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TECHNICAL PROGRESS REPORT NO. 1

MICRONIZED COAL-FIRED RETROFIT SYSTEM FOR SO_x REDUCTION

Prepared for

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1.0 EXECUTIVE SUMMARY

The PROJECT proposes to install a new TCS micronized coal fired heating plant for the PHRO Greenhouse Complex in the Town of Krzeszowice, Poland (near Krakow). PHRO utilizes 14 heavy oil-fired boilers to produce heat for its greenhouse facilities and also home heating to several adjacent housing cooperatives. The boilers currently burn a high-sulfur content heavy oil, called Mazute.

The new micronized coal fired boiler would: (1). provide a significant portion of the heat load for PHRO, and a portion of the adjacent residential heating, (2). dramatically reduce sulfur dioxide air pollution emissions, while satisfying new Polish air regulations, and (3). provide attractive savings to PHRO, based on the quantity of displaced oil.

TCS, Inc. will maintain primary responsibility for PROJECT implementation and for supply of micronization equipment. Other key U.S. equipment suppliers will include:

- (a). Babcock & Wilcox ("Boiler-island")
- (b). Amerex, Inc. (Baghouse)
- (c). Control Techtronics International, Inc. (Control system)

Currently, the Town of Krzeszowice is considering a district heating program that would replace some, or all, of the 40 existing small in-town heating boilers that presently burn high-sulfur content coal. Potentially the district heating system can be expanded and connected into the PHRO boiler network; so that, PHRO boilers can supply all, or a portion of, the Town's heating demand. The new TCS micronized coal system could provide a portion of this demand.

The TCS system potentially could provide two important advantages to PHRO and the Town of Krzeszowice, including: (1). displace a portion of the coal use and reduce a portion of the existing air emissions resulting from the existing small in-town coal fired boilers, and (2). establish "ground-work" for installing a "second" TCS system to displace all of the remaining coal use and reduce all of the remaining existing air emissions resulting from the 40 small in-town coal fired boilers. These considerations will be assessed and addressed in TCS's Final Budget Period I Report.

The new micronized coal fired boiler would: (1). provide a significant portion of the heat load for PHRO, (2). dramatically reduce sulfur dioxide air pollution emissions, while satisfying new Polish air regulations, and (3). provide attractive savings to PHRO, based on the quantity of displaced oil.

The TCS technology is protected by five (5) U.S. Patents and an array of foreign patents. TCS recently applied for an additional Patent that pertains to enhancement of its mill's performance.

Micronized coal is coal micro-pulverized to a particle size consistency similar to a very fine talcum powder. Because of its micron-size particle distribution, micronized coal has unique combustion characteristics that are similar to those associated with oil. Reasons for the similarity to oil, is that micronized coal has: (a). high combustion reactivity, (b).

lower ignition temperatures, (c). earlier combustion completion, and (d). minimum slagging or erosion effects.

Sulfur dioxide reductions during combustion with micronized coal is possible by co-micronizing limestone with coal. Sulfur dioxide (SO₂) air emissions are reduced due to a number of synergistic causes, including: a). intimate mixing and contact between coal and limestone particles, and b). accelerated calcination and sulfation reactions resulting from the small particle distribution of coal and limestone.

Nitrogen oxide reductions utilizing a TCS system result primarily from: (a). lower excess air than other conventional coal combustion systems, and (b). staged combustion achieved with a proprietary Babcock & Wilcox XCL Low-NOX burner.

Carbon monoxide reductions result because of the extremely high degree of carbon burnout achieved with micronized coal.

2.0 PROGRAM INTRODUCTION

The work to be performed is part of the equipment assessment program in the Support for Eastern European Democracy (SEED) Act of 1989 (P.L. 101-179). Following the guidance of this legislation, a U.S.-Poland Bilateral Steering Committee (BSC) was established to define the program. The BSC is directing a program of assistance to Poland that would reduce air pollution in Krakow, Poland from about 1,300 boiler houses that provide heat for industrial, commercial, and residential applications, plus about 100,000 small stoves for home heating. The 1,300 boiler houses and 100,000 home heating stoves in Krakow primarily utilize solid fossil fuels and have been collectively called "low emissions sources" because of their low stack heights and the consequent low elevation entry of flue gases into the ambient air.

