DOE/PC/95255--T3

MULTIPLE POLLUTANT REMOVAL USING THE CONDENSING HEAT EXCHANGER

Final Test Plan

For

Task 3 Long Term Testing at the ECTC

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MASTER

U. S. DOE Contract - DE-AC22-95PC95255
CRD Contract - 1337

CLEARED BY
PATENT COUNSEL

1.0 Task 3 Program Objectives

The objective of this task is to demonstrate long term operation of a condensing heat exchanger for coal-fired conditions. A small condensing heat exchanger will be installed at the Environmental Control Technology Center (ECTC) in Barker, New York. It will be installed downstream of the flue gas particulate removal system. The test will determine the amount of wear, if any, on the Teflon™ covered internals of the heat exchanger. Visual inspection and measurements will be obtained for the Teflon™ covered tubes during the test. The material wear study will be conducted over a one year calendar period, and the CHX equipment will be operated to the fullest extent allowable.

2.0 Facility Description and Operation

The Environmental Control Technology Center (ECTC) will be used to provide the flue gas for the one year test on a small CHX unit. The ECTC is a comprehensive test facility for evaluating advanced emissions control technologies applied to high sulfur coals. The test facility utilizes about one percent of the flue gas available from the 662 MW Kintigh Station, a pulverized coal boiler operated by the New York State Electric and Gas Corporation (NYSEG) in Barker, New York.

A flow schematic of the ECTC Facility is shown in Figure 1. The facility is operated 24 hours a day, allowing long term continuous tests to be performed. The pilot CHX unit will be located in the mini-pilot wet scrubber sub-loop of the ECTC. This loop has a gas flow capacity of 1200-1500 ACFM and will provide the "design" flue gas velocity of 40 ft/s between the tubes at the inlet of the heat exchanger. The pilot CHX test unit will be located downstream of the electrostatic precipitator in place of the mini-pilot wet scrubber. The inlet ductwork to the CHX unit will have a port available to make flue gas particle concentration measurements.

The CHX unit that will be used for the life test will be a skid mounted single-stage unit as shown in Figure 2. In addition to a heat exchanger, the unit will also have a flue gas inlet control damper, water pump, and water circulation tank. Figure 3 is a top view drawing of the heat exchanger module of the CHX pilot test unit. The internal dimensions of the heat exchanger are 12 5/32 inches by 14 3/8 inches. There are six heat exchanger tubes in each row. The heat exchanger tube rows are staggered from each other (triangular pitch) so there is no open line of site from the top to the bottom of the heat exchanger. The flue gas enters at the top the heat exchanger and exits at the bottom. The cooling water will enter at the bottom of tubes and exit at the top. The flue gas inlet duct will be removable to allow access to the top of the heat exchanger for inspection of the Teflon™ coverings on the top rows of tubes.

