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CONFINED ZONE DISPERSION
FLUE GAS DESULFURIZATION DEMONSTRATION

Quarterly Report No. 3
For the Period
May 1, 1991 to July 31, 1991

Prepared for:
U.S. Department of Energy
Pennsylvania Electric Company
Pennsylvania Energy Development Authority
New York State Electric & Gas Corporation
Rockwell Lime Company

Prepared by:
Bechtel Corporation
Fifty Beale Street
San Francisco, California 94105-1895

September 5, 1991

Cooperative Agreement No. DE-FC22-90PC90546
Patents Cleared by Chicago on September 12, 1991

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DOE/PC/90546--T3

DE92 003084

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Section 1

INTRODUCTION

The CZD process involves flue gas post-treatment, physically located between a boiler's outlet and its particulate collector, which in the majority of cases is an electrostatic precipitator. The features that distinguish this process from other similar injection processes are:

- Injection of an alkaline slurry directly into the duct, instead of injection of dry solids into the duct ahead of a fabric filter.
- Use of an ultrafine calcium/magnesium hydroxide, type S pressure-hydrated dolomitic lime. This commercial product is made from plentiful, naturally occurring dolomite.
- Low residence time, made possible by the high effective surface area of the type S lime.
- Localized dispersion of the reagent. Slurry droplets contact only part of the gas while the droplets are drying, to remove up to 50 percent of the SO₂ and significant amounts of NO_x. The process uses dual fluid rather than rotary atomizers.
- Improved ESP performance via gas conditioning from the increased water vapor content, and lower temperatures. Supplemental conditioning with SO₃ is not believed necessary for satisfactory removal of particulate matter.

The waste product is composed of magnesium and calcium sulfite and sulfate, with some excess lime. This product mixed with fly ash is self-stabilizing because of the excess lime values, and thus tends to retain heavy metals in insoluble forms within the fly ash.

The demonstration is being conducted at Penelec's Seward Station, Unit #15. This boiler is a 147 Mwe coal-fired unit, which utilizes Pennsylvania bituminous coal (approximately 1.2 to 2.5% sulfur). One of the two flue gas ducts leading from the boiler has been retrofitted with the CZD technology.

The goal of this demonstration is to prove the technical and economic feasibility of the CZD technology on a commercial scale. The process is expected to achieve 50% SO₂ removal and possibly 30-40% NO_x removal at lower capital and O&M costs than other systems.

The U.S. Department of Energy and Bechtel Corporation are engaged in a cooperative project to demonstrate the CZD Technology. DOE is providing half, or \$4.6 million, of the project's total \$9.2 million cost. Others contributing to the project are Pennsylvania Electric Company (\$3 million), Bechtel (\$760,000), the Pennsylvania Energy Development Authority (\$750,000), New York Gas and Electric Company (\$100,000), and Rockwell Lime Company (\$23,000).

To achieve its objectives, the project is divided into the following three phases:

Phase 1:	Design and Permitting
Phase 2:	Construction and Start-up
Phase 3:	Operation and Disposition

Phase 1 activities were completed on January 31, 1991. Phase 2 activities were essentially concluded on July 31, 1991, although some instrumentation work is still in progress. Phase 3a, Parametric Testing, was initiated on July 1, 1991. This Quarterly Technical Progress Report covers Phase 2 and Phase 3a activities from May 1, 1991 through July 31, 1991.

For further information on the structure of this demonstration project, Appendix A provides a project description by phase, Work Breakdown Structure (WBS) Diagram, and a detailed description of the WBS.

Section 2

SUMMARY

This is the third quarterly report for this project and it covers work performed on Phases 2 & 3a of the project from May 1, 1991 through July 31, 1991. Phase 2, which is essentially complete, included equipment acquisition and installation, facility construction, and start-up operations. Phase 3a covers the parametric test period and includes:

- Performing wind tunnel tests on atomizers at the University of California at Davis to determine performance characteristics, and selecting atomizers to be used in the parametric test program,
- Testing and calibration of the atomizers outside the duct,
- In-duct water injection tests to establish and define the confined zone,
- In-duct lime slurry injection tests for SO₂ and NO_x reduction,
- Evaluating the performance of electrostatic precipitators (ESP) during parametric tests, and consulting with ESP experts, if necessary, to improve performance,
- Evaluating the effects of process variables on emission control performance,
- Determining operating conditions for optimum overall performance, and
- Evaluating the effects of using alternative coals and reagents:
 - High and medium sulfur coals
 - Alternate reagents including pressure hydrated dolomitic lime, hydrated calcitic lime, and fresh slaked calcitic lime.

At the conclusion of parametric testing (end of Budget Period 1), additional plant modifications will be required to permit handling the larger volume of lime needed during the continuous one-year CZD demonstration. Additional instrument and control changes will also be necessary to automate the CZD system and completely integrate its operation with Seward Station Unit #15. These modifications and changes will be incorporated during Phase 3b (Budget Period 2) which also includes the one-year continuous demonstration period.

Phase 2 activities were scheduled to be completed by mid-May. While tie-in of the new long duct extension was completed on schedule, delays in the delivery of atomizer lances, thermocouple assemblies, and several other items delayed start-up operations by about one month. Start-up and operator training activities commenced on June 10, 1991, and were completed by the end of June. Although virtually all CZD process equipment was installed and checked out by July 1, 1991, two items were incomplete - soot blowers and thermocouples. On July 15, 1991, a contract was awarded to the Zack Company for installation of the soot blower wiring and piping, and for installation of the thermocouples and thermocouple wiring. Zack started this work on July 18, and is expected to finish all items by August 16, 1991.

Phase 3a was initiated early in March with wind tunnel testing of atomizer nozzles at U. C. Davis. Details of this testing were described in Quarterly Report No. 2 dated May 30, 1991. As a result of the delays described above, the parametric test program has been re-scheduled as follows:

PARAMETRIC TEST PROGRAM
Original and Current Schedules

		June				July				August				September			October			November				December							
		7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27
Calibration of atomizing nozzles, duct velocity traverses, final leak checks	Original Plan																														
	Current Plan																														
Factorial water tests in flue gas duct	Original Plan																														
	Current Plan																														
Factorial dolomitic lime injection tests	Original Plan																														
	Current Plan																														
Factorial calcitic lime injection tests	Original Plan																														
	Current Plan																														

The current plan is based on working some overtime hours and assumes no major boiler outages or equipment failures. With careful test planning and some rearrangement of individual tests, it is believed the parametric test program can be completed by the end of December.

Dedication ceremonies for the CZD demonstration facility were held at Seward Station on July 17, 1991. Pennsylvania Lt. Governor Mark S. Singel delivered the keynote address. Other speakers included Dr. C. Lowell Miller of the DOE, Harold K. Forsen of Bechtel, and Anthony T. Sossong of PEDDA. Penelec's Eugene R. Cathcart was the Master of Ceremonies.

Section 3

PROJECT STATUS

This section of the report provides details of the work performed from May 1, 1991 through July 31, 1991, covering equipment acquisition and installation, facility construction, construction management, project management and travel. It also describes the initial activities carried out as part of the parametric test program.

3.1 EQUIPMENT ACQUISITION AND INSTALLATION (WBS No. 1.2.1)

Procurement and installation of all major equipment and instruments required for the CZD system has been completed. The status of individual items is described below:

- Air compressors, receiver, and electric power supply - complete, tested, and ready for service.
- Atomizers - lance and atomizer assemblies are complete, water testing/calibration is in progress.
- Instruments and controls - surface thermocouples have been received and installed on the duct bottom and sides, probe thermocouples will not be shipped until early August. The Zack Company was the successful bidder and was awarded a contract to install the thermocouples in their test ports and wire them to the multipoint recorders. They will also wire the surface thermocouples to the multipoint recorder. All remaining instrument hook-ups are expected to be completed by the last week in August, including the Bailey Infi 90 system for data acquisition, monitoring, and analysis. The Bailey Infi 90 equipment is an extension of Penelec's existing Bailey Net 90 system. Penelec's environmental services group is installing the continuous emissions monitoring system (CEMS) needed to control and evaluate the performance of the CZD system. CEMS is also expected to be completely operational by the end of August.
- Lime feed and transfer system - complete, tested, and ready for service.

3.2 FACILITY CONSTRUCTION (WBS No. 1.2.2)

This item is complete and has been in satisfactory operation since May 5, 1991. The scope of this item included fabrication and installation of the new extended duct section, structural steel and supports, ladders, platforms, painting, insulation, removal of the existing section of duct, tie-in of the new section, and all related work necessary to provide a completely operable duct extension. Piping and wiring of the soot blowers installed in the new duct section will be completed by the Zack Company under their current contract.

3.3 CONSTRUCTION MANAGEMENT (WBS No. 1.2.4)

Bechtel's Site Engineer completed his assignment on July 19, 1991 and has returned to San Francisco. Final activities include drawing corrections as necessary to provide accurate as-built drawings of the demonstration facilities.

3.4 MANAGEMENT AND TRAVEL (WBS No. 1.2.5)

Dedication ceremonies for the CZD demonstration facility were held at Seward Station on July 17, 1991. Pennsylvania Lt. Governor Mark S. Singel delivered the keynote address. Other speakers included Dr. C. Lowell Miller of the DOE, Harold K. Forsen of Bechtel, and Anthony T. Sossong of PEDDA. Penelec's Eugene R. Cathcart was the Master of Ceremonies.

In conjunction with the dedication ceremonies, a brochure was prepared describing the CZD process, demonstration facility, technology, and benefits. Copies of this brochure are available to all interested parties.

All monthly and quarterly reports required under the Cooperative Agreement were submitted to DOE.

3.5 CZD PARAMETRIC TESTING (WBS No. 1.3.2)

A test stand was constructed for testing and calibration of the atomizer lance assemblies. The test stand duplicates the piping sizes, lengths, and instrumentation installed on the supply headers for the atomizing lances. This permits accurate calibration of the atomizing nozzles at varying conditions of flow and pressure, and simulates actual operating conditions. Section C-1 of Appendix C contains results of tests conducted on the test stand.

