Quarterly Progress Report

For: METHANE de-NOX® for Utility PC Boilers

Covering Period: October 1, 2000 to December 31, 2000

Date of Report: January 30, 2001

Recipient: Institute of Gas Technology (IGT)
1700 Mount Prospect Road
Des Plaines, IL 60018-1804

Award Number: DE-FC26-00NT40752

Subcontractors: Babcock Borsig Power (BBP) [formerly DB Riley, Inc. (DBR)]
Gas Research Institute (GRI)
All-Russian Thermal Engineering Institute (VTI)

Partners: IGT Sustaining Membership Program (SMP) will provide cash co-funding in the amount of $150,000. GRI will provide cash co-funding in the amount of $700,000. BBP will provide in-kind co-funding in the amount of $97,000.

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Project Objective: The overall project objective is the development and validation of an innovative combustion system, based on a novel coal preheating concept prior to combustion, that can reduce NO_x emissions to 0.15 lb/million Btu or less on utility pulverized coal (PC) boilers. This NO_x reduction should be achieved without loss of boiler efficiency or operating stability, and at more than 25% lower levelized cost than state-of-the-art SCR technology. A further objective is to make this technology ready for full-scale commercial deployment by 2002-2003 in order to meet an anticipated market demand for NO_x reduction technologies resulting from the EPA's NO_x SIP call.

Background: Conventional measures for NO_x reduction in PC combustion processes primarily rely on combustion modifications and post combustion controls. In general, combustion modification technologies try to reduce the formation of NO_x precursors while destroying already-formed NO_x. A variety of NO_x reduction technologies are in use today, including Low-NO_x Burners (LNB's), flue gas recirculation (FGR), and gas or other fuel reburning. Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR) are post combustion

techniques. NO_x reduction efficiencies from these technologies vary from 30 to 60%, with up to 90% for SCR.

A novel pulverized coal-preheating approach for NO_x reduction has been developed by the All Russian Thermal Engineering Institute (VTI), in Russia, for use on PC utility boilers. The technology consists of a burner modification that preheats pulverized coal to elevated temperatures (up to 1500°F) prior to coal combustion. This releases coal volatiles, including fuel-bound nitrogen compounds, into a reducing environment, which converts the coal-derived nitrogen compounds to molecular N_2. The quantity of natural gas fuel required for PC preheating is in the range of 3 to 5% of the total burner heat input. Basic combustion research and development of the preheat PC burner was conducted by VTI in the early 1980's. Following these promising laboratory results, commercial-scale coal preheat burners of 30 and 60 MW_t capacity were developed and demonstrated in field tests conducted in several Russian power stations:

The advanced pulverized coal (PC) preheat combustion system being developed in this project for direct-fired PC boilers combines the VTI preheat burner together with elements of IGT's successful METHANE de-NOX technology for NO_x reduction. METHANE de-NOX has been commercially demonstrated on coal, MSW and biomass-fired stoker boilers in the U.S. and Japan. Overall, the new PC preheat system combines several NO_x reduction strategies into an integrated, low-NO_x, PC combustion system, including a novel PC burner design using natural gas-fired coal preheating, and internal and external combustion staging in the primary and secondary combustion zones. This integrated system can achieve very low NO_x levels – down to 0.15 lb/million Btu – without the complications, limitations and expense of SCR or SNCR technology.

Status:

Work during the quarter included completion of the pilot-scale PC Preheat system design and reviews by IGT, VTI and BBP. Based on capabilities, cost and schedule considerations, it was decided that production of the final equipment fabrication drawings and fabrication of all equipment except the natural gas-fired Preheat combustor would be handled by BBP. This represents an increase in workscope for BBP, and a modification of their subcontract with IGT to cover the additional work has been agreed to by both parties and is currently being executed. Fabrication cost estimates for the equipment were obtained and a fabricator selected. Based on bench scale test results and CFD modeling, IGT completed the design of the pilot Preheat combustor. Concurrent with development of the pilot system design, an initial pilot test plan was established. Finally, CFD modeling of the PC Preheat combustor was completed by IGT and modeling started for the BBP test furnace.

