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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<sub>x</sub>)  
EMISSIONS FROM COAL-FIRED BOILERS

Technical Progress Report  
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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<sub>x</sub>) 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<sub>x</sub> combustion equipment through the collection and analysis of long-term emissions data. A target of achieving fifty percent NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> emissions between the LNB and LNB+AOFA configurations is the result of AOFA, the balance of the NO<sub>x</sub> 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
ECCEM	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 <sub>x</sub> burner
LOI	loss on ignition
(M)Btu	(million) British thermal unit
MOOS	Mills out of service
MW	megawatt
N	nitrogen
NO <sub>x</sub>	nitrogen oxides
NSPS	New Source Performance Standards
O, O <sub>2</sub>	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 <sub>2</sub>	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<sub>x</sub>) 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<sub>x</sub> combustion technologies on NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> reduction capabilities of the following advanced low NO<sub>x</sub> combustion technologies:
  - a. Advanced overfire air (AOFA)
  - b. Low NO<sub>x</sub> 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<sub>x</sub> reduction methods using sophisticated statistical techniques.

3. Evaluate the progressive cost effectiveness (i.e., dollars per ton NO<sub>x</sub> removed) of the low NO<sub>x</sub> combustion techniques tested.
4. Determine the effects on other combustion parameters (e.g., CO production, carbon carryover, particulate characteristics) of applying the NO<sub>x</sub> reduction methods listed above.

## 2. PROJECT DESCRIPTION

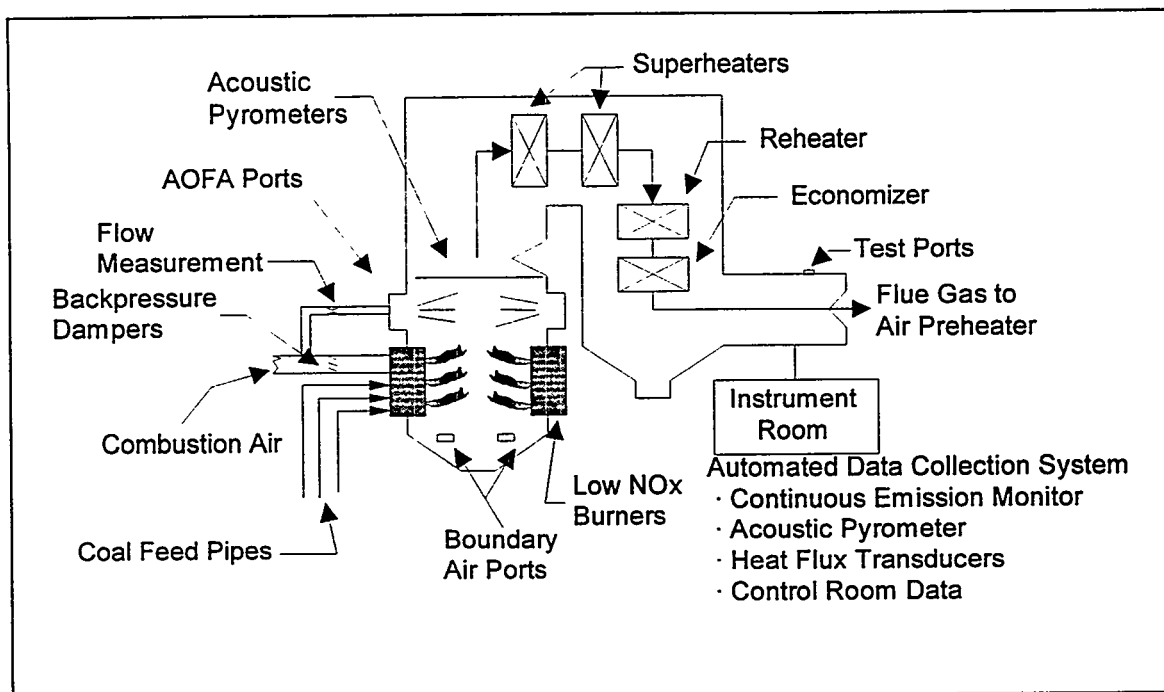
### 2.1. Test Program Methodology

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<sub>x</sub>, SO<sub>2</sub>, O<sub>2</sub>, 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<sub>x</sub> 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 <sub>x</sub>	Stack SO <sub>2</sub>
Stack O <sub>2</sub>	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<sub>x</sub> 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  $\text{NO}_x$  reduction techniques attempt to stage the introduction of oxygen into the furnace. This staging reduces  $\text{NO}_x$  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  $\text{NO}_x$  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 $\text{NO}_x$ Burners**

Low  $\text{NO}_x$  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  $\text{NO}_x$  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.

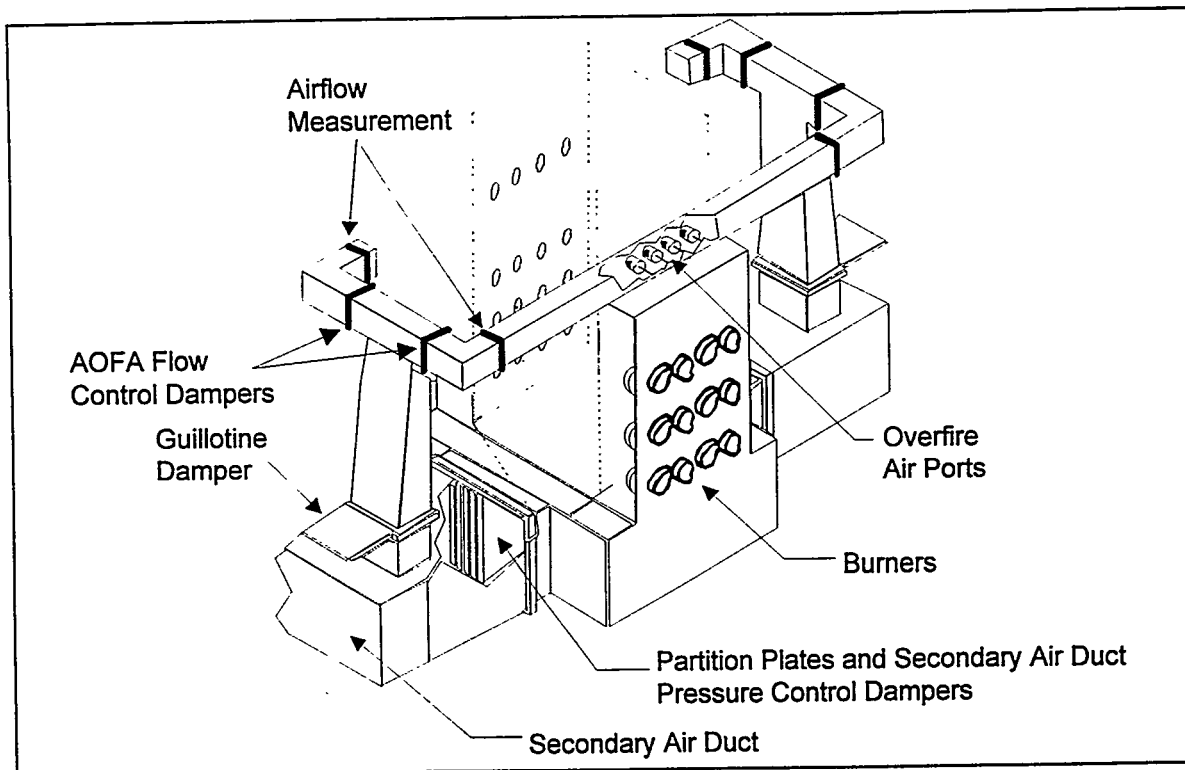
In the FWEC Controlled Flow/Split Flame (CFSF) burner (Figure 3), secondary combustion air is divided between inner and outer flow cylinders. A sliding sleeve damper regulates the total secondary air flow entering the burner and is used to balance



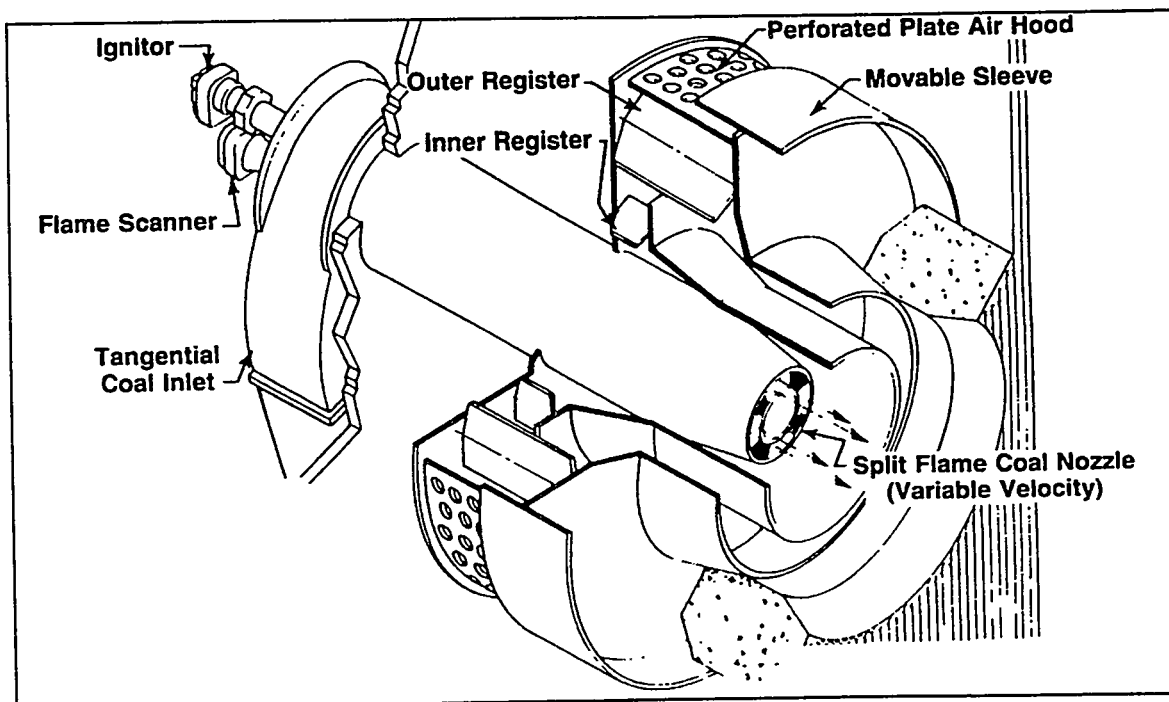
the burner air flow distribution. An adjustable outer register assembly divides the burners secondary air into two concentric paths and also imparts some swirl to the air streams. The secondary air which traverses the inner path, flows across an adjustable inner register assembly that, by providing a 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 NOx 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 NO<sub>x</sub> Burner Tests Report [3], and
- Phase 3B Low NO<sub>x</sub> 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 NO<sub>x</sub> digital controls / optimization strategies as applied to NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> abatement technologies installed at this site (LNB and AOFA). This scope addition will provide documented effectiveness of these control/optimization methods on NO<sub>x</sub> emissions and boiler efficiency improvements and guidelines for retrofitting boiler combustion controls for NO<sub>x</sub> 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 O<sub>2</sub>, 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, O<sub>2</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> Concentric Firing System) and Alabama Power's Gaston Unit 4 (a 250 MW B&W unit with B&W XCL low NO<sub>x</sub> 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.