A series of duct velocity traverses were completed to measure the flue gas flows through the test duct. The readings were compared to the in-duct flow meter after the meter was aligned and calibrated by a factory technician. The final readings were within 2% of the calculated average flow rate, and were in the range of 240,000 to 255,000 scfm. Corresponding velocities were in the range of 45

to 48 feet per second. Section C-2 of Appendix C contains duct velocity traverse measurement results.

Water testing and calibration of the atomizing nozzles continued outside the duct. Spray tips with different spray angles were tested and calibrated to provide greater flexibility and better control of the confined zone in the duct. Shallow angle tips can be used near the duct walls to prevent impingement. Section C-1 of Appendix C contains results of water testing and calibration of the atomizing nozzles. Water flushing and testing of the lime slurry preparation, transfer, and handling systems was also completed. (See Section C-4 of Appendix C for details.)

Flow tests on the air compressors confirmed their ability to meet design conditions. Maximum flow at the atomizer supply header with one compressor running was 2100 scfm, and with two compressors the flow was 4150 scfm. Design pressure, 125 psi, was maintained during the tests. Service Data and Service Technicians Reports on the air compressor testing are contained in Section C-3 of Appendix C.

3.6 MANAGEMENT AND TRAVEL (WBS No. 1.3.10)

A paper is being prepared for presentation at the 1991 International Joint Power Generation Conference in San Diego, California, on October 6 - 10, 1991. The paper will focus on the current CZD demonstration program, and will be co-authored by Bechtel, Penelec, and DOE/PETC.

All monthly and quarterly reports required under the Cooperative Agreement were submitted to DOE.

3.7 TEST SITE PHOTOS

Pages 8 through 14, which follow, contain photos of the new duct extension at Seward Station and associated CZD test facilities.

TOP VIEW OF NEW DUCT EXTENSION AT SEWARD STATION

VIEW OF NEW DUCT EXTENSION AT SEWARD STATION SHOWING:

- (a) Lime slurry storage tanks (at left of photo, under duct)
- (b) Weather enclosure for recording instruments (at left of photo, on top of duct)
- (c) Buell electrostatic precipitator (at right center of photo, adjacent to duct)

VIEW OF NEW DUCT EXTENSION AT SEWARD STATION SHOWING 180°
RETURN BEND AND 90° BEND AT ENTRANCE TO BUELL ELECTROSTATIC
PRECIPITATOR

ON TOP OF DUCT, VIEW LOOKING TOWARD SUPPLY HEADERS FOR
ATOMIZING NOZZLES SHOWING:

- (a) Temperature test ports (vertical pipes on sides of walkway)
- (b) Weather enclosure for recording instruments (upper right of photo)
- (c) Coittrell electrostatic precipitator (upper center of photo)

VIEW OF SUPPLY HEADERS FOR ATOMIZING NOZZLES

Large lower pipe is for air supply, smaller pipe above is for lime slurry supply

Control valves to right are for lime slurry supply

LIME SLURRY PREPARATION AREA SHOWING VIBRATING SCREEN (LEFT CENTER OF PHOTO) FOR SEPARATING GRITS FROM SLURRY

LIME SLURRY STORAGE TANKS AND TRANSFER PUMPS

Section 4

PLANNED ACTIVITIES

During the next quarter (August through October, 1991) The following work is planned:

4.1 PHASE 2 - CONSTRUCTION AND START-UP

The piping and electrical connections to the duct-mounted soot blowers, final connections of the duct thermocouples to the temperature recording system, and installation of the the Bailey data acquisition and reduction system are expected to be completed by August 16, 1991.

4.2 PHASE 3 - OPERATION AND DISPOSITION

Factorial water tests in the flue gas duct, will involve testing the calibrated atomizers in the flue gas duct to determine their best configuration and the minimum ratio of atomizing air to water required to avoid wetting the duct and turning vanes. These tests will take place during the period from about August 23 to September 6, 1991.

Factorial lime injection tests will commence following successful conclusion of the atomizer calibration and factorial water tests. A revised schedule for the parametric test program, showing the originally planned dates, is shown below:

PARAMETRIC TEST PROGRAM
Original and Current Schedules

		June				July				August				September				October				November				December					
		7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27
Calibration of atomizing nozzles, duct velocity traverses, final leak checks	Original Plan																														
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	Current Plan																														
Factorial dolomitic lime injection tests	Original Plan																														
	Current Plan																														
Factorial calcitic lime injection tests	Original Plan																														
	Current Plan																														

The current plan is based on working some overtime hours and assumes no major boiler outages or equipment failures. With careful test planning and some rearrangement of individual tests, it is believed the parametric test program can be completed by the end of December.

4.3 PHASE 3 - PROJECT MANAGEMENT

As results become available from the parametric test program, a Project Evaluation Report and Continuation Application will be prepared to permit their timely submittal.

A paper, describing the current CZD demonstration program, will be presented in October at the International Joint Power Generation Conference in San Diego, California.

Appendix A

DESCRIPTION OF PROJECT AND WORK BREAKDOWN STRUCTURE

A.1 PROJECT DESCRIPTION

To accomplish the objectives of this project, the test program contains two distinct periods:

- The first period, of six months duration, includes daily factorial runs to test different reagents, atomizers, additives, and slurry concentrations.
- The second period, of one year duration, will demonstrate the performance of the CZD system on a continuous basis under actual power plant operating conditions.

A detailed description of the Work Breakdown Structure for this project, as shown in Figure A-1, is given in subsection A.2. The work is scheduled to be accomplished in three phases as follows:

- Phase 1 work was completed on January 31, 1991. During this phase, Bechtel developed a process design, P&ID's, and performed detailed engineering for a new extended duct to be used in the CZD demonstration in Unit 15 at Penelec's Seward Station. Bechtel wrote all the specifications for equipment and instruments, and started procurement activities. Interface with the appropriate environmental agencies was accomplished through Penelec, with Bechtel providing assistance as needed.
- Phase 2 work was substantially completed by July 31, 1991. This phase included equipment acquisition and installation, facility construction, and start-up operations. Bechtel completed procurement of the equipment, instruments, materials, and fabrication of the new long duct. Penelec performed construction and installation of these items in accordance with specifications prepared by Bechtel. At completion of construction, using Penelec operating and maintenance personnel, Bechtel trained the operators, started all major elements of the CZD system, and verified that the installation and control system functioned according to requirements. During this phase, the installation of equipment and instrumentation was limited to that necessary for parametric testing to be accomplished in Phase 3.

- Phase 3 work will be conducted in two parts. Parametric testing, Phase 3a, will be accomplished during the period from June 3, 1991 through November 29, 1991. During this period, Bechtel will carry out a parametric test program to optimize the performance of the CZD process. The test program is designed to develop operating conditions that will achieve high reliability and low cost operation. Phase 3b, from December 2, 1991 to July 1, 1993, will complete this demonstration project. Based on the results of the parametric test program, Bechtel will complete additional design, procurement, installation, and facility construction as necessary to permit a one-year continuous demonstration. The CZD system will be fully instrumented and integrated with the operation of Penelec's Unit 15. The goal will be to demonstrate the performance of the CZD process for SO₂ and NO_x removal without significantly affecting either boiler operation or plant particulate emission. Using Penelec operating and maintenance personnel, Bechtel will train the operators, start-up, and operate the CZD system. Bechtel will supervise the one-year continuous demonstration, and will carry out various performance tests, data acquisition, and chemical analyses. After the demonstration is completed, the system may remain in operation or the test apparatus may be dismantled and the site restored to its former condition, depending on Penelec's wishes. In either case, the new long straight duct will remain in operation.

To promote the dissemination of technical information to industry during the CZD demonstration, technical papers will be presented at various conferences. These papers will provide non-proprietary technical and economic data, results and conclusions. The technical papers will also be made available for publication in appropriate journals. Representatives of the utilities will be invited to visit the demonstration site to learn first hand how the CZD process handles SO₂ and NO_x removal from utility flue gas operations.

Figure A-1 Work Breakdown Structure (WBS) Diagram

A.2 WORK BREAKDOWN STRUCTURE DESCRIPTION

The following tasks will be performed, during the three phases of the project, to demonstrate the cost effective control of SO₂ and NO_x emissions from the pre-NSPS coal-fired utility boiler #15 at Penelec's Seward Station:

Phase 1: Design and Permitting

WBS No. 1.1.2 Design and Procurement

- Prepare process flow diagrams, for each of the two periods, including material balances and stream properties. Prepare technical specifications for process equipment.
- Prepare detailed designs for the fabrication of the duct extension and its associated construction and installation.
- Prepare site-specific detailed designs for installation of the compressed air system, lime feed system, and atomizers with their related headers and distribution piping, including instruments and controls.
- Prepare technical specifications for procurement of required support equipment, and its associated construction and installation.
- Issue bids for equipment with long delivery times.

WBS No. 1.1.3 Management and Travel

- Project Management. Provide overall management of the work required to complete this phase, including coordination with Penelec and the groups providing project financial assistance. Bechtel's project management plan includes provisions for meetings with the DOE and formal reviews of project work, as well as provisions for submitting reports in accordance with the Federal Assistance Reporting Checklist, Attachment C.
- Travel. Bechtel travel includes project management travel to the Penelec site and to DOE's offices for meetings, and travel by the project engineer and other members of the project team as required to complete the task activities. All travel and subsistence to be in accordance with Government regulations.

Phase 2: Construction and Start-up

WBS No. 1.2.1 Equipment Acquisition and Installation

- Procure air compressors and electric power supply.
- Procure atomizers.
- Procure instruments and controls.
- Procure lime feed system.
- Procure lime transfer system.
- Provide assistance to Penelec for installation of all process and support equipment, including drawings, specifications, design packages for bidding, and other related design information.

WBS No. 1.2.2 Facility Construction

- Approve shop drawings for fabrication of duct extension.
- Provide site engineering support and related assistance to Penelec as required for quality and schedule control.

