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INNOVATIVE CLEAN COAL TECHNOLOGY (ICCT)

500 MW DEMONSTRATION OF ADVANCED
WALL-FIRED COMBUSTION TECHNIQUES
FOR THE REDUCTION OF NITROGEN OXIDE (NO_x)
EMISSIONS FROM COAL-FIRED BOILERS

Technical Progress Report
Second Quarter 1994

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EXECUTIVE SUMMARY

This quarterly report discusses the technical progress of an Innovative Clean Coal Technology (ICCT) demonstration of advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. The project is being conducted at Georgia Power Company's Plant Hammond Unit 4 located near Rome, Georgia. The primary goal of this project is the characterization of the low NO_x combustion equipment through the collection and analysis of long-term emissions data. A target of achieving fifty percent NO_x reduction using combustion modifications has been established for the project. The project provides a stepwise retrofit of an advanced overfire air (AOFA) system followed by low NO_x burners (LNB). During each test phase of the project, diagnostic, performance, long-term, and verification testing will be performed. These tests are used to quantify the NO_x reductions of each technology and evaluate the effects of those reductions on other combustion parameters.

Baseline, AOFA, LNB, and LNB plus AOFA test segments have been completed. Analysis of the 94 days of LNB long-term data collected show the full-load NO_x emission levels to be approximately 0.65 lb/MBtu with flyash LOI values of approximately 8 percent. Corresponding values for the AOFA configuration are 0.94 lb/MBtu and approximately 10 percent. For comparison, the long-term, full-load, baseline NO_x emission level was approximately 1.24 lb/MBtu at 5.2 percent LOI. Comprehensive testing in the LNB+AOFA configuration indicate that at full-load, NO_x emissions and flyash LOI are near 0.40 lb/MBtu and 8 percent, respectively. Based on a preliminary analysis, approximately 17 percent of the incremental change in NO_x emissions between the LNB and LNB+AOFA configurations is the result of AOFA, the balance of the NO_x reduction resulting from other operational adjustments.

On September 3, 1993, Hammond Unit 4 began a nine month outage and on June 4, 1994 the unit resumed operation. The major activities during this outage included: (1) installation of the digital control system, (2) replacement of the two remaining Foster Wheeler mills with Babcock and Wilcox MPS 75 mills, (3) replacement of the precipitator, and (4) upgrade of the low pressure turbine.

The digital control system installed as part of Phase 4 of this project is now fully operational. Documentation of the digital control system is now underway. Testing of the advanced control/optimization package is still in progress. The software supplier of this package is making substantial improvements to this package to accommodate the current application.

Due to the unit outage and startup activities during June 1994, no testing was conducted this quarter.

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TABLE OF ABBREVIATIONS

acfm	actual cubic feet per minute
AMIS	All mills in service
AOFA	Advanced Overfire Air
ASME	American Society of Mechanical Engineers
C	carbon
CAA(A)	Clean Air Act (Amendments)
CEM	Continuous emissions monitor
CFSF	Controlled Flow/Split Flame
Cl	chlorine
CO	carbon monoxide
DAS	data acquisition system
DCS	digital control system
DOE	United States Department of Energy
ECEM	extractive continuous emissions monitor
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ETEC	Energy Technology Consultants
F	Fahrenheit
FC	fixed carbon
FWEC	Foster Wheeler Energy Corporation
Flame	Flame Refractories
GPC	Georgia Power Company
H	hydrogen
HHV	higher heating value
HVT	High velocity thermocouple
ICCT	Innovative Clean Coal Technology
KPPH	kilo pounds per hour
lb(s)	pound(s)
LNB	low NO _x burner
LOI	loss on ignition
(M)Btu	(million) British thermal unit
MOOS	Mills out of service
MW	megawatt
N	nitrogen
NO _x	nitrogen oxides
NSPS	New Source Performance Standards
O, O ₂	oxygen
OFA	overfire air
PA	primary air
psig	pounds per square inch gauge
PTC	Performance Test Codes

TABLE OF ABBREVIATIONS (continued)

RSD	relative standard deviation
S	sulfur
SCS	specific collection area
SCS	Southern Company Services
SO ₂	sulfur dioxide
SoRI	Southern Research Institute
Spectrum	Spectrum Systems Inc.
THC	total hydrocarbons
UARG	Utility Air Regulatory Group
VM	volatile matter

1. INTRODUCTION

This document discusses the technical progress of a U. S. Department of Energy (DOE) Innovative Clean Coal Technology (ICCT) Project demonstrating advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. The project is being conducted at Georgia Power Company's Plant Hammond Unit 4 (500 MW) near Rome, Georgia.

The project is being managed by Southern Company Services, Inc. (SCS) on behalf of the project co-funders: The Southern Company, the U. S. Department of Energy (DOE), and the Electric Power Research Institute. In addition to SCS, The Southern Company includes five electric operating companies: Alabama Power, Georgia Power, Gulf Power, Mississippi Power, and Savannah Electric and Power. SCS provides engineering, research, and financial services to The Southern Company.

The Clean Coal Technology Program is a jointly funded effort between government and industry to move the most promising advanced coal-based technologies from the research and development stage to the commercial marketplace. The Clean Coal effort sponsors projects which are different from traditional research and development programs sponsored by the DOE. Traditional projects focus on long range, high risk, high payoff technologies with the DOE providing the majority of the funding. In contrast, the goal of the Clean Coal Program is to demonstrate commercially feasible, advanced coal-based technologies which have already reached the "proof of concept" stage. As a result, the Clean Coal Projects are jointly funded endeavors between the government and the private sector which are conducted as Cooperative Agreements in which the industrial participant contributes at least fifty percent of the total project cost.

The primary objective of the Plant Hammond demonstration is to determine the long-term effects of commercially available wall-fired low NO_x combustion technologies on NO_x emissions and boiler performance. Short-term tests of each technology are also being performed to provide engineering information about emissions and performance trends. A target of achieving fifty percent NO_x reduction using combustion modifications has been established for the project. Specifically, the objectives of the projects are:

1. Demonstrate in a logical stepwise fashion the short-term NO_x reduction capabilities of the following advanced low NO_x combustion technologies:
  - a. Advanced overfire air (AOFA)
  - b. Low NO_x burners (LNB)
  - c. LNB with AOFA
  - d. Advanced Digital Controls and Optimization Strategies
2. Determine the dynamic, long-term emissions characteristics of each of these combustion NO_x reduction methods using sophisticated statistical techniques.

3. Evaluate the progressive cost effectiveness (i.e., dollars per ton NO_x removed) of the low NO_x combustion techniques tested.
4. Determine the effects on other combustion parameters (e.g., CO production, carbon carryover, particulate characteristics) of applying the NO_x reduction methods listed above.

2. PROJECT DESCRIPTION

2.1. Test Program Methodology

In order to accomplish the project objectives, a Statement of Work (SOW) was developed which included the Work Breakdown Structure (WBS) found in Table 1. The WBS is designed around a chronological flow of the project. The chronology requires design, construction, and operation activities in each of the first three phases following project award.

Table 1: Work Breakdown Structure			
Phase	Task	Description	Date
0	0	Phase 0 Pre-Award Negotiations	
1	1	Phase 1 Baseline Characterization	
	1.1	Project Management and Reporting	8/89 - 4/90
	1.2	Site Preparation	8/89 - 10/89
	1.3	Flow Modeling	9/89 - 6/90
	1.4	Instrumentation	9/89 - 10/89
	1.5	Baseline Testing	11/89 - 4/90
2	2	Phase 2 Advanced Overfire Air Retrofit	
	2.1	Project Management and Reporting	4/90 - 3/91
	2.2	AOFA Design and Retrofit	4/90 - 5/90
	2.3	AOFA Testing	6/90 - 3/91
3	3	Phase 3 Low NOx Burner Retrofit	
	3.1	Project Management and Reporting	3/91 - 8/93*
	3.2	LNB Design and Retrofit	4/91 - 5/91
	3.3	LNB Testing with and without AOFA	5/91 - 8/93*
4*	4*	Advanced Low NOx Digital Control System*	8/93 - 4/95*
5*	5*	Final Reporting and Disposition	
	5.1	Project Management and Reporting	5/95 - 12/95*
	5.2	Disposition of Hardware	12/95*

* Indicates change from original work breakdown structure.

The stepwise approach to evaluating the NOx control technologies requires that three plant outages be used to successively install: (1) the test instrumentation, (2) the AOFA system, and (3) the LNBs. These outages were scheduled to coincide with existing plant maintenance outages in the fall of 1989, spring of 1990, and spring of 1991. The planned retrofit progression has allowed for an evaluation of the AOFA system while operating with the existing pre-retrofit burners. As shown in Figures 1, the AOFA air supply is separately ducted from the existing forced draft secondary air system. Backpressure dampers are provided on the secondary air ducts to allow for the introduction of greater quantities of higher pressure overfire air into the boiler. The burners are designed to be plug-in replacements for the existing circular burners.

Figure 1: Plant Hammond Unit 4 Boiler

The data acquisition system (DAS) for the Hammond Unit 4 ICCT project is a custom designed microcomputer based system used to collect, format, calculate, store, and transmit data derived from power plant mechanical, thermal, and fluid processes. The extensive process data selected for input to the DAS has in common a relationship with either boiler performance or boiler exhaust gas properties. This system includes a continuous emissions monitoring system (NO_x, SO₂, O₂, THC, CO) with a multi-point flue gas sampling and conditioning system, an acoustic pyrometry and thermal mapping system, furnace tube heat flux transducers, and boiler efficiency instrumentation. The instrumentation system is designed to provide data collection flexibility to meet the schedule and needs of the various testing efforts throughout the demonstration program. A summary of the type of data collected is shown in Table 2.

Following each outage, a series of four groups of tests are planned. These are: (1) diagnostic, (2) performance, (3) long-term, and (4) verification. The diagnostic, performance, and verification tests consist of short-term data collection during carefully established operating conditions. The diagnostic tests are designed to map the effects of changes in boiler operation on NO_x emissions. The performance tests evaluate a more comprehensive set of boiler and combustion performance indicators. The results from these tests will include particulate characteristics, boiler efficiency, and boiler outlet emissions. Mill performance and air flow distribution are also tested. The verification tests are performed following the end of the long-term testing period and serve to identify any potential changes in plant operating conditions.

Table 2: Inputs to Data Acquisition System

Boiler Drum Pressure	Superheat Outlet Pressure
Cold Reheat Pressure	Hot Reheat Pressure
Barometric Pressure	Superheat Spray Flow
Reheat Spray Flow	Main Steam Flow
Feedwater Flow	Coal Flows
Secondary Air Flows	Primary Air Flows
Main Steam Temperature	Cold Reheat Temperature
Hot Reheat Temperature	Feedwater Temperature
Desuperheater Outlet Temp.	Desuperheater Inlet Temp.
Economizer Outlet Temp.	Air Heater Air Inlet Temp.
Air Heater Air Outlet Temp.	Ambient Temperature
BFP Discharge Temperature	Relative Humidity
Stack NO _x	Stack SO ₂
Stack O ₂	Stack Opacity
Generation	Overfire Air Flows

As stated previously, the primary objective of the demonstration is to collect long-term, statistically significant quantities of data under normal operating conditions with and without the various NO_x reduction technologies. Earlier demonstrations of emissions control technologies have relied solely on data from a matrix of carefully established short-term (one to four hour) tests. However, boilers are not typically operated in this manner, considering plant equipment inconsistencies and economic dispatch strategies. Therefore, statistical analysis methods for long-term data are available that can be used to determine the achievable emissions limit or projected emission tonnage of an emissions control technology. These analysis methods have been developed over the past fifteen years by the Control Technology Committee of the Utility Air Regulatory Group (UARG). Because the uncertainty in the analysis methods is reduced with increasing data set size, UARG recommends that acceptable 30 day rolling averages can be achieved with data sets of at least 51 days with each day containing at least 18 valid hourly averages.