<b>Table 3: Phase 4 Milestones / Status</b>	
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

<b>Table 4: Digital Control System Timeline</b>	
June 1992	<ul style="list-style-type: none"> <li>• Begin preliminary engineering</li> </ul>
August 1992	<ul style="list-style-type: none"> <li>• Issue request for proposals for digital control system</li> </ul>
February 1993	<ul style="list-style-type: none"> <li>• Foxboro I/A system received at SCS</li> </ul>
April 1993	<ul style="list-style-type: none"> <li>• Issue purchase order to Foxboro</li> </ul>
June 1993	<ul style="list-style-type: none"> <li>• Start detail engineering</li> </ul>
June 1993	<ul style="list-style-type: none"> <li>• Begin configuration</li> </ul>
January 1994	<ul style="list-style-type: none"> <li>• Configuration complete</li> <li>• Start checkout</li> </ul>
February 1994	<ul style="list-style-type: none"> <li>• Foxboro I/A system shipped to Plant Hammond for installation</li> </ul>
May 1994	<ul style="list-style-type: none"> <li>• Installation complete</li> </ul>
June 1994	<ul style="list-style-type: none"> <li>• Unit Startup</li> </ul>

<b>Table 5: Digital Control System Configuration Milestones</b>	
June - August 1993	<ul style="list-style-type: none"> <li>• Finalized Input Output Listing</li> <li>• Developed Functional Drawings</li> <li>• Initiated Logic Development and System Interface</li> </ul>
September 1993	<ul style="list-style-type: none"> <li>• Two Week Configuration Training</li> </ul>
September - December 1993	<ul style="list-style-type: none"> <li>• Developed Configuration</li> <li>• Continued Logic Development and Developed Logic Configuration</li> <li>• Completed All Configuration</li> </ul>
January - February 1994	<ul style="list-style-type: none"> <li>• Began DCS Configuration Checkout</li> <li>• Continued Graphic Linking to Configuration</li> <li>• Configured Data Links and Began Data Link Checkout</li> <li>• Configuration Cleanup</li> </ul>
February 22, 1994	<ul style="list-style-type: none"> <li>• DCS Shipped to Site</li> </ul>

<b>Table 6: Digital Control System Installation and Checkout Overview</b>	
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

<b>Table 7: Digital Control System Startup and Tuning Timeline</b>	
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 <sub>2</sub> , 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

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

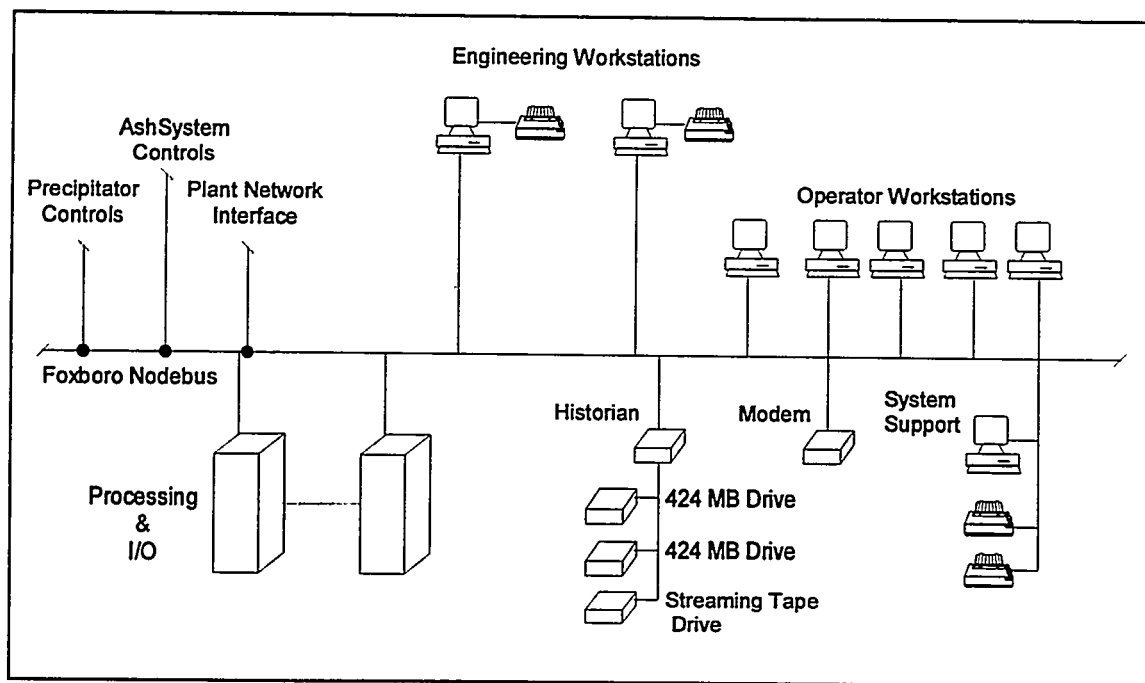
<b>Table 9: Function of Application Processors</b>	
Application Processor	Function
4AP001	Main application processor used for production control, graphic display, equipment monitoring, and alarm processing
4AP002	Secondary application processor used as backup for 4AP001 and equipment tagout support
4AP003	Primary functions includes historian, plant networking, reporting, and backup of 4AP001

<b>Table 10: Fieldbus Module Descriptions</b>	
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

