeneration project.