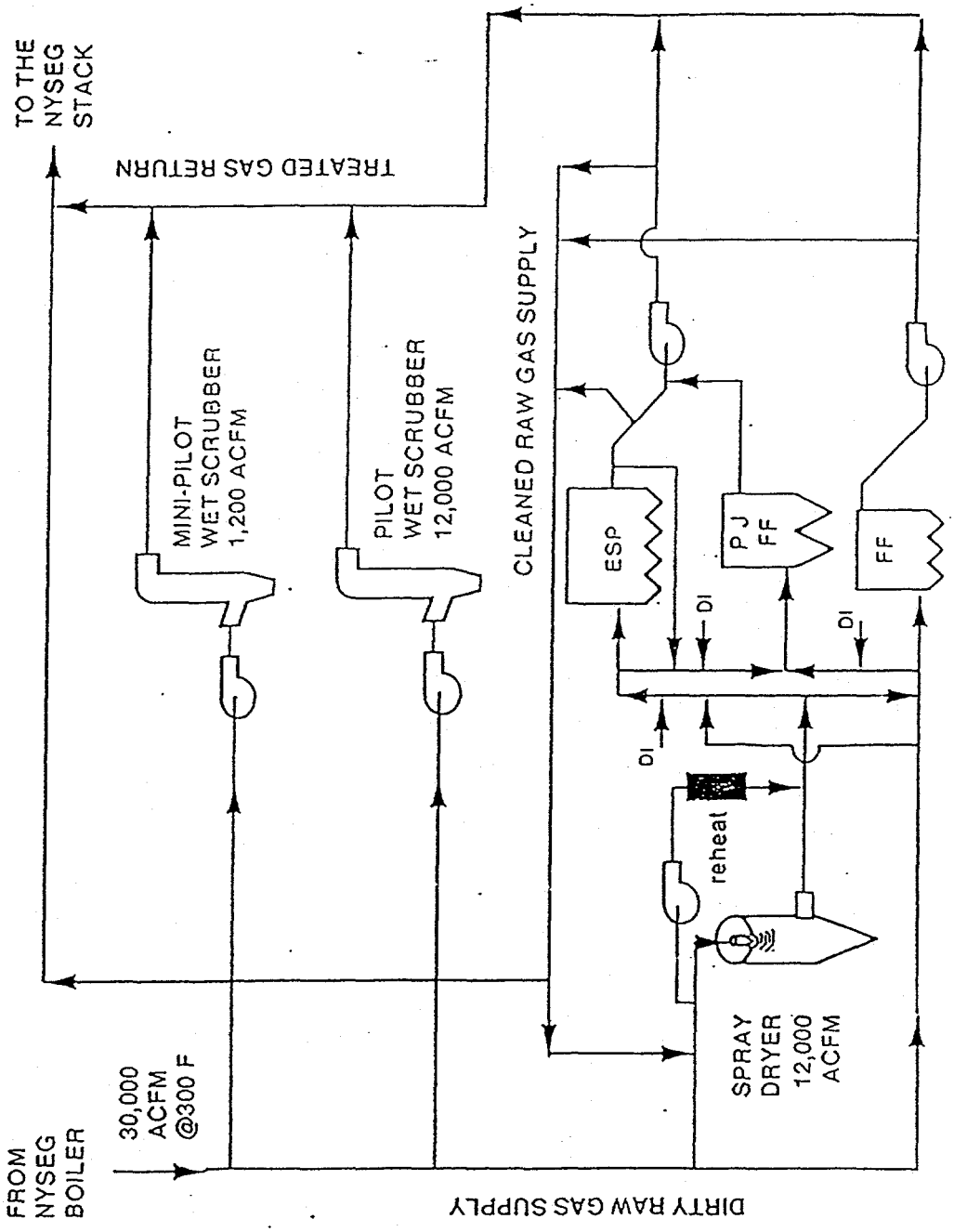

Figure 1. Gas Flow Schematic of the EPRI Environmental Control Technology Center

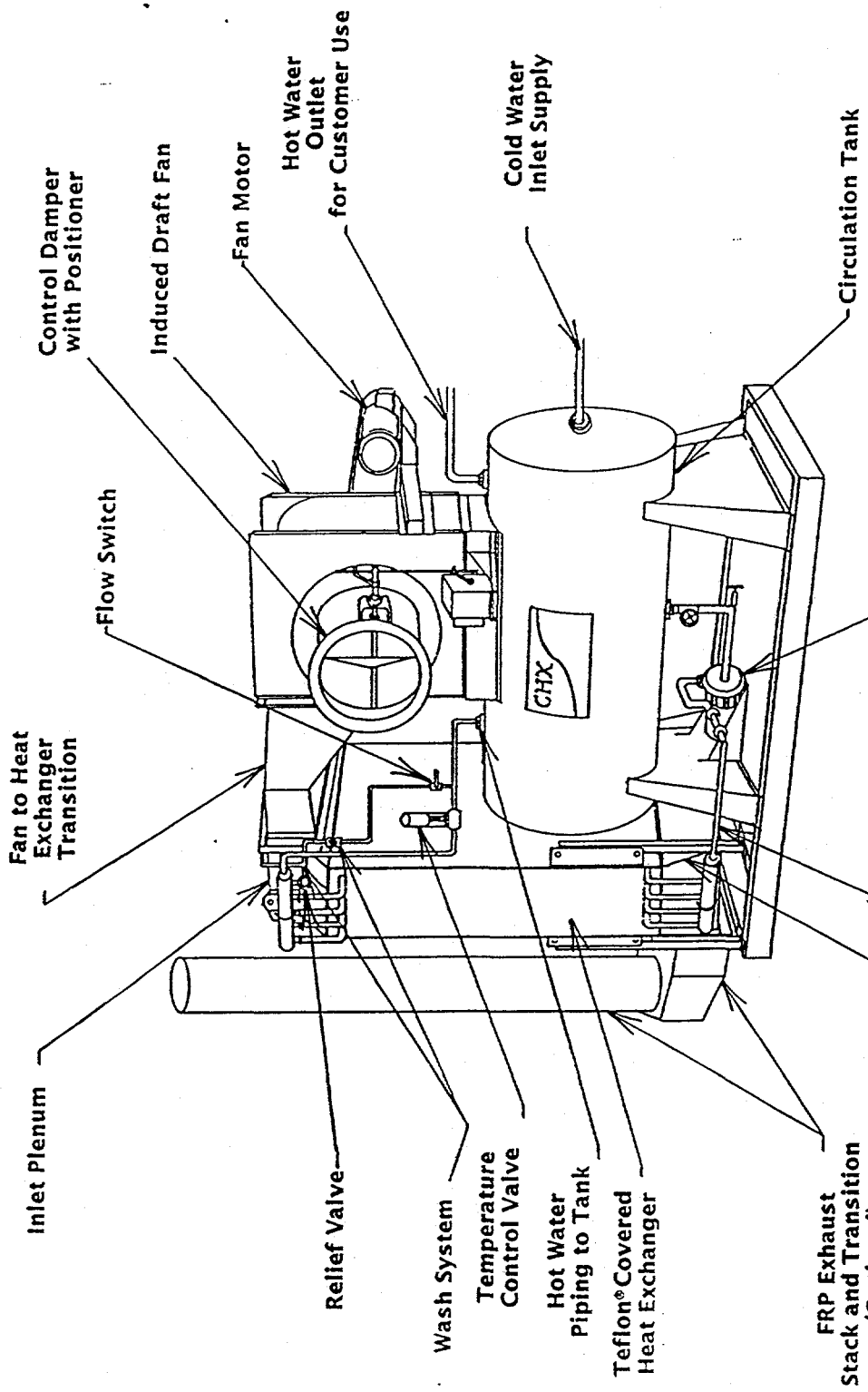

Figure 2. Schematic Diagram of the Skid Mounted CHX Pilot Unit

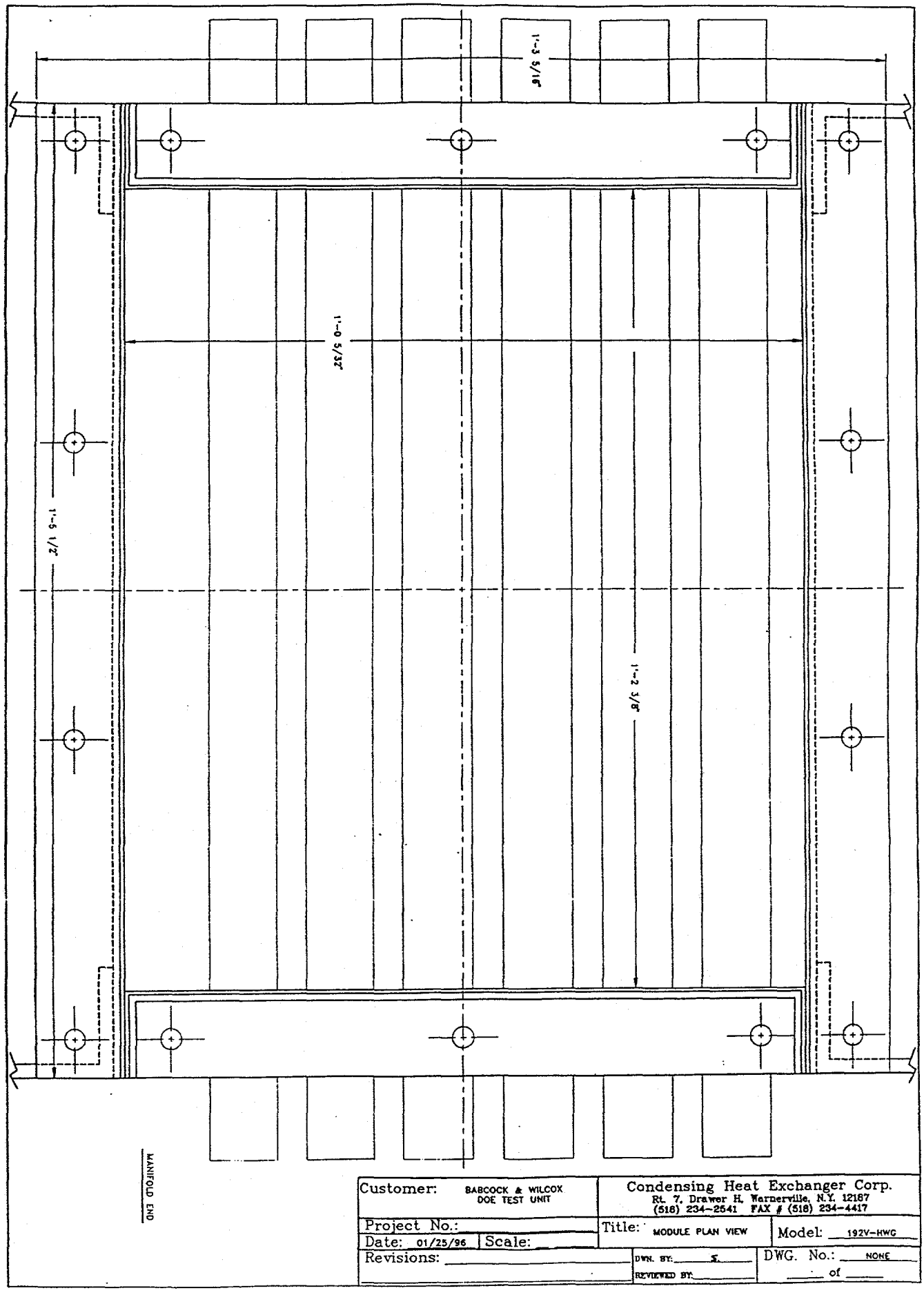

Figure 3 - Top View of Heat Exchanger Module

3.0 Experimental Approach

In a commercial application, the region of the condensing heat exchanger that will experience the most severe wear and abrasion is at the flue gas inlet. This is the area where the flue gas and the particles first come into contact with the Teflon™ covered heat exchanger tubes. It is also the region where the gas temperature and Teflon™ temperature will be the greatest. The life test will be designed to represent the conditions expected in a commercial coal-fired application using an IFGT condensing heat exchanger. A single-stage CHX unit can be used in the place of an IFGT for the life test if the test conditions at the inlet to the single-stage test unit can be controlled so that it is the same as expected for an IFGT installation.

The ECTC pilot facility and the condensing heat exchanger will be operated in a manner that provides conditions representative of commercial operation at the flue gas inlet of an IFGT condensing heat exchanger. This will include:

- A flue gas with a representative particulate loading , temperature, and flow for a commercial coal-fired application. The CHX unit will be located downstream of the electrostatic precipitator. The particulate loading of the flue gas entering the unit will be maintained at 0.03 lbs/million Btu or greater during the test period.

- Controlling the temperature and flow rate of the cooling water for the condensing heat exchanger to provide the Teflon™ temperature expected at the flue gas inlet of a full scale IFGT unit.