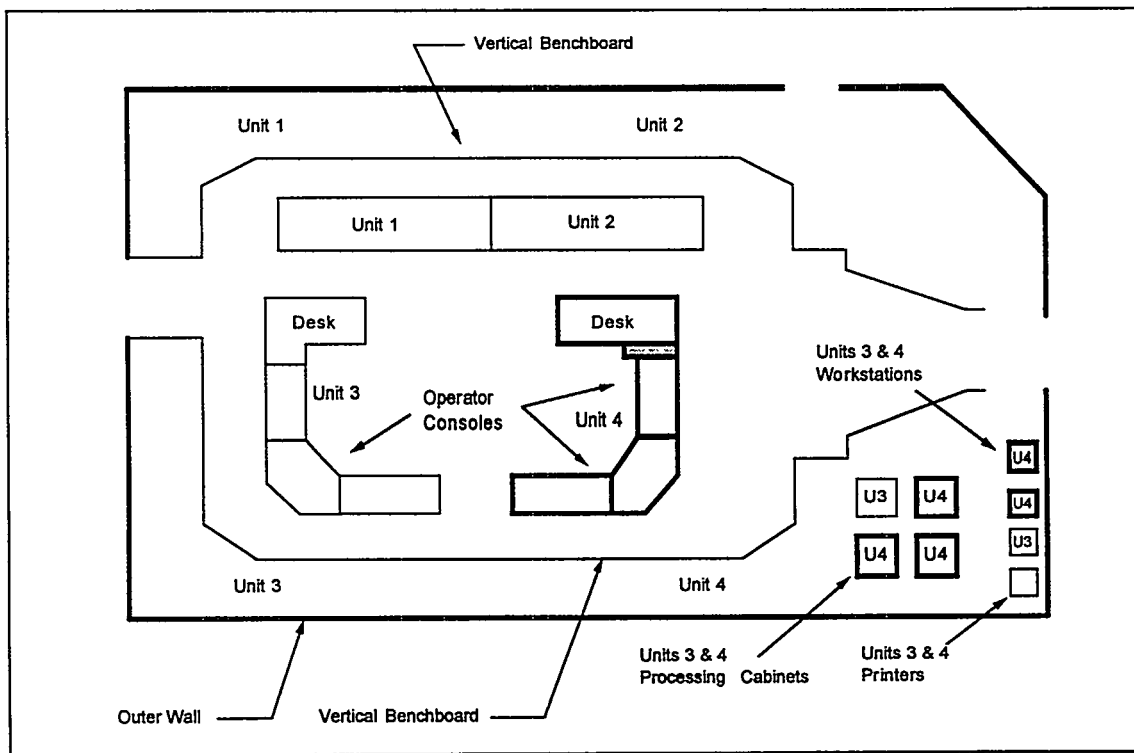
**Table 11: Cabinet Locations**

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

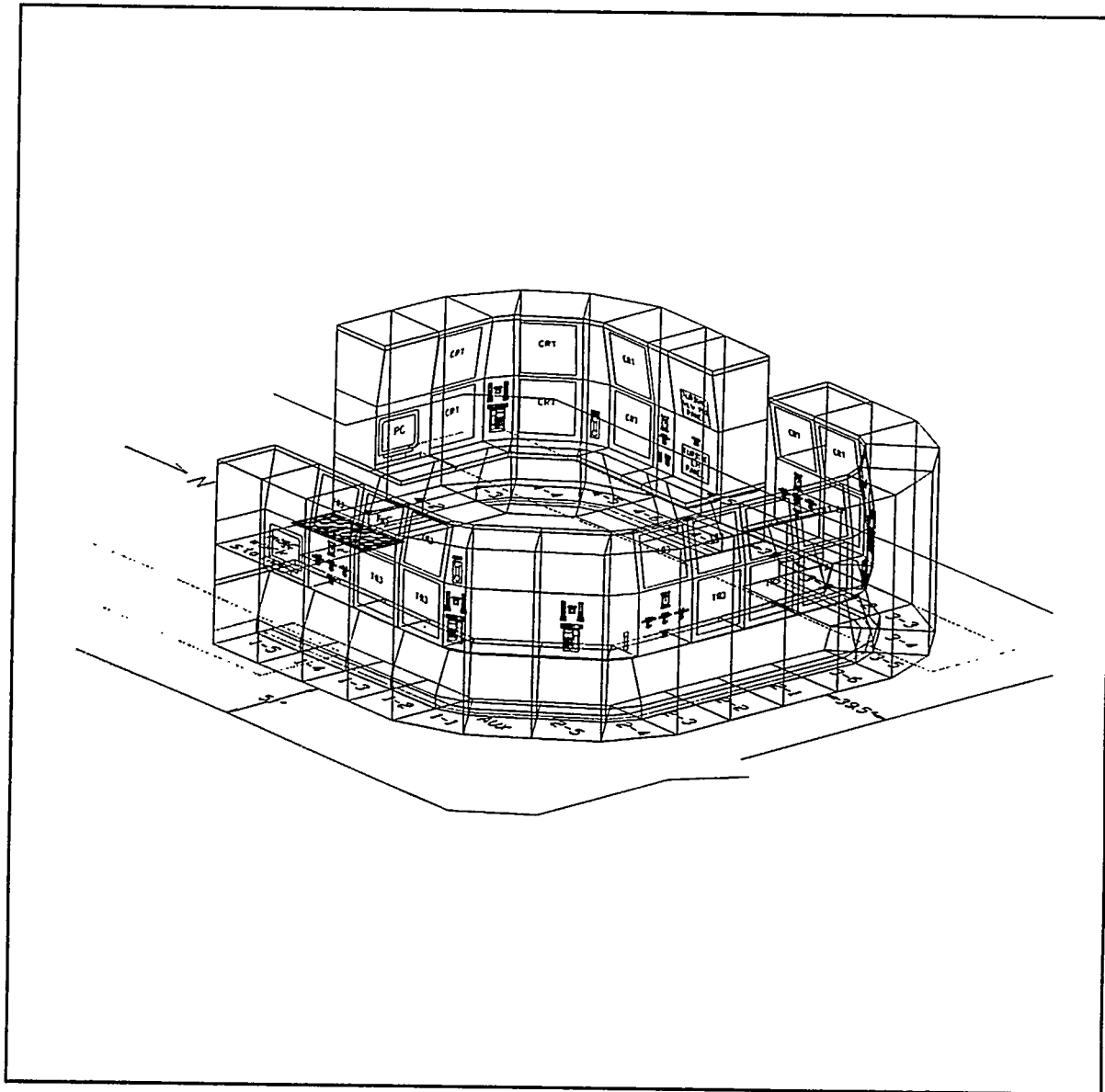




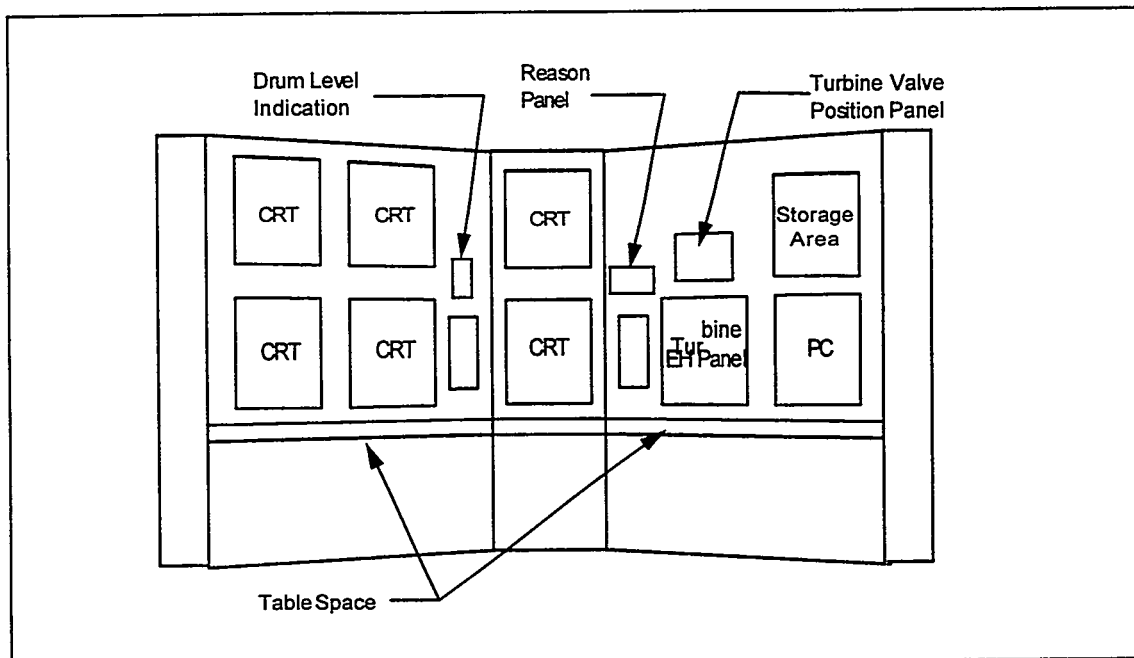
**Figure 4: Unit 4 DCS Overview**



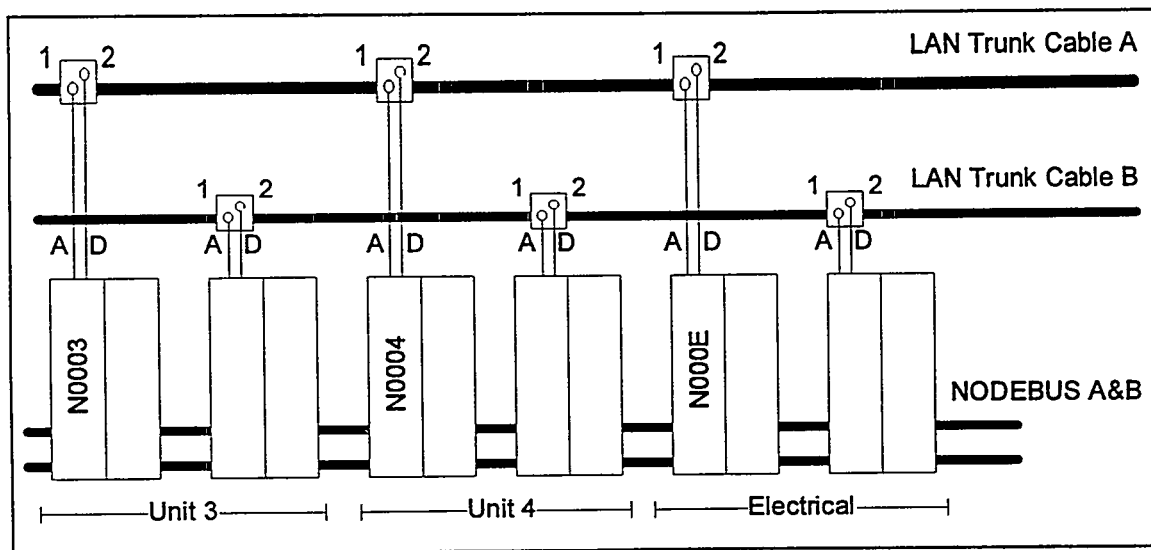
**Figure 5: Unit 1-4 Control Room Layout as Currently Implemented**



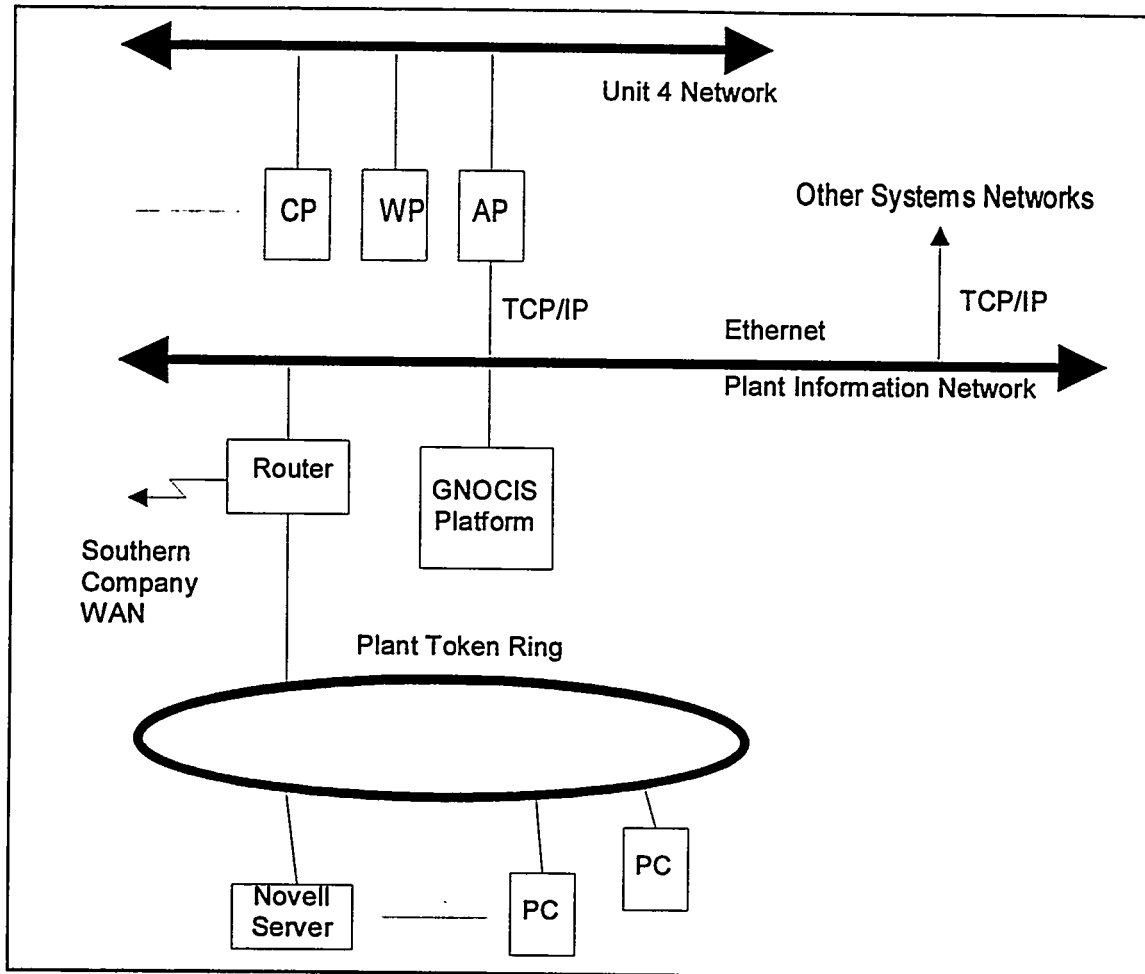
**Figure 6: Unit 1-4 Control Room Layout (Planned)**



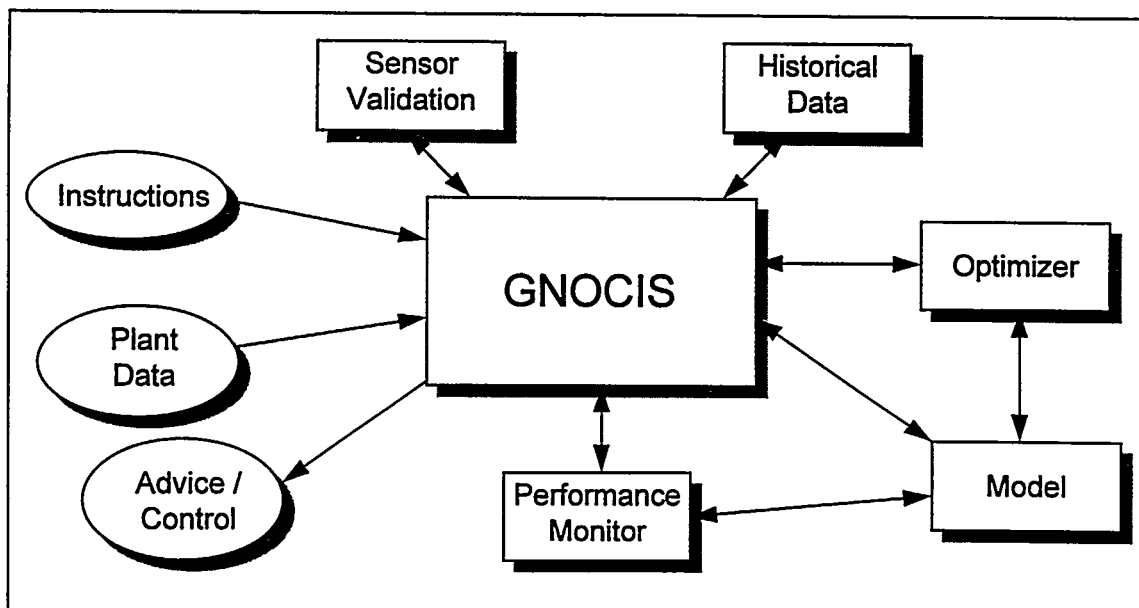
**Figure 7: Unit 4 Benchboard**



**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
Forth 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
Forth 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<sub>x</sub> 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

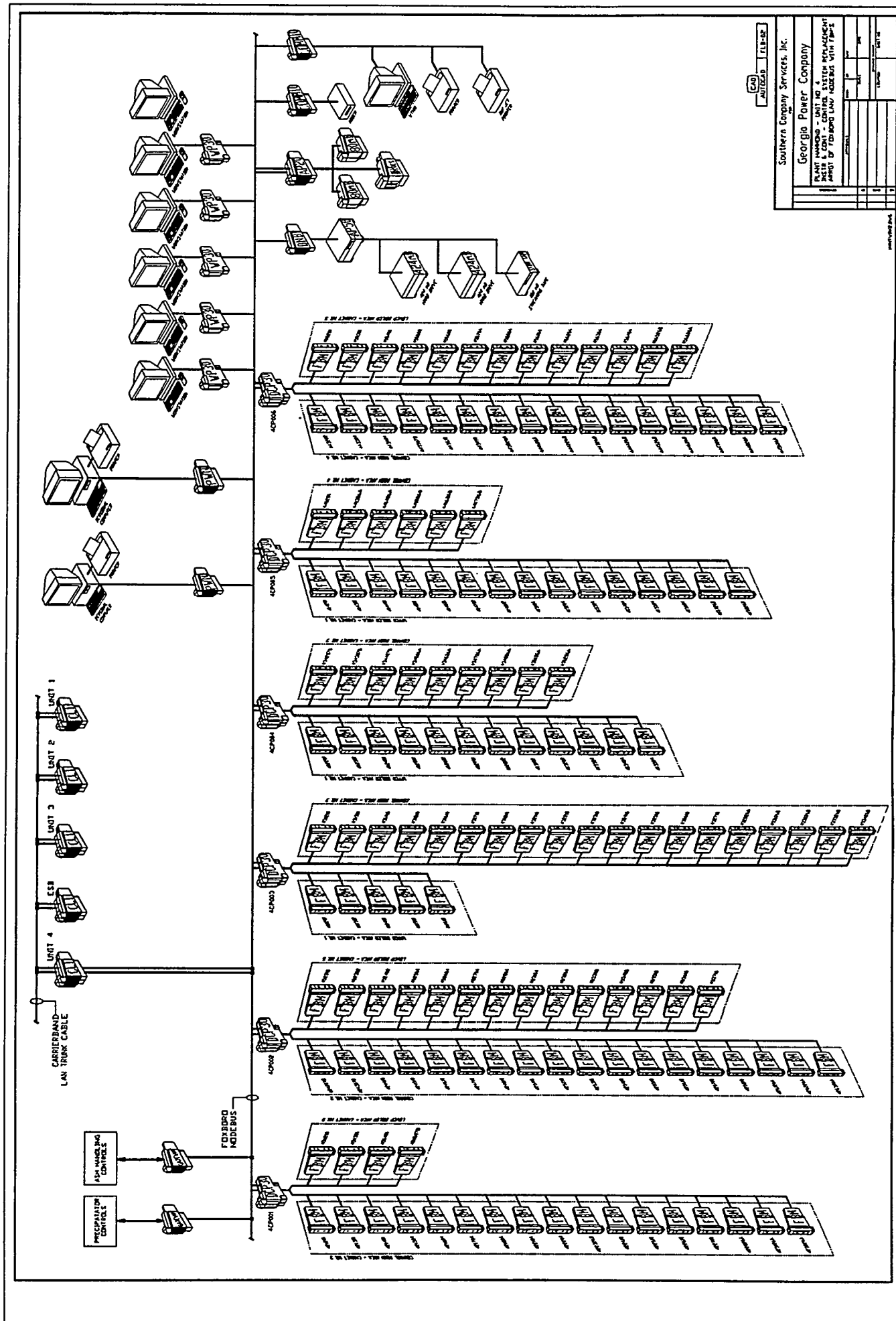
8. AUXILIARY CONTROL
9. DCA HEATER LEVEL CONTROL
10. ASH HANDLING SYSTEM
11. PRECIPITATOR ENERGY MANAGEMENT SYSTEM
12. PRECIPITATOR FIRE PROTECTION
13. MOTOR BREAKER/START-STOP LOGIC
14. BURNER MANAGEMENT SYSTEM
  - a. Furnace Purge Logic
  - b. Master Fuel Trip Logic
  - c. Ignitor Trip Logic
  - d. 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**



CAO  
AUTREAU  
FEB-82

Southern Company Services, Inc.

