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INSTALLATION OF A STOKER-COAL PREPARATION PLANT

IN

KRAKOW, POLAND

Technical Progress Report 3

November-December, 1994

Work Performed Under Cooperative Agreement DE-FC22-94PC94114

EFH Coal Company

Mars, PA

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INSTALLATION OF A STOKER-COAL PREPARATION PLANT IN KRAKOW, POLAND

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Cooperative Agreement No.
DE-FC22-94PC94114

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EXECUTIVE SUMMARY

This report describes the progress made during this reporting period of a two year project to demonstrate that the air pollution from a traveling grate stoker being used to heat water at a central heating plant in Krakow, Poland can be reduced significantly by (1) substituting the unwashed, unsized coal currently being used with a mechanically cleaned, double-sized stoker fuel and by (2) optimizing the operating parameters of the stoker. It is anticipated that these improvements will prove to be cost effective and hence be adopted by the other central heating plants in Krakow and indeed, throughout Eastern European cities where coal continues to be the primary source of fuel.

EFH Coal Company has formed a partnership with two Polish institutions -- MPEC, a central heating company in Krakow, and Naftokrak-Naftobudowa, preparation plant designers and fabricators, for the execution of this effort.

The washability data from a 20mm x 0.5mm size fraction of raw coal from the Nikwa Modrejow Mine were evaluated. The data show that the ash content of this coal can be reduced from 34.0 percent to 9.0 percent by washing in a heavy-media cyclone at 1.725 sp.gr.; the actual yield of clean coal would be 63.1 percent. This product would meet compliance limitations of 500 g of SO_2/GJ.

An evaluation of the predicted results that can be expected when washing five different candidate Polish coals shows that compliance products containing less than 640 g SO_2/GJ and 10 percent ash at attractive yields can be produced by washing the raw coals in a heavy-media cyclone. The quest for long-term sources of raw coal to feed the proposed 300 tph stoker coal preparation plant continued throughout the reporting period. Five potential candidate sources have been located and contracts for coal deliveries should be executed early next quarter. Those contracts will be performance based in that remuneration will be based on the actual yield of stoker-quality coal produced by the new plant.

An agreement was signed between ECOCOAL and Kopalnia Dolomitu for the lease of a 1000-A site near the town of Jaworzno for constructing the new stoker coal preparation plant.

Delays in formalizing the EFH/Polish Partners agreement delayed finalizing the coal supply contracts which, in turn, precluded collecting the Polish coal samples for characterization and combustion performance.

Additional meetings were held with Polish coal preparation equipment suppliers to obtain price and delivery quotations for long lead-time process equipment.

Discussions with financial institutions regarding the cost of producing a quality stoker coal in Poland and for identifying sources of private capital to help cost share the project continued.

The search for markets for utilizing surplus production from the new plant continued.

INTRODUCTION

The work being performed under this Cooperative Agreement between the United States Department of Energy (DOE) and EFH Coal Company (Participant) is one part of the assessment program in the Support for Eastern European Democracy (SEED) Act of 1989 (P.L. 101-179).

In October 1991, a Memorandum of Understanding (MOU) titled "Collaboration on the Krakow Clean Fossil Fuels and Energy Efficiency Program, A Project of Elimination of Low Emission Sources in Krakow" was signed by the DOE and the Ministry of Environmental Protection, Natural Resources and Forestry of the Republic of Poland, that describes the cooperation that is being undertaken by the respective governments to accomplish the goals of this program.

The DOE has selected eight U.S. companies to work with the government of Poland to improve the country's air quality, particularly around the historic city of Krakow. Although the program is focused on Krakow, it is intended to serve as a model for similar pollution control programs throughout Poland and, in deed, much of Eastern Europe. The total cost of the SEED program is $31 million with DOE funding about half that amount.

It is estimated that currently there are an estimated 23 district heating plants, 3,000 small boilers, and 125,000 home stoves in the Krakow area-- all coal fired.

PURPOSE

The purpose of the U.S./Polish Memorandum of Understanding is to encourage the formation of commercial ventures by providing: project development support; resources; and services to reduce low emission sources in Krakow, Poland.

These commercial ventures can take the form of contracts, joint ventures, partnerships, and other commercially-feasible arrangements to achieve the purposes of this statute.

OBJECTIVE

The specific objective of the work to be performed by EFH Coal under the terms of this Cooperative Agreement is to improve the quality of stack gas emissions from low -stack boilers in the Krakow area of Poland.