Task 1.1 *Pilot-Scale Design*

Based on the technology transfer documentation provided to IGT by VTI and review and comparison of Russian and U.S. utility coals and PC firing methods, a design coal (Table 1) was selected and the design basis (Table 2) established for the pilot-scale PC Preheat system.

Table 1. Design Coal Analysis (Harrisburg #5)

PROXIMATE, as received	Wt %
Moisture	10.85
Volatile Matter	32.09
ULTIMATE, dry	
C	75.32
H	4.95
O+Cl	8.58
N	1.68
S	1.80
ASH	7.67
HHV, Btu/lb (wet)	12,072

Table 2. Pilot Scale PC Preheat Design Basis

PC Preheat Burner Firing Rate, kcal/hr	756,048
Fuel	Pulverized Coal
Burner Design Basis Coal	Harrisburg #5 (VM^{daf} = 38.99%)
PC mass flow rate (2% moisture), kg/hr	103.5
Preheat Temperature of PC/Combustion products mixture, °C	710
Velocity of PC/ Combustion Products mixture at burner exit, m/s	18
Total flow rate of secondary air, nm^3/hr	838
Temperature of secondary air, °C	300
Velocity of secondary air at burner exit, m/s	25
Velocity of dusty air stream at burner exit, m/s	18
Excess air at the burner exit, %	10

Note: Vm^{daf} is volatile matter in mass percent on a dry and ash free basis

Pilot-Scale PC Preheat System Description

Ref: PC Preheat Burner Process Flow Diagram, GTI Drawing No. PC-F-0400-D (Figure 1)
PC Preheat Burner Drawing Summary (ATTACHMENT 1)

The flow diagram presents an overview of the PC Preheat technology and its components, as it will be applied in BBP's pilot-scale furnace test facility. System equipment and major flow streams are shown for two modes of pilot test operation: Option #1 is based on a bin storage system for delivering PC to the burner while the second mode, Option #2, is a direct-fired PC delivery system that is considered the standard scheme used in U.S. utility boiler operations.

Raw coal transported to the site will be stored in an existing bin at the Babcock Borsig Power test furnace facility. From storage, raw coal will be sized in an existing pulverizer at BBP's site and stored in a dedicated silo. PC flow from the silo is controlled via an existing volumetric Vibra-Screw Feeder. Downstream of the feeder is an existing Rotary Airlock isolating the equipment from the test furnace. From this point on, two different PC delivery systems will be tested:

Option #1

In the bin storage system, PC from the existing feeder/rotary airlock is routed into a Mixer, Item #1, where a small amount of air (~20 °C) is mixed with PC for transport purposes. From the Mixer, PC is conveyed through a Compensator device, Item #2. The Compensator makes up for the vertical growth as the Preheater sections, Items #4 & 6, heat up to 800 °C. PC now enters the Natural Gas Combustor, Item #3, where it mixes with the hot products of combustion from a natural gas burner.

Directly flanged to the Combustor is the Preheater, which is divided into two sections: 1st Preheater (Item #4) and the 2nd Preheater (Item #6). The first section, Item #4 is an air-cooled jacketed pipe constructed in 3 flanged segments. Air-cooling simulates full-scale applications and the segmented design permit changes to the PC preheat residence time by removing segments from the arrangement. The 2nd Preheater, Item #6, is non-cooled. Based on achieving a PC preheat temperature of 710 °C, calculations show that PC/combustion product mixture velocity in the preheater (Item #4 & 6) and residence time are well within the design criteria determined in previous testing by VTI. The preheated mixture directly enters the pilot-scale PC burner. Based on VTI's experience in operating similar pilot-scale preheat burners, orientation of the test burner fuel inlet is rotated from the vertical. The burner design incorporates multi-annular channels for injection of PC and secondary air into the test furnace. The central tube of the burner is used for probing the flame. Vanes are also provided in the secondary air channels to impart swirl.