Georgia Power Company

PLANT: MAGDOGA - UNIT #2

PLANT: MAGDOGA - UNIT #4

PLANT: MAGDOGA - UNIT #6

PLANT: MAGDOGA - UNIT #8

PLANT: MAGDOGA - UNIT #10

PLANT: MAGDOGA - UNIT #12

PLANT: MAGDOGA - UNIT #14

PLANT: MAGDOGA - UNIT #16

PLANT: MAGDOGA - UNIT #18

PLANT: MAGDOGA - UNIT #20

PLANT: MAGDOGA - UNIT #22

PLANT: MAGDOGA - UNIT #24

PLANT: MAGDOGA - UNIT #26

PLANT: MAGDOGA - UNIT #28

PLANT: MAGDOGA - UNIT #30

PLANT: MAGDOGA - UNIT #32

PLANT: MAGDOGA - UNIT #34

PLANT: MAGDOGA - UNIT #36

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PLANT: MAGDOGA - UNIT #84

PLANT: MAGDOGA - UNIT #86

PLANT: MAGDOGA - UNIT #88

PLANT: MAGDOGA - UNIT #90

PLANT: MAGDOGA - UNIT #92

PLANT: MAGDOGA - UNIT #94

PLANT: MAGDOGA - UNIT #96

PLANT: MAGDOGA - UNIT #98

PLANT: MAGDOGA - UNIT #100

UNIT 10

**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  
REG 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



[/usr/disp/U4-BOILER] 14:30 8-8-94

KEYWORD=MEN11 MEN12 Burner

LOGS Select

Page

# UNIT 4 BOILER OVERVIEW PAGE 1

MEGAWATTS 479

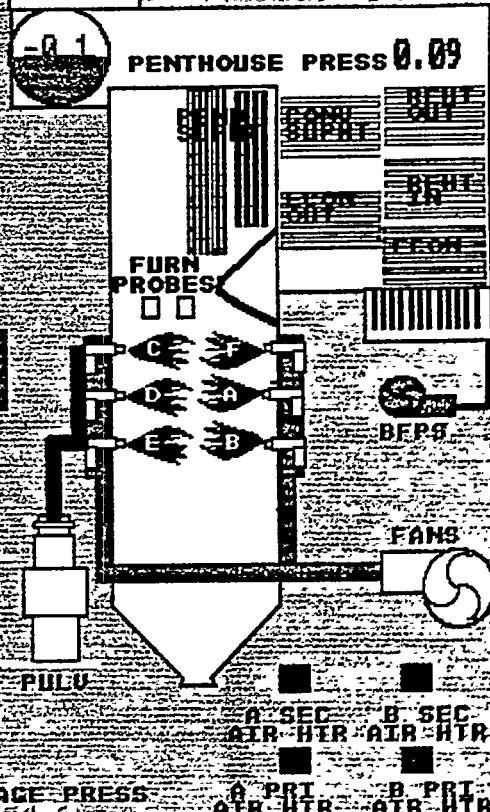
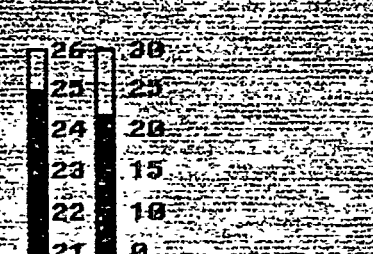
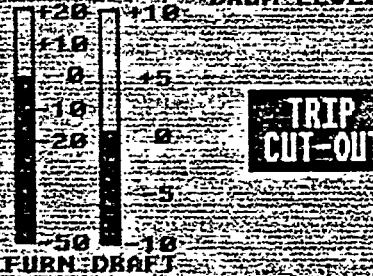
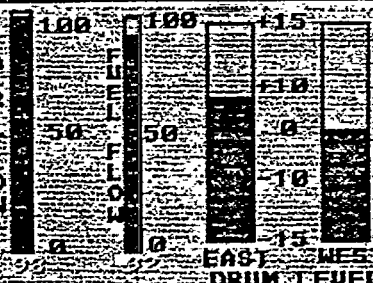
AIR FLOW 222713  
STEAM FLOW 218954  
FUEL FLOW 160628  
SUPERHEAT TEMP LH 734  
SUPERHEAT TEMP RH 734  
REHEAT TEMP IN 833  
REHEAT TEMP OUT 1002  
FURN PROBE DEG A 274  
FURN PROBE DEG B 274

OPACITY 6 MIN AVG 99  
OPACITY 157  
CO 1361249  
FLUE GAS FLOW 1361249  
EXCESS O2 4.22  
#1RH O2 ANALYZER 5.31  
#2RH O2 ANALYZER 4.35  
#3RH O2 ANALYZER 4.06  
#4LH O2 ANALYZER 3.72  
#5LH O2 ANALYZER 4.32  
#6LH O2 ANALYZER 6.01

O2 5.01  
CO 3.033  
NOX 34154  
SO2 729544  
THC 1.613

FEEDWATER FLOW A 3123  
X100 B 3123  
FEEDWATER PRESS 2545  
DRUM PRESS 2570  
PRI AIR/FURN  
DIFF PRESS 2.9

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/USP/CONTROL/04/04\_UMS

15:43 8-2-94

309

KEYBOARD MENU 1 MENU 2 TRENDS BURNER LOGS

Page

# UNIT #4 UNIT MASTER

Pressure Ratio 99.2%

BOILER DEMAND  
515.8 MW

Low  
Limit  
200.0 MW

High  
Limit  
520.0 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

▼ R M ▲

ACC HI LIM 11 HI LIMIT  
520 MW

ACC LO LIM T3 LOWER  
200 MW T4 LO LIMIT

PREV  
DISP

MENU

TURB  
OVIEW

MASTER  
SCREEN

Megawatts

T3

HI LIMIT 520.0

LO LIMIT 200.0

RAISE

LOWER

AGC SCREEN

FUEL MASTER

A M

A FUEL %

R 98.3

SETPOINT 99.2

78.6

O2 COMPENSATOR

A M

A BIAS %

R 0.0

SETPOINT 3.4

0.3

000:00:06:00 03 S

103.15 FUEL %

99.76 AIR %

90.73 F/W %

87.54 STMF %

FEED WATER MASTER

A M

A F/W DEMAND %

R 90.1

DRUM LVL SETPOINT -0.05

90.1

FURNACE DRAFT

10 5 0 5 10

20 10 0 10 20

30 20 10 20 30

40 30 20 30 40

50 40 30 40 50

ID FAN MASTER

A M

A FURN PRESS INMC

R -0.43

SETPOINT -0.35

51.6

FD FAN MASTER

A M

A AIR FLOW %

R 100.1

SETPOINT 100.1

59.6

THROTTLE PRESS

ACK

PREV DISP

FD FANS

ID FANS

BFP CONT

▲

▲

▼

▼

1/15/94/01/04/04 AMILE

16:00 8-2-94

KEYBOARD MENU1 MENU2 TRENDS BURNER LOGS PAGE

4A  
IGNITORS

PERCENT 02  
P A FAN ON  
IGNITOR EN  
SEAL AIR LOW  
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

