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Automated Boiler Combustion Controls for Emission Reduction and Efficiency Improvement

**Quarterly Report
August 15 - November 15, 1995**

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SEVENTH QUARTER
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1.0 EXECUTIVE SUMMARY - SEVENTH QUARTER

Control Techtronics International, (CTI) is conducting a project to reduce air emissions and increase efficiency in coal fired boilers in Krakow, Poland and to create a commercial venture in Poland which can act as a leader for efficient combustion in boilers throughout the region. In Budget Period One (first year), CTI demonstrated both efficiency improvement and emission reduction at MPEC's Balicka district heating plant in the Widok section of Krakow.

In the first quarter of Budget Period One, there were ongoing contract negotiations with MPEC as the host site for the first CTI installation in Poland. Preliminary engineering was done concurrent to these negotiations. In addition, the transfer and development of training materials began.

In the second quarter, a contract with MPEC was signed which allowed commencement of other project work. This included putting subcontract agreements in place with other Polish partners, completing engineering, revising and coordinating schedules and conducting some of the training.

By the end of the third quarter of Budget Quarter One, 75% of the material was fabricated and 25% of the total material was shipped to the Balicka site. Baseline performance testing was conducted by the Politechnika on one steam and one hot water boiler. Classroom and in-plant training in the U. S. was provided to four key personnel from Penn State to the Politechnika were translated and adapted for use in the Polish culture and language. Efforts to secure sites for Budget Period Two began in the third quarter.

In the fourth quarter, progress was made on several project tasks. Fabrication of all materials was finished in late November, 1994. However, shipments were not completed until the beginning of February. Installation began in October, 1994 and continued until December, 1994. At this point, installation halted for two months. This delay was because of problems with invoicing and payment of VAT. As a result, the contract between CTI and MPEC had to be amended and new subcontract agreements were written with ENAP and Naftokrak. This problem delayed the entire project for over two months.

Graded coal for the Balicka testing as specified in the contract between CTI and MPEC was obtained by MPEC, with the assistance of Mr. Uruski from Katowice.

Progress was made to secure sites for Budget Period Two of the project. John West and Tomasz Szewczyk had follow-up meetings with 3 possible sites, receiving 2 letters of intent.

During the fifth quarter the installation and performance of controls for the 5 boilers was virtually completed. Testing on a hot water boiler was accomplished. Graded coal was obtained, further operators trained, additional letters of intent, adoption of controls for Poland proceeded, and Tomasz Szewczyk continued as project coordinator.

During the sixth quarter a trip to Warsaw was made to meet with the Director of the US Export -Import Bank (Julie Balaga) to help secure financing through BOS Bank for budget year 2 sites. Meetings were held with additional possible budget year 2 sites, along with a presentation with BRK and Dr. Thomas Butcher in Katowice, and with a Charnov boiler house.

During the seventh quarter (Aug. 15 to Nov.15), an additional letter of intent was secured (Army base in Krakow region - not the Airport), testing on the steam boiler at Balicka (with written report by Dr. Cyklis), and the establishment of the limited liability company "CTI Polska".

Planned tasks for the eighth quarter include preparing CTI Polska's sales brochure, securing contracts for sites, and submitting engineering bills of material for projects.

2.0 Introduction

Control Techtronics International (CTI) is conducting a project to reduce air emissions and increase efficiency in coal fired boilers in Krakow, Poland and to create a commercial venture in Poland which can act as a leader for efficient combustion in boilers throughout the region. To achieve the technical goals of the project, CTI will use a three part program as follows:

1. Analyze the fuel specifications of a given plant and recommend modifications as necessary.
2. Apply automatic combustion controls systems to the boilers.
3. Train plant operators in proper plant operation as well as proper use of control systems.

To achieve the commercial goals, CTI will form a commercial venture in Poland to market and service the CTI program after successful demonstration.

In Budget Period One, CTI demonstrated the efficiency improvement and emission reduction at MPEC's Balicka district heating plant in the Widok section of Krakow. CTI worked with several organizations to accomplish this work. The Pennsylvania State University (PSU) provided technical assistance in analysis of the fuel quality, technical assistance in the application of the controls, training material and techniques, and project management assistance. The Politechnika Krakowska (PK) conducted performance tests on the boilers at Balicka and conducted training in the Polish language. Naftokrak - Naftobudowa (NK) was the installing contractor. MPEC is the owner of the host site for the first CTI installation. Energoparatura (ENAP) built the control panels that were engineered by CTI and contain both Polish and American components. CTI is also interfacing with the Honeywell system heating controls in the Widok district.