Option #2

In the direct fired system, the pilot plant arrangement changes in order to prepare a fuel stream containing PC and primary air to simulate pneumatic transport conditions found in the majority of, if not all, existing U.S. utility PC burner systems. PC Preheat technology implementation with this type of fuel delivery scheme requires a solids separator, PC Coal Cyclone, Item #9.

In this test scheme, PC first drops by gravity from the Vibra Screw Feeder/Rotary Airlock and is directed into the Eductor Mixer, Item #8. In the mixer, PC is combined with air and pneumatically transported into the PC Coal Cyclone. At the cyclone, PC solids are separated from the air and drop from the cyclone outlet through a new Rotary Airlock, Item #12, into the inlet of Mixer, Item #1. See Option #1 to complete the system description.

The PC Coal Cyclone off gas is piped to the PC Preheat Burner where it can be re-introduced at the burner assembly and injected into the furnace.

Pilot System Thermal Insulation Requirements

Insulation is required for personnel safety and control of heat losses around the following equipment. BBP shall recommend and procure.

- Natural Gas Combustor, Item #3
- 1st Preheater, Item #4
- 2nd Preheater, Item #6
- PC Burner, Item #7
- PC Coal Cyclone, Item #9
- Piping and Ducts to be determined

Pilot System Piping Requirements

- Solid/Air transport piping shall utilize long radius elbows, not less than 5 pipe diameters.
- Solid transfer piping shall contain no sudden restriction or obstructions. Flange and/or fitting internal diameters shall be aligned and surfaces smooth.

Pilot System Instrumentation Requirements

A preliminary instrumentation summary is given below.

- Thermocouple for measurement of gas temperature at the Natural Gas Combustor – 1700 °C type R
- Thermocouple for measurement of PC temperature in preheater; 2 – up to 1700 °C (type R) and 8 - up to 900 °C (type N)
- Thermocouple for measurement of Preheater wall temperature, 6 – up to 1100 °C
- Thermocouple for measurement of PC temperature at test burner inlet, 1 – up to 800 °C
- Thermocouple for measurement of cooling air, 3 – up to 400 °C
- Thermocouple for measurement at test burner of: secondary air and PC Coal Cyclone gas outlet,
- Gas sample probes, gas species to be determined.
    - At Natural Gas Combustor Outlet
    - At 1st and 2nd Preheater – select 4 elevations
- PC solid sample probes
    - At 1st and 2nd Preheater – select 4 elevations
    - At test furnace - select 2 locations

- Pressure measurements
    - Measure supply pressure of all system streams
    - Measure pressure at burner inlet for PC, secondary air and cyclone outlet gases
    - Measure delta-P across PC Coal Cyclone
- Flow measurements
    - Measure PC flow to burner
    - Measure natural gas flow to Combustor
    - Measure air flow to the following
    - Natural Gas Combustor, Combustion Air
    - Mixer Transport Air
    - PC Burner Secondary Air – Inner Air
    - PC Secondary Air – Outer Air
    - 1st Preheater Cooling Air
    - Ejection Mixer Transport Air

Task 1.2 *CFD Modeling*

IGT previously conducted substoichiometric firing tests of a pilot-scale prototype for the natural gas-fired preheater burner. The data collected during these tests was used to develop a preliminary spreadsheet model from which a CFD model of the PC preheater was developed. In the current quarter, CFD modeling of the PC Preheat combustor was completed by IGT and modeling will now be started for the BBP test furnace.

Task 1.3 *Pilot-Scale Equipment Fabrication and Installation*

Design drawings for the Pilot PC Preheat burner system were completed in the current quarter from which fabrication drawings will be developed by BBP's burner engineering department. Fabrication cost estimates were obtained and a fabricator selected. Design and fabrication drawings for the natural gas-fired Preheat combustor were developed and materials obtained. Fabrication cost estimates were obtained and a fabricator selected.