0000  
26 INWC  
20.8 INWC  
728  
12282 LBS/HR  
320 DEC F  
298 PSI  
LOW/LOW  
HEATER ON

SEAL AIR BLOWER

PULV OVIEW

MASTER SCREEN

CONTROL POSITION

4A MILL HOT AIR  
PA FLOW 79.6%

4A MILL COLD AIR

4A FEEDER SPEED  
FLOW 64974/HR

FUEL MASTER

A BIAS %  
R 5.0  
SETPOINT  
79.9  
OUT %  
31.0

A TEMP F  
L 158.4  
SETPOINT  
165.0  
INLET %  
0.0

A DEMAND %  
L 77.8  
SETPOINT  
3.6  
OUT %  
74.2

A HEAT RELEASE %  
R 99.3  
SETPOINT  
99.4  
OUT %  
77.6

ACK

PREV DISP

MENU

REC & IGN'S

▲

▲

▼

▼

BURNER GATES

1/05/001104/04/04 OFTRED1

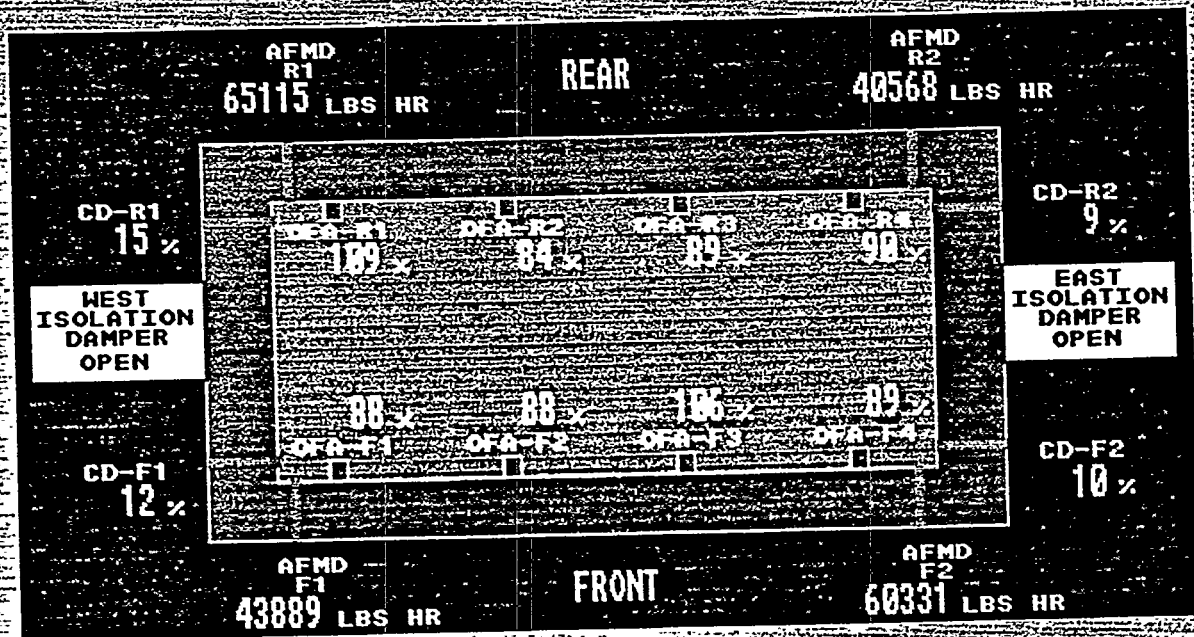
10:15 8-3-94

KEYBRD=MENU1=MENU2=TRENDS=BURNER=LOGS

PrSc

# UNIT 4 OVERFIRE DAMPER OVERVIEW

OVERFIRE TOTAL AIR FLOW 212931 LBS/HR



PREV  
DISP

OVERFIRE  
CONTROLS

FRONT  
OVERFIRE

REAR  
OVERFIRE

1/15/87/control/04/04 FANS

8:53 8-3-94

Exit

KEYBOARD

MENU1

MENU2

TRENDS

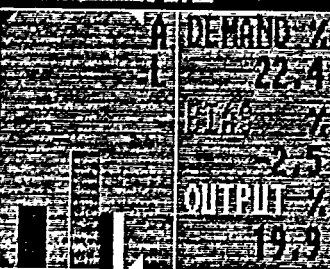
BURNER

LOCS

Print

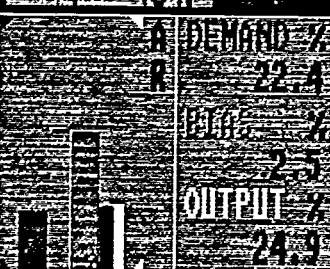
4A FD INLET VANE

A M 1 2  
3 F



4B FD INLET VANE

A M 1 2  
3 F



02 COMPENSATOR

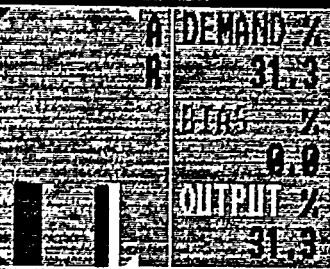
SELECTED 4.9%

A M



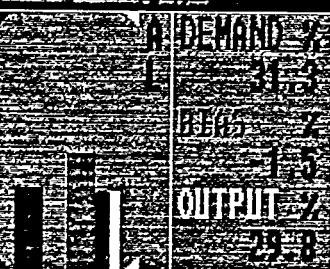
4A ID INLET DAMPER

A M 1 2  
3 F



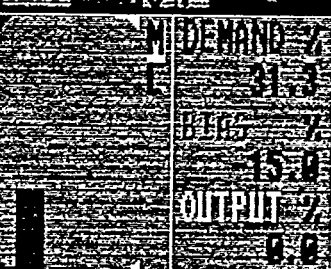
4B ID INLET DAMPER

A M 1 2  
3 F



4C ID INLET DAMPER

A M 1 2  
3 F



4A FD INLET VANE

4B FD INLET VANE

02 COMPENSATOR

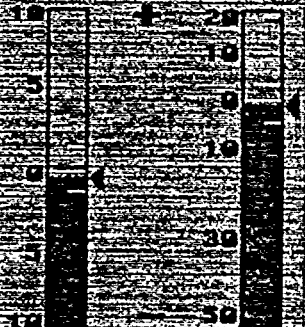
4A ID INLET DAMPER

4B ID INLET DAMPER

BOILER  
VIEW

FANS  
VIEW

FURNACE DRAFT



ACK

PREV  
DISP





E:\usr\disp\14\_FDFANS1

8:41 8-3-94

NOV 24

NEVERD MENU1

MENU2

Turner

LOGS

Select

Page

A FDF INLET VANE

A	M	1	2
		3	F

B FDF INLET VANE

A	M	1	2
		3	F

A DEMAND %  
L 21.4  
DEAS %  
-2.5  
OUTPUT %  
18.9

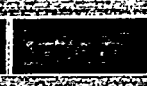
B DEMAND %  
R 21.4  
DEAS %  
2.5  
OUTPUT %  
23.9



4A FDF  
READY  
START



4B FDF  
READY  
START



A FDF DISCH PRESS 4.77 INHG  
B FDF DISCH PRESS 3.00 INHG  
A FDF AMPS 111  
B FDF AMPS 129

TOTAL AIR FLOW  
27551 SCFH  
625

A ID FAN AMPS 455  
B ID FAN AMPS 454  
C ID FAN AMPS 0

A FDF DISCH DAMPER

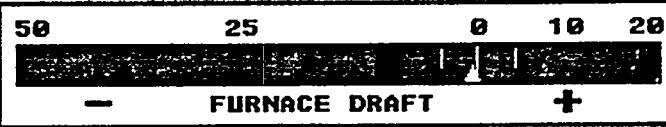
1	2
3	F

B FDF DISCH DAMPER

1	2
3	F

OUTPUT %  
100.0

OUTPUT %  
100.0



ACK PREV DISP ID FANS

▲ ▲

▼ ▼

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

8:42 8-3-94

Bus

KEYBRD MENU M-N12 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

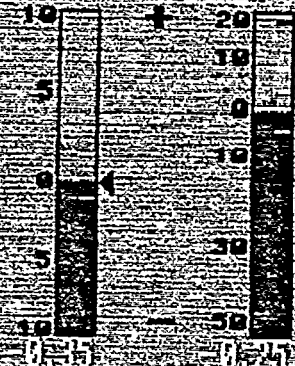
A 1 2  
3 F

M 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



ID FANS  
PERMIT



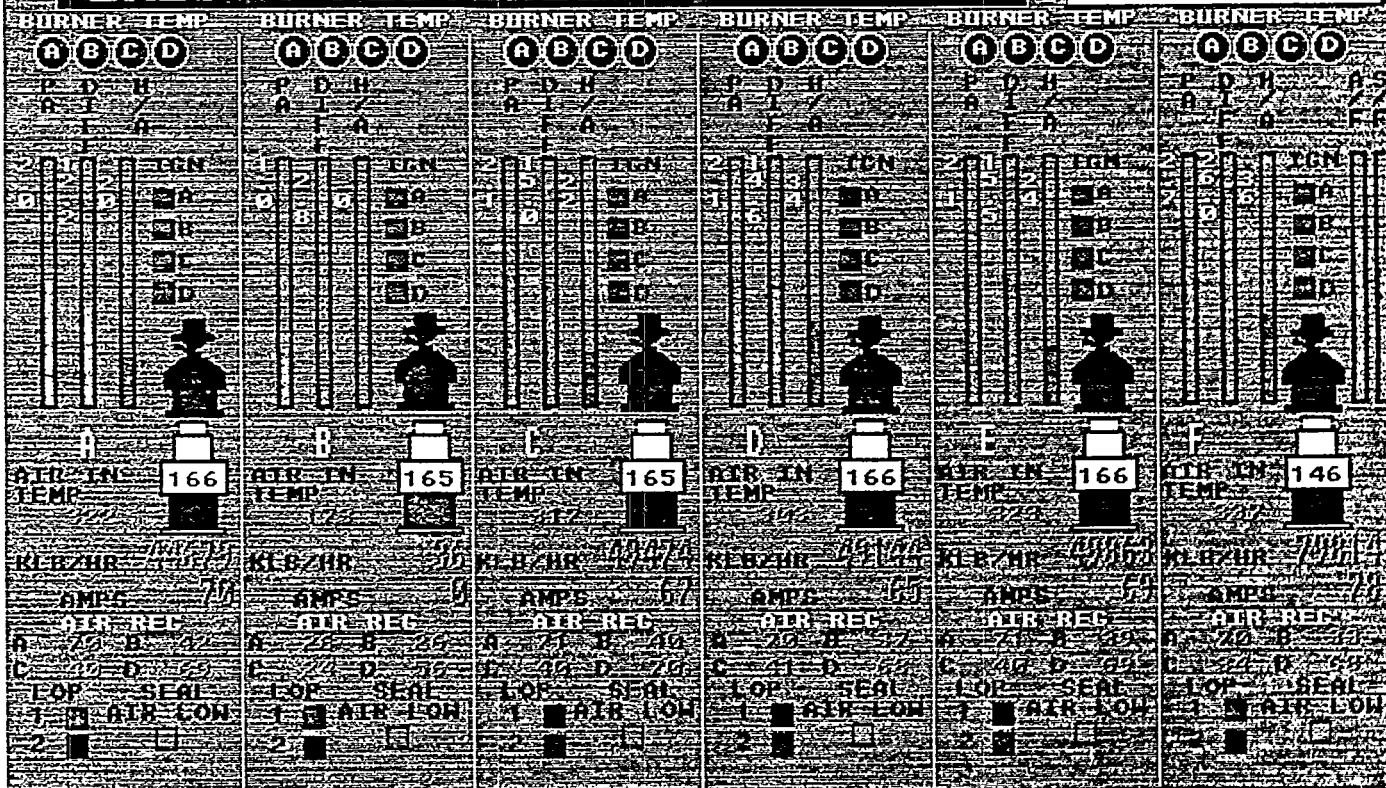
17/05/74 15:04 PULVIST

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

STN PRESS FURNACE DRAFT  
PSIC HARRON WIDE RH

02 AUG  
1974

1/052/013p/04 PURGE

10:20 8-3-94

KEYWORD MENU1 MENU2 TRENDS BURNER LOGS

1431

## 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

17/05/10/001/04/04 00101

02:51:03 94

005

KEYBRD=MENU1 MENU2 TRENDS=URNER LOGS

005

# #4 OVERFIRE AIR FLOW CONTROL

WEST

FRONT DAMPER  
CONTROLS

OVERFIRE TOTAL AIR FLOW  
13725 LBS/HR

REAR DAMPER  
CONTROLS

EAST

AFMD-F1

11.6 LBS/HR

0 SETPOINT

AFMD-F2

11.6 LBS/HR

0 SETPOINT

AFMD-R1

1.0 LBS/HR

0 SETPOINT

AFMD-R2

9.3 LBS/HR

0 SETPOINT

CD-F1 DAMPER CTRLR

A R 1 2 3 4

N DEMAND %

R 11.6

SETPOINT

11.6

OUTDEC OUTINC

CD-F2 DAMPER CTRLR

A R 1 2 3 4

N DEMAND %

R 9.8

SETPOINT

9.8

OUTDEC OUTINC

CD-R1 DAMPER CTRLR

A R 1 2 3 4

N DEMAND %

R 1.0

SETPOINT

1.0

OUTDEC OUTINC

CD-R2 DAMPER CTRLR

A R 1 2 3 4

N DEMAND %

R 9.3

SETPOINT

9.3

OUTDEC OUTINC

ACK

PREV  
DISP

OFIRE  
OVIEW



## 三、结论

KEYBRD=MENU1 MENU2=TRENDS=BURNER=LOGS

三、三、三、三

## OVERFIRE CONTROLS

## REAR DAMPER CONTROLS

WEST

EAST

**OFA-F1 DAMPER**

OFA-F2 DAMPER

OFA-F3 DAMPER

OFA-F4 DAMPER

**A** **M** **12**  
**3** **1** **1**

12

11



M R	DEMAND %	
	89.0	
	SE BRADING	
	75.0	
OUTDEC		OUTINC

M R	DEMAND %
	89.2
S E	SETPRINT
	75.0
Q U I D E C	Q U I D I N C

M	DEMAND	7
		105.9
R	STUPID	7
		75.0
	OUTDEC	OUTINC

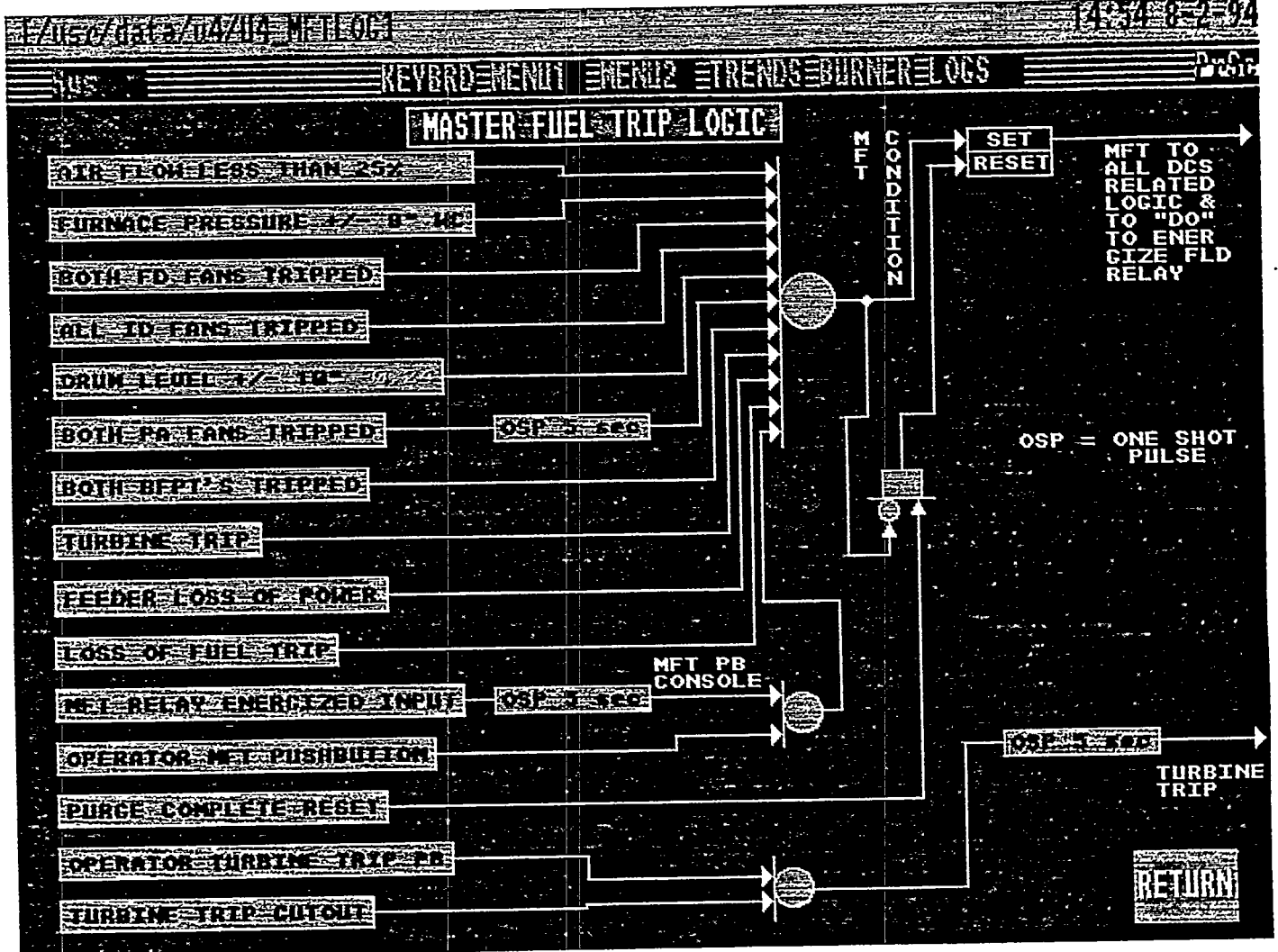
M R	DEMAND %
	88.8
	SELEPOINT
	75.0
OUTDEC	OUTING