This objective will be accomplished by designing, constructing, and operating a beneficiation facility that will produce a low-ash, double-sized stoker coal for burning in the typical traveling grate stokers commonly in use throughout this area. The low-ash, uniformly sized, quality stoker coal when burned properly in existing boilers will increase combustion efficiency, reduce stoker maintenance, and reduce significantly carbon monoxide, sulfur dioxide, and particulate levels in the stack gas emissions.

To facilitate the achievement of the stated objective, EFH Coal has executed an agreement with MPEC (a district heating company in Krakow) and Naftokrak/Naftobudowa (a construction and maintenance enterprise) to design, construct and operate a 300 tph coal cleaning facility. EFH Coal has also subcontracted with the Pennsylvania State University to characterize two candidate Polish coals and to perform combustion tests on washed sublots of these Polish coals in their combustion simulator facility.

WORK STATEMENT

It is projected that a two-year effort will be needed to accomplish the objectives of this Cooperative Agreement, consisting of two budget periods and including the following nine tasks:

Budget Period I

- Task 1 - Polish Coal Washability and Combustion Performance Evaluation
- Task 2 - Raw Coal Supply Contracts
- Task 3 - Specification of Major Preparation Plant Components
- Task 4 - Preparation Plant Flowsheet Design
- Task 5 - Cost Evaluations
- Task 6 - Securing Stoker Coal Supply Contracts
- Task 7- Final Economic Evaluation and Risk Assessment

Budget Period II

- Task 8 - Plant Construction
- Task 9 - Plant Startup and Demonstration

PROGRESS DURING THIS PERIOD

Task 1.0 - Polish Coal Washability and Combustion Performance Evaluation

No Activity.

Task 2.0 Raw Coal Supply Contracts

As a bankable, stable raw coal supply is essential to the performance of this project, EFH personnel met with Brzesze, Gliwicka, Bytom, Staszic, and Katowice Holding companies during the reporting period with the goal of obtaining at least two secure, long-term, coal-supply contracts. In addition to the quality of raw coals available, other supply considerations include the amount of reserves available and the proximity of the mine to the proposed site of the new stoker-coal preparation plant.

To gain further insight on the amenability of Polish raw coals to the production of "compliance-quality" coals (i.e., coals having SO_2 emission rates less than 640 g/GJ), available washability data from a sample of coal sized 20 mm x 0.5 mm from the Nickwa Modrejow Mine were evaluated. As shown in Table 1, this raw coal had an ash content of 34.0 and a sulfur content of 0.65, respectively which, if burned in its raw state in a boiler, would produce 765 g of SO_2 per GJ.

Through the use of a logistic function computer program, the yields and product quantities that might be achieved by washing this raw coal over a range of partition densities were calculated. These partition densities were selected to determine the highest specific gravity of separation that could be used in both a jig and a dense-medium cyclone to obtain a saleable product containing no more than 500 g of SO_2/GJ. Based on experience, imperfections of 0.125 and 0.019 for the jig and dense medium cyclone, respectively, were selected for washers washing this 20 mm x 0.5 mm size fraction.

As noted in Table 1, the jig washers could produce an acceptable (i.e., SO_2 emission rate $<$ 500 g/GJ) at a partition density of 1.55. This product would contain 9.1 percent ash, 0.65 percent sulfur, and have a calorific value of 47.5 MJ/Kg; but the yield of clean coal would be only 47.5 percent.

Alternatively, by washing this coal in a dense-medium cyclone an acceptable product (500 g SO_2/GJ) at a partition density of 1.725 a product containing 9 percent ash, 0.66 percent sulfur, and 260 MJ/Kg; and the yield of saleable coal would increase to 63.1 percent--an increase in yield of 15.6 percentage points over the jig. The benefits to be accrued by washing this coal in a dense-medium cyclone rather than in a jig are illustrated in Table 2.

Table 1 - Predicted Washer Results, Nickwa Modrejow Mine, 20 mm x 0.5 mm Size Fraction

	Raw Coal	Washer Type					
		Jig			Dense-Medium Cyclone		
Partition Sp Gr	----	1.375	1.425	1.550	1.525	1.625	1.725
Yield, percent	100.0	33.4	37.9	47.5	57.4	60.7	63.1
Ash, percent	34.0	7.5	8.0	9.1	7.0	8.0	9.0
Sulfur, percent	0.65	0.63	0.64	0.65	0.63	0.65	0.66
Calorific Value MJ/Kg	17.0	27.0	26.5	47.5	27.0	26.5	26.0
Emission gSO_2/GJ	765	470	480	500	470	480	500