Task 1.4 *Pilot-Scale Testing*

An initial outline of the pilot system testing and data requirements was completed. A total of four U.S. coals will be tested at the 3 MMBtu/h scale. Two modes of pulverized coal delivery, a bin storage delivery system and a direct-fired delivery system will be evaluated. Key operating variables to be tested are the preheat temperature and coal residence time at temperature prior to the coal combustor.

Task 1.5 *Pilot-Scale Data Evaluation* – No Activity

Task 1.6 *Task 1 Management and Reporting*

Work during the quarter included project review and planning correspondence with VTI and BBP, modification of BBP's subcontract to include fabrication of the pilot scale test equipment,

and obtaining quotes and selecting vendors for pilot-scale test system and natural gas-fired combustor.

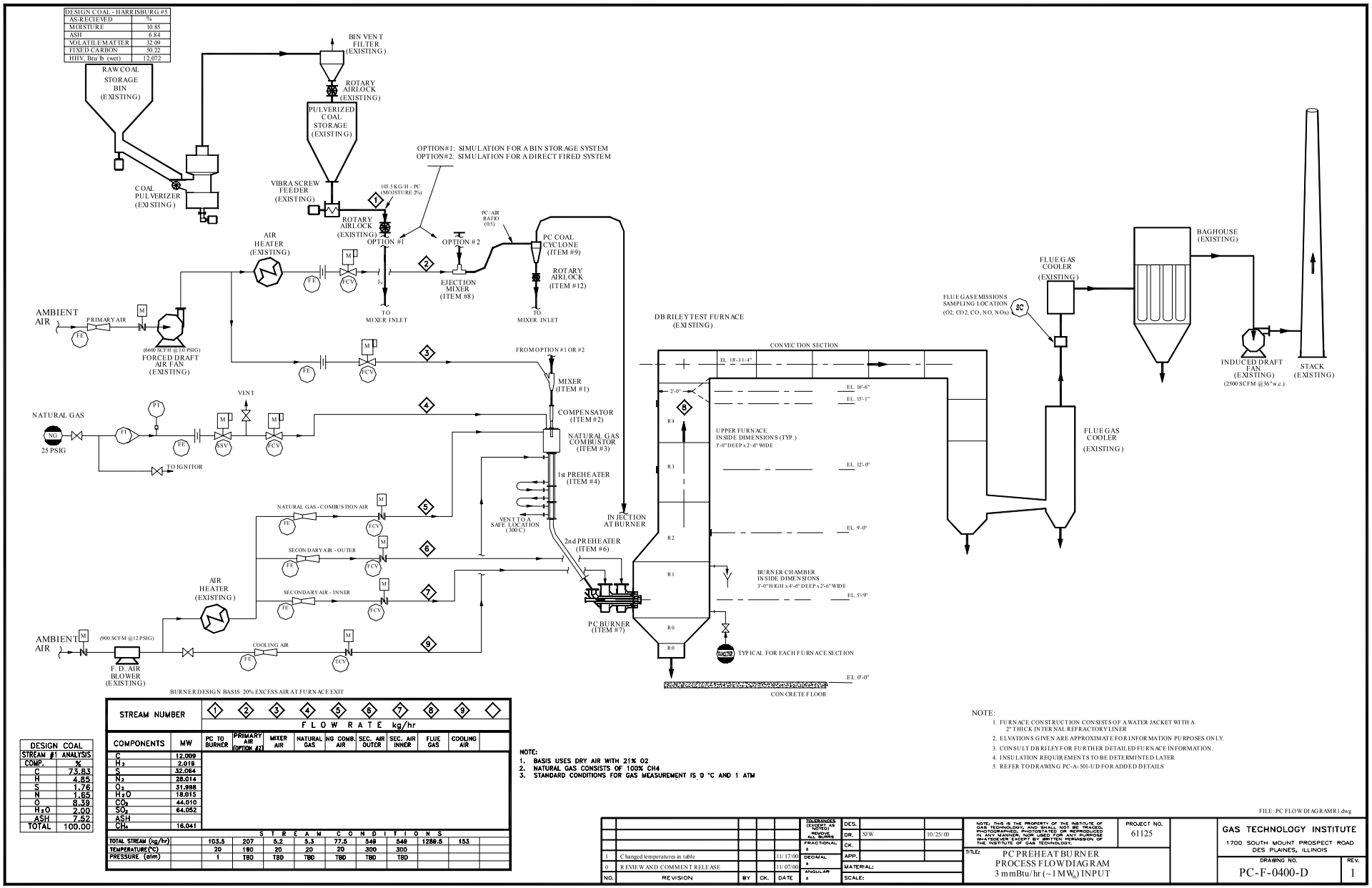
An estimate of $48,735 was received from BBP for the additional design and fabrication work on the pilot system to be added to BBP's subcontract workscope. This is within the original budget allowance for this work and does not increase the overall project cost. The proposed subcontract amendment language was reviewed and agreed to by IGT and BBP and is currently being added to the subcontract.