In Budget Period Two, CTI has established a limited liability company, "CTI Polska". The stock ownership is:

Tomasz Szewczyk (President), 10%
Wieslaw Kalinowski (Vice President), 10%
Control Techtronics International, 80%

Testing and documentation of the results of both the steam and hot water boilers have been accomplished. See results in Professor Cyklis' article attached. These are:

- 85% particulate emission reduction
- 20% energy savings
- several year ROI

Additional sites for these controls are to be accomplished in the Krakow region. These are to be the "springboard" for installations throughout Poland and perhaps the Eastern European region. Originally, DOE / BRK directed that these additional sites be within Krakow. As we were closing contracts with the Children's Hospital and FAMO, Mr. Wertz directed that no coal boilers should be fired inside Krakow (gas only). CTI plans to accomplish the additional coal boiler retrofit, in the Krakow "region", but needs a contract extension.

3.0 DESCRIPTION OF ACTIVITIES DURING THE SEVENTH QUARTER

Progress was made on several project tasks during the seventh quarter. Three high events occurred:

- 1) CTI Polska was established, two key personnel became shareholders and effective 1/1/96, they will be full-time employees of that limited liability company. Tomasz Szewczyk is becoming President, Wieslaw Kalinowski, VP, and Johnny West, Jr. , VP. John West, Sr. is Chairman of the Supervisory Board.
- 2) The results of the steam boiler at Balicka were presented by Dr. Cyklis, and put into an article which is attached.
- 3) In mid-October, CTI presented results to 190 Polish persons interested in meeting their country's environmental requirements by 1998. This was organized by DOE at the Forum Hotel.

4.0 STATUS OF TASKS - SEVENTH QUARTER

Following is the status of completion for each task being worked on in Budget Year 2:

Task 1: Formation and operation of a commercial Joint Venture.

A limited liability company, CTI Polska was formed with the following ownership: Tomasz Szewczyk, 10%, Wieslaw Kalinowski, 10%, Control Techtronics International, 80%. Tomasz is President.

Task 3: Installation and Start-up of Control Components.

Installation was completed.

Task 4: Procurement of Graded Coal.

Completed in April, 1995.

Task 6: Select and Train Polish Field and Marketing Engineer.

Tomasz Szewczyk continues to act as the main point of contact in Poland for CTI. Mr. Tomasz Szewczyk attended the CTI international sales meetings and the annual ASHRAE conference in Chicago in January, 1995 in an effort to extend his training. In this quarter Mr. Szewczyk became actively involved in selection of sites for Budget Period Two. Mr. Kalinowski of NK- NB became the start-up engineer. Both continue to learn, do well and their interest builds.

Task 7: Operator Training for Balicka Personnel.

Training took place in Krakow for the operators during the fourth quarter at the same time as start-up of the first boiler. Further training must be accomplished when the boilers start-up this winter.

Task 8: Testing and Documentation of performance at Balicka.

Final testing was conducted after start-up of the hot water boiler used in the baseline tests. Results were astonishing:

25% Energy Reduction
85% Particulate Reduction

Steam boiler testing was completed in late Fall 95.

Task 10: Identify Other Plant Sites for Control Systems.

Five letters of intent have been received to date. One, (Children's Hospital) turned into a "pumpkin" as Mr. Wertz reversed his position and declined to fund cleaning up the air at Children's Hospital.

Task 12: Engineering, Fabrication of Shipment of Controls.

A small portion of this was accomplished at Balicka boiler house. The balance needs to be accomplished in the Winter when the work on Phase 2 sites begins.

Task 15: Joint Operator Training.

The initial operator training was very successfully accomplished. Further training will be needed in the Winter when the boilers at Balicka become operational full-time.

5.0 NEXT QUARTER ACTIVITIES (Nov.15, 1995 to Feb. 15, 1996)

The following are major activities that are anticipated to take place in the next quarter.

1. Close Budget Year 2 contracts.
2. Begin work on Budget Year 2 projects.
3. Complete operator training at MPEC / Balicka.
4. Additional training of CTI Polska staff.
5. Prepare CTI Polska brochure.

6.0 FOREIGN TRAVEL REPORT

John West of CTI was in Poland the middle two weeks of October to meet with Polish participants in the project as well as over 190 prospective customers at the DOE Seminar. The approximate cost of the trip was \$2,100. Several project meetings were held including meetings with MPEC, Naftokrak, Politechnia, BRK, Mr. Uruski of Katowice, and DOE personnel.

PRE ECOLOGICAL MODERNIZATION OF BOILERS WITH MECHANIZED GRATE, SUPPORTED BY AUTOMATED COMBUSTION PROCESS

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1. Foreword.