WBS No. 1.2.3 Start-up (Checkout) and Operator Training for Parametric Testing

- Provide start-up engineer to supervise commissioning of all CZD components and systems.
- Train Penelec's operators to run the CZD system and perform the tasks required to conduct parametric testing.
- Establish procedures for coordination of test operations with Penelec's plant management and operations personnel.
- Finalize all elements of Test Plan.

WBS No. 1.2.4 *Construction Management*

- Provide construction management support to Penelec as requested. Penelec will have prime control and responsibility for all construction activities at Seward Station.

WBS No. 1.2.5 *Management and Travel*

- Project Management. Provide overall management of the work required to complete this phase, including coordination with Penelec and the groups providing project financial assistance. Plan and conduct meetings with the DOE and the project team for review of project work. Submit reports in accordance with the Federal Assistance Reporting Checklist, Attachment C.
- Travel. Bechtel travel includes project management travel to the Penelec site and to DOE's offices for meetings, and travel by the project engineer and other members of the project team as required to complete the task activities. All travel and subsistence to be in accordance with Government regulations.

Phase 3: Operation and Disposition

WBS No. 1.3.1 *Lime Procurement*

- Procure all types of lime and other reagents required to conduct parametric and continuous (one-year) test programs.

WBS No. 1.3.2 *CZD Parametric Testing*

- Perform wind tunnel tests on atomizers at the University of California at Davis to determine performance characteristics. Select atomizers to be used in the parametric test program.
- Evaluate performance of electrostatic precipitators (ESP) during parametric tests. Consult with ESP experts, if necessary, to improve performance.
- Evaluate effects of process variables on emission control performance.

- Determine operating conditions for optimum overall performance.
- Evaluate effects of using alternative coals and reagents:
 - High and medium sulfur coals
 - Alternate reagents including pressure hydrated dolomitic lime, hydrated calcitic lime, and fresh slaked calcitic lime.

WBS No. 1.3.3 *Completion of Design, Procurement and Installation*

- Based on the results of the parametric tests, complete the design packages and procure all process equipment needed to completely automate and integrate the operation of the CZD system with boiler #15 at Seward Station.
- Procure all instruments and controls needed for continuous operation, monitoring, and data collection.

WBS No. 1.3.4 *Completion of Facility Construction*

- Install facilities for lime unloading and storage to support the increased capacity required for continuous operation of the CZD system.
- Insulate piping and provide weather protection and enclosures as required to permit continuous, all-year operation of the CZD system.
- Provide construction management support to Penelec as requested. Penelec will have prime control and responsibility for all construction activities at Seward Station.

WBS No. 1.3.5 *Start-up (Checkout) and Operator Training for Continuous Operation*

- Provide start-up engineer to supervise commissioning of all new CZD components and systems.
- Train Penelec's operators to run the CZD system and perform the tasks required to conduct the one-year continuous demonstration.

- Establish procedures for coordination of data collection and reduction with Penelec's plant management and operations personnel.

WBS No. 1.3.6 CZD Demonstration with Continuous Operation

- Operate the CZD system under optimized conditions for one year completely integrated with the power plant operation.
- Measure emission control system performance:
 - SO₂ and NO_x performance tests
 - ESP performance tests
 - ESP performance improvements, if required
 - Chemical analysis of solid wastes
 - Continuous data recording and acquisition
- Determine power plant impacts.

WBS No. 1.3.7 Duct and Hopper Cleaning

- Perform periodic inspection and cleaning, if necessary, during intervals when the boiler is not operating to determine the long-term extent of duct fouling resulting from CZD system operation.

WBS No. 1.3.8 Data Evaluation and Reporting

- Correlate and evaluate all data collected during the entire CZD test program, including parametric tests as well as continuous operation.
- Summarize key data and test results:
 - Inlet and outlet concentration of SO₂, NO_x, and oxygen
 - Amount of lime used and lime utilization
 - Variation in flue gas temperature during lime slurry injection
 - Variation in ESI² recorded data
 - Variation in percent opacity at the stack
 - Lime deposition on duct surfaces
- Use technological, economic, environmental, and operating evaluations from the demonstration project to prepare

Demonstration Test Reports and a Technology Performance and Economic Evaluation Report.

WBS No. 1.3.9 *Disposition*

- Disposition of the CZD system equipment installation:
 - The new long straight duct will remain in operation.
 - The disposition of all other equipment (continued operation or removal and storage) will be decided by Penelec.

WBS No. 1.3.10 *Management and Travel*

- Project Management. Provide overall management of the work required to complete this phase, including coordination with Penelec and the groups providing project financial assistance. Plan and conduct meetings with the DOE and the project team for review of project work. Submit reports in accordance with the Federal Assistance Reporting Checklist, Attachment C.
- Travel. Bechtel travel includes project management travel to the Penelec site and to DOE's offices for meetings, and travel by the project engineer and other members of the project team as required to complete the task activities. All travel and subsistence to be in accordance with Government regulations.

Appendix B

REPORT DISTRIBUTION LIST

The number in parentheses () indicates the number of copies submitted.

U.S. Department of Energy - PETC

Mr. Arthur L. Baldwin (2)
PETC Technical Project Manager
Mail Stop 920-L
U.S. Department of Energy / PETC
P.O. Box 10940
Pittsburgh, PA 15236

Mr. Martin J. Byrnes (1)
Contract Specialist
AD-21, Mail Stop 921-165
U.S. Department of Energy / PETC
P.O. Box 10940
Pittsburgh, PA 15236

Dr. C. Lowell Miller (1)
Associate Deputy Assistant
FE-22, 3E-042, Forrestal
U.S. Department of Energy
Washington, D.C. 20585

Mr. Robert Fischer (1)
Office of Patent Counsel
U.S. Department of Energy
9800 South Cass Avenue
Argonne, IL 60439

Office of Technology Transfer (3)
Mail Stop 58-MEZZ
U.S. Department of Energy / PETC
P.O. Box 10940
Pittsburgh, PA 15236

Dr. S. N. Roger Rao (1)
Burns and Roe Technical Group Manager
P.O. Box 18288
Pittsburgh, PA 15236

Mr. Larry M. Joseph (1)
HQ DOE Program Manager
FE-22, 3E-042, Forrestal
U.S. Department of Energy
Washington, D.C. 20585

Pennsylvania Electric Company

Mr. S. T. Higgins (1)
Project Manager
Pennsylvania Electric Company
1001 Broad Street
Johnstown, PA 15907

Mr. J.A. Seebacher (1)
Manager, Fuels Contracts and Planning
Pennsylvania Electric Company
1001 Broad Street
Johnstown, PA 15907

Pennsylvania Energy Development Authority

Mr. Dane C. Bickley (1)
Director
Pennsylvania Energy Development Authority
116 Pine Street, Second Floor
Harrisburg, Pennsylvania 17101-1227

New York State Electric & Gas Corporation

Mr. L. C. Rittenhouse (1)
Manager - Homer City Operations
New York State Electric & Gas Corporation
Homer City Power Plant
P.O. Box 29
Homer City, Pennsylvania 15748

Rockwell Lime Company

Mr. Joseph H. Brisch (1)
Sales Manager
Rockwell Lime Company
4223 Rockwood Road
Manitowoc, Wisconsin 54220-9619

Appendix C
SUPPORTING DATA

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C-1	Results of test stand testing of atomizer lance assemblies and atomizer nozzle water test and calibrations
C-2	Duct velocity traverse measurement results
C-3	Results of air compressor tests
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SECTION
C-1

Results of test stand testing of atomizer lance assemblies
and atomizer nozzle water test and calibrations

Nozzle Testing

The main goal of atomizer nozzle testing was to correlate water pressure with flow rate through the nozzles. The total flow through each nozzle is constant so that when the liquid rate through the nozzle is reduced or increased by a given amount, the compressed air rate increases or decreases correspondingly. When the liquid rate is reduced, the compressed air rate increases and liquid and air pressures are self adjusting to give a constant total flow.

The primary need for testing to correlate pressure with flow rate resulted from the current system design. For the parametric test phase, no flow meters have been provided at the lime distribution header. Instead, lime slurry flow is monitored by means of pressure gauges provided at the top of the header. The atomizers were tested with water for calibration because the viscosity of lime slurry in the range of 10-12% (the upper range to be used for CZD tests) is very similar to that of water. Thus, pressure and flow data collected from atomizer water tests can be used to predict operation of the atomizers using lime slurry.

The atomizer nozzles were also tested using two different spray tips with different spray angles, 60 degrees and 25 degrees. The degree of atomization, pressure, and flow through the atomizers does not vary whether a 60 degree or 25 degree tip is used. However, the atomized jet from a 60 degree cone covers a larger area which increases the area of mixing with the flue gas, and also increases the heat and mass transfer rate thereby enabling the lime slurry particles to dry before reaching the turning vanes in the duct. The atomized jet dispersed from a 25 degree cone covers a smaller area and is more concentrated in that smaller area. These tips are useful for atomizers installed close to the wall of the duct to prevent wetting of the walls.

The atomizers were tested in a test stand designed to simulate the piping and other supply conditions that exist when they are installed in the duct. In addition to determination of pressure, flow and compressed air requirements, the tests also revealed any thread or weld leaks that might be present.

Atomizer testing was performed at different flow rates ranging from 0.5 to 4.0 gpm. Individual water pressures at each atomizer were recorded along with corresponding total water pressure. For each individual water pressure, the compressed air consumed was measured in ACFM. These readings were converted to SCFM, and the air pressure and temperature during operations was also recorded. From the above information, the flow of air and water, in pounds, was calculated at each flow rate, and the air to water ratios were also calculated.