Plans for Next Quarter:

- The 3 MMBtu/h pilot-scale preheat burner fabrication will be completed and installation at the BBP test facility will be started.
- The pilot-scale test plan and matrix will be completed.
- CFD modeling of BBP's 100 MMBtu/h boiler for commercial-scale testing will be started.

Milestone Status Table: The planned completion dates for all project tasks and major milestones are shown in the following table. As of this date, IGT expects the overall project to be completed on schedule in August 2002.

ID No.	Task / Milestone Description	Planned Completion	Actual Completion	Comments
♦	Kickoff Meeting	5/2/2000	5/2/2000	Complete
1.0	Technology Development			
1.1	Pilot-Scale Design	8/31/2000	12/31/2000	Complete
1.2	CFD Modeling	6/30/2001		30% Complete
1.3	Pilot-Scale Equipment Fabrication and Installation	11/30/2000		Started
1.4	Pilot-Scale Testing	3/31/2001		Test Planning Started
1.5	Pilot-Scale Data Evaluation	4/30/2001		
1.6	Task 1 Management and Reporting	4/30/2001		
♦	Task 1 Report	4/30/2001		
2.0	Technology Validation			
2.1	Commercial Prototype Engineering Design	7/31/2001		
2.2	Baseline Data Review	7/31/2001		
2.3	Commercial Prototype Construction	10/31/2001		
2.4	Commercial Prototype Testing	2/15/2002		
2.5	Data Processing and Evaluation	3/31/2002		
2.6	Commercialization Plan Development	6/15/2002		
2.7	Design and Fabrication of Commercial Burner System	7/31/2002		
2.8	Task 2 Management and Reporting	8/10/2002		
♦	Final Report	8/10/2002		



BURNER DESIGN BASIS: 20% EXCESS AIR AT FURNACE EXIT

STREAM NUMBER		1	2	3	4	5	6	7	8	9	◇
		FLOW RATE kg/hr									
COMPONENTS	MW	PC TO BURNER	PRIMARY AIR (OPTION #2)	MIXER AIR	NATURAL GAS	NG COMB. AIR	SEC. AIR OUTER	SEC. AIR INNER	FLUE GAS	COOLING AIR	
C	12.009										
H_2	2.016										
S	32.064										
N_2	28.014										
O_2	31.998										
H_2O	18.015										
CO_2	44.010										
SO_2	64.052										
ASH											
CH_4	16.041										
STREAM CONDITIONS											
TOTAL STREAM (kg/hr)		105.5	207	5.2	5.3	77.5	548	548	1288.5	153	
TEMPERATURE (°C)		20	180	20	20	20	300	300			
PRESSURE (atm)		1	TBD	TBD	TBD	TBD	TBD	TBD			

DESIGN COAL	
STREAM #1	ANALYSIS
COMP.	%
C	73.83
H	4.85
S	1.76
N	1.65
O	8.39
H_2O	2.00
ASH	7.52
TOTAL	100.00

NOTE:
1. BASIS USES DRY AIR WITH 21% O2
2. NATURAL GAS CONSISTS OF 100% CH4
3. STANDARD CONDITIONS FOR GAS MEASUREMENT IS 0 °C AND 1 ATM