## ACK

PREV  
DISP

## OFIRE VIEW





























KEYBOARD MENU1 MENU2 TRENDS BURNER LOGS

F000

# UNIT 4 BURNER DISPLAY - PAGE 1

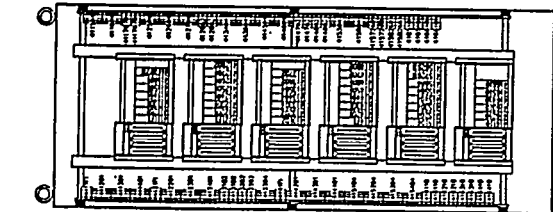
## FRONT WALL REAR WALL

<b>CD</b> 2 3  1 5 4 1 632 F 2 668 F 3 669 F 4 618 F 5 528 F	<b>CC</b> 2 3  1 5 4 1 619 F 2 705 F 3 716 F 4 653 F 5 483 F	<b>CB</b> 2 3  1 5 4 1 698 F 2 729 F 3 674 F 4 688 F 5 499 F	<b>CA</b> 2 3  1 5 4 1 635 F 2 673 F 3 682 F 4 653 F 5 538 F	<b>FA</b> 2 3  1 5 4 1 656 F 2 655 F 3 634 F 4 634 F 5 575 F	<b>FB</b> 2 3  1 5 4 1 492 F 2 585 F 3 654 F 4 633 F 5 549 F	<b>FC</b> 2 3  1 5 4 1 645 F 2 674 F 3 669 F 4 635 F 5 561 F	<b>FD</b> 2 3  1 5 4 1 623 F 2 669 F 3 681 F 4 644 F 5 488 F
<b>DD</b> 2 3  1 5 4 1 694 F 2 682 F 3 658 F 4 637 F 5 583 F	<b>DC</b> 2 3  1 5 4 1 682 F 2 714 F 3 716 F 4 669 F 5 548 F	<b>DB</b> 2 3  1 5 4 1 648 F 2 671 F 3 646 F 4 619 F 5 546 F	<b>DA</b> 2 3  1 5 4 1 657 F 2 692 F 3 711 F 4 655 F 5 568 F	<b>AA</b> 2 3  1 5 4 1 622 F 2 655 F 3 634 F 4 594 F 5 -30 F	<b>AB</b> 2 3  1 5 4 1 618 F 2 648 F 3 628 F 4 547 F 5 667 F	<b>AC</b> 2 3  1 5 4 1 668 F 2 678 F 3 648 F 4 542 F 5 642 F	<b>AD</b> 2 3  1 5 4 1 635 F 2 681 F 3 655 F 4 693 F 5 293 F
<b>ED</b> 2 3  1 5 4 1 628 F 2 657 F 3 660 F 4 643 F 5 565 F	<b>EC</b> 2 3  1 5 4 1 578 F 2 692 F 3 702 F 4 655 F 5 577 F	<b>EB</b> 2 3  1 5 4 1 664 F 2 652 F 3 681 F 4 672 F 5 488 F	<b>EA</b> 2 3  1 5 4 1 738 F 2 707 F 3 626 F 4 622 F 5 525 F	<b>BA</b> 2 3  1 5 4 1 642 F 2 618 F 3 605 F 4 673 F 5 570 F	<b>BB</b> 2 3  1 5 4 1 702 F 2 696 F 3 667 F 4 674 F 5 539 F	<b>BC</b> 2 3  1 5 4 1 105 F 2 734 F 3 732 F 4 733 F 5 608 F	<b>BD</b> 2 3  1 5 4 1 711 F 2 711 F 3 713 F 4 713 F 5 681 F

PREV  
DISPALM  
ACK

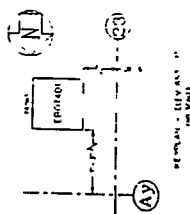
PAGE 2

**Appendix E**  
**I/O Cabinet Arrangement Drawings**



FRONT VIEW  
(TYPICAL FOR REAR)

MA34 3075

[illegible]

## NOTES

1. CABINET IS A HOFFMAN (HOFMANN) COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING MEAS 12 ENCLOSURE (MODEL NO. A-90361050A)
2. THE ALPHA CHARACTER AT THE END OF SERIAL OF THE LETTERING NUMBERS IS THE TYPICAL CABINET DESIGNATION

CAD AUTOCAD FLR-01

Southern Company Services Inc.

**Georgia Power Company**

IT MANAGER - UNIT NO. 4  
9000 CEN. - COUNCIL SYSTEM REPRESENTATIVE  
CABINET NO. 1 - UPPER BUILDING  
WORKMENT

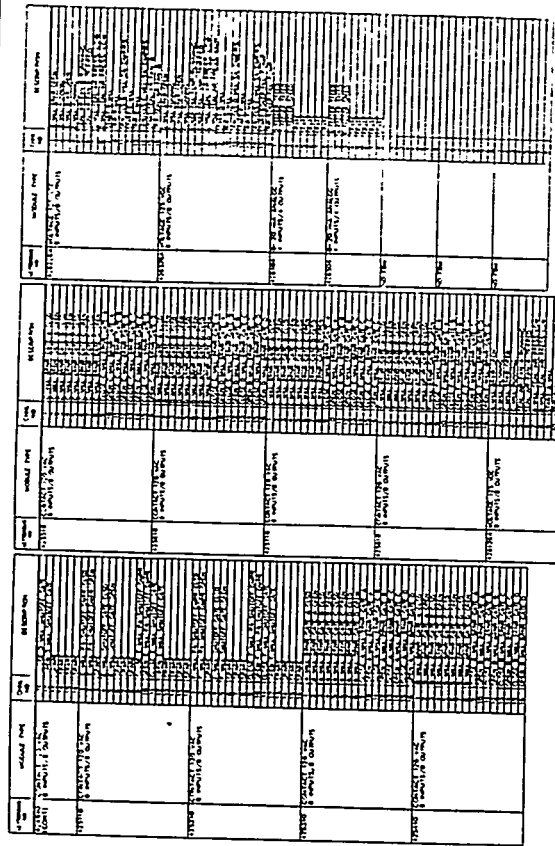
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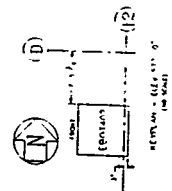
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**SECTION A-A**



## Notes

- CABINET IS A HOFFMAN ENGINEERING COMPANY  
 SINGLE-DOOR DUAL ACCESS SAFE STAMPING MEWA 12  
 ENCLOSURE (MODEL NO. 800336720)  
 THE ALPHA CHARACTER AT THE END OF SOME OF THE  
 LETTERING NUMBERS IS THE TITANUM CASE  
 DESIGNATION

CAO  
AUTOCAD  
FLS-01

**Southern Company Services Inc**

**Georgia Power Company**  
All Hands-On - Unit No. 4

3 FT @ CONT - CONTROL SYSTEM DISPLACEMENT  
D CABINET NO 2 - CONTROL ROOM AREA  
ORANGE MEN

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
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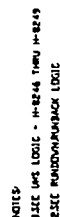
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**Appendix F**  
**Example DCS Documentation**

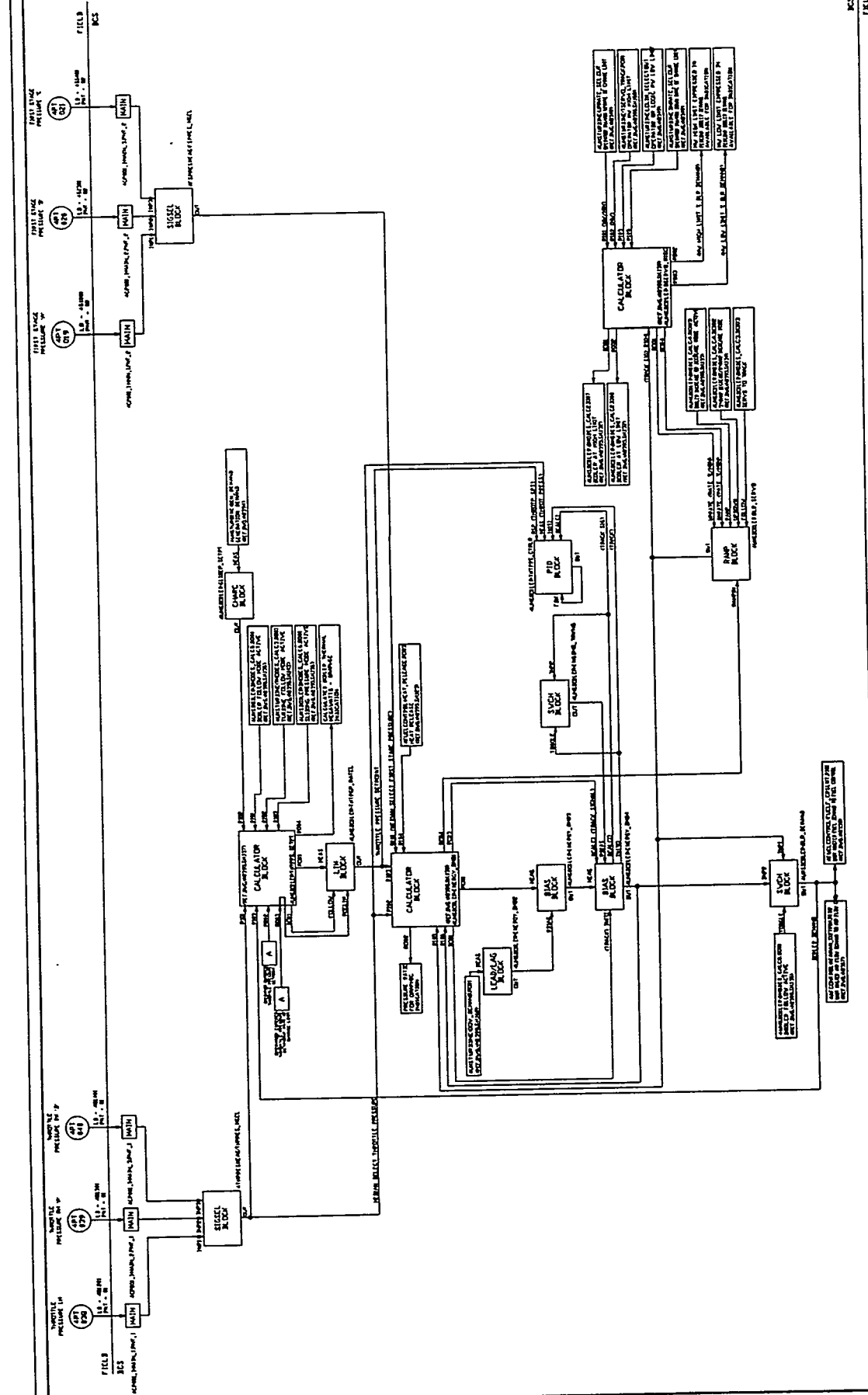


Southern Company Services, Inc.