The air/water ratios give an indication of the degree of atomization provided by the atomizers. Previous testing has established that ratios above 0.4 generally produce a very fine degree of atomization, while ratios below 0.4 produce coarser

atomization. However, in a constant flow nozzle, high air/water ratios result in a decrease in the amount of water (or lime slurry) flowing and therefore directly affect the amount of SO₂ and NO_x removal. Additionally, high air/water ratios also increase the cost of removal due to increased air compressor operating costs. To optimize air requirements and provide good lime utilization, an operating rate of 2.5 gpm per nozzle was selected as the base flow rate for the parametric tests.

The attached data, collected during nozzle testing, was tabulated and graphed to allow determination of corresponding pressures and flow rates.

NOV 21 11 50 AM

LANCE NO 15 ATOMIZER TYPE : 25° cone
7/18/91

No.	INLET PRESSURE		Total Pressure	Compressed Air		AV ACFM	Σ SCFM	Time	Inlet			Outlet			Loss
	1	2		1	2				111	111	111	111	111	111	
0.5	88	87	88876	50	50	50	146.5	84	112	111	111	116	1105	4.17	2.649
	92	90	930166	45	43	44	124.63	84	107	106	106	110	8.13	1.949	
1.0	104	104	1036	37.5	37.5	37.5	107.8	84	110	110	110	110	8.24	0.989	
	103	103	103	38.5	37.5	37.5	108.76	84	110	110	110	112	8.32	0.997	
	103	102	1023	38.5	37.5	38.5	110.17	84	111	111	111	112	8.42	1.009	
1.5	106	106	1071063	34	34	34.5	97.36	84	109	109	109	112	7.44	0.591	
	107	106	1071066	34	33.5	35	98.216	84	110	110	110	111	7.512	0.606	
2.0	109	109	109109	30	30	29	82.84	84	103	102	104	104	6.33	0.379	
	111	110	110103	30	29	31	85.56	84	108	108	108	109	6.54	0.392	
2.5	119	121	120120	23	22.5	23	64.47	84	105	102	102	106	4.93	0.236	
	120	122	124122	24.5	22.5	23.5	67.02	84	108	108	108	108	5.12	0.245	
3.0	138	140	139139	22.5	21.0	22.5	63.75	84	112	112	112	114	4.87	0.154	
	140	140	140140	23.0	22.5	23.0	67.20	84	116	116	116	117	5.14	0.205	
3.5	139	141	140140	22.5	21.0	22.5	61.45	84	103	103	103	105	4.700	0.161	
	139	142	140140	20.0	18.0	19.5	53.97	84	105	105	105	109	4.128	0.141	
4.0	148	148	148148	19.0	17.0	18.0	50.91	84	106	106	106	109	3.89	0.116	
	147	147	147147	22.5	22.5	21.5	42.26	84	110	110	110	111	2.23	0.091	

7/18/91
2.649
1.949
0.989
0.997
1.009
0.591
0.606
0.379
0.392
0.236
0.245
0.154
0.205
0.161
0.141
0.116
0.091

DATE: LANCE NO: 112 ATOMIZER TYPE: 600

GPM	WATER PRESSURE			AV Water Pressure	Temp	COMPRESSED AIR			TEMP	SCFM	111 MP	112 MP	113 MP	114 MP	115 MP	116 MP	117 MP	118 MP	119 MP	120 MP	121 MP	122 MP	123 MP	124 MP	125 MP	126 MP	127 MP	128 MP	129 MP	130 MP	131 MP	132 MP	133 MP	134 MP	135 MP	136 MP	137 MP	138 MP	139 MP	140 MP	141 MP	142 MP	143 MP	144 MP	145 MP	146 MP	147 MP	148 MP	149 MP	150 MP	151 MP	152 MP	153 MP	154 MP	155 MP	156 MP	157 MP	158 MP	159 MP	160 MP	161 MP	162 MP	163 MP	164 MP	165 MP	166 MP	167 MP	168 MP	169 MP	170 MP	171 MP	172 MP	173 MP	174 MP	175 MP	176 MP	177 MP	178 MP	179 MP	180 MP	181 MP	182 MP	183 MP	184 MP	185 MP	186 MP	187 MP	188 MP	189 MP	190 MP	191 MP	192 MP	193 MP	194 MP	195 MP	196 MP	197 MP	198 MP	199 MP	200 MP	201 MP	202 MP	203 MP	204 MP	205 MP	206 MP	207 MP	208 MP	209 MP	210 MP	211 MP	212 MP	213 MP	214 MP	215 MP	216 MP	217 MP	218 MP	219 MP	220 MP	221 MP	222 MP	223 MP	224 MP	225 MP	226 MP	227 MP	228 MP	229 MP	230 MP	231 MP	232 MP	233 MP	234 MP	235 MP	236 MP	237 MP	238 MP	239 MP	240 MP	241 MP	242 MP	243 MP	244 MP	245 MP	246 MP	247 MP	248 MP	249 MP	250 MP	251 MP	252 MP	253 MP	254 MP	255 MP	256 MP	257 MP	258 MP	259 MP	260 MP	261 MP	262 MP	263 MP	264 MP	265 MP	266 MP	267 MP	268 MP	269 MP	270 MP	271 MP	272 MP	273 MP	274 MP	275 MP	276 MP	277 MP	278 MP	279 MP	280 MP	281 MP	282 MP	283 MP	284 MP	285 MP	286 MP	287 MP	288 MP	289 MP	290 MP	291 MP	292 MP	293 MP	294 MP	295 MP	296 MP	297 MP	298 MP	299 MP	300 MP	301 MP	302 MP	303 MP	304 MP	305 MP	306 MP	307 MP	308 MP	309 MP	310 MP	311 MP	312 MP	313 MP	314 MP	315 MP	316 MP	317 MP	318 MP	319 MP	320 MP	321 MP	322 MP	323 MP	324 MP	325 MP	326 MP	327 MP	328 MP	329 MP	330 MP	331 MP	332 MP	333 MP	334 MP	335 MP	336 MP	337 MP	338 MP	339 MP	340 MP	341 MP	342 MP	343 MP	344 MP	345 MP	346 MP	347 MP	348 MP	349 MP	350 MP	351 MP	352 MP	353 MP	354 MP	355 MP	356 MP	357 MP	358 MP	359 MP	360 MP	361 MP	362 MP	363 MP	364 MP	365 MP	366 MP	367 MP	368 MP	369 MP	370 MP	371 MP	372 MP	373 MP	374 MP	375 MP	376 MP	377 MP	378 MP	379 MP	380 MP	381 MP	382 MP	383 MP	384 MP	385 MP	386 MP	387 MP	388 MP	389 MP	390 MP	391 MP	392 MP	393 MP	394 MP	395 MP	396 MP	397 MP	398 MP	399 MP	400 MP	401 MP	402 MP	403 MP	404 MP	405 MP	406 MP	407 MP	408 MP	409 MP	410 MP	411 MP	412 MP	413 MP	414 MP	415 MP	416 MP	417 MP	418 MP	419 MP	420 MP	421 MP	422 MP	423 MP	424 MP	425 MP	426 MP	427 MP	428 MP	429 MP	430 MP	431 MP	432 MP	433 MP	434 MP	435 MP	436 MP	437 MP	438 MP	439 MP	440 MP	441 MP	442 MP	443 MP	444 MP	445 MP	446 MP	447 MP	448 MP	449 MP	450 MP	451 MP	452 MP	453 MP	454 MP	455 MP	456 MP	457 MP	458 MP	459 MP	460 MP	461 MP	462 MP	463 MP	464 MP	465 MP	466 MP	467 MP	468 MP	469 MP	470 MP	471 MP	472 MP	473 MP	474 MP	475 MP	476 MP	477 MP	478 MP	479 MP	480 MP	481 MP	482 MP	483 MP	484 MP	485 MP	486 MP	487 MP	488 MP	489 MP	490 MP	491 MP	492 MP	493 MP	494 MP	495 MP	496 MP	497 MP	498 MP	499 MP	500 MP	501 MP	502 MP	503 MP	504 MP	505 MP	506 MP	507 MP	508 MP	509 MP	510 MP	511 MP	512 MP	513 MP	514 MP	515 MP	516 MP	517 MP	518 MP	519 MP	520 MP	521 MP	522 MP	523 MP	524 MP	525 MP	526 MP	527 MP	528 MP	529 MP	530 MP	531 MP	532 MP	533 MP	534 MP	535 MP	536 MP	537 MP	538 MP	539 MP	540 MP	541 MP	542 MP	543 MP	544 MP	545 MP	546 MP	547 MP	548 MP	549 MP	550 MP	551 MP	552 MP	553 MP	554 MP	555 MP	556 MP	557 MP	558 MP	559 MP	560 MP	561 MP	562 MP	563 MP	564 MP	565 MP	566 MP	567 MP	568 MP	569 MP	570 MP	571 MP	572 MP	573 MP	574 MP	575 MP	576 MP	577 MP	578 MP	579 MP	580 MP	581 MP	582 MP	583 MP	584 MP	585 MP	586 MP	587 MP	588 MP	589 MP	590 MP	591 MP	592 MP	593 MP	594 MP	595 MP	596 MP	597 MP	598 MP	599 MP	600 MP	601 MP	602 MP	603 MP	604 MP	605 MP	606 MP	607 MP	608 MP	609 MP	610 MP	611 MP	612 MP	613 MP	614 MP	615 MP	616 MP	617 MP	618 MP	619 MP	620 MP	621 MP	622 MP	623 MP	624 MP	625 MP	626 MP	627 MP	628 MP	629 MP	630 MP	631 MP	632 MP	633 MP	634 MP	635 MP	636 MP	637 MP	638 MP	639 MP	640 MP	641 MP	642 MP	643 MP	644 MP	645 MP	646 MP	647 MP	648 MP	649 MP	650 MP	651 MP	652 MP	653 MP	654 MP	655 MP	656 MP	657 MP	658 MP	659 MP	660 MP	661 MP	662 MP	663 MP	664 MP	665 MP	666 MP	667 MP	668 MP	669 MP	670 MP	671 MP	672 MP	673 MP	674 MP	675 MP	676 MP	677 MP	678 MP	679 MP	680 MP	681 MP	682 MP	683 MP	684 MP	685 MP	686 MP	687 MP	688 MP	689 MP	690 MP	691 MP	692 MP	693 MP	694 MP	695 MP	696 MP	697 MP	698 MP	699 MP	700 MP	701 MP	702 MP	703 MP	704 MP	705 MP	706 MP	707 MP	708 MP	709 MP	710 MP	711 MP	712 MP	713 MP	714 MP	715 MP	716 MP	717 MP	718 MP	719 MP	720 MP	721 MP	722 MP	723 MP	724 MP	725 MP	726 MP	727 MP	728 MP	729 MP	730 MP	731 MP	732 MP	733 MP	734 MP	735 MP	736 MP	737 MP	738 MP	739 MP	740 MP	741 MP	742 MP	743 MP	744 MP	745 MP	746 MP	747 MP	748 MP	749 MP	750 MP	751 MP	752 MP	753 MP	754 MP	755 MP	756 MP	757 MP	758 MP	759 MP	760 MP	761 MP	762 MP	763 MP	764 MP	765 MP	766 MP	767 MP	768 MP	769 MP	770 MP	771 MP	772 MP	773 MP	774 MP	775 MP	776 MP	777 MP	778 MP	779 MP	780 MP	781 MP	782 MP	783 MP	784 MP	785 MP	786 MP	787 MP	788 MP	789 MP	790 MP	791 MP	792 MP	793 MP	794 MP	795 MP	796 MP	797 MP	798 MP	799 MP	800 MP	801 MP	802 MP	803 MP	804 MP	805 MP	806 MP	807 MP	808 MP	809 MP	810 MP	811 MP	812 MP	813 MP	814 MP	815 MP	816 MP	817 MP	818 MP	819 MP	820 MP	821 MP	822 MP	823 MP	824 MP	825 MP	826 MP	827 MP	828 MP	829 MP	830 MP	831 MP	832 MP	833 MP	834 MP	835 MP	836 MP	837 MP	838 MP	839 MP	840 MP	841 MP	842 MP	843 MP	844 MP	845 MP	846 MP	847 MP	848 MP	849 MP	850 MP	851 MP	852 MP	853 MP	854 MP	855 MP	856 MP	857 MP	858 MP	859 MP	860 MP	861 MP	862 MP	863 MP	864 MP	865 MP	866 MP	867 MP	868 MP	869 MP	870 MP	871 MP	872 MP	873 MP	874 MP	875 MP	876 MP	877 MP	878 MP	879 MP	880 MP	881 MP	882 MP	883 MP	884 MP	885 MP	886 MP	887 MP	888 MP	889 MP	890 MP	891 MP	892 MP	893 MP	894 MP	895 MP	896 MP	897 MP	898 MP	899 MP	900 MP	901 MP	902 MP	903 MP	904 MP	905 MP	906 MP	907 MP	908 MP	909 MP	910 MP	911 MP	912 MP	913 MP	914 MP	915 MP	916 MP	917 MP	918 MP	919 MP	920 MP	921 MP	922 MP	923 MP	924 MP	925 MP	926 MP	927 MP	928 MP	929 MP	930 MP	931 MP	932 MP	933 MP	934 MP	935 MP	936 MP	937 MP	938 MP	939 MP	940 MP	941 MP	942 MP	943 MP	944 MP	945 MP	946 MP	947 MP	948 MP	949 MP	950 MP	951 MP	952 MP	953 MP	954 MP	955 MP	956 MP	957 MP	958 MP	959 MP	960 MP	961 MP	962 MP	963 MP	964 MP	965 MP	966 MP	967 MP	968 MP	969 MP	970 MP	971 MP	972 MP	973 MP	974 MP	975 MP	976 MP	977 MP	978 MP	979 MP	980 MP	981 MP	982 MP	983 MP	984 MP	985 MP	986 MP	987 MP	988 MP	989 MP	990 MP	991 MP	992 MP	993 MP	994 MP	995 MP	996 MP	997 MP	998 MP	999 MP	1000 MP	1001 MP	1002 MP	1003 MP	1004 MP	1005 MP	1006 MP	1007 MP	1008 MP	1009 MP	1010 MP	1011 MP	1012 MP	1013 MP	1014 MP	1015 MP	1016 MP	1017 MP	1018 MP	1019 MP	1020 MP	1021 MP	1022 MP	1023 MP	1024 MP	1025 MP	1026 MP	1027 MP	1028 MP	1029 MP	1030 MP	1031 MP	1032 MP	1033 MP	1034 MP	1035 MP	1036 MP	1037 MP	1038 MP	1039 MP	1040 MP	1041 MP	1042 MP	1043 MP	1044 MP	1045 MP	1046 MP	1047 MP	1048 MP	1049 MP	1050 MP	1051 MP	1052 MP	1053 MP	1054 MP	1055 MP	1056 MP	1057 MP	1058 MP	1059 MP	1060 MP	1061 MP	1062 MP	1063 MP	1064 MP	1065 MP	1066 MP	1067 MP	1068 MP	1069 MP	1070 MP	1071 MP	1072 MP	1073 MP	1074 MP	1075 MP	1076 MP	1077 MP	1078 MP	1079 MP	1080 MP	1081 MP	1082 MP	1083 MP	1084 MP	1085 MP	1086 MP	1087 MP	1088 MP	1089 MP	1090 MP	1091 MP	1092 MP	1093 MP	1094 MP	1095 MP	1096 MP	1097 MP	1098 MP	1099 MP	1100 MP	1101 MP	1102 MP	1103 MP	1104 MP	1105 MP	1106 MP	1107 MP	1108 MP	1109 MP	1110 MP	1111 MP	1112 MP	1113 MP	1114 MP	1115 MP	1116 MP	1117 MP	1118 MP	1119 MP	1120 MP	1121 MP	1122 MP	1123 MP	1124 MP	1125 MP
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CO2-WATER