NOTE:
1. FURNACE CONSTRUCTION CONSISTS OF A WATER JACKET WITH A 2" THICK INTERNAL REFRACTORY LINER
2. ELVATIONS GIVEN ARE APPROXIMATE FOR INFORMATION PURPOSES ONLY.
3. CONSULT DB RILEY FOR FURTHER DETAILED FURNACE INFORMATION.
4. INSULATION REQUIREMENTS TO BE DETERMINTED LATER
5. REFER TO DRAWING PC-A-501-UD FOR ADDED DETAILS

FILE: PC FLOW DIAGRAM R1.dwg

NO.	REVISION	BY	CK.	DATE
1	Changed temperatures in table			11/17/00
0	REVIEW AND COMMENT RELEASE			11/07/00

TOLERANCES (EXCEPT AS NOTED) REMOVE ALL BURRS
FRACTIONAL ±
DECIMAL ±
ANGULAR ±

DES.
DR. SJW 10/25/00
CK.
APP.
MATERIAL:
SCALE:

PROJECT NO. 61125

TITLE: PC PREHEAT BURNER PROCESS FLOW DIAGRAM 3 mmBtu/hr (~1 MW_{th}) INPUT

GAS TECHNOLOGY INSTITUTE
1700 SOUTH MOUNT PROSPECT ROAD
DES PLAINES, ILLINOIS

DRAWING NO. PC-F-0400-D REV. 1

Figure 1. Pilot-Scale Test Rig for the PC Preheat Burner

ATTACHMENT 1

SUBJECT:

PC PREHEAT BURNER DRAWING SUMMARY

Gas Technology Institute
COMBUSTION TECHNOLOGY GROUP
1700 S. Mt. Prospect Rd
Des Plaines, Illinois 60018

Date: November 29, 2000

Revision: 3

Drawing No.	Drawing Title	Date	Rev.	Item #	Paper Size (mm x mm)	ACAD File Name
Babcock Borsig Power						
200000-7-2	General Arrgt of Pilot Test Furnace Front & Side Elevations	01/11/85	2			none
200001-7-2	General Arrgt of Pilot Test Furnace Plan Views Elev's 0'-0", 24'-0" & 42'-0"3	01/14/85	2			none
200026-5-0	Test Furnace Burner Mount	08/24/84	0			none
Gas Technology Institute						
PC-A-0500-D (SHEET 1 OF 2)	Test Furnace Burner Mount Details	05/26/00	0		D size 34" x 22"	PCBurnerMount.dwg
PC-A-0500-D (SHEET 2 OF 2)	Test Furnace Burner Mount Details	05/26/00	0		D size 34" x 22"	PCBurnerMount.dwg
PC-A-0501-UD	PC Preheat Burner - Pilot Scale Assembly	11/07/00	0		Undefined	PC BURNER ASSEMBLYR0.dwg
PC-B-0300-D	DB Riley Pilot Scale Combustion Facility Diagram (3-mmBtu/hr Input)	06/01/00	0		D size 34" x 22"	DBrileyP&ID.dwg
PC-MEC-03-D (SHEET 1 OF 2)	Natural Gas Combustor	12/07/00	0		D size 34" x 22"	--
PC-MEC-03-D (SHEET 2 OF 2)	Natural Gas Combustor	12/07/00	0		D size 34" x 22"	--
PC-MEC-04-D	1st Preheater		0		D size 34" x 22"	1st PreheaterR0.dwg
PC-F-0400-D	PC Preheat Burner - Process Flow Daigram	11/17/00	1		D size 34" x 22"	PC FLOW DIAGRAMR1.dwg
PC-PI-1000-D	PC Coal Burner Simplified P&ID	05/26/00	0		D size 34" x 22"	PCBurnerP&ID.dwg
SK-PC-1	Preheated PC Block Diagram	none			14" x 9"	PreheatedPCBlockDiagram.dwg
VTI						
1-00.10 (SHEET 1 OF 2)	Additional Devices for the Test Facility - 3 mmBtu/h (Sheet 2 of 2 Plan views)	09.00	0	-	-	Komponovka-1.jpg (Note: not an ACAD file)
1-00.10 (SHEET 2 OF 2)	Additional Devices for the Test Facility - 3 mmBtu/h (Sheet 1 of 2 Elevations views)	09.00	0	-	-	Komponovka-1.jpg (Note: not an ACAD file)
1-00.11	Location of the Test Burner	09.00	0	-	1108 x 720	Burner 1.dwg
1-00.20 (SHEET 1 OF 2)	Additional Devices (Sheet 2 of 2 Plan elevations)	09.00	0	-	-	Komponovka-2.jpg (Note: not an ACAD file)
1-00.20 (SHEET 1 OF 2)	Additional Devices for PC Coal Supply Sys (Sheet 2 of 2 Elevations views)	09.00	0	-	-	Komponovka-2.jpg (Note: not an ACAD file)