Parsons Power is responsible for the operation of the ECTC during the one year wear test of the pilot CHX unit. A subcontract agreement has been signed with Parsons Power that defines their responsibilities and the specific requirements for the test program. A copy of the subcontract agreement is attached as Appendix A.

4.0 ECTC/B&W Preparations

B&W and ECTC personnel will work together to ensure that all required activities have been defined, and responsible personnel are assigned to coordinate work. Specifically, B&W and ECTC personnel will meet to confirm the scope of supply for both labor and materials for the duration of the one year test program. This will include reviewing the requirements in the subcontract agreement, along with data documentation, quality, safety, and reporting requirements.

B&W will recondition the CHX unit as necessary so that it is in good working order before shipping to the ECTC. ECTC personnel will review equipment drawings and performance specifications and recommend facility modifications and installation procedures.

5.0 Site Prep & Equipment Installation

The CHX equipment will be shipped to the ECTC and installed by qualified mechanical and electrical erection personnel. Parsons Power (formerly Gilbert/Commonwealth) is currently the ECTC site subcontractor for these services. The CHX unit will be shipped completely assembled, but will require interconnecting fluework, electrical power, and cooling water. Other installation activities include support steel, installation of condensate drain piping, installation of measurement instrumentation, and functional checkout of the equipment.

6.0 One-Year Wear Test

The CHX unit will be operated at the design flue gas flow conditions for as many hours within the one-year calendar period as possible to evaluate Teflon™ wear characteristics. It is anticipated that the cumulative operation time will be approximately 10 to 11 months. This accounts for scheduled maintenance periods and unplanned equipment downtime at the ECTC.