**Georgia Power Company**

ARMED STEAM PLANT - UNIT NO. 4  
INSTRUMENTS AND CONTROLS - FUNCTIONAL  
CONTROL DIAGRAM - UNIT MASTER - SHEET 1

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REMARKS

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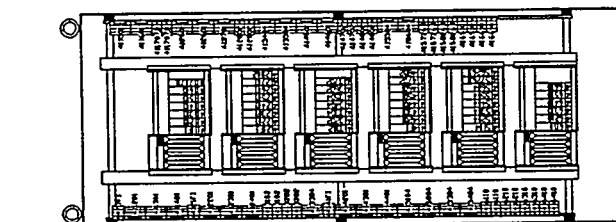
Southern Company Services, Inc. for Georgia Power Company

PLANT HAMMOND - UNIT NO. 4  
INSTRUMENTS & CONTROLS  
BOILER MODES, ENERGY DEMAND  
4UMSBOILER:ENERGY\_DMD1

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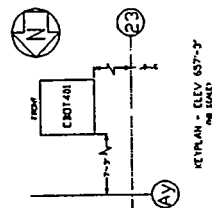
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SECTION A-A

**SIDE VIEW**

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are:

- CABINET IS A HOFFMAN ENGINEERING COMPANY  
SINGLE-DOOR RUAL ACCESS FREE STANDING WEMA 18  
ENCLOSURE MODEL NO A-902645IDA  
THE ALPHA CHARACTER AT THE END OF SOME OF THE  
LETTERING NUMBERS IS THE TERMINAL CABLE  
IDENTIFICATION

CDV-01

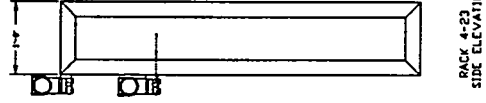
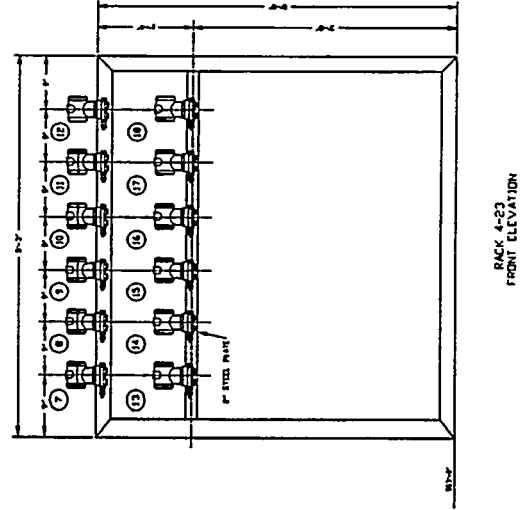
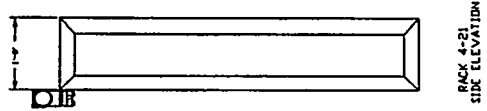
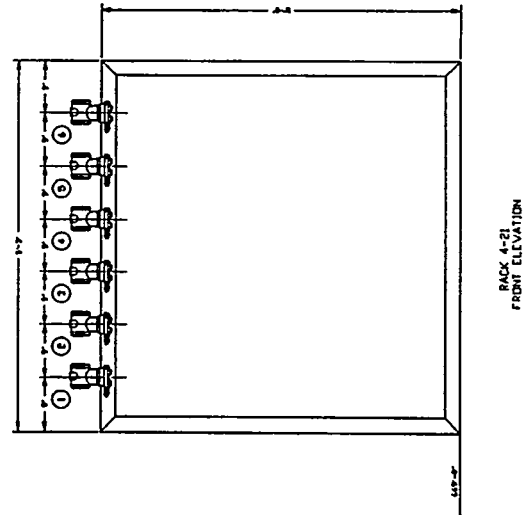
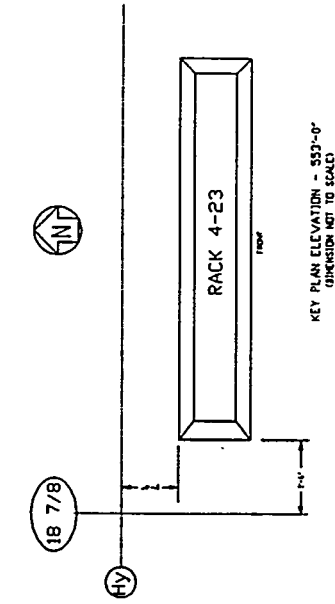
**Southern Company Services, Inc.**

Georgia Power Company, Atlanta, Ga.  
General Engineering Department

PLANT HANDBOOK - UNIT NO. 4  
INSTR 6 CONT - CONTROL SYSTEM REPLACEMENT  
AND CANNING UNIT NO. 1 - UPPER MILL AREA

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ALL RIGHTS TO THE VETERAN'S CONTRIBUTION OF \$100.00 TO THE  
SOLDIER'S HOME IN THE DISTRICT OF COLUMBIA

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**Southern Company Services, Inc.**

**Georgia Power Company**

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

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**INTERVIEW**



PROJECT 1	PROJECT 2	PROJECT 3	PROJECT 4	PROJECT 5	PROJECT 6	PROJECT 7	PROJECT 8	PROJECT 9	PROJECT 10	PROJECT 11	PROJECT 12	PROJECT 13	PROJECT 14	PROJECT 15	PROJECT 16	PROJECT 17	PROJECT 18	PROJECT 19	PROJECT 20	PROJECT 21	PROJECT 22	PROJECT 23	PROJECT 24	PROJECT 25	PROJECT 26	PROJECT 27	PROJECT 28	PROJECT 29	PROJECT 30	PROJECT 31	PROJECT 32	PROJECT 33	PROJECT 34	PROJECT 35	PROJECT 36	PROJECT 37	PROJECT 38	PROJECT 39	PROJECT 40	PROJECT 41	PROJECT 42	PROJECT 43	PROJECT 44	PROJECT 45	PROJECT 46	PROJECT 47	PROJECT 48	PROJECT 49	PROJECT 50	PROJECT 51	PROJECT 52	PROJECT 53	PROJECT 54	PROJECT 55	PROJECT 56	PROJECT 57	PROJECT 58	PROJECT 59	PROJECT 60	PROJECT 61	PROJECT 62	PROJECT 63	PROJECT 64	PROJECT 65	PROJECT 66	PROJECT 67	PROJECT 68	PROJECT 69	PROJECT 70	PROJECT 71	PROJECT 72	PROJECT 73	PROJECT 74	PROJECT 75	PROJECT 76	PROJECT 77	PROJECT 78	PROJECT 79	PROJECT 80	PROJECT 81	PROJECT 82	PROJECT 83	PROJECT 84	PROJECT 85	PROJECT 86	PROJECT 87	PROJECT 88	PROJECT 89	PROJECT 90	PROJECT 91	PROJECT 92	PROJECT 93	PROJECT 94	PROJECT 95	PROJECT 96	PROJECT 97	PROJECT 98	PROJECT 99	PROJECT 100
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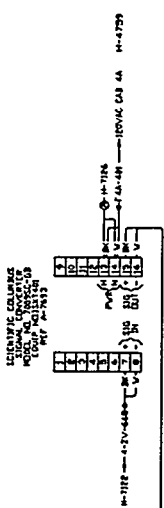
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2007-210	A	1	3	5	7	9	11	13	15	17	19
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2077-210	A	8	10	12	14	16	18	20	22	24	26
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2097-210	A	10	12	14	16	18	20	22	24	26	28
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2137-210	A	14	16	18	20	22	24	26	28	30	32
2147-210	A	15	17	19	21	23	25	27	29	31	33
2157-210	A	16	18	20	22	24	26	28	30	32	34
2167-210	A	17	19	21	23	25	27	29	31	33	35
2177-210	A	18	20	22	24	26	28	30	32	34	36
2187-210	A	19	21	23	25	27	29	31	33	35	37
2197-210	A	20	22	24	26	28	30	32	34	36	38
2207-210	A	21	23	25	27	29	31	33	35	37	39
2217-210	A	22	24	26	28	30	32	34	36	38	40
2227-210	A	23	25	27	29	31	33	35	37	39	41
2237-210	A	24	26	28	30	32	34	36	38	40	42
2247-210	A	25	27	29	31	33	35	37	39	41	43
2257-210	A	26	28	30	32	34	36	38	40	42	44
2267-210	A	27	29	31	33	35	37	39	41	43	45
2277-210	A	28	30	32	34	36	38	40	42	44	46
2287-210	A	29	31	33	35	37	39	41	43	45	47
2297-210	A	30	32	34	36	38	40	42	44	46	48
2307-210	A	31	33	35	37	39	41	43	45	47	49
2317-210	A	32	34	36	38	40	42	44	46	48	50
2327-210	A	33	35	37	39	41	43	45	47	49	51
2337-210	A	34	36	38	40	42	44	46	48	50	52
2347-210	A	35	37	39	41	43	45	47	49	51	53
2357-210	A	36	38	40	42	44	46	48	50	52	54
2367-210	A	37	39	41	43	45	47	49	51	53	55
2377-210	A	38	40	42	44	46	48	50	52	54	56
2387-210	A	39	41	43	45	47	49	51	53	55	57
2397-210	A	40	42	44	46	48	50	52	54	56	58
2407-210	A	41	43	45	47	49	51	53	55	57	59
2417-210	A	42	44	46	48	50	52	54	56	58	60
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2437-210	A	44	46	48	50	52	54	56	58	60	62
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2477-210	A	48	50	52	54	56	58	60	62	64	66
2487-210	A	49	51	53	55	57	59	61	63	65	67
2497-210	A	50	52	54	56	58	60	62	64	66	68
2507-210	A	51	53	55	57	59	61	63	65	67	69
2517-210	A	52	54	56	58	60	62	64	66	68	70
2527-210	A	53	55	57	59	61	63	65	67	69	71
2537-210	A	54	56	58	60	62	64	66	68	70	72
2547-210	A	55	57	59	61	63	65	67	69	71	73
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2607-210	A	61	63	65	67	69	71	73	75	77	79
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2667-210	A	67	69	71	73	75	77	79	81	83	85
2677-210	A	68	70	72	74	76	78	80	82	84	86
2687-210	A	69	71	73	75	77	79	81	83	85	87
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2707-210	A	71	73	75	77	79	81	83	85	87	89
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2727-210	A	73	75	77	79	81	83	85	87	89	91
2737-210	A	74	76	78	80	82	84	86	88	90	92
2747-210	A	75	77	79	81	83	85	87	89	91	93
2757-210	A	76	78	80	82	84	86	88	90	92	94
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2847-210	A	85	87	89	91	93	95	97	99	101	103
2857-210	A	86	88	90	92	94	96	98	100	102	104
2867-210	A	87	89	91	93	95	97	99	101	103	105
2877-210	A	88	90	92	94	96	98	100	102	104	106
2887-210	A	89	91	93	95	97	99	101	103	105	107
2897-210	A	90	92	94	96	98	100	102	104	106	108
2907-210	A	91	93	95	97	99	101	103	105	107	109
2917-210	A	92	94	96	98	100	102	104	106	108	110
2927-210	A	93	95	97	99	101	103	105	107	109	111
2937-210	A	94	96	98	100	102	104	106	108	110	112
2947-210	A	95	97	99	101	103	105	107	109	111	113
2957-210	A	96	98	100	102	104	106	108	110	112	114
2967-210	A	97	99	101	103	105	107	109	111	113	115
2977-210	A	98	100	102	104	106	108	110	112	114	116
2987-210	A	99	101	103	105	107	109	111	113	115	117
2997-210	A	100	102	104	106	108	110	112	114	116	118
3007-210	A	101	103	105	107	109	111	113	115	117	119
3017-210	A	102	104	106	108	110	112	114	116	118	120
3027-210	A	103	105	107	109	111	113	115	117	119	121
3037-210	A	104	106	108	110	112	114	116	118	120	122
3047-210	A	105	107	109	111	113	115	117	119	121	123
3057-210	A	106	108	110	112	114	116	118	120	122	124
3067-210	A	107	109	111	113	115	117	119	121	123	125
3077-210	A	108	110	112	114	116	118	120	122	124	126
3087-210	A	109	111	113	115	117	119	121	123	125	127
3097-210	A	110	112	114	116	118	120	122	124	126	128
3107-210	A	111	113	115	117	119	121	123	125	127	129
3117-210	A	112	114	116	118	120	122	124	126	128	130
3127-210	A	113	115	117	119	121	123	125	127	129	131
3137-210	A	114	116	118	120	122	124	126	128	130	132
3147-210	A	115	117	119	121	123	125	127	129	131	133
3157-210	A	116	118	120	122	124	126	128	130	132	134
3167-210	A	117	119	121	123	125	127	129	131	133	135
3177-210	A	118	120	122	124	126	128	130	132	134	136
3187-210	A	119	121	123	125	127	129	131	133	135	137
3197-210	A	120	122	124	126	128	130	132	134	136	138
3207-210	A	121	123	125	127	129	131	133	135	137	139
3217-210	A	122	124	126	128	130	132	134	136	138	140
3227-210	A	123	125	127	129	131	133	135	137	139	141
3237-210	A	124	126	128	130	132	134	136	138	140	142
3247-210	A	125	127	129	131	133	135	137	139	141	143
3257-210	A	126	128	130	132	134	136	138	140	142	144
3267-210	A	127	129	131	133	135	137	139	141	143	145
3277-210	A	128	130	132	134	136	138	140	142	144	146
3287-210	A	129	131	133	135	137	139	141	143	145	147
3297-210	A	130	132	134	136	138	140	142	144	146	148
3307-210	A	131	133	135	1						

1	2	3	4	5	6	7	8	9	10
1	MAIN PRESS A								
2	MAIN FLOW								
3	MAIN FLOW								
4	FEEDWATER								
5	FEEDWATER								
6	FEEDWATER								
7	FEEDWATER								
8	FEEDWATER								
9	FEEDWATER								
10	FEEDWATER								

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[illegible]

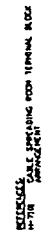
**דברי חכמים**

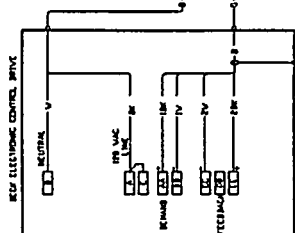
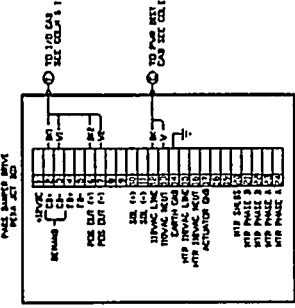
The diagram illustrates a 1000m long pipeline divided into 10 segments, each 100m long. The segments are labeled 1 to 10. The total length is 1000m. The diagram shows the layout of the pipeline and the location of the segments.