2.2. Unit Description

Georgia Power Company's Plant Hammond Unit 4 is a Foster Wheeler Energy Corporation (FWEC) opposed wall-fired boiler, rated at 500 MW gross, with design steam conditions of 2500 psig and 1000/1000°F superheat/reheat temperatures, respectively. The unit was placed into commercial operation on December 14, 1970. Prior to the LNB retrofit, six FWEC Planetary Roller and Table type mills provided pulverized eastern bituminous coal (12,900 Btu/lb, 33% VM, 53% FC, 1.7% S, 1.4% N) to 24 pre-NSPS, Intervane burners. During the LNB outage, the existing burners were replaced with FWEC Control Flow/Split Flame burners. The unit was also retrofit with six Babcock and Wilcox MPS 75 mills during the course of the demonstration (two each during the spring 1991, spring 1992, and fall 1993 outages). The burners are arranged in a matrix of 12 burners (4W x 3H) on opposing walls with each mill supplying coal to 4

burners per elevation. As part of this demonstration project, the unit was retrofit with an Advanced Overfire Air System, to be described later. The unit is equipped with a coldside ESP and utilizes two regenerative secondary air preheaters and two regenerative primary air heaters. The unit was designed for pressurized furnace operation but was converted to balanced draft operation in 1977. The unit, equipped with a Bailey pneumatic boiler control system during the baseline, AOFA, LNB, and LNB+AOFA phases of the project, is being retrofit with a Foxboro I/A distributed digital control system.

2.3. Advanced Overfire Air (AOFA) System

Generally, combustion NO_x reduction techniques attempt to stage the introduction of oxygen into the furnace. This staging reduces NO_x production by creating a delay in fuel and air mixing that lowers combustion temperatures. The staging also reduces the quantity of oxygen available to the fuel-bound nitrogen. Typical overfire air (OFA) systems accomplish this staging by diverting 10 to 20 percent of the total combustion air to ports located above the primary combustion zone. AOFA improves this concept by introducing the OFA through separate ductwork with more control and accurate measurement of the AOFA airflow, thereby providing the capability of improved mixing (Figure 2).

Foster Wheeler Energy Corporation (FWEC) was competitively selected to design, fabricate, and install the advanced overfire air system and the opposed-wall, low NO_x burners described below. The FWEC design diverts air from the secondary air ductwork and incorporates four flow control dampers at the corners of the overfire air windbox and four overfire air ports on both the front and rear furnace walls. Due to budgetary and physical constraints, FWEC designed an AOFA system more suitable to the project and unit than that originally proposed. Six air ports per wall were proposed instead of the as-installed configuration of four per wall.

2.4. Low NO_x Burners

Low NO_x burner systems attempt to stage the combustion without the need for the additional ductwork and furnace ports required by OFA and AOFA systems. These commercially-available burner systems introduce the air and coal into the furnace in a well controlled, reduced turbulence manner. To achieve this, the burner must regulate the initial fuel/air mixture, velocities and turbulence to create a fuel-rich core, with sufficient air to sustain combustion at a severely sub-stoichiometric air/fuel ratio. The burner must then control the rate at which additional air, necessary to complete combustion, is mixed with the flame solids and gases to maintain a deficiency of oxygen until the remaining combustibles fall below the peak NO_x producing temperature (around 2800°F). The final excess air can then be allowed to mix with the unburned products so that the combustion is completed at lower temperatures. Burners have been developed for single wall and opposed wall boilers.

In the FWEC Controlled Flow/Split Flame (CFSF) burner (Figure 3), secondary combustion air is divided between inner and outer flow cylinders. A sliding sleeve damper regulates the total secondary air flow entering the burner and is used to balance

the burner air flow distribution. An adjustable outer register assembly divides the burners secondary air into two concentric paths and also imparts some swirl to the air streams. The secondary air which traverses the inner path, flows across an adjustable inner register assembly that, by providing a variable pressure drop, apportions the flow between the inner and outer flow paths. The inner register also controls the degree of additional swirl imparted to the coal/air mixture in the near throat region. The outer air flow enters the furnace axially, providing the remaining air necessary to complete combustion. An axially movable inner sleeve tip provides a means for varying the primary air velocity while maintaining a constant primary flow. The split flame nozzle segregates the coal/air mixture into four concentrated streams, each of which forms an individual flame when entering the furnace. This segregation minimizes mixing between the coal and the primary air, assisting in the staged combustion process. The adjustments to the sleeve dampers, inner registers, outer registers, and tip position are made during the burner optimization process and thereafter remain fixed unless changes in plant operation or equipment condition dictate further adjustments.

2.5. Application of Advanced Digital Control Methodologies

The objective of Phase 4 of the project is to implement and evaluate an advanced digital control/optimization system for use with the combustion NOx abatement technologies installed on Plant Hammond Unit 4. The advanced system will be customized to minimize NOx production while simultaneously maintaining and/or improving boiler performance and safety margins. This project will provide documented effectiveness of an advanced digital control /optimization strategy on NOx emissions and guidelines for retrofitting boiler combustion controls for NOx emission reduction. It is anticipated that a commercial or near-commercial control/optimization package will be utilized in this demonstration. Modifications and extensions will be made to the software package as necessary to make it more appropriate for this application.

Figure 2: Advanced Overfire Air System

Figure 3: Low NO_x Burner Installed at Plant Hammond

3. PROJECT STATUS

3.1. Project Summary

Baseline, AOFA, LNB, and LNB+AOFA test phases have been completed. Details of the testing conducted each phase can be found in the following reports:

- Phase 1 Baseline Tests Report [1],
- Phase 2 AOFA Tests Report [2],
- Phase 3A Low NOx Burner Tests Report [3], and
- Phase 3B Low NOx Burner plus AOFA Tests Report [4].

Chemical emissions testing was also conducted as part of the project and the results have been previously reported [5]. Phase 4 of the project -- evaluation of advanced low NOx digital controls / optimization strategies as applied to NOx abatement -- is now in progress.

3.2. Current Quarter Activities

On June 6, 1994 Hammond Unit 4 resumed operation following a nine month outage beginning September 3, 1993. During this extended outage, the unit underwent extensive upgrades and modifications including:

- Installation of new digital control system,
- Installation of new ash handling controls (PLC)*,
- Installation of new soot blower controls (PLC)*,
- Replacement of the two remaining FWEC mills with Babcock and Wilcox MPS 75 mills*,
- Feeder replacement*,
- Replacement of precipitator*,
- Upgrade of low pressure turbine*,
- Burner repairs and modifications*,
- Replacement of two partial boiler water walls*,
- Modifications of the mill primary air system*,
- Rebuild of "C" induced draft fan*,
- Installation of new electric drive units,
- Refurbishment of the primary air heaters*, and
- Installation of new transmitters.

The Unit 3 control system was also replaced during this time interval. *

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*Not in Wall-Fired Project scope of work.

The digital control system installed as part of Phase 4 of this project is now fully operational. Documentation of the digital control system is now underway. Testing of the advanced control/optimization package is still in progress. The software supplier of this package is making substantial improvements to this package to accommodate the current application.

Due to the unit outage and startup activities during June 1994, no testing was conducted this quarter.

3.3. Advanced Low NO_x Digital Controls System

The objective of this scope addition to the project at Plant Hammond is to evaluate and demonstrate the effectiveness of advance digital control/optimization methodologies as applied to the NO_x abatement technologies installed at this site (LNB and AOFA). This scope addition will provide documented effectiveness of these control/optimization methods on NO_x emissions and boiler efficiency improvements and guidelines for retrofitting boiler combustion controls for NO_x emission reduction. The major tasks for this project addition includes: (1) design and installation of a distributed digital control system, (2) instrumentation upgrades, (3) advanced controls/optimization design and implementation, and (4) characterization of the unit both before and after activation of the advanced strategies. Major milestones for this phase are shown in Table 3.

3.3.1. Digital Control System

An integral part of Phase 4 of the project was the design and installation of a digital control system to be the host of the advanced control/optimization strategies being developed. SCS Engineering had overall responsibility for the following major activities:

- Preliminary engineering,
- Procurement,
- Detail engineering,
- Digital control system configuration, and
- Installation and checkout.

A list of the systems indicating the scope of the digital control system replacement can be found in Appendix A. In general, the system consisted of Unit Master, Fuel Control, Air Flow Control, Furnace Pressure Control, Feedwater Control, Steam Temperature Control, Condensate Control, Auxiliary Control*, DCA Heater Level Control, Ash Handling System*, Precipitator Energy Management System*, Precipitator Fire Protection*, and Burner Management System. In total, the digital control system was configured for 2352 input/output points consisting of 572 analog inputs, 116 analog outputs, 1032 digital inputs, and 632 digital outputs with the balance being allocated spares. The milestones in the design, installation, and startup of the Hammond Unit 4 digital control system as shown in Table 4.

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* Not in Wall-Fired Project scope of work.

Preliminary Engineering

During second quarter 1992, preliminary engineering was undertaken by GPC and SCS personnel to determine the overall scope of the project including development of a digital control system specification, preliminary input/output list, and evaluations of existing instrumentation and drives. In that the pre-existing system was based on a Bailey pneumatic boiler control system, much of existing instrumentation and drives were also pneumatic and therefore likely candidates for replacement. Since a large percentage of the cost of a digital control system retrofit can be the result of the replacement of the instrumentation and drives, a case-by-case evaluation was made as to the necessity for replacement. In general, the decision was made to upgrade all pneumatic instrumentation to electronics. The decision affected almost exclusively pressure and flow transmitters. As for final drives, when warranted by performance or reliability considerations, these were also upgraded.

Procurement

The largest single procurement for Phase 4 of this project was the digital control system. Since a team of GPC and SCS personnel were to perform all engineering and configuration on the digital control system, the specification for this system focused on the required components (i.e., displays, printers, and input/outputs), hardware, reliability, scalability, use of off-the-shelf equipment, and software ease-of-use, configurability, and compliance with software standards.

On August 14, 1992, the DCS specification developed during preliminary engineering was transmitted by SCS to three DCS vendors (Bailey, Westinghouse, and Foxboro). These three vendors were chosen as the result of GPC and SCS having extensive prior design experience with each. Based on a joint evaluation of the proposals by SCS and GPC personnel, Foxboro, as evaluated low cost bidder, was issued a purchase order for the digital control system on April 1, 1993. As a result of equipment availability and as a courtesy to SCS, Foxboro shipped the DCS to SCS prior to receipt of a purchase order from SCS. During the intervening period, Foxboro was at risk for this equipment. The selection of Foxboro as the supplier of this system was based on cost, technical, and guarantee issues. Site specific technical issues were highly pertinent to the selection decision. A description of the Foxboro DCS is provided in subsequent paragraphs.

Detail Engineering

SCS Engineering and Plant Hammond personnel began detail design of the Hammond Unit 4 digital control system during second quarter 1993. Major activities associated with the detail engineering included:

- Electrical
  - Cable Tray and Conduit Layout
  - Cable Routing
  - Instrumentation and Power Circuit Design
  - Termination Layout
- Instrumentation and Controls
  - Control Room Layout and Console Design

- Operator Graphics
- Functional Control Logic
- Ladder Logic
- Instrumentation Calibrations
- DCS Assembly and Checkout

Since Hammond Unit 4 was scheduled for an extended outage starting September 1993 and continuing to May 1994, and, based on prior experience, it was not expected that the digital control system retrofit would be the critical path in the outage. This expectation was borne out by actual experience.

Most detail engineering was conducted at SCS Engineering offices near Birmingham. In that plant personnel were intimately involved in the design of the digital control system, the frequency and duration of site visits by SCS personnel was much reduced over what otherwise been required. Also, a Hammond Unit 4 control technician participated in the setup and checkout of the digital control system in Birmingham which further reduced the need for site visits.

The digital control system, shipped from Foxboro, Massachusetts, was delivered to SCS offices in several lots over a period beginning January 29, 1993 and continuing through February 28, 1993. Following receipt, the system was assembled and a hardware checkout conducted during which several components were found defective. These components were returned to Foxboro for warranty replacement. The components replaced included: one operator display, two field bus modules, one power supply, and one control processor.

Configuration

Configuration of the Foxboro digital control system took place at SCS facilities in Birmingham. From June to August 1993, control functionals and logic development was in progress (Table 5). During September 1993 and prior to extensive configuration efforts, SCS personnel participated in a two week configuration training school in SCS offices. This course was conducted by a Foxboro representative. Configuration of the system was completed during December 1993, followed by graphic linking and configuration checkout and cleanup during January and February 1994. The digital control system was then shipped to the site on February 22, 1994.