During the test period, ECTC personnel will monitor the operation of the pilot facility and the CHX unit. The CHX pilot unit will be instrumented to provide continuous status information during operation. Data will be periodically collected on the operating status of both the ECTC pilot facility and the CHX unit. Changes in the operation of the facility (fuel supply changes, upsets due to other testing, etc.), and elapsed exposure time of the CHX unit will also be recorded. The design operating conditions for the CHX pilot unit and the instrumentation requirements for monitoring operation at the test site are identified in the subcontract agreement with Parsons Power, attached as Appendix A. Operating parameters critical to the safe operation of the unit, such as inlet flue gas temperature and outlet water temperature will also be monitored as part of the CHX unit's integrated safety system. ECTC personnel will be trained to take appropriate action if the system's alarm panel annunciates and the unit is automatically shut down.

The CHX unit will be located downstream of an electrostatic precipitator and the particulate loading of the flue gas entering the unit will average about 0.03 lbs/million Btu or greater. EPA Method 5 particulate loading measurements will be made at the inlet of the CHX unit after start up of the test. An opacity meter will be used to monitor the flue gas particulate at the outlet of the ESP. EPA Method 5 measurements will be repeated for the CHX unit on a periodic basis to confirm that the opacity meter readings still reflect the particulate loading for the unit.

Prior to start up of the system, the top row of tubes and the adjacent Teflon™ covered heat exchanger surfaces will be visually inspected. Photographs will be taken of the exposed area at the inlet of the heat exchanger before the test is started. This will also be done after the life test is completed.