ATOMIZER TYPE : *gib*

IF

DATE

Total pressure 148

GPM	INLET PRESSURE			AVAILABLE PRESSURE	Total Temp Water Pressure	COMPRESSED AIR			SCFM	TEMP	PRE-HEAT
	1	2	3			1	2	3			
0.5	98	98	98			50	50	50		72	100 100 100
1	100	100	100			43	42	42		72	103 104 105
1.5	109	107	107			37.5	35	35		72	103 104 105
2.0	114	114	114			33	30	31		72	107 107 107
2.5	120	120	122		159	28.5	25	25		72	110 111 111
3.0	120	122	122			28.5	25	27.5		72	110 107 107
3.5	124	123	126			26.0	23.5	23.5		72	110 109 109
4.0	147	147	144			22.5	20.5	22.5		74	109 109 109
4.5	152	153	155			21.0	18.0	22.5		74	105 106 105
5.0	143	142	144			21.0	19.0	21.5			

116 113 113 Total pr 113
102 104 104 110
NO 110 110 110

29 28 27
160 160 160
27 22.5 24
118 119 120
123 125 126 WATER / AIR FLOW CHARACTERISTICS

$$\begin{array}{r} 4604.4R \\ \hline 4604.4R \\ \hline \end{array}$$

1 and 11: 1B

ATOMIZER TYPE: 250 cone

[illegible][illegible]

DATE: LARGE NO: 1F ATOMIZER TYPE: 60° cone

AT 2.5 GPM

LB of WATER 20.85
 LB of MP 0.2743
 0.289
 0.298
 0.2541
 0.313
 0.3212
 0.267
 0.275
 0.2880
 0.323
 0.2880
 0.2916

TIME	WATER PRESSURE			AVAILABLE PRESSURE	TOTAL WATER PRESSURE	COMPRESSED AIR			SCFM	Temp °F	11" H ₂ O			LB of WATER	LB of MP
	1	2	3			1	2	3			1	2	3		
1.119	120	120	122	120.66	159	28.5	25	25	74.825	72	110	104	106	5.72	0.2743
2.5	120	122	122	121.33	159	28.5	25	27.5	78.915	72	112	111	113	6.046	0.289
1.5	124	126	126	125.33	140	29	27	27	81.37	-	113	113	113	6.22	0.298
2.0	118	119	120	119.0	160	27	22.5	24	69.41	-	102	104	104	5.30	0.2541
2.5	123	125	126	124.66	160	30	28	30	85.425	-	110	110	110	6.53	0.313
3.0	118	119	120	119.0	142	31	29	30	87.568	-	111	111	111	6.698	0.3212
3.5	118	119	120	119.0	160	28	22.5	27	72.871	-	102	103	102	5.57	0.267
4.0	120	120	122	120.66	160	28.5	22.5	28.5	75.1677	-	104	104	104	5.75	0.275
4.5	118	120	120	119.33	160	29	25	27	78.497	-	110	110	110	6.005	0.2880
5.0	124	126	128	126.0	162	31.0	28.5	29.0	88.140	-	118	116	117	6.74	0.323
5.5	120	124	125	123.0	161	30.0	22.5	28.5	78.497	-	110	110	110	6.005	0.2880
6.0	120	124	125	123.0	162	30.0	25.0	28.5	80.910	-	110	110	110	6.18	0.2916

GPM 1 AT 110 PSI

NO DATA

Atomizer Type - 2-5°

Lot No: 1B

8/5/91

Date

GPM	Water Pressure		AV With Pressure	Temp	Compressed Air			TI MP	Pressure			Lb of Water	Lb of Air
	1	2			1	2	3		1	2	3		
0.5	90	-	90	F	30	-	50	147.90	116	-	116	116	1
1	104	-	104	F	42	-	10	119.1	111	-	112	111.5	1.09
1.5	102	-	102.25	-	39	-	37.5	110.4	111	-	112	111.5	1.08
2	108	-	108	-	32.5	-	32.5	91.2	103	-	103	103	1.04
2.5	124	-	124	-	28.2	-	28.3	81.4	109	-	109	109	1.03
3	128	-	128.5	-	24.5	-	24.5	68.7	103	-	103	103	1.02
4	140	-	141	-	22.5	-	22.5	64.2	107	-	107	107	1.01
5	146	-	146.5	-	20.5	-	20.5	59.2	110	-	110	110	1.01
6													
7													
8													

WATER / AIR FLOW CHARACTERISTICS

Nozzle 1B

0.50 in.