Installation, Checkout, Startup, and Tuning

Installation of the digital control system was managed by Plant Hammond personnel and a local electrical contractor, Inglet and Stubbs, was engaged to perform the actual installation. During the digital control system installation, a SCS representative was on-site to assist plant personnel and provide coordination between SCS and the site.

The checkout team consisted of representatives of both Plant Hammond and SCS I&C and Electrical departments (Table 6). On-site drawing updates were performed to reflect field modifications. Checkout of the digital control system began on March 28, 1994 and continued through May 31, 1994. In total, 1750 circuits were checked. No major problems were encountered during this checkout.

Hammond Unit 4 resumed operation on June 4, 1994 and by June 13, all loops were in automatic with the exception of final superheat temperature, throttle pressure, air and excess O₂, and overfire air. In general, these latter loops were made functional by June 16, however, overfire air was not placed into automatic until July 26. A timeline of the major activities during startup and tuning can be found in Table 7.

Based on experience to date, the following operating improvements can be attributed to the installation of the digital control system:

- More stable unit operation,
- Additional safety and protection schemes,
- Startup/shutdown automatic pressure ramp,
- Tighter throttle pressure control,
- Tighter steam temperature control,
- Increased/improved load response to remote dispatch, and
- Availability of information for engineering studies.

Foxboro I/A System

Based on a competitive evaluation, a Foxboro I/A Series System DCS was selected for this project. The Foxboro I/A Series System is a fully distributable, digital control system designed to address a broad range of application requirements. The DCS provides nodes of interchangeable hardware and software modules which can be matched to the process application. Although not necessarily unique to the Foxboro I/A System, the following are some of the important characteristics of this digital control system:

- Fully distributable, both functionally and physically, allowing installation of the control system hardware in the field (i.e. near the burner front and mills) -- no special environment for the control system hardware is needed.
- Extensive use of standard communication networks. I/A Series nodes communicate with each other using a MAP compatible network. Gateways are provided for communication to other devices via RS-232-C, RS-485, X.25, Modbus, Allen-Bradley Data Highway, IEEE 802.3 (CSMA/CD), IEEE 802.4 (token passing) and others.
- Open system architecture. The digital control system is build using the following constructs: (1) operating system - "VENIX", a version of "UNIX", (2) development language - "C", (3) relational data base - "INFORMIX", and (4) network - IEEE 802.3 and 802.4. Adherence to these standards facilitates software portability from and to other platforms and allows current software to be utilized as new hardware technology is introduced.
- Increased reliability from the use of sealed modules interconnected by serial communications and the application of redundant hardware modules on critical control loops.

A overview of the system installed at Hammond Unit 4 is shown in Figure 4 and specifics of the DCS installed at Hammond Unit 4 follows. A detail schematic of the digital control system interconnections as installed at Hammond Unit 4 can be found in Appendix B.

Node

The I/A series architecture is based on the concept of a node. A node operates independently, performing automation-related functions. The DCS at Plant Hammond has three nodes:

- N0000E - Electrical Switchboard Node
- N00003 - Unit 3 Node
- N00004 - Unit 4 Node

All nodes connect to each other through the carrierband LAN (described below).

Modules

The I/A series consist of two basic types of modules (Table 8).

The Control Processor (CP) is a station that connects to a Nodebus and Fieldbus modules to perform:

- Regulatory, logic, timing , and sequential control
- Data acquisition, alarm detection, and notification

The DCS installed on Hammond 4 has seven CP-30, fault-tolerant, control processors (4CP001 - 4CP007) and one CP-10 control processor (4CP008) (see overview in Appendix B). The functions assigned to these processors at Hammond Unit 4 can be found in Appendix C.

The Application Processor (AP) is a station that connects to the Nodebus to perform computation intensive and file server functions. These processors are configured by software to perform system functions such as:

- System equipment management,
- Database management,
- Historical data collection,
- Graphic display support,
- Production control,
- Configuration of software functions, and
- Application program development

Unit 4 has two AP-20s (4AP001 and 4AP002) and one AP-50 (4AP003). The latter system is based on Sun Sparc processor architecture. The specific functions of these Application Processors are shown in Table 9.

Gateway

The I/A Series gateways are stations on a Nodebus that provide a communications link between an I/A Series node and other networks and devices, such as programmable controller networks. The Unit 4 has three gateways: 4GW001 - Ash Handling Gateway; 4GW002 - Energy System Management Gateway; and 4GW003 - Sootblowing System Gateway. These gateways are monitored by the application processor 4AP003. The Ash Handling System and Sootblowing System gateways connect to Allen-Bradley Data Highways while the Energy Management System gateway connects to a Modicon system.

Fieldbus and Fieldbus Modules

The Fieldbus is a dual-redundant serial data communications bus that employs asynchronous protocol and conforms to the requirements of the EIA standard RS-485. All Fieldbus transactions are initiated by a master station and the Fieldbus Modules are slave devices. Error and failure protection schemes are utilized on the Fieldbus to prevent or reduce single-, double-, and odd-bit-number errors; burst errors; and single failure of a Fieldbus Module.

Fieldbus modules provide the interface between process sensors and actuators and the Fieldbus. The modules convert the electrical signals used by the field devices to a digital format suitable for use on the Fieldbus. The Fieldbus and Fieldbus Modules are arranged as shown in Appendix B. Unit 4 has the types of Fieldbus Modules as shown in Table 10.

Control Room Modifications

As part of this project, the control room was modified to accept the new Unit 4 digital control system. A plan drawing of the retrofitted Unit 1-4 control room is shown in Figure 5. As shown, the pre-existing Unit 4 benchboards were removed and replaced with a CRT based control panel. Also shown in this figure is the retrofitted Unit 3 benchboard which was upgraded during Fall 1993. In addition to the upgrades to Units 3 and 4, Georgia Power is also considering upgrading the digital control systems on Units 1 and 2. Figure 6 shows the control room as envisioned following upgrades on all four units. Digital control system and control room modifications for Units 1, 2, and 3 are not a part of the Wall-Fired Project. A schematic of the new Unit 4 benchboard is shown in Figure 7. As can be inferred from this figure, operator interaction with the digital control system will be almost exclusively through the operator displays.

Networking

The Unit 4 DCS has been interfaced with the other DCS's at the site. As shown in Figure 8, Unit 3, Unit 4, and Electrical DCS systems are connected through a dual-redundant IEEE 802.3 (CSMA/CD) compliant local area network (LAN). Through this LAN, the three DCSs are able to share process information and graphics. If for some reason either the A or B LAN fails, all DCSs can maintain normal operation. An additional benefit of these LANs are the ability to share costly resources such as engineering consoles, historical drives, etc.

In addition to the inter-DCS network, the Unit 4 DCS (and the others also), are connected through a router to the plant's token-ring PC engineering and administrative LAN and the corporate wide area network (WAN) (Figure 9). The latter will enable remote access of process data and facilitate software maintenance. A Sun Sparcstation 5, hosting the advanced control/optimization software, will be connected to this network.

Operator Graphics

An extensive set of graphics have been developed for operator use. These displays are accessed at the operator consoles and are organized hierarchically. Using soft buttons on the displays, the top level display provide rapid control and observation of all major components. These push buttons have descriptions displayed on them which guide the operator or technician to the proper graphic. For example, one of the push buttons is labeled "MASTER SCREEN." From this graphic, the operator can access all major high level controls including Fuel Master, Feedwater Master, O₂ Compensator, ID Fan Master, and FD Fan Master. In addition, from the master menu, trends of process variables are readily obtained. Examples of various operator graphics can be found in Appendix D.

Cabinet Arrangements

Arrangement drawings for the five I/O cabinets are shown in Appendix E. As mentioned previously, the cabinets are geographically dispersed throughout the plant to reduce cable runs. A general overview of the inputs and outputs to each cabinet is shown in Table 11. Due to this being a retrofit installation, the distribution of I/O and the minimization of cable runs is suboptimal to what may be achieved in a new "greenfield" installation.

Documentation

Documentation to be issued to the site includes the following:

- Functional Control Diagram,
- Configuration Drawings,
- Calculator Block Detail Drawing,
- Cabinet Arrangements,
- Instrument Rack Drawings
- Terminal Block Arrangements,
- Termination Drawings
- Wiring Diagrams,
- Elementary Diagrams,
- Circuit Schedules,
- Raceway Schedules,
- Equipment Report,
- Training Manual, and

- Operators Manual.

Examples of several of these documents can be found in Appendix F. All documentation for the digital control system is scheduled for completion by the end of 1994.

3.3.2. Advanced Controls and Optimization

The software and methodology to be demonstrated at Hammond Unit 4 is the Generic NO_x Control Intelligent System (GNOCIS) whose development is being funded by a consortium consisting of the Electric Power Research Institute, PowerGen (a U.K. power producer), The Southern Company, U.K. Department of Trade and Industry, and U.S. Department of Energy [6]. The objective of the GNOCIS project is to develop an on-line enhancement to existing digital control systems that will result in reduced NO_x emissions, while meeting other operational constraints on the unit (principally heat rate and other regulated emissions). The core of the system will be a model of the NO_x generation characteristics of a boiler, that will reflect both short-term and longer-term shifts in boiler emission characteristics. The software will apply an optimizing procedure to identify the best set points for the plant. The recommended set points will be used for closed-loop control of the process or, at the plants discretion, the set points will be conveyed to the plant operators via the DCS. The software will incorporate sensor validation techniques and be able to operate during plant transients (i.e. load ramping, fuel disturbances, and others). Figure 10 shows the major elements of GNOCIS.

The GNOCIS software and methodology is currently under development and is scheduled to be implemented at PowerGen's Kingsnorth Unit 1 (a 500 MW tangentially-fired unit with an ICL Level 3 Low NO_x Concentric Firing System) and Alabama Power's Gaston Unit 4 (a 250 MW B&W unit with B&W XCL low NO_x burners) prior to comprehensive testing at Hammond. Following "re-characterization" of Hammond 4, currently scheduled for August through December 1994, the advanced controls and optimization strategies will be activated and run open-loop. If the results from the open-loop testing warrant, the advanced controls/optimization package will be operated closed-loop with testing (short- and long-term) starting in January 1995 and continuing through March 1995.

During second quarter 1994, discussions continued with the core technology supplier in an effort to enhance their product to meet the requirements of the GNOCIS project. These requirements were identified during the initial evaluation process and include combinatorial constraints and on-line retraining. The developer is actively pursuing the inclusion of these enhancements in a new major release of their product currently scheduled for commercial deployment during December 1994. PowerGen and SCS are both in receipt of the previous release of the software and a pre-release version of the software will be made available to both parties during third quarter 1994.