During the one year exposure test period, B&W personnel will periodically travel to the ECTC to inspect the Teflon™ covered tubes for wear, review operating data, and discuss progress with ECTC personnel. Teflon™ wear measurements will be made on the two top tube rows of the heat exchanger unit. Specific locations will be identified on each tube surface for periodic inspection. The types of measurements to be made include:

- The overall diameter of the Teflon™ covered tubes will be measured at periodic intervals and at a number of locations. A micrometer will be used to measure the top-to-bottom and side-to-side dimensions of the top row of tubes at the predetermined locations. A digital caliper will be used for the horizontal diameter measurements and a micrometer will be used for the vertical diameter measurements. The overall accuracy of the horizontal diameter measurement is expected to be 0.001 inches and the overall measurement of the vertical diameter measurement is expected to be 0.0005 inches.

- A nondestructive method will be used to measure the thickness of the Teflon™ covering on the tubes. A Coating Thickness Gage, using an eddy current measurement principle will be used to make the measurement. The instrument has a range of 0.001 to 0.040 inches (1 to 40 mils) and an accuracy of ±1% of its reading. The Teflon™ covering will have a nominal thickness of 0.015 inches at the start of the test. Teflon™ thickness measurements will be made for the top surface of the first and second row of heat exchanger tubes. Thickness measurements will also be made at specified angles from top center (0-45 degrees) for the top row of tubes. Thickness measurements can not be made for angles from top center for the second row of tubes because of the staggered array (overlap of the tubes for adjacent rows) of the tubes. Measurements will be made at the predetermined locations. An average thickness will also be calculated for the top of each of the two tube rows of tubes.

- Surface roughness of the Teflon™ covering on the tubes will also be investigated at the time the other inspections are being performed. Two approaches will be used:

  - A replication technique will be used at the predetermined locations during each inspection. The replicas will be examined under a microscope to determine changes in roughness that occurred since the last examination. Photographs will be made from the replicas.

  - A profilometer will be used to estimate the roughness of the Teflon™ covering on the top row of tubes at predetermined locations. The profilometry measurements will be for indication only because our roughness standards are not traceable to NIST.

The surface roughness measurements can only be made on the top row of tubes because of the dimensional constraints caused by the close tube spacing and the staggered array of the tube rows.

The above measurements will be made at the time the CHX unit is installed at the ECTC pilot facility to establish the base case condition prior to exposure to the flue gas. The next inspection will be after one month of continuous operation. The remaining time intervals may be increased, based on the wear measurements obtained, but no interval between measurements will exceed four months. If only negligible wear is detected after six months of continuous operation, the particulate loading of the flue gas entering the heat exchanger may be increased and the test will be continued.

If there is significant thinning, abrasion, or there are small holes in the Teflon™ covering for any of the tubes during the test, additional examination will be performed at the conclusion of the test. If needed, a minimum of three tubes (one from the top, one from the middle, and one from the bottom of the heat exchanger) will be removed from the heat exchanger for more detailed examination and study. For areas where the Teflon™ has been damaged, samples will be removed for microscopic and chemical examination to determine the major damage mechanisms.

7.0 Data Analysis & Report

The purpose of this activity is to conduct a complete and detailed evaluation of the data collected throughout the one-year test program and to report these results to the DOE. Test data will be collected at the ECTC facility in the form of raw test data, visual observations and physical measurements on the Teflon™ covered tubes. The ECTC will provide B&W with monthly reports that include the amount of exposure time and any abnormal operating conditions. Operational data for the pilot facility and the CHX unit will also be provided to B&W on a periodic basis.

The incremental and cumulative dimensional changes of the Teflon™ covering on the tubes will be evaluated as a function of the CHX unit's performance history. The effect of tube location in the heat exchanger, if any, will also be noted. The expected lifetime of a CHX unit in a coal-fired flue gas application will be estimated based on the results of the measurements.

B&W will prepare a comprehensive report in accordance with the DOE provided format and guidelines. The report will provide a detailed accounting of the work performed for the 1-year test program. The major goal of this report is to describe the type and amount of Teflon™ wear observed and to clearly state the impact of this wear for commercial installations.

8.0 Schedule

EVENT	START DATE	COMPLETE DATE
ECTC/B&W Preparations	11-95	1-96
Site Prep & Equipment Installation	11-95	2-96
1-Year Wear Test	3-96	3-97
Site Restoration	4-97	5-97
Data Analysis & Report	3-96	6-97

APPENDIX A

SUBCONTRACT AGREEMENT WITH PARSONS POWER

SUBCONTRACT AGREEMENT

WITH

PARSONS POWER

INTRODUCTION

This agreement covers the services to be provided by Parsons Power (formerly Gilbert Commonwealth) for the installation and operation of a pilot CHX® condensing heat exchanger for a life test at the Environmental Control Technology Center (ECTC) located in Barker, New York. The life test will consist of operating a CHX® pilot unit for one year in a flue gas environment representative of what is found in a coal fired utility downstream of a commercial particulate removal device. The flue gas will be supplied by the Somerset generating station, owned and operated by the New York State Electric and Gas Corporation (NYSEG).