Table 2 - Cost Comparison of Jig vs. Dense-Medium Cyclone, Nickwa Modrejow Mine, 20 x 0.5 mm size fraction

	Washer Type	
	Jig	Dense-Medium Cyclone
Raw Coal Feed, mt/mo	115,000	115,000
Clean Coal Produced, mt/mo	53,000	70,000
Clean Coal Ash, percent	9.1	9.0
Clean Coal Sulfur, percent	0.65	0.66
Calorific Value, MJ/Kg	26	26
SO_2 Emission Rate, g/GJ	500	500
5-yr Coal Production, Million mt	3.2	4.2
5-yr Refuse Production, Million mt	3.7	2.7
Clean Coal Production Cost, $/ton	75.90	57.50

While the ash, sulfur, SO_2 emission rate, and calorific value of the coals produced by the two washers are nearly identical, the dense-medium cyclone plant would produce 17,000 metric tons per month of more saleable coal than the jig plant, both being fed 115,000 tpm of raw coal. Over a 5-year period, the dense-medium cyclone plant would not only produce 1 million tons more of saleable coal, but it also would produce 1 million tons less of refuse.

Although dense-medium cyclone plants are more complex, require more capital, and cost more to operate than a comparable capacity jig plant, the 15.6 percentage point higher yield by cyclones more than offsets the lower capital and operating cost of the jig plant.

Because of the significantly higher yields achievable through the use of dense-medium cyclones and the fact that they can separate clean coal from refuse more effectively, the estimated cost for a dense-medium product is $57.50/mt compared to a cost of $75.90/mt for a jig plant -- a savings of $18.40/mt of clean coal (see Table 2).

Table 3 summarizes the results of simulating the technical efficiency and economics of using dense medium cyclones to treat five different Polish coals. As noted, all of the predicted clean coals have ash contents no greater than 10 percent, sulfur contents less than 0.94 percent and, with the exception of the Piast mine coal, SO_2 emission rates less than the prescribed maximum of 640 g/GJ. Clean coal production costs range from a low of $41.90 to $57.50 per metric ton; this estimated cost of production does not include cleaning the minus 6 mm raw-coal fines.

After a total of some forty-five meetings with a variety of coal suppliers who represent about 85 percent (100 million metric tons per year) of Poland's coal production, it is now safe to assume that supplies of raw coal of the quantity and quality that meet the requirements of the project are available.

As no firm contract has yet been executed, coal supply negotiations to date are considered tentative in that the final selection of a raw coal supply will be based on the price, characteristics, (size distribution and washability analysis), and combustion performance of the samples of raw Polish coals that will be evaluated next Quarter under Tasks 1.1 and 1.2.

Task 3.0 - Specification of Major Preparation Plant Components

Based on a preliminary flowsheet, the following major equipment items have been identified, and sized, and for which quotations are being sought for source, price, and delivery:

Raw Coal Feeder
Tamp Iron Magnet
Raw-Coal-Belt Conveyor
Water Sprays
Prewet Box
Double-Deck Vibrating Prewet Screen
Sieve Bends
Desliming Vibrating Screen
Dense-Medium Pumps (2)
Dense-Medium Sumps (2)
Dense-Medium Cyclones (4)
Product Drain-and-Rinse Vibrating Screens (2)
Refuse Drain-and-Rinse Vibrating Screens (2)
Product Magnetic Separators (2)
Refuse Magnetic Separators (2)
Stoker Coal Product Vibrating Sizing Screen
Stoker Coal Product Belt Conveyor
Utility Coal Belt Conveyor
Refuse Belt Conveyor

Additionally, sources are being sought for a fine coal cleaning circuit and a water treatment facility.

Task 4.0 - Preparation Plant Flowsheet Design

While the precise size distribution and washability characteristics of the specific raw coal that ultimately will be processed in the stoker coal preparation plant will not be known until after the coals are evaluated under Task 1.1, there is now available sufficient data on Polish coals (as described in earlier reports) to allow the development of a conceptional flowsheet.

Based on the aforementioned simulated technical performance of jigs and dense-medium washers, it is quite evident that the dense-medium cyclone is the washer of choice. Although the specific sources of minus 20 mm raw coal have yet to be selected, enough is known about Polish coals to justify selecting the major components of equipment and "roughing out" a preliminary flowsheet. While there are likely to be differences in such details as the amount of minus 1 mm material in the feed and in the overall yield, these differences do not preclude the advancement of the final flowsheet.