Table 3: Phase 4 Milestones / Status	
Milestone	Status
Digital control system design, configuration, and installation	Completed
Digital control system startup	Completed
Instrumentation upgrades	In Progress
Advanced controls/optimization design	In Progress
Characterization of the unit pre- activation of advanced strategies	8/94 - 12/94
Characterization of the post- activation of advanced strategies	1/95 - 3/95

Table 4: Digital Control System Timeline	
June 1992	• Begin preliminary engineering
August 1992	• Issue request for proposals for digital control system
February 1993	• Foxboro I/A system received at SCS
April 1993	• Issue purchase order to Foxboro
June 1993	• Start detail engineering
June 1993	• Begin configuration
January 1994	• Configuration complete • Start checkout
February 1994	• Foxboro I/A system shipped to Plant Hammond for installation
May 1994	• Installation complete
June 1994	• Unit Startup

Table 5: Digital Control System Configuration Milestones

June - August 1993	• Finalized Input Output Listing • Developed Functional Drawings • Initiated Logic Development and System Interface
September 1993	• Two Week Configuration Training
September - December 1993	• Developed Configuration • Continued Logic Development and Developed Logic Configuration • Completed All Configuration
January - February 1994	• Began DCS Configuration Checkout • Continued Graphic Linking to Configuration • Configured Data Links and Began Data Link Checkout • Configuration Cleanup
February 22, 1994	• DCS Shipped to Site

Table 6: Digital Control System Installation and Checkout Overview

Installation	Plant Hammond personnel and local contractor
Checkout team	Plant Hammond I&C Plant Hammond Electrical SCS I&C SCS Electrical
Schedule	Two shifts Cabinet checkout upon release from construction
Checkout	Start date - March 28, 1994 Operation of fans - May 7, 1994 Initial acid wash oil fires - May 14, 1994 Completion date - May 31, 1994
Number of circuits checked	1750
Problems encountered	No major problems

Table 7: Digital Control System Startup and Tuning Timeline	
Unit initially tied unit on-line	June 4, 1994
Unit off-line for turbine inspection	June 7, 1994
Unit back on-line	June 12, 1994
All loops in automatic except final superheat steam temperature, air, O ₂ , fuel, throttle pressure, and overfire air.	June 13, 1994
Final superheat steam temperature in automatic	June 14, 1994
Automatic air flow control and excess oxygen control	June 15, 1994
Automatic fuel control and throttle pressure control	June 16, 1994
Turbine EH controls interface tuning	June 23, 1994
Boiler/turbine load ramp testing and remote dispatch	June 29, 1994
Overfire air dampers in automatic	July 26, 1994

Table 8: Module Types	
System Station	Fieldbus
Application Processors	Analog Modules
Control Processors	Digital Modules
Workstation Processors	
System Integrators/Gateways	
Tank Processors	

Table 9: Function of Application Processors

Application Processor	Function
4AP001	Main application processor used for production control, graphic display, equipment monitoring, and alarm processing
4AP002	Secondary application processor used as backup for 4AP001 and equipment tagout support
4AP003	Primary functions includes historian, plant networking, reporting, and backup of 4AP001

Table 10: Fieldbus Module Descriptions

Fieldbus Module	Type
FBM01	Isolated interface for up to 8 analog 0-20 ma DC inputs
FBM02	Isolated interface for up to 8 thermocouple and/or millivolt inputs
FBM04	Isolated interface for up to 4 analog 0-20 ma DC inputs and 4 analog 0-20 ma outputs
FBM07A	High power isolated interface for up to 16 contact DC voltage inputs
FBM26A	High power isolated interface for up to 8 contact DC voltage inputs and 8 externally powered DC switch outputs
FBM26B	High power isolated interface for up to 8 contact sense inputs and 8 externally powered DC switch outputs
FBM09A	High power isolated interface for up to 8 DC voltage inputs and 8 externally powered DC switch outputs
FBM10	120 VAC isolated interface for up to 8 DC inputs and 8 output channels for 120 VAC with current overload protection

Table 11: Cabinet Locations		
Cabinet	Location	Inputs/Outputs
1	Upper boiler area; elevation 657'-3"; adjacent to acoustic pyrometer ports and project instrumentation trailer	Burners Sleeve Position , Main Steam, Reheat, Extractive CEM, Secondary Air Flows, Primary and Secondary Air Temperatures, Other Boiler Parameters
2	Control room area; behind Unit 4 benchboard	Turbine, Compliance CEM, Burner Flame Scanners (Coal), Mill Start/Stop
3	Control room area; behind Unit 4 benchboard	AOFA; Burner Ignitors; ID Fan; Flame Scanners (Oil Guns)
4	Control room area; behind Unit 4 benchboard	Boiler Feedpump Turbines, Condensate Pump
5	Lower boiler area near mills	Primary air to mills, Mill temperatures, Turbine extraction temperatures Feedwater heaters

Figure 4: Unit 4 DCS Overview

Figure 5: Unit 1-4 Control Room Layout as Currently Implemented

Figure 6: Unit 1-4 Control Room Layout (Planned)

Figure 7: Unit 4 Benchboard

Figure 8: DCS Network

Figure 9: Hammond Plant Network

Figure 10: GNOCIS Major Elements

4. FUTURE PLANS

The following table is a quarterly outline of the activities scheduled for the remainder of the project:

Table 12: Future Plans	
Quarter	Activity
Third Quarter 1994	• Re-Baseline Unit
Fourth Quarter 1994	• Advanced Controls Testing
First Quarter 1995	• Advanced Controls Testing (continued)
Second Quarter 1995	• Complete Advanced Controls Testing
Third Quarter 1995	• Final Reporting & Disposition
Fourth Quarter 1995	• Final Reporting & Disposition

5. ACKNOWLEDGMENTS

The following project participants are recognized for their dedicated efforts toward the success of the wall-fired low NO_x demonstration: Mr. Ernie Padgett, Georgia Power Company, and Mr. Mike Nelson, Southern Company Services, for their coordination of the design and retrofit efforts and Mr. Jose Perez, full-time Instrumentation Specialist from Spectrum Systems, Inc. Also Messrs. Jim Witt and Jimmy Horton of Southern Company Services for design, procurement, and installation of the instrumentation systems. The following companies have provided outstanding testing and data analysis efforts: Energy Technology Consultants, Inc., Flame Refractories, Inc., Southern Research Institute, W. S. Pitts Consulting, and Radian Corporation. Finally, the support from Mr. Art Baldwin, DOE ICCT Project Manager, Dr. Rick Squires, EPRI Project Manager, Mr. Russ Pflasterer, EPRI Project Manager, and Mr. Stratos Tavoulareas, Energy Technologies Enterprises Corporation, is greatly appreciated.

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Appendix A
Digital Control System Scope

PLANT HAMMOND UNIT 4

PLANT DIGITAL CONTROL SYSTEM
SCOPE 12/8/93

SYSTEMS

1. UNIT MASTER
2. FUEL CONTROL
  - a. Feeder Speed
  - b. Primary Air Flow Control
  - c. Primary Air Temperature Control
  - d. Mill Outlet Temperature Control
3. AIR FLOW CONTROL
  - a. Air/Fuel Ratio Control
  - b. Secondary Air Control
  - c. Burner Sleeve Damper Control
  - d. Overfire Air Damper Control
  - e. Overfire Air Flow Control
  - f. Forced Draft Fan Inlet Vanes
  - g. Forced Draft Fan Outlet Dampers
  - h. Forced Draft Fan Logic
4. FURNACE PRESSURE CONTROL
  - a. Induced Draft Fan Inlet Vanes
  - b. Induced Draft Fan Outlet Dampers
  - c. Induced Draft Fan Logic
5. FEEDWATER CONTROL
  - a. Drum Level Control
  - b. Boiler Feedpump Minimum Flow Control
6. STEAM TEMPERATURE CONTROL
  - a. Superheat Steam Temperature Control
  - b. Reheat Steam Temperature Control
7. CONDENSATE CONTROL
  - a. Hotwell Level Control
  - b. Deaerator Level Control

8. AUXILIARY CONTROL
9. DCA HEATER LEVEL CONTROL
10. ASH HANDLING SYSTEM
11. PRECIPITATOR ENERGY MANAGEMENT SYSTEM
12. PRECIPITATOR FIRE PROTECTION
13. MOTOR BREAKER/START-STOP LOGIC
14. BURNER MANAGEMENT SYSTEM
  - a. Furnace Purge Logic
  - b. Master Fuel Trip Logic
  - c. Ignitor Trip Logic
  - d. Pilot Oil Torch Trip Valve Control
  - e. Coal Ignitor Control Interface
  - f. Pulverizer Control

I/O

1. Spares - 605
2. AI's - 572
3. AO's - 116
4. DI's - 1032
5. DO's - 632

TOTAL - 2352

Appendix B

Digital Control System Arrangement Drawings

CAD
 AUTOCAD
 FL3-02

Southern Company Services, Inc.
 Georgia Power Company
 PLANT NAME: UNIT NO. 4
 PLANT ADDRESS: 1000 N. GASTON ST., ATLANTA, GA 30309
 PROJECT: FIBER OPTIC LAN ADAPTER WITH F-200

DATE	BY	CHKD	APP'D

10/1/82
 10/1/82
 10/1/82
 10/1/82

Appendix C
Control Processor Functional Arrangement

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 1

Unit Master Analog Control
Unit Master Digital Control
AGC Analog/Digital
Fuel Control Analog/Digital
Feeder Control Analog//Digital
Air Cross Limiting Analog/Digital
Rundown logic
Runback logic
Throttle Pressure median select
First stage pressure median select
Mill amps (possible feeder rundown)
Megawatt input
Turbine vibration inputs
Turning gear motor start/stop
Turning gear oil pump start/stop
Turning gear engage/disengage
Feeder start/stop logic
Turbine trip logic
Lighter oil pump start/stop
Main turbine EHC oil pump start/stop
Air side seal oil pump start/stop
Hydrogen side seal oil pump start/stop
Emergency bearing oil pump start/stop
Emergency seal oil pump start/stop
HP seal oil pump back-up start/stop
Governor valve status inputs
Turbine drain valve cutout
Miscellaneous turbine analog inputs
Precipitator alarms - digital inputs
Feeder auxiliary relay

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 2

Mill differential pressure analog inputs
Mill primary air differential inputs
Mill coal/air temperature inputs
Mill air flow control analog/digital
Mill temperature control analog/digital
Mill start/stop logic
Mill lube oil pump 1 start/stop
Mill lube oil pump 2 start/stop
Mill seal air fan start/stop logic
Mill burner gate open/close logic
Mill primary air gate open/close logic
Mill shut off gate open close logic
Mill coal flame scanner inputs/alarms/trips(?)
Mill lube oil temperature alarms
Mill lube oil pressure alarms
Mill seal air dampers open/close
Lighter oil tank indication
Loss of fuel logic
Master fuel tripping logic
Flame scanner cooling air fan start/stop

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 3

- Digital logic for total control of 24 ignitors
- Low Nox burner sleeve damper control
- Sulfur injector start/stop
- Ignitor oil flame inputs/logic
- OFA damper controls
- OFA isolation damper control
- OFA air flow inputs
- Pilot oil valve open/close logic
- CEMs inputs
- DOE advanced Nox controls
- Opacity input

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 4

Temperature compensated total air flow measurement
Air flow control analog/digital
Fuel cross limiting analog/digital
FD inlet vane control analog/digital
FD outlet damper control analog/digital
FD fans start/stop
FD fan damper/vane limit switch status
Fan brakes control
FDFX auxiliary relay logic
O2 measurements
O2 control signal selection logic
O2 control analog/digital
Furnace pressure median select inputs
Furnace pressure control analog/digital
ID fan inlet damper control analog/digital
ID fan outlet damper control analog/digital
ID fan directional blocking logic
ID fan MFT logic
ID fan tripping logic
ID fan mft kicker analog control
ID fan start/stop
ID fan speed changer logic
IDFX relay logic
Primary/secondary air heater temperatures
Primary/secondary air heater differentials
Primary/secondary air heater start/stops
ID/FD damper logic (mft, fan trip, fan isolation)

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 5

LH superheat/reheat pass damper control analog/digital
RH superheat/reheat pass damper control analog/digital
LH lower superheat spray valve control analog/digital
RH lower superheat spray valve control analog/digital
LH upper superheat spray valve control analog/digital
RH upper superheat spray valve control analog/digital
RH economizer bypass control analog/digital
LH economizer bypass control analog/digital
Reheat spray valve control analog/digital
Reheat spray block valve control
BFPT vibration analog inputs
Primary air inlet vane control analog/digital
Primary air fan outlet damper control logic
Primary air fans start/stop logic
PAFx relay
Primary air heaters inlet damper control analog/digital
Economizer feed stop valve open/close
Cond. vacuum breaker open/close
Gland steam exhauster open/close
Vapor ext loop seal start/stop
Furnace probes control
Superheat power relief safety valve control
Steam seal valves control
Mass blowdown valve control
Feedwater flow temperature compensation
Drum level pressure compensation
Feedwater valve control

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 6

Boiler fill start/stop
Boiler fill valve control
Single element drum level control analog/digital
Three element drum level control analog/digital
BFPTs feedwater control analog/digital
BFPTs minimum flow control
BFPTs turbine controls interface
BFPTs turning gear control
BFPT drains indication
BFPTs turning gear oil pump start/stop
BFPTs EH fluid oil pump start/stop
BFPTs MBOP start/stop
BFPTs EBOP start/stop
BFPTs ABOP start/stop
BFPTs lube oil temperature control
Feedwater heater DCA/Level control analog/digital
Feedwater heater extraction check valve solenoids
Heater drain pumps start/stop
Deaerator level control analog/digital
Hotwell level control analog/digital
Condensate pumps start/stop
Condenser quick fill valve control
Main turbine oil temperature control
Misc. BFP analog input signals
Generator hydrogen temperature control