B&W is the prime contractor to the DOE for this work. The Electric Power Research Institute (EPRI), the owner and operator of the ECTC, signed a Facilities Use Agreement with B&W that permits B&W to perform the life test at the ECTC site. Parsons Power provides engineering services at the ECTC site. This agreement with Parsons Power covers the services to be provided at the ECTC as a subcontractor to B&W.

The pilot condensing heat exchanger will be reconditioned, as needed, by the CHX® Corporation, Warnerville, New York and shipped to the ECTC in a condition suitable for use. Parsons Power will be responsible for the installation and operation of the unit on a slipstream of the ECTC facility, maintenance support, on-site instrumentation and data acquisition support, and decommissioning the unit at the completion of the test. The CHX® unit is expected to be operated continuously (24 hours/day), whenever possible, during the life test. B&W will be responsible for periodically making wear measurements on the Teflon covered tubes of the CHX® pilot unit.

SPECIFIC REQUIREMENTS

The following provides a description of the services to be provided by Parsons Power under this agreement.

1) Determine a suitable location within the ECTC facility that will house the CHX® pilot unit for the one year life test. The pilot unit will be located in a heated building that permits easy access to the unit for periodic inspection. It should also be located downstream of a particulate cleanup device, preferably a precipitator.

2) Make the necessary flue work modifications and connections to the pilot CHX unit to provide the flue gas conditions required. The site location should have provisions for:

   a) the pilot CHX® unit to be shut down for inspection and wear measurements without interfering with the operation of the plant.

   b) flue gas opacity measurements to be made at the outlet of the particulate removal device (to be provided by Parsons Power).

   c) flue gas flow measurements to the CHX® unit (to be provided by Parsons Power).

   d) a portion of the flue gas to pass around the particulate removal device, if desired, in order to provide a flue gas with greater particulate loading. B&W will provide the additional opacity measurement instrumentation required if this option is exercised.

3) Connect the cooling water and electrical power sources to the CHX® pilot unit. Parsons Power will be responsible for all plumbing and electrical lines connected to the CHX® pilot unit. Cooling water and electrical power will be provided to the unit as specified in Table 1. The CHX® pilot unit's safety system will be functioning during the test. The safety system will be independent of the ECTC flue gas control system.

4) Provide for disposal of:

   a) cooling water after it exits the system.

   b) water used to periodically wash the heat exchanger tubes.

   c) condensate water, if any.

5) Operate the CHX® pilot unit as described in Table 1, attached. Parsons Power will also provide EPA Method 5 measurement services to determine the particle loading at the inlet to the CHX® pilot unit. These services will be provided at least four times during the life test.

6) Provide routine status inspection of the CHX® pilot unit during the life test to ensure that it is operating correctly. Personnel will be available to:

   a) periodically review operating data to ensure that the flue gas conditions and operating parameters of the unit are within the design operating limits,

b) make adjustments to the flue gas flow, flue gas temperature, and water recirculation, as needed, to ensure that the test requirements are being satisfied, and

c) take corrective action if the unit is automatically shut down or alarms are set off because an operating limit is exceeded. B&W and CHX® Corporation will provide the training and instructions needed for Parsons Power personnel to bring the unit back on line.

d) isolate and drain the CHX® pilot unit if there is a shutdown and there is any danger of the water in the unit freezing.

7) Provide for the acquisition and recording of data needed to monitor the operation of the unit. This will include:

a) plant operational data relevant to the life test, such as plant load, fuel characterizations, ESP operation, etc.

b) outputs from the instrumentation on the CHX® pilot unit. This will include the flue gas temperatures (inlet and outlet) and the water temperatures (inlet and outlet).

c) outputs from instruments in the ECTC facility used for this test, including:

- gas analyzer readings for SO_2 and O_2.
- opacity measurements to monitor the particulate loading of the flue gas at the outlet of the particulate removal device.
- the flue gas flow rate through the CHX® pilot unit.

d) cumulative hours that the CHX® pilot unit has been operating during the test.

Manual data will be recorded a minimum of twice a day when the CHX® pilot unit is operating. If the operation of the plant is changed (load changes, fuel changes, etc.) the data should be recorded more frequently. Data acquisition system data will be recorded hourly (arithmetic average of readings taken every 5 minutes).

Recorded data will be transmitted to the B&W project engineer on a monthly basis. The data can be in the form of written reports, or computer readable disks. Data acquisition outputs will be provided in engineering units.