In October 1991, a Memorandum of Understanding (MOU) was signed by the U.S. Department of Energy (USDOE) and the Ministry of Environmental Protection, Natural resources and Forestry of the Republic of Poland. The MOU is titled, "Collaboration on the Krakow Clean Fossil Fuels and Energy Efficiency Program, A Project of Elimination of Low Emission Sources in Krakow." This MOU describes the cooperation that is being undertaken by the governments of the United States and the Republic of Poland to accomplish this program. Funding for the program is being provided through the Agency for International Development (AID).

The purpose of the program is to encourage the formation of commercial ventures between U.S. and Polish firms to provide equipment and/or services to reduce pollution from low emission sources in Krakow, Poland. These commercial ventures may take the form of contracts, joint ventures, partnerships, or any other commercially feasible arrangements that accomplishes the purposes of the statute.

Project development support includes all activities that must be accomplished by U.S. organizations and their proposed team members before the enterprise can expect to receive revenues from its activities in

Krakow. These activities may include efforts to determine how to establish a U.S.-owned business in Poland, identify the Polish regulations relevant to the proposed project, conduct marketing studies, identify facilities and a labor force for the venture, and acquire a manufacturing plant. The proposed activities may also include the construction and testing of equipment to be sold (e.g., furnaces) or to produce a fuel to be sold. The proposed activities may utilize Polish fuels, as appropriate, to confirm technical feasibility.

The assistance provided is through cost-shared cooperative agreements between the USDOE and U.S. companies. Participation of Polish firms through teaming arrangements with U.S. proposers, while not required, is strongly encouraged. Fifty percent minimum cost sharing is required.

The work to be conducted as part of the project described herein involves the construction of a new heating plant at the PHRO Greenhouse Complex in the Town of Krzeszowice, Poland (near Krakow). The facility will include: (a). new coal and limestone storage silos, (b). TCS Coal Micronization System, (c). Babcock & Wilcox "boiler island", (d). Amerex baghouse, (e) Control Techtronics International control system, and (f) balance of plant and equipment supplied by various Polish engineering design and construction companies and equipment suppliers.

Primary objective will be to (a). provide significant reductions in air pollution emissions for PHRO, (b). demonstrate an important U.S. Clean Coal Technology utilizing Polish coal and limestone, and (c). lower PHRO's operating costs.

3.0 TASK ACCOMPLISHMENTS

Task 1: COORDINATION, DOE LIAISON, REPORTS, FINANCIAL MANAGEMENT

TCS has maintained communications and liaison between the U.S. Department of Energy (USDOE) and all PROJECT participants and is responsible for financial management and administration of Budget Period I of the PROJECT.

Task 2: CONFIRM ALL SITE CRITERIA

This task is complete. TCS submitted a request to, and received, information and data from, PHRO regarding specific siting, existing equipment, and energy consumption, including: (a). verification of key operational and siting criteria at the PHRO Greenhouse Complex such as: daily, weekend and seasonal thermal load profiles, (b). boiler design criteria, (c). boiler mass-energy flow throughput, peak and average required heat flows, other material and mass balance data verification, (d). auxiliary power requirements, electrical hookup, instrumentation and control, and (e). location drawings of existing equipment especially at points of interface with new equipment.

Task 3: NEW EQUIPMENT SPECIFICATION

This task is complete. Based on results of Task 2, TCS completed an analysis of existing facility equipment and requirements to establish preliminarily design and performance criteria for new equipment

requirements. A detailed energy consumption profile was evaluated to determine the optimum size boiler for application at PHRO, resulting in a boiler capacity of 40,000 pph (12 Mwt). This boiler size established fuel input and heat output criteria for the facility. Other key equipment assessed included: (a). one (1) TCS micronization mill, (b). Babcock & Wilcox FM boiler and Babcock & Wilcox XCL Low-NOx burners, (c). Amerex baghouse, (d). Control Techtronics International control and monitoring system, (e). coal, limestone and ash handling and conveying equipment, (f). mechanical equipment such as fans, air compressor, ductwork, and (g) building.