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 7

Boiler Annunciator Points
Turbine Annunciator Points
Hydrogen Annunciator Points
BFPT Annunciator Points
Event Recorder Points

Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 8

Burner Thermocouple Inputs
Burner Temperature Alarms

Appendix D
Operator Control Graphics

13:54 11-30-94

Sys Alarm Help KEYBOARD MENU 1 MENU 2 TRENDS Unit 4 Page

UNIT 4 MENU KEYBOARD

MASTER
SCREEN

AGC
SCREEN

BOILER
PURGE

EQUIP
SCREEN

MASTER
FUEL
TRIP

A
4160V
BUS

TURBINE

OIL/HYD
COOLING
REC CONT

BOILER
STATUS
GAUGES

BOILER
FEED
PUMP
VIEW

BOILER
FEED
PUMP
VIEW

BOILER
FEED
PUMP
VIEW

BOILER
FEED
PUMP
VIEW

BOILER
FEED
PUMP
VIEW

BOILER
FEED
PUMP
VIEW

BOILER
FEED
PUMP
VIEW

BOILER
VIEW
PG 1

FANS
VIEW

AIR/GAS
VIEW

SEC AIR
HEATERS

PRI AIR
HEATERS

SEC AIR
HEATERS

PRI AIR
HEATERS

PRI AIR
HEATERS

PULV
VIEW

PULV
VIEW

PULV
VIEW

PULV
VIEW

PULV
VIEW

PULV
VIEW

PULV
VIEW

PULV
VIEW

PREV
DISP

MENU
1

MENU
2

TREND
MENU

1/057/disp/04 BOILER OVER

14:30 8-8-94

005

KEYWORD MENU1 MENU2 Burner

LOGS

Select

Prsc

UNIT 4 BOILER OVERVIEW PAGE 1

MEGAWATTS 479

AIR FLOW 222713
STEAM FLOW 218954
FUEL FLOW 160628
SUPERHEAT TEMP LH 734
SUPERHEAT TEMP RH 734
REHEAT TEMP IN 833
REHEAT TEMP OUT 1002
FURN PROBE DEG A 743
FURN PROBE DEG B 743

OPACITY 6 MIN AVG 99
OPACITY 100
CO 187
FLUE GAS FLOW 1361249
EXCESS O2 4.22
#1RH O2 ANALYZER 4.31
#2RH O2 ANALYZER 4.35
#3RH O2 ANALYZER 4.36
#4LH O2 ANALYZER 4.32
#5LH O2 ANALYZER 4.32
#6LH O2 ANALYZER 4.31

O2 5.215
CO 0.053
NOX 3415.4
SO2 729.44
THC 1.613

FEEDWATER FLOW A 3123
X100 B 3123
FEEDWATER PRESS 2545
DRUM PRESS 2570
PRI AIR/FURN
DIFF PRESS 6.9

BOILER DC POTENTIAL

PREV PAGE
DISP 2

2299 2335
THROTTLE PRESS X100

1554.6
1ST STAGE PRESS

A SEC B SEC
AIR HTR AIR HTR
A PRI B PRI
AIR HTR AIR HTR

1/050/ctrl01/u4/u4_UMS1

15:43 8-2-94

309

KEYBRD MENU1 MENU2 TRENDS BURNER LOGS

Page

UNIT #4 UNIT MASTER

Pressure Ratio 99.2%

BOILER DEMAND
515.8 MW

Low
Limit
2000.0 MW

High
Limit
5200.0 MW

Maximum Rate 10.0 MW/MIN

GENERATION
515.8 MW
Generation
Setpoint
520.0 MW

Boiler
Decr

Boiler
Base

Boiler
Incr

Unit Master
in Auto

Turbine
Decr

Turbine
Base

Turbine
Incr

Boiler
Follow

Sliding
Pressure

Turbine
Follow

MW
Control

ACC
Select

Throttle Pressure
2401.8 PSIG

SETPOINT 2400.0 PSI
TARGET
SETPOINT 2400.0 PSI
RATE 10.0 PSI/MIN

GOVERNOR CONTROL

▼ A M ▲

ACC HI LIM T1 HI LIMIT
520 MW T2

ACC LO LIM T3 LOWER
200 MW T4 LO LIMIT

PREV
DISP

MENU

TURB
OVIEW

MASTER
SCREEN

15:54 8-2-94

— 10 —

000:00:06:00 03 S

103.15	FUEL	%
99.76	AIR	%
90.73	F/W	%
87.54	STME	%

THE

Parameter	Value
BIAS	0.0
SETPoint	3.4
Width	0.3

HI LIMIT	LO LIMIT
520.0	200.0

RAISE LOWER

AGC SCREEN

FURNACE DRAFT

ID FAN MASTER

FD FAN MASTER

A F/W %
 R DEMAND 90.1
 DRUM LOG
 BEPOINT -0.05
 %
 90.1

Figure 1 consists of two bar charts side-by-side. The left chart is labeled 'Control' and the right chart is labeled 'Intervention'. Both charts have a vertical axis representing the number of children per woman, ranging from 0 to 10. The horizontal axis represents the frequency or count for each number of children. In the 'Control' chart, the distribution is skewed to the right, with the highest frequency at 2 children (count of approximately 18) and a long tail extending to 10 children. In the 'Intervention' chart, the distribution is more centered, with the highest frequency at 1 child (count of approximately 20) and a much shorter tail, with very few women having 8 or more children.

金 屋

A	FURN	INNO
R	PRESS	-0.43
	SETPOINT	-0.35
	PIES	7
		51.6

白 雪

AIR FLOW	100.1
FEEDOUT	100.1
WATER %	59.6

BFP
DATE:

1/11/94/ent/01/04/04 AMILL

16:00 8-2-94

KEYBRD MENU1 MENU2 TRENDS BURNER LOGS

4A
IGNITORS

PERCENT 02
P-A FAN ON
IGNITOR IN
SEAL AIR FLOW
LUBE OIL PUMP
SEAL AIR BLOWER

4A MILL

START PERMIT
PA DIFF PRESS
MILL DIFF PRESS
MILL AMPS
MILL PA FLOW
MILL PA INLET TEMP
THROTTLE PRESS
LUBE OIL PRESS LOW
LUBE OIL TEMP LOW
HEATER ON

SEAL AIR BLOWER

PULV OVIEW

MASTER SCREEN

CONTROL POSITION

4A MILL HOT AIR
PA FLOW 79.67
A M 1 2 3 F

4A MILL COLD AIR
A M 1 2 3 F

4A FEEDER SPEED
FLOW 64.97 T/H
A M 1 2 3 F

FUEL MASTER
A M

A BIAS %
R 5.0
SETPOINT 79.9
FLOW % 31.0

A TEMP F
L 158.4
SETPOINT 165.0
FLOW % 0.0

A DEMAND %
L 77.8
SETPOINT 74.2
FLOW % 74.2

A HEAT RELEASE %
R 99.3
SETPOINT 99.4
FLOW % 77.6

ACK

PREV DISP

MENU

REC & IGN'S

UP

DOWN

BURNER GATES

1/05/001104/04/04 OFTRED1

10:15 8-3-94

KEYBRD=MENU1=MENU2=TRENDS=BURNER=LOGS

UNIT 4 OVERFIRE DAMPER OVERVIEW

OVERFIRE TOTAL AIR FLOW 212931 LBS/HR

PREV OVERFIRE FRONT REAR
DISP CONTROLS OVERFIRE OVERFIRE

Exit

KEYPAD

MENU1

MENU2

TRENDS

BURNER

LOCS

Page

4A FD INLET VANE

A M 1 2
3 F

4B FD INLET VANE

A M 1 2
3 F

O2 COMPENSATOR

SELECTED 4.9%

A M

4A ID INLET DAMPER

A M 1 2
3 F

4B ID INLET DAMPER

A M 1 2
3 F

4C ID INLET DAMPER

A M 1 2
3 F

4A FD INLET VANE

4B FD INLET VANE

O2 COMPENSATOR

4A ID INLET DAMPER

4B ID INLET DAMPER

4C ID INLET DAMPER

4A ID INLET DAMPER

4B ID INLET DAMPER

4C ID INLET DAMPER

4A ID INLET DAMPER

4B ID INLET DAMPER

4C ID INLET DAMPER

4A ID INLET DAMPER

4B ID INLET DAMPER

4C ID INLET DAMPER

4A ID INLET DAMPER

4B ID INLET DAMPER

4C ID INLET DAMPER

4A ID INLET DAMPER

4B ID INLET DAMPER

ACK

PREV
DISP

ACK

PREV
DISP

ACK

PREV
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PREV
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PREV
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PREV
DISP