ATTACHMENT 1 (Con't)

gti	SUBJECT: PC PREHEAT BURNER DRAWING SUMMARY				Gas Technology Institute COMBUSTION TECHNOLOGY GROUP 1700 S. Mt. Prospect Rd Des Plaines, Illinois 60018 **Date:** November 29, 2000 **Revision:** 3	
Drawing No.	**Drawing Title**	**Date**	**Rev.**	**Item #**	**Paper Size**	**ACAD File Name**
1-01	Dependence of the necessary temperature of pc preheating on desired NOx reduction	07.00	0		215 x 279	Fig 1-01.doc (NOT an ACAD file)
1-01.00	Mixer	09.00	0	1	267 x 400	Mixer1.dwg
1-02.00	Compensator	09.00	0	2	267 x 400	Compensator.dwg
1-04.00	PC Preparation Facility VOID	09.00	0		2870 x 4050	PC coal heater-faterr.dwg
1-04.00A	PC Preparation Facility	11.00	0		2870 x 4050	PC coal heater.dwg
1-04.10 (SHEET 1 OF 2)	1st PC Preparation Area (Sheet 1 of 2) VOID	09.00	0	4	574 x 820	PC coal heater.dwg
1-04.10 (SHEET 2 OF 2)	1st PC Preparation Area (Sheet 2 of 2) VOID	09.00	0	4	574 x 820	"
1-04.10A (SHEET 1 OF 2)	1st PC Preparation Area (Sheet 1 of 2)	11.00	0	4	574 x 820	PC coal heater-1A.dwg
1-04.10A (SHEET 2 OF 2)	1st PC Preparation Area (Sheet 2 of 2)	11.00	0	4	574 x 820	"
1-04.20	FGR Mixer NOT APPLICABLE	09.00	0	5	574 x 810	PC coal heater-2.dwg
1-04.30	2nd PC Preparation Area VOID	09.00	0	6	574 x 810	PC coal heater-3.dwg
1-04.30A	2nd PC Preparation Area	11.00	0	6	574 x 810	PC coal heater-3A.dwg
1-04.40A	PC Preheat, Setting 1	11.00	0	4	574 x 810	PC coal heater-2A.dwg
1-04.50A	PC Preheat, Setting 2	11.00	0	4	574 x 810	PC coal heater-2A.dwg
1-05.00	The Test Burner NOT APPLICABLE	09.00	0	7	1540 x 1108	Burner 2.dwg
1-05.00A	Location of the Test Burner NOT APPLICABLE	11.00	0	7	1540 x 1108	Burner ve1.dwg
1-05.10	Central Tube NOT APPLICABLE	09.00	0	7	1560 x 1108	Central tube.dwg
1-05.10A	Central Tube NOT APPLICABLE	11.00	0	7	1560 x 1108	Central tube ve1.dwg
1-05.20	Pipe of PC Duct NOT APPLICABLE	09.00	0	7	1560 x 1108	Tube 1.dwg
1-05.20A	Pipe of PC Duct NOT APPLICABLE	11.00	0	7	1560 x 1108	PC coal tube ve1.dwg
1-05.21	Vane NOT APPLICABLE	09.00	0	7	180 277	Inner vane.dwg
1-05.21A	Vane NOT APPLICABLE	11.00	0	7	180 277	Secondary inner vane-A.dwg