Conceptually, the plant will be fed 300 tph of minus 25 mm raw coal that will be scalped at 25 mm., deslimed at 1 mm and the 25 mm x 1 mm washed in a heavy-medium cyclone. This dense-medium cyclone product will, after passing over a drain-and-rinse screen, be rescreened at 6 mm to produce a 25 mm x 6 mm stoker coal and a minus 6 mm utility coal.

Task 5.0 - Cost Evaluations

Activities related to the technical and economic performance of the proposed plant that were initiated last quarter were continued throughout this reporting period.

Based on the assumption that the new preparation plant will use heavy media cyclones as the primary washer, sources of domestic magnetite were sought. One potential source of inexpensive heavy-media was located at the Central Metallurgical Supply Co. near the town of Jaworzno where a waste product (mill scale) appears to have the physical and magnetic properties required for coal washing in cyclones.

If the washing characteristics of the finally selected coal sources are similar to those shown in Table 3 and if the proposed flowsheet produces the predicted yields, then it should be possible to produce a high-quality stoker coal meeting all of the technical and environmental requirements for between $41.90 and $57.50 per metric ton (see Table 3).

Task 6.0 - Securing Stoker Coal Supply Contracts

Additional meetings were held with a number of potential buyers of the surplus stoker and steam coals produced by the new plant.

Task 7.0 - Final Economic Evaluation and Risk Assessment

The search for an acceptable site for the new preparation plant which was begun last reporting period continued throughout this reporting period. Additional meetings were held in and around the cities of Krakow, Katowice, Walbrzych, and Jaworzno.

One of the more interesting of the sites evaluated to date was the Staszik mine/preparation plant complex located near Katowice that is owned and operated by the Katowice Coal Holding Company (KWH). This facility currently produces 4 million tons of coal per year and employs some 7,500 persons; they plan to increase this level of production to 12 million tons per year. Like most other Polish preparation plants they mechanically clean only the raw coal larger than 20 mm and sell the minus 20 mm raw coal to the electric utility, steam generating and water heating plants (See Task 2).

Table 3 - Summary of Predicted Results, Washing Polish Coals in a Dense-Medium Cyclones

	Mine				
	Piast	Janina 1	Janina 2	Staszik	Nickwa Modrejow
Clean Coal Produced, tpm	86,000	80,000	96,000	84,000	70,000
Clean Coal Ash, percent	6.3	7.0	10.0	6.2	9.0
Clean Coal Sulfur, percent	0.94	0.82	0.92	---	0.66
SO_2 Emission Rate, g/GJ	675	565	634	---	500
5-yr Clean Coal Production, million metric tons	5.2	4.8	5.8	5.0	4.2
5-yr Refuse Production, million metric tons	1.5	1.8	0.9	1.7	2.3
Clean Coal Production Cost,$/ton	46.80	50.30	41.90	47.90	57.50

An agreement was signed between ECOCOAL and Kopalnia Dolomitu for the lease of a 1000-A site near the town of Jaworzno. This is a particularly interesting location for constructing the new plant in that all necessary utilities are available, it is accessible by both road and rail, and there is sufficient space for at least seven years of refuse production. The lease runs through the year 2024.

The Gantt chart (Figure I) summarizes progress to date.

DIFFICULTIES ENCOUNTERED

The protracted delays in formalizing the EFH Coal/Polish Partners (MPEC and Naftkrak-Naftobudowa) agreement delayed the initiation of the search for Polish coal sources (Task 2.0) to feed the new preparation plant. This, in turn, delayed the collection of the two Polish coal samples that are to be tested for size distribution, washability characteristics, and combustion performance. The end result was that work on Task 1.0 could not be started as planned.

Because the basic inputs to Task 4.0 (Preparation Plant Flowsheet Design) are the analytical results of Tasks 1.0 and 2.0, failure to complete these tasks as planned precludes a final plant design.