ACK

PREV
DISP

E:\usr\disp\14_FDFANS

8:41 8-3-94

NOV

NEVERD

MENU1

MENU2

Turner

LOGS

Select

Page

A FDF INLET VANE

A M 1 2
3 F

A DEMAND %

L 21.4

DEAS %

-2.5

OUTPUT %

18.9

B FDF INLET VANE

A M 1 2
3 F

A DEMAND %

R 21.4

DEAS %

2.5

OUTPUT %

23.9

4A FDF
READY
START

4B FDF
READY
START

A FDF DISCH PRESS

4.77 INHG

B FDF DISCH PRESS

3.90 INHG

A FDF AMPS

110

B FDF AMPS

110

TOTAL AIR FLOW

27551 SCFH

65

A ID FAN AMPS

455

B ID FAN AMPS

454

C ID FAN AMPS

0

A FDF DISCH DAMPER

1 1 2
3 F

OUTPUT %

100.0

B FDF DISCH DAMPER

1 1 2
3 F

OUTPUT %

100.0

ACK

PREV
DISP

ID
FANS

1/USP/001/201/04/04 ID FANS

8:42 8-3-94

sys

KEYBRD

MENU1

MENU2

Burner

LOGS

Select

Page

A IDF INLET DAMPER

A M 1 2
3 F

A DEMAND %
R 29.7

OUTPUT %
29.7

B IDF INLET DAMPER

B M 1 2
3 F

A DEMAND %
L 29.7

BEAS %
-1.5
OUTPUT %
28.2

C IDF INLET DAMPER

A M 1 2
3 F

A DEMAND %
L 29.7

BEAS %
-15.8
OUTPUT %
0.0

UNIT 4 ID FANS

FURNACE DRAFT

A IDF DISCH DAMPER

1 2
3 F

POSITION/
FEEDBACK %
98.2

OUTPUT %
100.0

B IDF DISCH DAMPER

1 2
3 F

POSITION/
FEEDBACK %
98.6

OUTPUT %
100.0

C IDF DISCH DAMPER

1 2
3 F

POSITION/
FEEDBACK %
0.1

OUTPUT %
0.0

FD FANS

AMPS
A 333
B 332

ID FANS

AMPS
A 453
B 457
C 0

ID FANS

SUCTION
PRESS
1 -8.47
2 -9.23

ACK

PREV
DISP

FD
FANS

17/05/74 15:30/04 PULVST

10:15 8-3-94

KEYBOARD MENU1 MENU2 TRENDS BURNER LOGS

UNIT 4 PULVERIZER OVERVIEW

MEGAWATTS 339

PREV
DISP

FD&ID
FANS

FD
FANS

ID
FANS

FUEL
TRIP

NO LOAD
FUEL TRIP
CUTOUT & RESET

STM PRESS FURNACE DRAFT
PSIC MARKON WIDE

02 AUG
1974

17/052/012p/04 PURGE

10:20 8-3-94

KEYWORD MENU1 MENU2 TRENDS BURNER LOGS

PAGE

UNIT #4 PURGE PERMISSIVES

ALL MILLS TRIPPED

TOTAL AIRFLOW
BETWEEN 30-40% 73.5%

EITHER FD FAN RUNNING

BOTH PA FAN DAMPERS ARE CLOSED
AND EITHER FD FAN RUNNING

FURNACE PRESSURE WITHIN LIMITS

ALL IGNITORS RETRACTED

ALL BURNER SLEEVE DAMPERS OPEN
TO LIGHT-OFF POSITION OR GREATER

PILOT OIL VALVE CLOSE COMMAND

BOTH PA FANS TRIPPED

NO MFT TRIP CONDITION

MASTER FUEL TRIP RELAY ENERGIZED

ALL FEEDER TRIPPED

SH/RH PASS DAMPERS ARE
IN PURGE POSITION

PURGE
COMPLETE

3 MIN
PURGE
TIMER

300
SEC

PURGE
ACTIVE
LIGHT

PURGE
ACTIVE
LIGHT

PREV
DISP

PULV
SAB

FD
FANS

ID
FANS

FUEL
TRIP

NO LOAD
FUEL TRIP
CUTOUT & RESET

17/0510/011/04/04 00101

02:50:03 94

005

KEYBRD=MENU1 MENU2 TRENDS=BURNER LOGS

P25

#4 OVERFIRE AIR FLOW CONTROL

WEST

FRONT DAMPER
CONTROLS

OVERFIRE TOTAL AIR FLOW
13725 LBS/HR

REAR DAMPER
CONTROLS

EAST

AFMD-F1

17123 LBS/HR

0 SETPOINT

AFMD-F2

17065 LBS/HR

0 SETPOINT

AFMD-R1

15127 LBS/HR

0 SETPOINT

AFMD-R2

17012 LBS/HR

0 SETPOINT

CD-F1 DAMPER CTRLR

A M 1 2
3 1

N DEMAND %

R 11.6

SETPOINT

11.6

OUTDEC OUTINC

CD-F2 DAMPER CTRLR

A M 1 2
3 1

N DEMAND %

R 9.8

SETPOINT

9.8

OUTDEC OUTINC

CD-R1 DAMPER CTRLR

A M 1 2
3 1

N DEMAND %

R 1.0

SETPOINT

1.0

OUTDEC OUTINC

CD-R2 DAMPER CTRLR

A M 1 2
3 1

N DEMAND %

R 9.3

SETPOINT

9.3

OUTDEC OUTINC

ACK

PREV
DISP

OFIRE
OVIEW

1/05/2004 04:04:00

0:59 8-9-94

005

KEYBRD=MENU1=MENU2=TRENDS=BURNER=LCS

PAGE

#4 FRONT OVERFIRE AIRPORT CONTROLS

OVERFIRE
CONTROLS

REAR DAMPER
CONTROLS

WEST

EAST

OFA-F1 DAMPER

A 1 2
3 4

OFA-F2 DAMPER

A 1 2
3 4

OFA-F3 DAMPER

A 1 2
3 4

OFA-F4 DAMPER

A 1 2
3 4

ACK

PREV
DISP

OFIRE
VIEW

KEYBOARD MENU1 MENU2 TRENDS BURNER LOGS

F000

UNIT 4 BURNER DISPLAY - PAGE 1

FRONT WALL

REAR WALL

CD 2 3 1 5 4 1 632 F 2 668 F 3 669 F 4 618 F 5 528 F	CC 2 3 1 5 4 1 619 F 2 785 F 3 716 F 4 658 F 5 483 F	CB 2 3 1 5 4 1 698 F 2 729 F 3 674 F 4 688 F 5 499 F	CA 2 3 1 5 4 1 635 F 2 673 F 3 682 F 4 653 F 5 538 F	FA 2 3 1 5 4 1 656 F 2 655 F 3 634 F 4 634 F 5 575 F	FB 2 3 1 5 4 1 492 F 2 585 F 3 654 F 4 633 F 5 549 F	FC 2 3 1 5 4 1 645 F 2 674 F 3 669 F 4 635 F 5 561 F	FD 2 3 1 5 4 1 623 F 2 669 F 3 681 F 4 644 F 5 488 F
DD 2 3 1 5 4 1 694 F 2 682 F 3 658 F 4 637 F 5 583 F	DC 2 3 1 5 4 1 682 F 2 714 F 3 716 F 4 669 F 5 548 F	DB 2 3 1 5 4 1 648 F 2 671 F 3 646 F 4 619 F 5 546 F	DA 2 3 1 5 4 1 657 F 2 692 F 3 711 F 4 655 F 5 568 F	AA 2 3 1 5 4 1 622 F 2 655 F 3 634 F 4 594 F 5 -30 F	AB 2 3 1 5 4 1 618 F 2 648 F 3 628 F 4 547 F 5 667 F	AC 2 3 1 5 4 1 668 F 2 678 F 3 648 F 4 542 F 5 642 F	AD 2 3 1 5 4 1 635 F 2 681 F 3 655 F 4 693 F 5 293 F
ED 2 3 1 5 4 1 628 F 2 657 F 3 660 F 4 643 F 5 565 F	EC 2 3 1 5 4 1 578 F 2 692 F 3 702 F 4 655 F 5 577 F	EB 2 3 1 5 4 1 664 F 2 652 F 3 681 F 4 672 F 5 488 F	EA 2 3 1 5 4 1 738 F 2 707 F 3 626 F 4 622 F 5 525 F	BA 2 3 1 5 4 1 642 F 2 618 F 3 685 F 4 673 F 5 570 F	BB 2 3 1 5 4 1 702 F 2 696 F 3 667 F 4 674 F 5 539 F	BC 2 3 1 5 4 1 105 F 2 734 F 3 732 F 4 733 F 5 688 F	BD 2 3 1 5 4 1 711 F 2 711 F 3 713 F 4 713 F 5 681 F

PREV
DISPALM
ACK

PAGE 2

Appendix E
I/O Cabinet Arrangement Drawings

[illegible]

CAD
AUTOCAD
1481 PG DWG
148-01

FRONT VIEW
(TYPICAL FOR BEAR)

A

SECTOR A-A

[illegible][illegible]

3) CABINET IS A WORKMAN ENGINEERING COMPANY
SINGLE-DOOR DUAL ACCESS SAFE STANDING 12
ENCLOSURE (MODEL NO. A-10134/50A)

4) THE ALPHA CHARACTER AT THE END OF SOME OF THE
LETTERING NUMBERS IS THE HUMAN CIPHER
DESIGNATION

CAD	AUTOCAD	FLB-01	sign in book

Soultera Company Services Inc

Georgia Power Company
PLANT HAWKINS - UNIT NO. 4

MASTER & CONT - CONTROL SYSTEM ALIGNMENT
I/O CABINET NO 2 - CONTROL ROOM AREA
ALIGNMENT

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

[illegible]

10-201	11-811

NOTES

3

[illegible]

SECTION A-A

SOC VIEW

FRONT VIEW
(FINISH FOR RISE)

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NOTES:
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Southern Company Services for
 Georgia Power Company
 10-201 H-8173

Appendix F
Example DCS Documentation

NOTES:
 1. SEE LMS LOGIC - H-8246 THRU H-8249
 2. SEE RUNDOWN/RUNBACK LOGIC

GAS		H-8245	
AUTOCAB		CDV-02	
Southern Company Services, Inc.			
Georgia Power Company			
HARRISON STEAM PLANT - UNIT NO. 4			
INSTRUMENTS AND CONTROLS - FUNCTIONAL			
CONTROL DIAGRAM - UNIT MASTER - SHEET 1			
REVISION	DATE	BY	CHK
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FIELD NO. 115

FIELD NO. 116

FIELD NO. 117

FIELD NO. 118

FIELD NO. 119

FIELD NO. 120

Georgia Power Company, Atlanta, Ga.
General Engineering Department

STEAM BOILER - UNIT NO. 1
 STEAM BOILER - UNIT NO. 2
 STEAM BOILER - UNIT NO. 3
 STEAM BOILER - UNIT NO. 4
 STEAM BOILER - UNIT NO. 5
 STEAM BOILER - UNIT NO. 6
 STEAM BOILER - UNIT NO. 7
 STEAM BOILER - UNIT NO. 8
 STEAM BOILER - UNIT NO. 9
 STEAM BOILER - UNIT NO. 10

NO.	DESCRIPTION	DATE	BY
1	STEAM BOILER - UNIT NO. 1		
2	STEAM BOILER - UNIT NO. 2		
3	STEAM BOILER - UNIT NO. 3		
4	STEAM BOILER - UNIT NO. 4		
5	STEAM BOILER - UNIT NO. 5		
6	STEAM BOILER - UNIT NO. 6		
7	STEAM BOILER - UNIT NO. 7		
8	STEAM BOILER - UNIT NO. 8		
9	STEAM BOILER - UNIT NO. 9		
10	STEAM BOILER - UNIT NO. 10		

4-8348

BOILER MODES, ENERGY DEMANDS

4UMSBOILER:ENERGY_DMD1

[illegible]

NOTES:

1. CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR BULK ACCESS FREE STANDING (EXCLUDING MODEL NO A-90-26-251A)

2. THE ALPHA CHARACTER AT THE END OF SOME OF THE LETTERING NUMBERS IS THE TERMINAL CABLE DESIGNATION

CDV-01

Southern Company Services, Inc.

Georgia Power Company, Atlanta, Ga.
General Accounting Department

PLANT HANDED - JULY MD 4
CONTROLS CONT - LIND 9 ALTHAM
1/2 UPPER SILENCE AREA

APPROPRIATE

	1-6/8 - 1-7/8	
	10	
	10	

[illegible]

10-201	H-8170

[illegible]

ALL SHOULD BE VIEWED CONVICTION OF A FIVE YEAR
RECEIVED JULY 1968

CAD	AUTOCAD	SJV-02

Southern Company Services, Inc.

Georgia Power Company

SECOND STEAM PLANT - UNIT NO. 4
INSTRUMENTS AND CONTROLS - DETAILS

INSTRUMENTS AND CONTROLS - DETAILS
INSTRUMENT RACKS 4-21 AND 4-22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

DATE	10-10-14
TIME	11:00

[illegible][illegible]

References

[illegible]

[illegible]