The instrumentation requirements for this life test are identified in Table 2. Parsons Power will document the instrumentation calibrations performed on ECTC

instrumentation used for the life test. Calibration documentation will be made available to B&W on request and provided at the conclusion of the life test. B&W will be responsible for the instrumentation on the CHX® pilot unit or brought on site for wear measurements.

Parsons Power will provide B&W with copies of fuel analysis reports, as they are available, during the test period.

8) Provide monthly status reports to the B&W project engineer that include:

   a) the number of hours the CHX® pilot unit has been operated at the design conditions.

   b) any changes in plant operation that occurred during the past month.

   c) any maintenance or other service that was provided for the CHX® pilot unit during the past month.

   d) abnormal operation or shutdown of the CHX® unit.

   e) recorded data from the test.

9) Provide general assistance during the test program to include:

   a) availability of Parsons Power and EPRI personnel to review operational data for the test program. These are expected to be in the form of team meetings to review progress.

   b) availability of plant personnel to assist with preparing the unit for the periodic wear measurements that will be made on the tubes. The assistance will involve isolating the CHX® unit from the flue gas source, shutting down the unit, removing the top of the unit for inspection, and replacing the top on the unit after the inspection is completed. B&W personnel will perform the wear measurements. Wear measurements will be made a minimum of seven times during the test (pretest condition and at the end of months 1, 2, 4, 6, 9 and 12). Wear measurements may be performed at shorter time intervals, if needed.

10) Disconnecting the CHX® unit from the ECTC facility at the conclusion of the test program and preparing it for shipment. This will include draining the water out of the unit prior to shipment, packaging the unit for shipment, and loading the unit on its carrier.

11) Restore the test site to its original condition.

SUBCONTRACTOR COSTS

This is a Cost Plus Fixed Fee contract with a maximum cost of $185,664 and a fixed fee of $12,713. Monthly bills will be submitted to the B&W project engineer with the monthly status reports.

TERMS AND CONDITIONS

B&W personnel shall have access to and use of the facilities at the ECTC as described in the ECTC Facilities Agreement, dated October 3, 1995.

The Period of Performance for this Phase I effort is from 12-1-95 through 9-30-97.

The list of DOE contract requirements applicable to this subcontract are identified in Appendix A, attached. The subcontractor is responsible for compliance to these requirements.

PARSONS POWER AGREES TO FURNISH AND DELIVER ALL ITEMS AND PERFORM ALL SERVICES SET FORTH HEREIN FOR THE CONSIDERATION STATED ABOVE.

IN WITNESS WHEREOF, THE DULY AUTHORIZED REPRESENTATIVES OF BABCOCK & WILCOX AND PARSONS POWER HAVE EXECUTED THIS SUBCONTRACT ON THE DATES SHOWN.

FOR THE ADMINISTRATIVE CONVENIENCE OF BOTH PARTIES THIS AGREEMENT WILL BECOME PART OF PURCHASE ORDER S1590 TO BE ISSUED UPON THE AGREEMENTS FULL EXECUTION.

BABCOCK AND WILCOX R&D DIVISION	PARSONS POWER
SIGNATURE	SIGNATURE
Rod Bruckner PRINT NAME	Robert A. Burns PRINT NAME
12-20-95 DATE	January 12, 1996 DATE

TABLE 1

DESIGN OPERATING CONDITIONS FOR THE CHX® PILOT UNIT

FOR THE

ONE YEAR ECTC LIFE TEST

	PARAMETER	NOMINAL VALUE	RANGE
-	inlet flue gas temperature:	320 F	± 30 F
-	outlet water temperature:	170 F	± 20 F
-	cooling water supply	3.0 gal/min (est)	(---)
-	flue gas velocity between the tubes:	40 ft/sec	± 5 ft/sec
-	inlet flue gas flow	750 SCFM	+ 50 SCFM - 0 SCFM
-	inlet particulate loading	representative of poor to good particulate cleanup from a commercial removal device (0.03 to 0.3 lbs/10^6 Btu).	
-	electrical power	110 volts AC	

TABLE 2
CHX LIFE TEST INSTRUMENTATION LIST

Measurement Parameter	Instrument	Provided By	Calibration Frequency	Measurement Frequency
Inlet water temperature	Type K Thermocouple	B&W	NA	Continuous DAS
Outlet water temperature	Type K Thermocouple	B&W	NA	Continuous DAS
Inlet gas temperature	Type K Thermocouple	B&W	NA	Continuous DAS
Outlet gas temperature	Type K Thermocouple	B&W	NA	Continuous DAS
Particle loading EPA Method 5		Parsons Power	NA	Periodic
Opacity	opacity meter	Parsons Power	weekly	Continuous DAS
Gas flow across orifice pressure diff. pressure temperature	 pressure trans diff pressure tran Type K TC	Parsons Power	 semi-annually semi-annually NA	Continuous DAS
Pressure at CHX inlet	pressure transmitter	Parsons Power	semi-annually	Continuous DAS
Pressure drop across CHX	differential pressure transmitter	Parsons Power	semi-annually	Continuous DAS
CHX exposure time	clock	Parsons Power	NA	Continuous
Teflon wear tube dimension surface profile thickness	 micrometer profilometer eddy current	B&W	 annually NA during use	Periodic
Sulfur dioxide	SO_2 analyzer	Parsons Power	daily	Continuous DAS
Oxygen	O_2 analyzer	Parsons Power	daily	Continuous DAS