Task 4: CONCEPTUAL PLAN AND PRELIMINARY SITE LAYOUT OF NEW EQUIPMENT

This task is complete. TCS completed a preliminary engineering plan and site layout with "focus" on identifying potential "problem areas" of the PROJECT and issues which were discussed with PHRO during the initial site visit by TCS during the week of April 15, 1996.

TCS produced drawings indicating layout of new equipment in relation to existing facilities and siting requirements. Likewise, schematic one-line drawings and logic diagrams were prepared with sufficient detail to present a preliminary understanding of all mechanical, electrical, and structural systems, equipment location. The following new equipment and facility requirements were considered:

1. Coal/limestone unloading hopper, with feeder to bucket elevator.
2. Bucket elevator, with "flip-flop" gate at top for directional flow of coal and limestone.
3. Concrete stave coal storage silo.
4. Concrete stave limestone storage silo.
5. Screw conveyor feeders on both coal and limestone silos.
6. TCS Ferrous/Non-Ferrous Metal Detection and Rejection System in conjunction with new coal and limestone screw conveyors.
7. TCS mill on new firing floor in front of boiler.
8. Transport pipe between TCS mill and B&W burner, with appropriate NFPA-type protection valves.
9. Babcock & Wilcox FM-Series Package Boiler, equipped with B&W XCL Low NOx burner (w/. auxiliary oil gun), steam-coil air heater, FD fan, sootblowing system, and "on-floor" pneumatic puffer system.
9. Breeching and insulation between B&W economizer outlet and inlet to Amerex baghouse. Also ducting between baghouse, I.D. fan and stack.
10. Amerex Pulsejet fabric filter.
11. I.D. fan.
12. Metal stack.
13. Double-dump ash valve on baghouse discharge for ash discharge point to either a truck, or a metal box storage and hauling system.
14. Compressed air system, w/. compressor, air filtration, receiver tank, and dryer.
15. Electrical motor control center for new motors.
16. Control Techtronics International complete multi-loop combustion control system, including: distributive control panel, direct digital control capability, control valves, motor speed inverters, level control, temperature, pressure, flow instrumentation, system alarm annunciator, and electric/electronic field wiring. Burner management and flame safeguard system for B&W burner.

17. Oil storage tank for standby fuel use and for boiler start-up, shut-down. Includes: pre-piped fuel oil pump skid, strainers, valves, piping and fittings to B&W burner.
18. Foundations and supports for new equipment, also flat concrete slab for new boiler house building.
19. Pre-engineered-type (e.g., Butler-type) building for "boiler-island" protection.
20. All balance-of-plant structural, mechanical, and electrical sub-systems.

Task 5: PRELIMINARY FINANCING APPLICATIONS

This task is partially complete. Preliminary discussions were conducted regarding potential funding for the PROJECT with the following organizations:

- * Voivodship Fund for Environmental Protection (Krakow).
- * EcoFund (Warsaw)

Positive response was received from both organizations.

PHRO plans to submit a formal proposal to the EcoFund in September 1996 for hopeful approval of about 25 to 30 percent (i.e., of project cost) grant funding.

Depending on final costing of project, PHRO may apply for a Voivodship Fund loan, which would provide debt financing for the balance of project cost, at lower than market rates, and a possibility of up to 50 percent forgiveness of debt principal, if all environmental standards are met.

Babcock & Wilcox has reiterated that if necessary, assuming viable project economics, it is prepared to offer a portion of financing for the PROJECT, through an extended payment plan.

Task 6: PRELIMINARY LEGAL AND FINANCIAL COMPARISON

This task will be the indicated form of financing and legal risk assessment for the portion of PROJECT not financed by USDOE.

This task will be completed upon final determination of project costs.

Task 7: SELECT POLISH ENGINEERING AND CONSTRUCTION MANAGEMENT FIRM

This task is complete. This task involved selection of Energoprojekt-Katowice (E.P.-K), a Polish Engineering Firm, experienced in boilerhouse design and construction. Selection was based on experience of Babcock & Wilcox-Warsaw; wherein, it interviewed numerous Polish engineering firms as candidate for design and project implementation for TCS's and future B&W project. E.P.-K was also known by, and acceptable to, PHRO.