A	B	C	D	E	F	G	H	I
EQUIPMENT DESCRIPTION	JUNCTION BOX NUMBER	INCORPORATING POWER CABLE NUMBER (TO 1/2 GAS)	POWER TO DRIVE CABLE NUMBER (TO 1/2 GAS)	POWER BECK CABINET REFERENCE NUMBER	INCORPORATING CONTROL CIRCUIT NUMBER	CONTROL CIRCUIT TO DRIVE	EDBOPS 1/2 CABINET D	REFERENCE BRAYING D
A HOT AIR BHP JP	E851453	E851463-1	E851463-1A	H-7100	A-7T-627	A-7T-627A	E801485	H-7147
B HOT AIR BHP JP	E851454	E851463-2	E851463-2A	H-7100	A-7T-628	A-7T-628A	E801485	H-7147
C HOT AIR BHP JP	E851455	E851463-3	E851463-3A	H-7100	A-7T-629	A-7T-629A	E801485	H-7147
D HOT AIR BHP JP	E851456	E851463-4	E851463-4A	H-7100	A-7T-630	A-7T-630A	E801485	H-7147
E HOT AIR BHP JP	E851457	E851463-5	E851463-5A	H-7100	A-7T-631	A-7T-631A	E801485	H-7147
F HOT AIR BHP JP	E851458	E851463-6	E851463-6A	H-7100	A-7T-632	A-7T-632A	E801485	H-7147
G HOT AIR BHP JP	E851459	E851463-7	E851463-7A	H-7100	A-7T-633	A-7T-633A	E801485	H-7147
H TEMP AIR BHP JP	E851460	E851463-8	E851463-8A	H-7100	A-7T-634	A-7T-634A	E801485	H-7147
I TEMP AIR BHP JP	E851461	E851463-9	E851463-9A	H-7100	A-7T-635	A-7T-635A	E801485	H-7147
J TEMP AIR BHP JP	E851462	E851463-10	E851463-10A	H-7100	A-7T-636	A-7T-636A	E801485	H-7147
K TEMP AIR BHP JP	E851463	E851463-11	E851463-11A	H-7100	A-7T-637	A-7T-637A	E801485	H-7147
L TEMP AIR BHP JP	E851464	E851463-12	E851463-12A	H-7100	A-7T-638	A-7T-638A	E801485	H-7147
M TEMP AIR BHP JP	E851465	E851463-13	E851463-13A	H-7100	A-7T-639	A-7T-639A	E801485	H-7147
N TEMP AIR BHP JP	E851466	E851463-14	E851463-14A	H-7100	A-7T-640	A-7T-640A	E801485	H-7147
O TEMP AIR BHP JP	E851467	E851463-15	E851463-15A	H-7100	A-7T-641	A-7T-641A	E801485	H-7147
P TEMP AIR BHP JP	E851468	E851463-16	E851463-16A	H-7100	A-7T-642	A-7T-642A	E801485	H-7147
Q TEMP AIR BHP JP	E851469	E851463-17	E851463-17A	H-7100	A-7T-643	A-7T-643A	E801485	H-7147
R TEMP AIR BHP JP	E851470	E851463-18	E851463-18A	H-7100	A-7T-644	A-7T-644A	E801485	H-7147
S TEMP AIR BHP JP	E851471	E851463-19	E851463-19A	H-7100	A-7T-645	A-7T-645A	E801485	H-7147
T TEMP AIR BHP JP	E851472	E851463-20	E851463-20A	H-7100	A-7T-646	A-7T-646A	E801485	H-7147
U TEMP AIR BHP JP	E851473	E851463-21	E851463-21A	H-7100	A-7T-647	A-7T-647A	E801485	H-7147
V TEMP AIR BHP JP	E851474	E851463-22	E851463-22A	H-7100	A-7T-648	A-7T-648A	E801485	H-7147
W TEMP AIR BHP JP	E851475	E851463-23	E851463-23A	H-7100	A-7T-649	A-7T-649A	E801485	H-7147
X TEMP AIR BHP JP	E851476	E851463-24	E851463-24A	H-7100	A-7T-650	A-7T-650A	E801485	H-7147
Y TEMP AIR BHP JP	E851477	E851463-25	E851463-25A	H-7100	A-7T-651	A-7T-651A	E801485	H-7147
Z TEMP AIR BHP JP	E851478	E851463-26	E851463-26A	H-7100	A-7T-652	A-7T-652A	E801485	H-7147
AA TEMP AIR BHP JP	E851479	E851463-27	E851463-27A	H-7100	A-7T-653	A-7T-653A	E801485	H-7147
AB TEMP AIR BHP JP	E851480	E851463-28	E851463-28A	H-7100	A-7T-654	A-7T-654A	E801485	H-7147
AC TEMP AIR BHP JP	E851481	E851463-29	E851463-29A	H-7100	A-7T-655	A-7T-655A	E801485	H-7147
AD TEMP AIR BHP JP	E851482	E851463-30	E851463-30A	H-7100	A-7T-656	A-7T-656A	E801485	H-7147
AE TEMP AIR BHP JP	E851483	E851463-31	E851463-31A	H-7100	A-7T-657	A-7T-657A	E801485	H-7147
AF TEMP AIR BHP JP	E851484	E851463-32	E851463-32A	H-7100	A-7T-658	A-7T-658A	E801485	H-7147
AG TEMP AIR BHP JP	E851485	E851463-33	E851463-33A	H-7100	A-7T-659	A-7T-659A	E801485	H-7147
AH TEMP AIR BHP JP	E851486	E851463-34	E851463-34A	H-7100	A-7T-660	A-7T-660A	E801485	H-7147
AI TEMP AIR BHP JP	E851487	E851463-35	E851463-35A	H-7100	A-7T-661	A-7T-661A	E801485	H-7147
AJ TEMP AIR BHP JP	E851488	E851463-36	E851463-36A	H-7100	A-7T-662	A-7T-662A	E801485	H-7147
AK TEMP AIR BHP JP	E851489	E851463-37	E851463-37A	H-7100	A-7T-663	A-7T-663A	E801485	H-7147
AL TEMP AIR BHP JP	E851490	E851463-38	E851463-38A	H-7100	A-7T-664	A-7T-664A	E801485	H-7147
AM TEMP AIR BHP JP	E851491	E851463-39	E851463-39A	H-7100	A-7T-665	A-7T-665A	E801485	H-7147
AN TEMP AIR BHP JP	E851492	E851463-40	E851463-40A	H-7100	A-7T-666	A-7T-666A	E801485	H-7147
AO TEMP AIR BHP JP	E851493	E851463-41	E851463-41A	H-7100	A-7T-667	A-7T-667A	E801485	H-7147
AP TEMP AIR BHP JP	E851494	E851463-42	E851463-42A	H-7100	A-7T-668	A-7T-668A	E801485	H-7147
AQ TEMP AIR BHP JP	E851495	E851463-43	E851463-43A	H-7100	A-7T-669	A-7T-669A	E801485	H-7147
AR TEMP AIR BHP JP	E851496	E851463-44	E851463-44A	H-7100	A-7T-670	A-7T-670A	E801485	H-7147
AS TEMP AIR BHP JP	E851497	E851463-45	E851463-45A	H-7100	A-7T-671	A-7T-671A	E801485	H-7147
AT TEMP AIR BHP JP	E851498	E851463-46	E851463-46A	H-7100	A-7T-672	A-7T-672A	E801485	H-7147
AV TEMP AIR BHP JP	E851499	E851463-47	E851463-47A	H-7100	A-7T-673	A-7T-673A	E801485	H-7147
AW TEMP AIR BHP JP	E851500	E851463-48	E851463-48A	H-7100	A-7T-674	A-7T-674A	E801485	H-7147
AX TEMP AIR BHP JP	E851501	E851463-49	E851463-49A	H-7100	A-7T-675	A-7T-675A	E801485	H-7147
AY TEMP AIR BHP JP	E851502	E851463-50	E851463-50A	H-7100	A-7T-676	A-7T-676A	E801485	H-7147
AZ TEMP AIR BHP JP	E851503	E851463-51	E851463-51A	H-7100	A-7T-677	A-7T-677A	E801485	H-7147
BA TEMP AIR BHP JP	E851504	E851463-52	E851463-52A	H-7100	A-7T-678	A-7T-678A	E801485	H-7147
BB TEMP AIR BHP JP	E851505	E851463-53	E851463-53A	H-7100	A-7T-679	A-7T-679A	E801485	H-7147
BC TEMP AIR BHP JP	E851506	E851463-54	E851463-54A	H-7100	A-7T-680	A-7T-680A	E801485	H-7147
BD TEMP AIR BHP JP	E851507	E851463-55	E851463-55A	H-7100	A-7T-681	A-7T-681A	E801485	H-7147
BE TEMP AIR BHP JP	E851508	E851463-56	E851463-56A	H-7100	A-7T-682	A-7T-682A	E801485	H-7147
BF TEMP AIR BHP JP	E851509	E851463-57	E851463-57A	H-7100	A-7T-683	A-7T-683A	E801485	H-7147
BG TEMP AIR BHP JP	E851510	E851463-58	E851463-58A	H-7100	A-7T-684	A-7T-684A	E801485	H-7147
BH TEMP AIR BHP JP	E851511	E851463-59	E851463-59A	H-7100	A-7T-685	A-7T-685A	E801485	H-7147
BI TEMP AIR BHP JP	E851512	E851463-60	E851463-60A	H-7100	A-7T-686	A-7T-686A	E801485	H-7147
BJ TEMP AIR BHP JP	E851513	E851463-61	E851463-61A	H-7100	A-7T-687	A-7T-687A	E801485	H-7147
BK TEMP AIR BHP JP	E851514	E851463-62	E851463-62A	H-7100	A-7T-688	A-7T-688A	E801485	H-7147
BL TEMP AIR BHP JP	E851515	E851463-63	E851463-63A	H-7100	A-7T-689	A-7T-689A	E801485	H-7147
BM TEMP AIR BHP JP	E851516	E851463-64	E851463-64A	H-7100	A-7T-690	A-7T-690A	E801485	H-7147
BN TEMP AIR BHP JP	E851517	E851463-65	E851463-65A	H-7100	A-7T-691	A-7T-691A	E801485	H-7147
BO TEMP AIR BHP JP	E851518	E851463-66	E851463-66A	H-7100	A-7T-692	A-7T-692A	E801485	H-7147
BP TEMP AIR BHP JP	E851519	E851463-67	E851463-67A	H-7100	A-7T-693	A-7T-693A	E801485	H-7147
BQ TEMP AIR BHP JP	E851520	E851463-68	E851463-68A	H-7100	A-7T-694	A-7T-694A	E801485	H-7147
BR TEMP AIR BHP JP	E851521	E851463-69	E851463-69A	H-7100	A-7T-695	A-7T-695A	E801485	H-7147
BS TEMP AIR BHP JP	E851522	E851463-70	E851463-70A	H-7100	A-7T-696	A-7T-696A	E801485	H-7147
BT TEMP AIR BHP JP	E851523	E851463-71	E851463-71A	H-7100	A-7T-697	A-7T-697A	E801485	H-7147
BU TEMP AIR BHP JP	E851524	E851463-72	E851463-72A	H-7100	A-7T-698	A-7T-698A	E801485	H-7147
BV TEMP AIR BHP JP	E851525	E851463-73	E851463-73A	H-7100	A-7T-699	A-7T-699A	E801485	H-7147
BW TEMP AIR BHP JP	E851526	E851463-74	E851463-74A	H-7100	A-7T-700	A-7T-700A	E801485	H-7147
BX TEMP AIR BHP JP	E851527	E851463-75	E851463-75A	H-7100	A-7T-701	A-7T-701A	E801485	H-7147
BY TEMP AIR BHP JP	E851528	E851463-76	E851463-76A	H-7100	A-7T-702	A-7T-702A	E801485	H-7147
BZ TEMP AIR BHP JP	E851529	E851463-77	E851463-77A	H-7100	A-7T-703	A-7T-703A	E801485	H-7147
CA TEMP AIR BHP JP	E851530	E851463-78	E851463-78A	H-7100	A-7T-704	A-7T-704A	E801485	H-7147
CB TEMP AIR BHP JP	E851531	E851463-79	E851463-79A	H-7100	A-7T-705	A-7T-705A	E801485	H-7147
CC TEMP AIR BHP JP	E851532	E851463-80	E851463-80A	H-7100	A-7T-706	A-7T-706A	E801485	H-7147
CD TEMP AIR BHP JP	E851533	E851463-81	E851463-81A	H-7100	A-7T-707	A-7T-707A	E801485	H-7147
CE TEMP AIR BHP JP	E851534	E851463-82	E851463-82A	H-7100	A-7T-708	A-7T-708A	E801485	H-7147
CF TEMP AIR BHP JP	E851535	E851463-83	E851463-83A	H-7100	A-7T-709	A-7T-709A	E801485	H-7147
CG TEMP AIR BHP JP	E851536	E851463-84	E851463-84A	H-7100	A-7T-710	A-7T-710A	E801485	H-7147
CH TEMP AIR BHP JP	E851537	E851463-85	E851463-85A	H-7100	A-7T-711	A-7T-711A	E801485	H-7147
CH TEMP AIR BHP JP	E851538	E851463-86	E851463-86A	H-7100	A-7T-712	A-7T-712A	E801485	H-7147
CI TEMP AIR BHP JP	E851539	E851463-87	E851463-87A	H-7100	A-7T-713	A-7T-713A	E801485	H-7147
CJ TEMP AIR BHP JP	E851540	E851463-88	E851463-88A	H-7100	A-7T-714	A-7T-714A	E801485	H-7147
CK TEMP AIR BHP JP	E851541	E851463-89	E851463-89A	H-7100	A-7T-715	A-7T-715A	E801485	H-7147
CL TEMP AIR BHP JP	E851542	E851463-90	E851463-90A	H-7100	A-7T-716	A-7T-716A	E801485	H-7147
CM TEMP AIR BHP JP	E851543	E851463-91	E851463-91A	H-7100	A-7T-717	A-7T-717A	E801485	H-7147
CM TEMP AIR BHP JP	E851544	E851463-92	E851463-92A	H-7100	A-7T-718	A-7T-718A	E801485	H-7147
CN TEMP AIR BHP JP	E851545	E851463-93	E851463-93A	H-7100	A-7T-719	A-7T-719A	E801485	H-7147
CO TEMP AIR BHP JP	E851546	E851463-94	E851463-94A	H-7100	A-7T-720	A-7T-720A	E801485	H-7147
CP TEMP AIR BHP JP	E851547	E851463-95	E851463-95A	H-7100	A-7T-721	A-7T-721A	E801485	H-7147
CQ TEMP AIR BHP JP	E851548	E851463-96	E851463-96A	H-7100	A-7T-722	A-7T-722A	E801485	H-7147
CR TEMP AIR BHP JP	E851549	E851463-97	E851463-97A	H-7100	A-7T-723	A-7T-723A	E801485	H-7147
CR TEMP AIR BHP JP	E851550	E851463-98	E851463-98A	H-7100	A-7T-724	A-7T-724A	E801485	H-7147
CS TEMP AIR BHP JP	E851551	E851463-99	E851463-99A	H-7100	A-7T-725	A-7T-725A	E801485	H-7147
CT TEMP AIR BHP JP	E851552	E851463-100	E851463-100A	H-7100	A-7T-726	A-7T-726A	E801485	H-7147
CU TEMP AIR BHP JP	E851553	E851463-101	E851463-101A	H-7100	A-7T-727	A-7T-727A	E801485	H-7147
CV TEMP AIR BHP JP	E851554	E851463-102	E851463-102A	H-7100	A-7T-728	A-7T-728A	E801485	H-7147
CW TEMP AIR BHP JP	E851555	E851463-103	E851463-103A	H-7100	A-7T-729	A-7T-729A	E801485	H-7147
CX TEMP AIR BHP JP	E851556	E851463-104	E851463-104A	H-7100	A-7T-730	A-7T-730A	E801485	H-7147
CY TEMP AIR BHP JP	E851557	E851463-105	E851463-105A	H-7100	A-7T-731	A-7T-731A	E801485	H-7147
CZ TEMP AIR BHP JP	E851558	E851463-106	E851463-106A	H-7100	A-7T-732	A-7T-732A	E801485	H-7147
CA TEMP AIR BHP JP	E851559	E851463-107	E851463-107A	H-7100	A-7T-733	A-7T-733A	E801485	H-7147
CB TEMP AIR BHP JP	E851560	E851463-108	E851463-108A	H-7100	A-7T-734	A-7T-734A	E801485	H-7147
CB TEMP AIR BHP JP	E851561	E851463-109	E851463-109A	H-7100	A-7T-735	A-7T-735A	E801485	H-7147
CC TEMP AIR BHP JP	E851562	E851463-110	E851463-110A	H-7100				