ATTACHMENT 1 (Con't)

gti	SUBJECT: PC PREHEAT BURNER DRAWING SUMMARY	Gas Technology Institute COMBUSTION TECHNOLOGY GROUP 1700 S. Mt. Prospect Rd Des Plaines, Illinois 60018 **Date:** November 29, 2000 **Revision:** 3				
Drawing No.	**Drawing Title**	**Date**	**Rev.**	**Item #**	**Paper Size**	**ACAD File Name**
1-05.30	Duct and Pipe of Inner Secondary Air Duct NOT APPLICABLE	09.00	0	7	1560 x 1108	Tube and duct-inner.dwg
1-05.30A	Duct and Pipe of Inner Secondary Air Duct NOT APPLICABLE	11.00	0	7	1560 x 1108	Tube and duct-inner ve1.dwg
1-05.31	Vane NOT APPLICABLE	09.00	0	7	180 x 277	Outer vane.dwg
1-05.31A	Vane NOT APPLICABLE	11.00	0	7	180 x 277	Secondary outer vane-A.dwg
1-05.40	Duct and Pipe of Peripheral Secondary Air Duct NOT APPLICABLE	09.00	0	7	1560 x 1108	Tube and duct-outer.dwg
1-05.40A	Duct and Pipe of Peripheral Secondary Air Duct NOT APPLICABLE	11.00	0	7	1560 x 1108	Tube and duct-outer ve1.dwg
1-06.00	PC Coal Tube	09.00	0	8	3900 x 5740	PC coal tube.dwg
1-07.00	Ejection Mixer	09.00	0	8	554 x 360	Mixer.dwg
1-08.00	PC Coal Cyclone	09.00	0	9	3900 x 5740	PC coal cyclone.dwg
1-09.00	Distributor	09.00	0	10	390 x 574	Divisor.dwg
1-10.00	Nozzle	09.00	0	11	180 x 277	Nozzle.dwg
1-11.00	Location of the Test Burner	11.00	0	7	1540 x 1108	Burner ve2.dwg
1-11.10	Central Tube	11.00	0	7	1540 x 1108	Central tube ve2.dwg
1-11.20	Pipe of PC Duct	11.00	0	7	1540 x 1108	PC coal tube ve2.dwg
1-11.21	Vane	11.00	0	7	180 x 277	Drying agent duct vane.dwg
1-11.30	Duct and Pipe of Inner Secondary Air Duct	11.00	0	7	1540 x 1108	Tube and duct-inner ve2.dwg
1-11.31	Vane	11.00	0	7	180 x 277	Secondary air outer vane.dwg

ATTACHMENT 1 (Con't)

gti	SUBJECT: PC PREHEAT BURNER DRAWING SUMMARY	Gas Technology Institute COMBUSTION TECHNOLOGY GROUP 1700 S. Mt. Prospect Rd Des Plaines, Illinois 60018 **Date:** November 29, 2000 **Revision:** 3

Drawing No.	Drawing Title	Date	Rev.	Item #	Paper Size	ACAD File Name
1-11.40	Duct and Pipe of Peripheral Secondary Air Duct	11.00	0	7	1540 x 1108	Tube and duct-outer ve2.dwg
1-11.50	Duct and Pipe of Drying Agent	11.00	0	7	1540 x 1108	Drying agent tube ve2.dwg
1-11.51	Vane	11.00	0	7	180 x 277	Secondary air inner vane.dwg
1-12.00	Scheme of the mixer	11.00	0	7	390 x 277	Mixer2.dwg