The research and testing associated with the scope of this article were carried out by the staff of the Division for the Thermodynamics and Testing of Heat Process Machines, sponsored by the US Department of Energy for the Polish - American Program to Reduce Pollution in the city of Krakow. The test equipment used was supplied by The Brookhaven National Laboratory in accordance with Polish and EPA (USA) Standards by the Bureau for the Development of the City of Krakow. The test team had an extensive experience in boiler performance testing.

2. The goal for the modernization of boilers.

Krakow is one the cities with greatest air pollution. It influences negatively the health of its inhabitants, their life span, also destroying the medieval architecture of the buildings. One of the pollution sources are coal firing boiler installations with mechanized grates. Exploitation of many such plants is justified economically, but the associated products of combustion create a significant pollution problem in the area.

The new ministerial regulations will enforce the reduction of pollutant emission as of December 31 1997 and it forces the boiler plant owners to emission control modifications. The imposed emission limits necessitate, amongst others, the use of more expensive fuels with lower sulphur contents. For those reasons the need arises to reduce the effluent emission while improving the boiler efficiency, and maintaining energy price at the present level.

3. Object for Modernization and Testing.

It was decided to make the first Polish installation of the Control Techtronics International, Control System Model 2000, at the Krakow City Enterprise for Heat Energy (Miejskie Przedsiębiorstwo Energetyki Ciepłej w Krakowie) at the Balicka Boiler Plant boilers Model WR-10 and PLM-2.5 ; The plant is located at Lindego Street 4 and it is managed by Mr. Leszek Ciurlik.

It was decided to instal two systems: one for three water boilers # WR-10 and one for two steam boilers # PLM-2.5. This decision was based on an analysis of the efficiency test results of these boilers, as carried out during the first phase of the Polish-American Program for Liquidation of Pollution in Krakow by the PPB ENERGOEXPERT s.c.

The control system for each boiler was shown schematically in Fig. 1. The associated boiler control parameters measured are: water flow and outlet temperature for water boilers or steam flow and pressure for a steam boiler; combustion chamber vacuum, also oxygen contents in the flue. There were three parameters controlled by the measurements: grate speed (deciding the boiler load), efficiency of blowers and exhaust fans (adjusting air flow to the combustion process, thus boiler load).

4. TEST RESULTS.

The tests were in accordance with PN-72/M-34128, BN - 86/1317-02 and EPA and for three boiler loads. The minimum and maximum boiler efficiencies were limited by the existing heat exchangers. The control system installed on the boiler # WR-10 permitted additional tests at a load lower than 25% of the rating.

The control system installation had improved efficiency and decidedly reduced emission of particulates. This is shown tabulated below and in Fig. 2, 3, 4, and 5. It can be seen that the mean efficiency increase for the tested boilers exceeds 15% (assuming annual load variations of 30% minimal load, 50% median load and 20% maximum load). A 90% reduction of particulate emission was obtained for low loads and 60% reduction for median loads. The control system was fully qualified for an effective emission control.

Fuel Type	Boiler Load	Fuel caloric value	Boiler efficiency	Particulates emission	Emission of organic particles	NOx Emitted	SO2 Emitted
Units	[MW]	[kJ/kg]	[%]	[g/GJ]	[g/GJ]	[g/GJ]	[g/GJ]
PLM-2.5	0.8	20899	61.8	633	8.68	152	513
STASZIC	1.5	20173	67.4	274	7.77	129	603
Manual Control	2.7	19951	72.2	63	2.13	130	583
PLM-2.5	1.2	21931	73.2	54	4.34	133	518
SIEMIENOWICE	1.8	21931	74.7	61	0.85	142	523
Controllers CTI	2.5	21931	75.5	64	0.55	149	528
WR-10	4.3	20982	57	816	1.52	127	512
STASZIC	6.4	20984	64	149	1.02	100	405
Manual Control	9.2	20844	75	112	0.45	92	353
WR-10	2.5	21873	82	35	1.09	131	465
SIEMIENOWICE	4.4	21873	81	35	1.09	116	475
siany	6.7	21950	77	69	0.56	109	490
Controllers CTI	9.6	21950	79	112	0.45	106	538

The installed system did not significantly influence the remaining effluents. It was to be noted however, that it resulted a 30% - 40 % reduction of power used by the blowers and exhaust fans.

5. Economical assessment of the installation.

The cost per boiler of the installation is 150 000 - 200 000 zł. (\$60 000 - \$80 000). Assuming 85zł./ tone (\$34) as the cost of fuel and removal of slag, it amounts to an equivalent of 2 100 tons of fuel. The savings associated with the increased efficiency, costs of energy and environmental taxes saved exceed 15% for the tested WR - 10 boiler. Having all that in mind, this investment will repay its cost after 12 000 tons of fuel are burned in this boiler.