5 + 0.1

SECTION
C-2

Duct velocity traverse measurement results

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____
 PROJECT _____ JOB NO. _____
 SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: I-50 ft

BAROMETRIC PRESSURE: 28.97 in. Hg

DATE: 7/18/91

DUCT GAUGE PRESSURE: 14.3 in. H₂O

TIME: 2:15-3:00

(0.51 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.75	273.4	52.3
2	0.61	277.6	47.3
3	0.78	285.2	53.8
4	0.82	292.8	55.4
5	0.74	289.2	52.5
6	0.80	278.4	54.2
7	0.74	281.2	52.2
8	0.81	291.6	55.0
9	0.85	296.6	56.6
10	0.74	271.2	52.6
11	0.72	283.2	51.6
12	0.88	286.2	57.1
13	0.85	295.6	56.5
14	0.88	295.8	57.5
15	0.67	287.8	49.9
16	0.80	287.6	54.5
17	0.87	290.6	57.6
18	0.72	273.8	51.9
19	0.77	273.8	54.4
20	0.64	270.2	48.9

BOILER LOAD: 132 MW

AVERAGE CALCULATED VELOCITY: 53.6 ft/s

AVERAGE TEMPERATURE: 278.1 °F

FLUE GAS FLOW RATE: 233,891 SCFM

COMMENTS: Traverse points 2, 5, & 20 appear too low in terms of velocity and temperature; disregard. Temperatures are noisy in the middle of the duct except near the floor, where T increases from left to right.

Average T = 288.1

Figure 3-1 Traverse Point Arrangement in the Duct for Velocity Measurement
Cross section looking downstream of injection point.

- Above average

3-5

PR:0473a wo:Rev.0

- T below average

Title of Project: _____

Project No. _____

Subject: _____

Works: _____

Computer: _____

Date: _____

Sheet No. _____

$$P_{F.G} = \left(\frac{29}{359}\right) \left(\frac{520}{T+460}\right) \left(\frac{28.97 - \frac{143}{13.6}}{29.92}\right)$$

$$\left(\frac{520}{T+460}\right) (0.0754)$$

.052014

49 29

$$\Delta H = \left(\frac{h}{12}\right) (0.826) \left(\frac{62.4}{P_{F.G}}\right)$$

82.5781

$$V = 0.84 \sqrt{2(32.2) [\Delta H]}$$

Average

$$Q = V_{avg} (88.4') (60)$$

$$= \frac{223,008 \text{ ac-ft}}{0.71}$$

$$\approx 233,891$$

$$\sqrt{\frac{14.7}{14.7-51}} \sqrt{\frac{460+288.1}{530}}$$

1.01781

= 1.21

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____
 PROJECT _____ JOB NO. _____
 SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: II - @ Vaness

BAROMETRIC PRESSURE: 29.18 in. Hg

DATE: 7/24/91

DUCT GAUGE PRESSURE: 14.4 in. H₂O

TIME: 1:15 → 2:00

(-0.52 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.75	269.5	51.5
2	0.73	272.4	50.9
3	0.81	280.6	53.9
4	0.96	286.4	58.9
5	0.90	286.2	57.1
6	0.78	273.5	52.7
7	0.87	277.2	55.8
8	0.94	285.8	58.3
9	0.89	288.6	59.9
10	0.99	288.2	59.9
11	0.80	278.2	53.5
12	0.90	277.2	56.7
13	0.87	285.8	56.1
14	0.83	286.2	54.8
15	0.82	285.8	54.4
16	0.90	281.4	56.9
17	0.92	281.6	57.4
18	0.78	285.2	53.1
19	0.78	287.2	53.2
20	0.60	288.2	46.6

BOILER LOAD: 144 MW

AVERAGE CALCULATED VELOCITY: 55.2 ft/s

AVERAGE TEMPERATURE: 282.3 °F

TRUE GAS FLOW RATE: 242,880 SCFM

COMMENTS: FOR INITIAL - profiles in the duct are essential. Constant disregard point 20) ranging from 2 to 99% difference, 144 MW.

However, reflecting in the lower third of the duct there are some

... 0.76 ... → 15 °F lower than the upper portion.

Average $T = 282.3^{\circ}\text{F}$

Figure 3-1 Traverse Point Arrangement in the Duct for Velocity Measurement
Cross section looking downstream of injection point.

Title of Project _____ Project No _____

Subject _____ Works _____

Computer _____ Date _____

Sheet No _____

$$P_{f.g.} = \left(\frac{29}{359} \right) \left(\frac{530}{14460} \right) \left(\frac{29.18 - \frac{144}{136}}{2992} \right)$$

$$\left(\frac{530}{14460} \right) (.0759)$$

$$DH = \left(\frac{7}{12} \right) (.826) \left(\frac{62.4}{P_{f.g.}} \right)$$

$$V = 0.84 \sqrt{2(32.17)(DH)}$$

$$Q = V_{f.g.}$$

$$Q = V_{f.g.} (28)(60)$$

$$= 291,456 \text{ scfm}$$

$$Q = 242,880 \text{ scfm}$$

$$\sqrt{14.7} \quad \sqrt{460 - 272.3}$$

$$14.7 - 52 \quad \sqrt{53.7}$$

$$1.018 \quad 1.20$$

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____
 PROJECT _____ JOB NO. _____
 SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: IV - @ Kure meter

BAROMETRIC PRESSURE: 29.18 in. Hg

DATE: 7/24/91

DUCT GAUGE PRESSURE: 15.3 in. H₂O

TIME: 9:30 → 10:15

(-0.55 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.89	264.6	56.2
2	0.65	268.4	51.5
3	0.85	274.2	58.5
4	0.71	275.2	50.6
5	0.77	276.4	51.0
6	0.80	265.0	53.3
7	0.78	268.2	52.8
8	0.95	272.2	58.4
9	0.77	277.8	56.4
10	0.78	278.6	56.5
11	0.80	267.6	53.4
12	0.78	273.2	53.0
13	0.90	279.2	56.8
14	0.87	279.8	55.0
15	0.26	274.4	55.7
16	0.85	269.6	55.2
17	0.77	274.2	52.6
18	0.95	278.4	58.7
19	0.70	278.2	50.3
20	0.26	276.2	55.7
21	0.86	275.8	55.5

AVERAGE CALCULATED VELOCITY: 54.6 ft/s

AVERAGE TEMPERATURE: 273.6 °F

TRUE GAS FLOW RATE: 240.339 SCFM

Kure meter reading: 250,000 SCFM

ED - GF - 144 MW

Figure 3-1 Traverse Point Arrangement in the Duct for Velocity Measurement
Cross section looking downstream of injection point.

PR:0473a wo:Rev.8
T above average
T below average

Title of Project: _____

Project No. _____

Subject: _____

Works: _____

Computer: _____

Date: _____

Sheet No. _____

$$P_{F.G.} = \left(\frac{29}{359} \right) \left(\frac{530}{7+460} \right) \left(\frac{29.18 - \frac{15.3}{15.0}}{29.92} \right)$$

$$\left(\frac{530}{7+460} \right) (0.0757)$$

$$DH = \left(\frac{L}{12} \right) (0.826) \left(\frac{62.4}{P_{F.G.}} \right)$$

$$V = 0.84 \sqrt{2(32.17) LH}$$

$$Q = V_o q (77)(60)$$

$$\sqrt{\frac{14.7}{14.7-55}} \sqrt{\frac{460+273.6}{530}}$$

1.0192

1.179

55.30
10.27

CALCULATION SHEET

CALC. NO. _____ REV. NO. _____

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____

PROJECT _____ JOB NO. _____

SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: II - VariesBAROMETRIC PRESSURE: 28.95 in. HgDATE: 7/30/91DUCT GAUGE PRESSURE: 14.9 in. H₂O
(-0.54 psig)TIME: 10:00 - 10:45

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.78	271.6	52.8
2	0.79	275.4	53.3
3	0.81	281.4	54.2
4	0.89	286.6	57.0
5	0.90	282.4	57.2
6	0.80	273.6	53.6
7	0.85	276.2	55.3
8	0.79	284.6	60.1
9	0.80	291.0	60.0
10	0.94	286.4	58.0
11	0.81	278.0	54.1
12	0.81	278.8	57.4
13	0.88	280.6	56.7
14	0.81	287.6	54.8
15	0.85	286.6	55.4
16	0.81	278.0	54.1
17	0.80	280.4	57.1
18	0.80	284.4	55.3
19	0.80	282.6	56.5
20	0.85	282.4	56.2

AVERAGE CALCULATED VELOCITY: 56.0 ft/sAVERAGE TEMPERATURE: 281.7 °FFLUE GAS FLOW RATE: 244,500 SCFMKURE METER READING: 246,500 SCFMBOILER LOAD: 43 MW

Title of Project _____ Project No. _____
 Subject _____ Works _____
 Computer _____ Date _____

Sheet No. _____

$$P.F.G. = \left(\frac{29}{359} \right) \left(\frac{530}{T+460} \right) \left(\frac{28.95 - \frac{14.9}{13.6}}{20.95} \right)$$

$$\left(\frac{530}{T+460} \right) (0.0952)$$

$$\Delta H = \left(\frac{h}{12} \right) (0.876) \left(\frac{67.4}{P.F.G.} \right)$$

$$1.084 \sqrt{2(37.7) \Delta H}$$

$$Q = V_{avg} (88) (60)$$

$$= 275,918 \text{ acfm}$$

$$\frac{275,918}{1.21}$$

$$= 244,560 \text{ scfm}$$

$$\frac{14.9}{14.9 - 5.1} = 1.21$$

$$\frac{460 + 281.7}{530} = 1.21$$

CALCULATION SHEET

CALC. NO. _____ REV. NO. _____

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____

PROJECT _____ JOB NO. _____

SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: 'A' ductBAROMETRIC PRESSURE: 29.10 in. HgDATE: 7/3/1991DUCT GAUGE PRESSURE: 15.03 in. H₂OTIME: 8:25 → 8:35(0.54 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
-------	-------------------------------------	-----------------	-------------------------

1	1.04	266.6	60.6
2	1.08	279.6	62.3
3	0.99	275.2	59.5
4	0.84	279.6	54.9
5	0.80	278.2	53.6

TEMPERATURE (°F)
VELOCITY (ft/s)'A' duct cross
section (8' x 11')

Looking into flow direction

AVERAGE CALCULATED VELOCITY: 58.2 ft/sAVERAGE TEMPERATURE: 275.8 °FPLUE GAS FLOW RATE: 256,080 SCFM

KURZ METER READING: _____ SCFM

BOILER LOAD: 144 MWCOMMENTS: Traverse was taken within 10 ft of the A side 1st stage ESP, therefore flow pattern in the duct may be turbulent.