E.P.-K agreed to provide cost estimates and a schedule for permit acquisition for Budget Period I. Cost estimates should be complete by late-July, 1996.

Task 8: TCS SITE VISIT

This task is complete. This task involved two site visits by TCS during the weeks of April 15, 1996, and June 24, 1996, key project participants, including: PHRO, Cracow Development Office (BRK), E.P.-K, Crakow Environmental Protection Dept., Ecofund, USAID-Warsaw, B&W-Warsaw, and designated coal and limestone suppliers.

During each trip, all engineering criteria, preliminary drawings to date for each trip, technical assumptions and general PROJECT status were reviewed.

Task 9: LABORATORY AND COST ANALYSIS OF CANDIDATE COAL

This task is complete. TCS conducted an analyses to determine if the PROJECT should utilize either a washed (i.e., higher energy content and lower ash & sulfur contents) or unwashed (i.e., lower energy content and higher ash & sulfur contents) Krakow-sourced coal.

A cost trade-off analyses was conducted to determine the optimum condition to utilize the coal (e.g., washed vs. unwashed) based on: price of delivered coal and limestone for desulfurization, effect on boiler efficiency, differences in boiler plant O&M costs, limestone consumption rates and differences, and ash disposal costs. Results indicated that a unwashed coal is more cost effective. In effect, although washed coal is more expensive on a cost per ton basis, its higher energy content, lower ash disposal costs, lower materials handling costs, less required limestone, and higher boiler efficiencies, results in net overall lower cost.

During TCS's April site visit, a trip was made to the KWK (large Polish coal mine holding company) Staszic Coal mine near Katowice, Poland. It was determined that, based on cost, coal characteristics, and proximity to project site, that a KWK Wesola coal is to be the designated project coal.

Arrangements were made to ship ten (10) metric tons of the KWK Wesola coal to the TCS Combustion Test Facility in Oakland, Maryland for combustion tests (described below).

Task 10: LABORATORY ANALYSIS OF CANDIDATE LIMESTONE

This task is complete. During TCS's April site visit, a trip was made to the Czerna Limestone Mine located in the project's hometown of Krzeszowice, Poland.

TCS previously conducted laboratory tests (through Penn State University) on four limestones in the Krakow region, including Czerna. The laboratory tests included: (a). calcium and magnesium content, and (b). thermogravimetric analysis (TGA). All four limestones yielded positive desulfurization results.

Arrangements were made to ship three (3) metric tons of the Czerna Limestone to the TCS Combustion Test Facility in Oakland, Maryland for combustion tests (described below).

Task 11: COMBUSTION TESTS

This task is scheduled for start on July 15, 1996. As indicated above, TCS arranged for shipment of ten (10) metric tons of the KWK Wesola Coal and three (3) metric tons of Czerna limestone to Oakland, Maryland.

The purpose of this task will be to conduct a series of combustion tests; wherein, sufficient quantities of the selected coal is: (a). micronized and burned individually, and (b). co-micronized with varying quantities of the selected limestone and burned together, to determine: combustion efficiencies, carbon burnout, sulfur reduction capabilities, NOx and SOx emissions and other criteria pollutants, ash analysis and other performance factors.

Combustion tests will be conducted at TCS's Combustion Test Facility in Oakland, Maryland. During the test phase, regular periodic monitoring will be maintained for key operating criteria and air emissions, including: O2, SOx, NOx CO, opacity, combustion air flows, and other key parameters.

Ash samples will be "caught" on a periodic basis; wherein, they will be analyzed by an independent test laboratory for percent of carbon content, an indicator of carbon burnout.

Task 12: FINALIZE EQUIPMENT SPECIFICATION AND MODIFICATIONS

This task will be completed following the combustion tests. Based on results of the preceding tasks, TCS will finalize all new equipment design and performance specifications and establish key dimensions for new equipment and sub-systems, including: coal and limestone storage silo and handling, material conveyor systems, TCS mill, Babcock & Wilcox FM-Series Boiler and XCL Low NOx burner, Amerex baghouse, F.D. and I.D. fans, ash handling system, stack, building and foundations, Control Techtronics International control and monitoring systems, motor control center, other mechanical and electrical auxiliary subsystems. Likewise, this task will determine all necessary modification or changes required for existing equipment and support systems.