FUTURE WORK

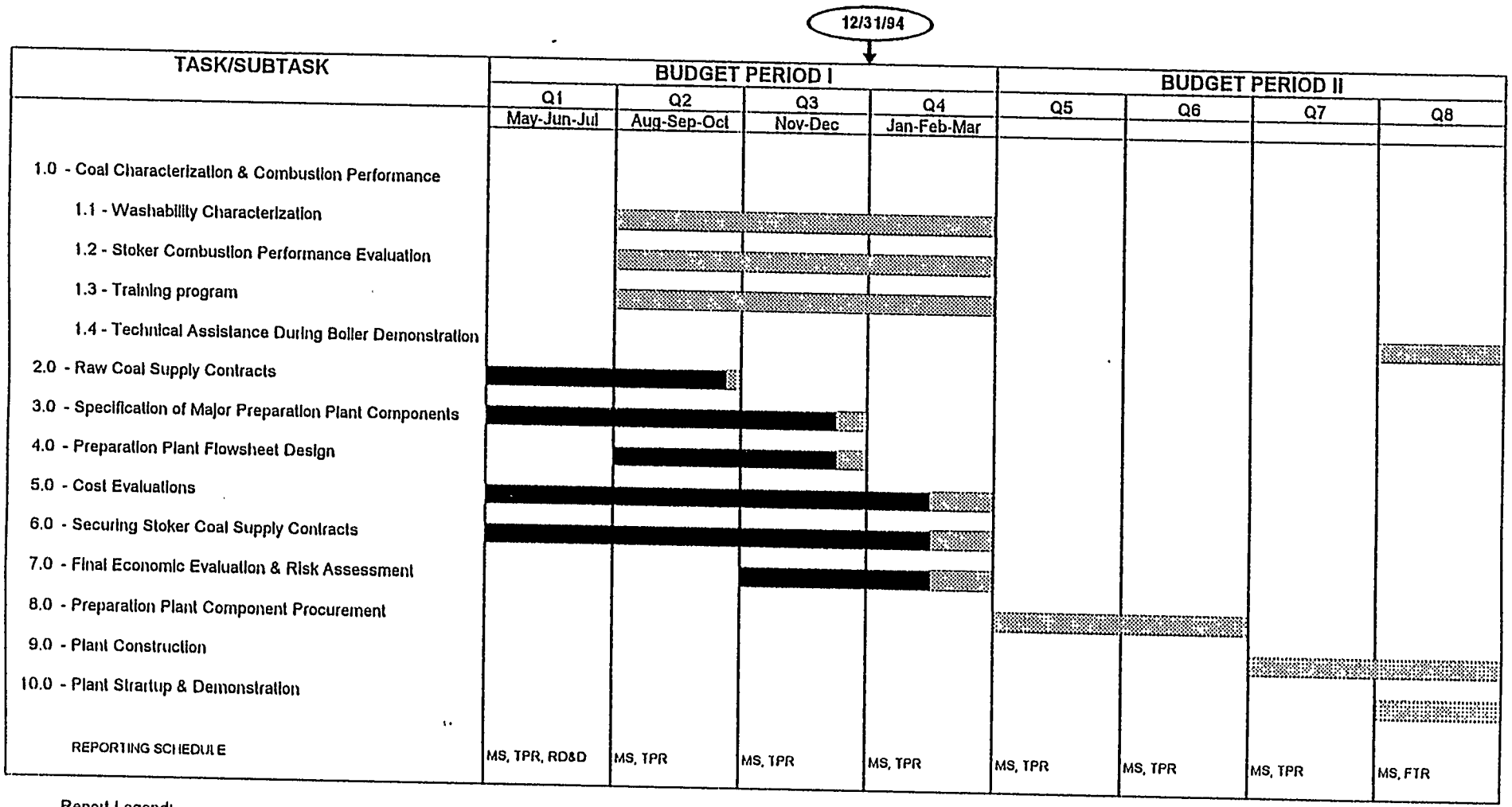
The following activities are planned for the next Quarter:

- Collect and ship to Penn State samples of two polish coals for evaluation (Task 1.0).
- Initiate work on Task 1.1, Coal Characterization.
- Initiate work on Task 1.2, Combustion Performance.
- Initiate work on Task 1.3, Training Program.
- Complete work on Task 2.0, Raw Coal Supply Contracts.
- Complete work on Task 3.0, Specification of Major Preparation Plant Components.
- Complete work on Task 4.0, Preparation Plant Flowsheet Design.
- Continue work on Task 5.0, Cost Evaluations.
- Continue work on Task 6.0, Securing Stoker Coal Supply Contracts.
- Continue work on Task 7.0, Final Economic Evaluation and Risk Assessment.

Figure 1 - GANTT CHART

KRAKOW CLEAN FOSSIL FUELS AND ENERGY EFFICIENCY PROGRAM

INSTALLATION OF A STOKER COAL PREPARATION PLANT IN KRAKOW, POLAND



Report Legend:

MS - Federal Assistance Management Summary
TPR - Technical Progress Report
RD&D - Notice of Energy RD&D Project
FTR - Final Technical Report

Performance Legend:

PLANNED

ACTUAL