Project No. _____
 Title of Project: _____
 Works: _____
 Subject: _____
 Date: _____
 Sheet No. _____

SRS

$$p_{sg} = \left(\frac{550}{550} \right) \left(\frac{550}{550} \right) \left(\frac{29.0 - \frac{15.03}{13.6}}{1.20} \right)$$

$$\left(\frac{550}{550} \right) \left(\frac{550}{550} \right)$$

$$p_{sg} = \left(\frac{550}{550} \right) \left(\frac{550}{550} \right) \left(\frac{29.0 - \frac{15.03}{13.6}}{1.20} \right)$$

$$p_{sg} = 1.04 \left(\frac{550}{550} \right) \left(\frac{550}{550} \right)$$

$$\begin{aligned} D &= 1.04 \left(\frac{550}{550} \right) \left(\frac{550}{550} \right) \\ &= 58.2 \left(\frac{550}{550} \right) \\ &= 307, 296 \text{ sec} \\ &= 1.20 \end{aligned}$$

$$= 230, 080 \text{ sec}$$

$$\begin{aligned} &\sqrt{\frac{14.7}{14.7 - 54}} \sqrt{\frac{60 + 275.8}{550}} \\ &= 1.20 \end{aligned}$$

CALCULATION SHEET

CALC NO. _____

REV. NO. _____

ORIGINATOR _____

DATE _____

CHECKED _____

DATE _____

PROJECT _____

JOB NO. _____

SUBJECT _____

SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: IV @ Kurz
meterBAROMETRIC PRESSURE: 29.10 in. Hg.DATE: 7/31/91DUCT GAUGE PRESSURE: 14.74 in. H₂OTIME: 8:50 → 9:20

(-0.53 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.83	264.4	54.1
2	0.70	265.8	49.7
3	0.98	271.8	59.1
4	0.81	273.6	53.8
5	0.87	276.8	55.5
6	0.84	266.9	54.5
7	0.86	265.4	55.2
8	0.90	272.2	59.5
9	0.94	277.6	58.2
10	0.94	277.6	58.2
11	0.84	270.6	54.5
12	0.80	271.2	53.4
13	0.92	275.8	57.4
14	1.00	277.6	59.9
15	1.00	277.2	61.7
16	0.74	270.8	51.3
17	0.76	270.2	52.0
18	0.75	273.2	51.8
19	0.72	275.2	50.8
20	0.72	274.4	50.7

AVERAGE CALCULATED VELOCITY: 55.1 ft/sAVERAGE TEMPERATURE: 272.2 °FFLUE GAS FLOW RATE: 242,003 SCFMKURZ METER READING: 252,000 SCFMBOILER LOAD: 144 MW

Average T = 272.4

Figure 3-1 Traverse Point Arrangement in the Duct for Velocity Measurement
Cross section looking downstream of injection point.

-T above average

-T below average

Title of Project _____ Project No _____

Subject _____ Works _____

Computer _____ Date _____

Sheet No _____

$$P_{F.G.} = \left(\frac{29}{359} \right) \left(\frac{530}{T+460} \right) \left(\frac{29.10 - \frac{1474}{13.6}}{29.92} \right)$$

$$\left(\frac{530}{T+460} \right) (0.0756)$$

$$\Delta H = \left(\frac{h}{12} \right) (.826) \left(\frac{62.4}{P_{T.G.}} \right)$$

$$V = 0.84 \sqrt{2(32.17) \Delta H}$$

$$\begin{aligned} Q &= V_{avg} (28) (60) \\ &= \frac{290,822 \text{ acfm}}{1.20} \\ &= 242,103 \text{ scfm} \end{aligned}$$

$$\begin{aligned} &\sqrt{\frac{11.7}{14.9-.53}} \sqrt{\frac{460+297.4}{530}} \\ &= 1.20 \end{aligned}$$

CALCULATION SHEET

CALC. NO. _____ REV NO. _____

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____

PROJECT _____ JOB NO. _____

SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: I-52 ft
nozzlesBAROMETRIC PRESSURE: 29.10 in. HgDATE: 7/31/91DUCT GAUGE PRESSURE: 14.54 in. H₂OTIME: 10:40-11:15(-0.52 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.84	264.2	54.4
2	0.85	265.8	54.7
3	0.85	271.8	55.0
4	1.00	280.2	60.0
5	0.95	279.2	58.5
6	0.90	271.0	56.6
7	0.84	270.8	54.7
8	0.83	277.8	56.5
9	0.91	283.0	57.6
10	0.87	282.6	56.1
11	0.81	277.2	53.4
12	0.90	277.8	54.7
13	0.89	281.0	56.7
14	0.89	285.8	56.8
15	0.84	282.4	55.1
16	0.87	279.8	56.6
17	0.95	280.2	58.5
18	0.90	284.6	57.2
19	0.89	282.6	56.9
20	0.85	283.2	55.4

AVERAGE CALCULATED VELOCITY: 56.3 ft/sAVERAGE TEMPERATURE: 278.2 °FFLUE GAS FLOW RATE: 241,500 SCFMKURE METER READING: 251,000 SCFMBOILER LOAD: 146 MW

Average T = 278.2°F

Figure 3-1 Traverse Point Arrangement in the Duct for Velocity Measurement
Cross section looking downstream of nozzle point.

- Above average

- T below average

Title of Project _____

Project No. _____

Subject: _____

Works _____

Computer _____

Date _____

Sheet No. _____

$$P_{f6} = \left(\frac{29}{359} \right) \left(\frac{530}{T+460} \right) \left(\frac{29.10 - \frac{14.51}{13.6}}{29.92} \right)$$

$$\left(\frac{530}{T+460} \right) (.0757)$$

$$JH = \left(\frac{2}{12} \right) (.826) \left(\frac{62.0}{f_{rs}} \right)$$

$$J = .24 \sqrt{7/3.14} \quad P_{f6}$$

$$Q = \frac{12.5 (28) (60)}{227264 \text{ sec}} \times 1.23$$

$$= 241,007 \text{ sec}^2$$

$$\frac{4.5}{112-50} = \frac{112-50}{550}$$

$$= 1.23$$

CALCULATION SHEET

CALC. NO. _____ REV. NO. _____

ORIGINATOR _____ DATE _____ CHECKED _____ DATE _____

PROJECT _____ JOB NO. _____

SUBJECT _____ SHEET NO. _____

DUCT TRAVERSE DATA FOR GAS VELOCITY CALCULATION

TRAVERSE #: IV - @ Kure meterDATE: 7/31/91TIME: 2:30-3:10BAROMETRIC PRESSURE: 29.10 in. HgDUCT GAUGE PRESSURE: 14.50 in. H₂O
(-0.52 psig)

POINT	DEFLECTION(h), in. H ₂ O	TEMPERATURE, °F	VELOCITY (CALC'D), ft/s
1	0.79	273.4	53.1
2	0.78	275.8	52.8
3	0.92	277.0	57.4
4	0.80	281.2	53.7
5	0.85	280.8	55.3
6	0.80	276.2	53.5
7	0.84	277.0	54.9
8	0.85	281.2	55.3
9	0.86	285.4	55.8
10	0.87	281.6	56.0
11	0.80	279.8	53.6
12	0.80	280.4	53.7
13	0.80	282.6	57.0
14	0.87	284.2	56.1
15	0.80	284.4	57.1
16	0.80	282.2	49.9
17	0.74	284.2	51.7
18	0.85	285.2	55.5
19	0.85	286.2	48.6
20	0.85	286.2	52.8

AVERAGE CALCULATED VELOCITY: 54.2 ft/sAVERAGE TEMPERATURE: 281.3 °FPIPE GAS FLOW RATE: 238-20 SCFMKURE METER READING: 250,500 SCFMBOILER LOAD: 146 MW

Average T = 281.3°F
 O - suspect velocity points - - too low

Figure 3-1 Traverse Point Arrangement in the Duct for Velocity Measurement
 Cross section looking downstream of injection point.