Task 13: STRUCTURAL AND FOUNDATION ANALYSIS

This task has basically been completed, subject to minor revisions in Task 12. Based on dead and live load weights of all new equipment, vibration analysis, and location in reference to existing plant components, this task involved a review of foundation and structural design requirements, including: (a). foundations for Babcock & Wilcox boiler and Amerex baghouses, coal and limestone silos, (b). structural supports for TCS mills, fuel & sorbent handling and conveying, and duct work, and (c). foundation for building and other ancillary components.

Task 14: DESIGN PLAN

This task is partially complete. In this task, TCS will produce design drawings and equipment specifications, not for actual construction activities, but with sufficient detail to provide assurance that all technical and cost factors have been adequately considered and quantified to the extent that PROJECT implementation could progress with a high level of confidence. A comprehensive list of all equipment components will be

developed indicating necessary engineering design and operational parameters.

Task 15: DESIGN PACKAGE REVIEW

This task is partially complete. The design package produced in the previous task was carried to Poland by TCS representatives for presentation and collaborative review by TCS, Babcock & Wilcox, and E.P.-Katowice. Emphasis will be placed on maintaining consistent engineering criteria and specifications; but with emphasis on assuring that all applicable and prevailing Polish engineering standards and codes are considered and maintained.

Included, would be a complete and detailed description and illustration of: (a). siting requirements, modifications and interfaces with existing structures and support utilities, (b). coal, limestone and ash storage and handling, (c). combustion systems and air emission control, (d). foundations, building and other support structures, (e). all primary ancillary components, and (f). detail of structural, mechanical, electrical, and instrumentation.

Task 16: IMPLEMENTATION AND INSTALLATION COST ESTIMATES

This task is partially complete. This task will be for TCS and E.P.-Katowice to develop a Budget Period II implementation and installation cost estimate for the PROJECT, including:

- * Permitting cost estimates.
- * Final construction drawings and specifications.
- * Equipment supplied by U.S. firms (e.g., TCS, Babcock & Wilcox, Amerex and Control Techtronics International).
- * Equipment provided by Polish suppliers.
- * Installation costs with detailed itemization of all major equipment components, installation and erection. Quotes will be obtained from key equipment suppliers and good engineering practice, with stated quantity takeoffs, will apply to the balance of the plant estimate.

The cost estimate will be provided in U.S. dollars. Equipment and installation activities based and provided in Poland will be estimated in Polish Zlotys and converted into U.S. dollars based on the official exchange rate prevailing on the date of submission.

Task 17: START-UP AND DEMONSTRATION OPERATIONAL COST ESTIMATES

This task will be completed in August 1996. The purpose of this task will be for TCS to develop a Budget Period II start-up and demonstration operational cost estimate for the PROJECT, including: Coal and limestone, Ash disposal, Labor, chemicals and materials, Support utilities and parasitic power, and Water and wastewater.

Task 18: PRELIMINARY PERMIT APPLICATIONS

This task is partially complete. This task will involve identification of key environmental and building permit requirements and necessary data that

would be required to progress the PROJECT into Budget Period II. USDOE authorized BRK to conduct preliminary air emission modelling, which is a necessary prelude to obtaining final air permits.

Task 19: PROJECT EVALUATION REPORT, SCHEDULE AND IMPLEMENTATION PLAN

This will be the final task to be completed, and should be available in the August-September 1996 timeframe. The purpose of this task will be to prepare and submit a PROJECT Evaluation Report that includes sufficient detail for an evaluation of the technical and commercial criteria to continue the PROJECT into Budget Period II.

An overall schedule indicating primary Budget Period II implementation tasks and critical path items from Permitting to PROJECT Start-up and Demonstration will be included. Likewise, an implementation and permit acquisition plan will be described that outlines how all new and existing equipment will be installed or modified to ensure minimum disruption to the daily operations of the PHRO Greenhouse Complex. An installation plan and schedule will be developed to ensure that sufficient existing boilers are fully functional at all times, if seasonally necessary, during installation and start-up.