APPENDIX A

The following Government additional provisions apply to this order:

FAR 52.203-6	RESTRICTIONS ON CONTRACTOR SALES TO THE GOVERNMENT (JUL 1985)
FAR 52.203-7	ANTI-KICKBACK PROCEDURES (OCT 1988)
FAR 52.215-1	EXAMINATION OF RECORDS BY COMPTROLLER GENERAL (JUL 1995)
FAR 52.215-2	AUDIT - NEGOTIATION (JUL 1995)
FAR 52.215-22	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA (JAN 1991)
FAR 52.215-23	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA - MODIFICATIONS (NOV 1994)
FAR 52.215-24	SUBCONTRACTOR COST OR PRICING DATA (NOV 1994)
FAR 52.215-25	SUBCONTRACTOR COST OR PRICING DATA - MODIFICATIONS (NOV 1994)
FAR 52.215-26	INTEGRITY OF UNIT PRICES (APR 1991)
FAR 52.215-27	TERMINATION OF DEFINED BENEFIT PENSION PLANS (SEP 1989)
FAR 52.215-31	WAIVER OF FACILITIES CAPITAL COST OF MONEY (SEP 1987) The Contractor did not include facilities capital cost of money as a proposed cost of this contract. Therefore, it is an unallowable cost under this contract.
FAR 52.215-39	REVERSION OR ADJUSTMENT OF PLANS FOR POST-RETIREMENT BENEFITS OTHER THAN PENSIONS (PRB) (FEB 1995)
FAR 52.219-8	UTILIZATION OF SMALL BUSINESS CONCERNS AND SMALL DISADVANTAGED BUSINESS CONCERNS (FEB 1990)

FAR 52.220-3	UTILIZATION OF LABOR SURPLUS AREA CONCERNS (APR 1984)
FAR 52.222-1	NOTICE TO THE GOVERNMENT OF LABOR DISPUTES (APR 1984)
FAR 52.222-4	CONTRACT WORK HOURS AND SAFETY STANDARDS ACT - OVERTIME COMPENSATION (JUL 1995)
FAR 52.222-26	EQUAL OPPORTUNITY (APR 1984)
FAR 52.222-35	AFFIRMATIVE ACTION FOR SPECIAL DISABLED AND VIETNAM ERA VETERANS (APR 1984)
FAR 52.222-36	AFFIRMATIVE ACTION FOR HANDICAPPED WORKERS (APR 1984)
FAR 52.222-37	EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS AND VETERANS OF THE VIETNAM ERA (JAN 1988)
FAR 52.223-2	CLEAN AIR AND WATER (APR 1984)
FAR 52.225-11	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES (MAY 1992)
FAR 52.227-14	RIGHTS IN DATA - GENERAL - ALTERNATES I, IV AND V (JUN 1987)
FAR 52.227-16	ADDITIONAL DATA REQUIREMENTS (JUN 1987)
FAR 52.230-2	COST ACCOUNTING STANDARDS (AUG 1992)
FAR 52.230-4	CONSISTENCY IN COST ACCOUNTING PRACTICES (AUG 1992)
FAR 52.230-5	ADMINISTRATION OF COST ACCOUNTING STANDARDS (DEC 1994)
FAR 52.232-22	LIMITATION OF FUNDS (APRIL 1984)
FAR 52.245-5	GOVERNMENT PROPERTY (COST-REIMBURSEMENT, TIME-AND-MATERIAL, OR LABOR-HOUR CONTRACTS)(JAN 1986)

FAR 52.246-9 INSPECTION OF RESEARCH AND DEVELOPMENT (APRIL 1984)

FAR 52.246-25 LIMITATION OF LIABILITY-SERVICES (APR 1984)

FAR 52.249-6 TERMINATION (MAY 1986)

DEAR 952.208-70 PRINTING (APR 1984)

DEAR 952.227-11 PATENT RIGHTS - RETENTION BY THE CONTRACTOR (SHORT FORM) (MAR 1995)

DEAR 952.227-13 PATENT RIGHTS - ACQUISITION BY THE GOVERNMENT (MAR 1995)

DOE PR 9-9.102-2 AUTHORIZATION AND CONSENT (JUN 1979)

DOE PR 9-9.104 NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT (JUN 1979)