- Above average
 - Below average

Project No. _____
 Title of Project: _____
 Works: _____
 Subject: _____
 Computer: _____
 Date: _____
 Sheet No. _____

$$P_{f.6} = \left(\frac{29}{359} \right) \left(\frac{530}{74460} \right) \left(\frac{29.10 - \frac{14.5}{13.6}}{29.92} \right)$$

$$\left(\frac{530}{74460} \right) (0.757)$$

$$\Delta H = \left(\frac{h}{r_2} \right) (.876) \left(\frac{62.4}{P_{f.6}} \right)$$

$$J = 0.84 \sqrt{2(32.17) \Delta H}$$

$$Q = \text{b.g. } (8860)$$

$$= \frac{286,176 \text{ scfm}}{1.20}$$

$$= 238,480 \text{ scfm}$$

$$\frac{1.20}{1.20} = 1.00$$

$$\frac{60 + 0.001}{530} = 0.0001887$$

$$= 1.20$$

SECTION
C-3

Results of air compressor tests

Atlas Copco

SERVICE DATA REPORT

comp. A

Date of Last Service _____
 Customer Bectel (Pun. Elect)
 Address Christman Rd
 Contact _____ Phone _____
 Mtr. Mfg SK509AN2491 H.P. 500
 R.P.M. 1725 Volts 4160 Amps 68.1
 S.F. 1.15 Motor S/N. PFG134003
 Work Order No. _____
 Unit Model 2R-5 63 Unit S/N 610752
 L.P.S/N 054924 H.P.S/N 095531
 Start Up Date _____ Unit Hours _____
 RPL.L.P.S/N _____ REPL. H.P.S/N _____
 Hours L.P. _____ Hours H.P. _____
 TYPE OF SERVICE
 Planned _____ Emergency _____
 Work Requested Start up Amper Load L1 L2 L3
Wrist Gen 2.6 L1 2.7 L2 2.9

MEASUREMENTS IN FULL LOAD CONDITION

WATER SYSTEM TEMPERATURES			AIR SYSTEM TEMPERATURES		
	Before	After		Before	After
Inlet	76		Ambient	90	
After Oil Cooler	86		Inlet	85	
After Intercooler	95		After Intercooler	90	
After L.P. Element	97		After L.P. Element	251	
After H.P. Element	98		After H.P. Element	302	
After Aftercooler	101		After Aftercooler	87	

SYSTEM PRESSURES			OIL SYSTEM TEMPERATURES		
Water In	40		Oil Sump	110	
Water Out	0		After Oil Cooler	96	
Unload Pressure	125				
Load Pressure	115				
Intercooler Loaded	27				
Intercooler Unloaded	78				
Oil Pressure	35				
Suction Filter	2				

GEAR BACKLASH					
L.P. Avg.		X	Corrected Factor		
H.P. Avg.		X	Corrected Factor		

BACKLASH AFTER ELEMENT CHANGE					
L.P. Avg.		X	Corrected Factor		
H.P. Avg.		X	Corrected Factor		

SHOCK PULSE MEASUREMENTS

57712
at 120
psi

Point	D.B.I.	Loaded Carpet		Loaded Peak		Unload Carpet		Unload Peak	
		Before	After	Before	After	Before	After	Before	After
1	29	8		16		3		14	
2	32	5		13		2		10	
3	35	16		14		0		8	
4	31	14		28		8		21	
5	29	7		14		0		7	
6	31	14		22		0		12	
7	22	9		16		3		11	

RECORD ALL SAFETY DEVICE SETTINGS

L.P. Air Temp. Out 428 H.P. Air Temp. Out 428 Oil Temp. 176 H.P. Air Temp. In 140
 Oil Pressure 25 psi Other _____ Other _____ Other _____
 Date 7/17/04 Service Tech. T. J.

SERVICE DATA REPORT

Comp. B

Date of Last Service _____ Work Order No. _____
 Customer Bectel (Penn Elect) Unit Model 2R-5 63 Unit S/N 610751
 Address Johnstown Pa L.P.S/N 054932 H.P.S/N 095399
 Contact _____ Phone _____ Start Up Date _____ Unit Hours _____
 Mtr. Mfg 5509AN2491 H.P. 500 RPL.L.P.S/N _____ REPL. H.P.S/N _____
 R.P.M. 1745 Volts 4160 Amps. 64.1 Hours L.P. _____ Hours H.P. _____
 S.F. 1.15 Motor S/N. PK-125001 Planned _____ Emergency _____

TYPE OF SERVICE

Work Requested _____
Went to 1-2.4 1-2.7 1-2.6

MEASUREMENTS IN FULL LOAD CONDITION

WATER SYSTEM TEMPERATURES

	Before	After
Inlet	76	
After Oil Cooler	79	
After Intercooler	94	
After L.P. Element	96	
After H.P. Element	97	
After Aftercooler	101	

AIR SYSTEM TEMPERATURES

	Before	After
Ambient	90	
Inlet	85	
After Intercooler	89	
After L.P. Element	276	
After H.P. Element	308	
After Aftercooler	87	

SYSTEM PRESSURES

	Before	After
Water In	60	
Water Out	0	
Unload Pressure	125	
Load Pressure	115	
Intercooler Loaded	28	
Intercooler Unloaded	40	
Oil Pressure	33	
Suction Filter	2	

OIL SYSTEM TEMPERATURES

	Before	After
Oil Sump	104	
After Oil Cooler	94	

GEAR BACKLASH

L.P. Avg. _____ X Corrected Factor _____
 H.P. Avg. _____ X Corrected Factor _____

BACKLASH AFTER ELEMENT CHANGE

L.P. Avg. _____ X Corrected Factor _____
 H.P. Avg. _____ X Corrected Factor _____

SHOCK PULSE MEASUREMENTS

Point	D.B.I.	Loaded Carpet		Loaded Peak		Unload Carpet		Unload Peak	
		Before	After	Before	After	Before	After	Before	After
1	29	9		17		9		16	
2	32	6		14		5		14	
3	30	7		19		2		8	
4	31	18		31		6		14	
5	29	6		14		2		10	
6	31	10		21		0		7	
7	20	8		16		5		13	

RECORD ALL SAFETY DEVICE SETTINGS

L.P. Air Temp. Out 427 H.P. Air Temp. Out 457 Oil Temp. 17 H.P. Air Temp. In 101
 Oil Pressure 20 Other _____ Other _____ Other _____

Date 7/1/91 Service Tech. John B

SERVICE TECHNICIANS REPORT

(Cont. from service data report)

S.O. No. 66592

Customer BuckelUnit 2-2R-5 635

S/N

Technician Tom B

Date _____

Overtime Authorized by _____

Authorized Representative (signature) _____

WORK PERFORMED

so I had to use block wire instead of red. The customer also has to make some changes in his starting panel wiring for our relay to work.

- The oil they going to use is a Ponsol with an ISO 32. It's a little light but it seems that's what the customers have using in his other 2's. The other the only oil they use in all their turbines. If there's a problem with this we'll call them.
- 4-4:30 Travel home

7/12/91 7:50 - 8 Travel to site.

8-4 - Today we went ahead and put the oil in.

- I also went ahead and calibrated all the sensors. I also went ahead and put an electrical check on both machines.

- We then went ahead and bugged both compressors. We found that the wire both going in the wrong direction from what it was supposed to be with wire. We have to pull the back off the starters. They told me that they'll switch the leads on Mon morning.

4-10:30 Travel home

ACKNOWLEDGEMENT OF RECEIPT OF SERVICES

Starting Time _____

Stopping Time _____

Date _____

These Services Were Received On This Date by _____

Authorized Representative (signature) C. W. Jones

(Cont. from service data report)

Customer

Unit

S/N

Technician

Date

Overtime Authorized by _____

Authorized Representative (signature)

WORK PERFORMED

7/15/91 5:30 - 12 Travel to jobsite.
12 - 5:30 - I first went ahead and humped
each camp. to make sure we were
going in the right direction. We then
went ahead and put the coupling
guards on.
- I then ran pump no. A sn. GIC 752.
I ran it unloaded until we took SPM
readings. I then loaded it up being
the max pressure of 125 psi. I then
ran it flat out at 120 psi. I took
a set of readings and found everyth-
ing ok. I couldn't take any readings
until the customer changed a trim lever.
- I then ran pump B sn. GIC 751 using
the same procedure as A. The only
thing I saw which we'll monitor is
pt. a on our SPM's it was slightly
high.
- Finally the day seemed to be over.
as I departed.

Travel home

ACKNOWLEDGEMENT OF RECEIPT OF SERVICES

Starting Time

Stopping Time

Date _____

These Services Were Received On This Date by

Authorized Representative (signature)

SECTION
C-4

Results of lime slurry preparation and transfer system test

Lime Slurry Preparation and Transfer

Penelec's existing lime storage and slurry preparation area at their Seward Plant consists of a storage silo with a capacity of about 30 tons, and a slurry preparation sump with a total volume of about 6000 gallons. Each of the two lime slurry storage tanks in the CZD demonstration plant can hold about 8000 gallons, and can easily hold the contents of the preparation sump.

A screw conveyor transports lime from the silo to the sump. The screw conveyor is operated in cycles, each cycle lasting 10 minutes. The volume of lime transported to the sump during this 10 minute cycle varies and is not precisely known. For CZD use, the target concentration of lime slurry is 20% solids. To achieve a 20% lime slurry in the sump, lime is fed through the conveyor by trial and error.

Lime slurry of unknown concentration from the sump is used by the Seward Plant for waste-water treatment. Since the sump is filled with lime both by the plant personnel for Penelec's uses, and by Mobile Maintenance personnel for Bechtel's CZD use, the concentration of lime slurry in the sump varies.

The following procedure was employed to test the system and prepare the lime slurry needed for CZD plant operations. The existing lime in the partially filled silo was calcitic lime. Therefore, it was decided to use this lime for initial parametric tests until it was exhausted, and then refill the silo with dolomitic lime. The lime slurry sump was filled with water and the screw conveyor was operated for 30 minutes, that is, 3 cycles of 10 minutes each. At the end of 3 cycles, the sump was completely full. A sample of the lime slurry was taken from the sump and sent to the plant laboratory for determination of density, specific gravity, and corresponding concentration of the lime slurry. At the end of 3 cycles, the concentration of lime slurry was 16%. The sump pump was used to transfer about 4000 gallons of the 16% lime slurry to one of the empty CZD lime slurry storage tanks.

Water was again added to the lime slurry sump until it was nearly full, and the screw conveyor was operated for another 2 cycles. The total concentration of the lime slurry in the sump increased to 25% as determined by laboratory analysis. Again, the sump pump was used to transfer 25% lime slurry to the partially filled lime slurry storage tank in the CZD plant. Upon analysis, the final concentration in the filled CZD lime slurry storage tank was found to be 19.5% solids.

END

**DATE
FILMED**

01/09/91