CABLE & RACEWAY RECORDS SYSTEM

PLANT: HAMMOND UNIT: 4

JOB: HAMMOND4 LOW NOx / BOILER CONTROL SYST
COMPACT EQUIPMENT REPORT FOR SYSTEM HM89204

EQUIPMENT	Description	Drawing
11AHTINT	11TH STG HP HTR A FDWR IN TEMP	H-7222
11AHTOUT	11TH STG HP HTR A DRAIN OUT TEMP	H-7222
11BHTINT	11TH STG HP HTR B FDWTR IN TEMP	H-7222
11BHTOUT	11TH STG HP HTR B DRAIN OUT TEMP	H-7222
11HTRCKV	11TH STAGE CHECKVALVE SOLENOID	H-7227
16HTRCKV	16TH STAGE CHECKVALVE SOLENOID	H-7225
16HTRINT	16TH STG LP HTR FDWTR IN TEMP	H-7225
16HTROUT	16TH STG LP HTR DRAIN OUT TEMP	
18HTRCKV	18TH STAGE CHECKVALVE SOLENOID	H-7229
18HTRINT	18TH STG LP HTR FDWTR IN TEMP	H-7225
18HTROUT	18TH STG LP HTR DRAIN OUT TEMP	
19HTRCKV	19TH STAGE CHECKVALVE SOLENOID	H-7229
19HTRINT	19TH STG LP HTR FDWTR IN TEMP	H-7225
19HTROUT	19TH STG LP HTR DRAIN OUT TEMP	
20HTRINT	20TH STG LP HTR FDWTR IN TEMP	H-7225
20HTROUT	20TH STG LP HTR DRAIN OUT TEMP	
4ABMINCL	BFP 4A MIN FLOW VALVE CLOSED LIM SW	
4AFDDHVD	4A F.D. FAN DISCH DMPR DRIVE	H-7231
4AFDDHVX	4A F.D. FAN DISCH DMPR POSITION	H-7231
4AHTAIRD	4A HOT AIR DAMPER DRIVE	H-7222
4AMINCLS	BFP 4A MIN FLOW VALVE CLOSED LIM SW	
4AMINOLS	BFP 4A MIN FLOW VALVE OPEN LIM SW	
4APAIHDH	4A PRI AIR FAN DISCH DAMPER DRIVE	H-7231
4APAINDD	4A P.A. FAN INLET VANE DRIVE	H-7231
4ATEMPAD	4A TEMPERING AIR DMPR DRIVE	H-7222
4ATMPPRB	4A FURNACE TEMPERATURE PROBE	H-7208
4BFDDHVD	4B F.D. FAN DISCH DMPR DRIVE	H-7231
4BFDDHVX	4B F.D. FAN DISCH DMPR POSITION	H-7231
4BHATAIRD	4B HOT AIR DAMPER DRIVE	H-7222
4BMINCLS	BFP 4B MIN FLOW VALVE CLOSED LIM SW	
4BMINCOL	BFP 4B MIN FLOW VALVE CLOSED LIM SW	
4BMINOLS	BFP 4B MIN FLOW VALVE OPEN LIM SW	
4BPADHDH	4B PRI AIR FAN DISCH DAMPER DRIVE	H-7231
4BPAINDD	4B P.A. FAN INLET VANE DRIVE	H-7231
4BTEMPAD	4B TEMPERING AIR DMPR DRIVE	H-7222
4BTMPPRB	4B FURNACE TEMPERATURE PROBE	H-7209
4CHATAIRD	4C HOT AIR DAMPER DRIVE	H-7223
4CTEMPAD	4C TEMPERING AIR DMPR DRIVE	H-7223
4DHATAIRD	4D HOT AIR DAMPER DRIVE	H-7223
4DTEMPAD	4D TEMPERING AIR DMPR DRIVE	H-7223

4-AS-924/5   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB405   FROM DRAWING H-4741   LENGTH 109
 P-REV 0 03/12/94 T-REV 0 03/12/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 5 (SECT C-C)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7136   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

RACEWAYS SD409 -N TK401 -N TK402 -N SD462 -N

4-AS-926/7   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB405   FROM DRAWING H-4741   LENGTH 109
 P-REV 0 03/12/94 T-REV 0 03/12/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 5 (SECT C-C)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7136   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

RACEWAYS SD409 -N TK401 -N TK402 -N SD462 -N

4-AS-928/9   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB405   FROM DRAWING H-4741   LENGTH 109
 P-REV 0 03/12/94 T-REV 0 03/12/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 5 (SECT C-C)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7136   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

RACEWAYS SD409 -N TK401 -N TK402 -N SD462 -N

4-AS-930/1   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB405   FROM DRAWING H-4741   LENGTH 109
 P-REV 0 03/12/94 T-REV 0 03/12/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 5 (SECT C-C)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7136   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

RACEWAYS SD409 -N TK401 -N TK402 -N SD462 -N

4-AS-932/3   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB406   FROM DRAWING H-4741/1   LENGTH 109
 P-REV 0 03/13/94 T-REV 0 03/13/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 6 (SECT D-D)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7137   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

RACEWAYS SD408 -N TK401 -N TK402 -N SD462 -N

4-AS-934/5   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB406   FROM DRAWING H-4741/1   LENGTH 109
 P-REV 0 03/13/94 T-REV 0 03/13/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 6 (SECT D-D)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7137   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

RACEWAYS SD408 -N TK401 -N TK402 -N SD462 -N

4-AS-936/7   TYPE C DRAWING H-4717   CABLECODE F3S 0016 C 04 FROM NODE CCTB406   FROM DRAWING H-4741/1   LENGTH 109
 P-REV 0 03/13/94 T-REV 0 03/13/94 NO CABLES 1   CABLE ROOM TERM RACK SECT 6 (SECT D-D)
 VOLTAGE 120 AC SUS: HM89204   NO COND 4 TO NODE EBOT403 TO DRAWING H-7137   PULL MH 0.0
 STATUS RFD SAC: SPARE 0   CONTROL ROOM AREA I/O CABINET NO.3   TERM MH 0.0

CH200 CODE L15 DRAWING H-7210 FROM NODE EBOT401 UPPER BOILER HOUSE I/O CAB NO.1
 REV 0 07/13/93 LENGTH 200
 STATUS NF PERCENT FILL 18 TO NODE EBSS427 REHEAT VALVE JCT BOX

MH 0.0
 MH/FT 0.00

CH200 CONTINUED

INCLUDED CIRCUITS 4-HS-1051-R 4-HS-1052-R 4-ZS-521-R 4-ZS-539-R

CH201 CODE L15 DRAWING H-7599 FROM NODE PBWP401 125VDC DIST CAB 4A
 REV 0 08/13/93 LENGTH 225
 STATUS ND PERCENT FILL 12 TO NODE PBWP402 BLR CONT 125VDC DIST CAB

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS DC4-BC-R

CH202 CODE L15 DRAWING H-7599 FROM NODE PBWP402 BLR CONT 125VDC DIST CAB
 REV 0 08/13/93 LENGTH 50
 STATUS ND PERCENT FILL 0 TO NODE EIUP001 UNITS 3 & 4 OPERATOR'S CONSOLE UPS

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS BCDCUPS-R

CH203 CODE L10 DRAWING H-7230 FROM NODE PBWP401 125VDC DIST CAB 4A
 REV 0 08/21/93 LENGTH 175
 STATUS ND PERCENT FILL 27 TO NODE EBOT401 UPPER BOILER HOUSE I/O CAB NO.1

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS BCDC401-R

CH204 CODE L10 DRAWING H-7230 FROM NODE PBWP401 125VDC DIST CAB 4A
 REV 0 08/21/93 LENGTH 75
 STATUS ND PERCENT FILL 27 TO NODE EBOT405 LOWER BOILER HOUSE I/O CABINET NO.5

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS BCDC405-R

CH205 CODE L10 DRAWING H-7230 FROM NODE PBWP402 BLR CONT 125VDC DIST CAB
 REV 0 08/21/93 LENGTH 25
 STATUS ND PERCENT FILL 27 TO NODE EBOT402 CONTROL ROOM AREA I/O CABINET NO.2

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS BCDC402-R

CH206 CODE L10 DRAWING H-7230 FROM NODE PBWP402 BLR CONT 125VDC DIST CAB
 REV 0 08/21/93 LENGTH 30
 STATUS ND PERCENT FILL 27 TO NODE EBOT403 CONTROL ROOM AREA I/O CABINET NO.3

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS BCDC403-R

CH207 CODE L10 DRAWING H-7230 FROM NODE PBWP402 BLR CONT 125VDC DIST CAB
 REV 0 08/21/93 LENGTH 35
 STATUS ND PERCENT FILL 27 TO NODE EBOT408 BURNER TEMP CABINET

MH 0.0
 MH/FT 0.00

INCLUDED CIRCUITS BCDC408-R

ACTIVE CABLE CODE LIST FOR HAMMOND 4 HAMMOND4 PAGE 1
 CABLE CODE DIAMETER REQUISITIONED ROUTED BALANCE

E2A0002C01 0.50 2000 80 1920

SINGLE CONDUCTOR #2AWG, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET

E2A0002C03 1.27 5000 483 4517

THREE CONDUCTOR #2AWG, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET

E2A0006C03 0.97 2000 45 1955

THREE CONDUCTOR #6AWG, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET

E2A0008C03 0.89 5000 617 4383

THREE CONDUCTOR #8AWG, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET

E2A0010C02 0.62 2000 77 1923

TWO CONDUCTOR #10AWG, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET

E2A0012C01 0.22 5000 2753 2247

SINGLE CONDUCTOR #12AWG, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET

E2A0350C01 0.97 2000 489 1511

SINGLE CONDUCTOR #350MCM, 2000V, COPPER CABLE, EPR INSULATION, HYPALON JACKET