—ONE MILLION—  
2013-2014  
FOR BIDDING OF

ALL SMOKE SHALL BE TERMINATED ON CIGARET  
ENDS IN CABINET.  
REFERS TO THE SMOKE TO SMOKE BUT NOT

[illegible]

[illegible]



COMPONENT IDENTIFICATION	JUNCTION BOX NUMBER	WIRING POINTS ON THE WIRE	POWER SET CABLES INTERLOCKING POINTS	MOVING CONTROL CIRCUIT NUMBER	CONTROL POINT TO DRIVE	TERMINAL I/O CABLE	REFERENCE NUMBER
A 100V 100 AMP 3P 4W	E101401	E101401-1	E101401-1A	E101401-1	E101401-1A	E101401-1A	E101401-1A
B 100V 100 AMP 3P 4W	E101402	E101402-1	E101402-1A	E101402-1	E101402-1A	E101402-1A	E101402-1A
C 100V 100 AMP 3P 4W	E101403	E101403-1	E101403-1A	E101403-1	E101403-1A	E101403-1A	E101403-1A
D 100V 100 AMP 3P 4W	E101404	E101404-1	E101404-1A	E101404-1	E101404-1A	E101404-1A	E101404-1A
E 100V 100 AMP 3P 4W	E101405	E101405-1	E101405-1A	E101405-1	E101405-1A	E101405-1A	E101405-1A
F 100V 100 AMP 3P 4W	E101406	E101406-1	E101406-1A	E101406-1	E101406-1A	E101406-1A	E101406-1A
G 100V 100 AMP 3P 4W	E101407	E101407-1	E101407-1A	E101407-1	E101407-1A	E101407-1A	E101407-1A
H 100V 100 AMP 3P 4W	E101408	E101408-1	E101408-1A	E101408-1	E101408-1A	E101408-1A	E101408-1A
I 100V 100 AMP 3P 4W	E101409	E101409-1	E101409-1A	E101409-1	E101409-1A	E101409-1A	E101409-1A
J 100V 100 AMP 3P 4W	E101410	E101410-1	E101410-1A	E101410-1	E101410-1A	E101410-1A	E101410-1A
K 100V 100 AMP 3P 4W	E101411	E101411-1	E101411-1A	E101411-1	E101411-1A	E101411-1A	E101411-1A
L 100V 100 AMP 3P 4W	E101412	E101412-1	E101412-1A	E101412-1	E101412-1A	E101412-1A	E101412-1A
M 100V 100 AMP 3P 4W	E101413	E101413-1	E101413-1A	E101413-1	E101413-1A	E101413-1A	E101413-1A
N 100V 100 AMP 3P 4W	E101414	E101414-1	E101414-1A	E101414-1	E101414-1A	E101414-1A	E101414-1A
O 100V 100 AMP 3P 4W	E101415	E101415-1	E101415-1A	E101415-1	E101415-1A	E101415-1A	E101415-1A
P 100V 100 AMP 3P 4W	E101416	E101416-1	E101416-1A	E101416-1	E101416-1A	E101416-1A	E101416-1A
Q 100V 100 AMP 3P 4W	E101417	E101417-1	E101417-1A	E101417-1	E101417-1A	E101417-1A	E101417-1A
R 100V 100 AMP 3P 4W	E101418	E101418-1	E101418-1A	E101418-1	E101418-1A	E101418-1A	E101418-1A
S 100V 100 AMP 3P 4W	E101419	E101419-1	E101419-1A	E101419-1	E101419-1A	E101419-1A	E101419-1A
T 100V 100 AMP 3P 4W	E101420	E101420-1	E101420-1A	E101420-1	E101420-1A	E101420-1A	E101420-1A
U 100V 100 AMP 3P 4W	E101421	E101421-1	E101421-1A	E101421-1	E101421-1A	E101421-1A	E101421-1A
V 100V 100 AMP 3P 4W	E101422	E101422-1	E101422-1A	E101422-1	E101422-1A	E101422-1A	E101422-1A
W 100V 100 AMP 3P 4W	E101423	E101423-1	E101423-1A	E101423-1	E101423-1A	E101423-1A	E101423-1A
X 100V 100 AMP 3P 4W	E101424	E101424-1	E101424-1A	E101424-1	E101424-1A	E101424-1A	E101424-1A
Y 100V 100 AMP 3P 4W	E101425	E101425-1	E101425-1A	E101425-1	E101425-1A	E101425-1A	E101425-1A
Z 100V 100 AMP 3P 4W	E101426	E101426-1	E101426-1A	E101426-1	E101426-1A	E101426-1A	E101426-1A
AA 100V 100 AMP 3P 4W	E101427	E101427-1	E101427-1A	E101427-1	E101427-1A	E101427-1A	E101427-1A
AB 100V 100 AMP 3P 4W	E101428	E101428-1	E101428-1A	E101428-1	E101428-1A	E101428-1A	E101428-1A
AC 100V 100 AMP 3P 4W	E101429	E101429-1	E101429-1A	E101429-1	E101429-1A	E101429-1A	E101429-1A
AD 100V 100 AMP 3P 4W	E101430	E101430-1	E101430-1A	E101430-1	E101430-1A	E101430-1A	E101430-1A
AE 100V 100 AMP 3P 4W	E101431	E101431-1	E101431-1A	E101431-1	E101431-1A	E101431-1A	E101431-1A
AF 100V 100 AMP 3P 4W	E101432	E101432-1	E101432-1A	E101432-1	E101432-1A	E101432-1A	E101432-1A
AG 100V 100 AMP 3P 4W	E101433	E101433-1	E101433-1A	E101433-1	E101433-1A	E101433-1A	E101433-1A
AH 100V 100 AMP 3P 4W	E101434	E101434-1	E101434-1A	E101434-1	E101434-1A	E101434-1A	E101434-1A
AI 100V 100 AMP 3P 4W	E101435	E101435-1	E101435-1A	E101435-1	E101435-1A	E101435-1A	E101435-1A
AJ 100V 100 AMP 3P 4W	E101436	E101436-1	E101436-1A	E101436-1	E101436-1A	E101436-1A	E101436-1A
AK 100V 100 AMP 3P 4W	E101437	E101437-1	E101437-1A	E101437-1	E101437-1A	E101437-1A	E101437-1A
AL 100V 100 AMP 3P 4W	E101438	E101438-1	E101438-1A	E101438-1	E101438-1A	E101438-1A	E101438-1A
AM 100V 100 AMP 3P 4W	E101439	E101439-1	E101439-1A	E101439-1	E101439-1A	E101439-1A	E101439-1A
AN 100V 100 AMP 3P 4W	E101440	E101440-1	E101440-1A	E101440-1	E101440-1A	E101440-1A	E101440-1A
AO 100V 100 AMP 3P 4W	E101441	E101441-1	E101441-1A	E101441-1	E101441-1A	E101441-1A	E101441-1A
AP 100V 100 AMP 3P 4W	E101442	E101442-1	E101442-1A	E101442-1	E101442-1A	E101442-1A	E101442-1A
AQ 100V 100 AMP 3P 4W	E101443	E101443-1	E101443-1A	E101443-1	E101443-1A	E101443-1A	E101443-1A
AR 100V 100 AMP 3P 4W	E101444	E101444-1	E101444-1A	E101444-1	E101444-1A	E101444-1A	E101444-1A
AS 100V 100 AMP 3P 4W	E101445	E101445-1	E101445-1A	E101445-1	E101445-1A	E101445-1A	E101445-1A
AT 100V 100 AMP 3P 4W	E101446	E101446-1	E101446-1A	E101446-1	E101446-1A	E101446-1A	E101446-1A
AU 100V 100 AMP 3P 4W	E101447	E101447-1	E101447-1A	E101447-1	E101447-1A	E101447-1A	E101447-1A
AV 100V 100 AMP 3P 4W	E101448	E101448-1	E101448-1A	E101448-1	E101448-1A	E101448-1A	E101448-1A
AW 100V 100 AMP 3P 4W	E101449	E101449-1	E101449-1A	E101449-1	E101449-1A	E101449-1A	E101449-1A
AX 100V 100 AMP 3P 4W	E101450	E101450-1	E101450-1A	E101450-1	E101450-1A	E101450-1A	E101450-1A
AY 100V 100 AMP 3P 4W	E101451	E101451-1	E101451-1A	E101451-1	E101451-1A	E101451-1A	E101451-1A
AZ 100V 100 AMP 3P 4W	E101452	E101452-1	E101452-1A	E101452-1	E101452-1A	E101452-1A	E101452-1A
BA 100V 100 AMP 3P 4W	E101453	E101453-1	E101453-1A	E101453-1	E101453-1A	E101453-1A	E101453-1A
BB 100V 100 AMP 3P 4W	E101454	E101454-1	E101454-1A	E101454-1	E101454-1A	E101454-1A	E101454-1A
BC 100V 100 AMP 3P 4W	E101455	E101455-1	E101455-1A	E101455-1	E101455-1A	E101455-1A	E101455-1A
BD 100V 100 AMP 3P 4W	E101456	E101456-1	E101456-1A	E101456-1	E101456-1A	E101456-1A	E101456-1A
BE 100V 100 AMP 3P 4W	E101457	E101457-1	E101457-1A	E101457-1	E101457-1A	E101457-1A	E101457-1A
BF 100V 100 AMP 3P 4W	E101458	E101458-1	E101458-1A	E101458-1	E101458-1A	E101458-1A	E101458-1A
BG 100V 100 AMP 3P 4W	E101459	E101459-1	E101459-1A	E101459-1	E101459-1A	E101459-1A	E101459-1A
BH 100V 100 AMP 3P 4W	E101460	E101460-1	E101460-1A	E101460-1	E101460-1A	E101460-1A	E101460-1A
BI 100V 100 AMP 3P 4W	E101461	E101461-1	E101461-1A	E101461-1	E101461-1A	E101461-1A	E101461-1A
BJ 100V 100 AMP 3P 4W	E101462	E101462-1	E101462-1A	E101462-1	E101462-1A	E101462-1A	E101462-1A
BK 100V 100 AMP 3P 4W	E101463	E101463-1	E101463-1A	E101463-1	E101463-1A	E101463-1A	E101463-1A
BL 100V 100 AMP 3P 4W	E101464	E101464-1	E101464-1A	E101464-1	E101464-1A	E101464-1A	E101464-1A
BM 100V 100 AMP 3P 4W	E101465	E101465-1	E101465-1A	E101465-1	E101465-1A	E101465-1A	E101465-1A
BN 100V 100 AMP 3P 4W	E101466	E101466-1	E101466-1A	E101466-1	E101466-1A	E101466-1A	E101466-1A
BO 100V 100 AMP 3P 4W	E101467	E101467-1	E101467-1A	E101467-1	E101467-1A	E101467-1A	E101467-1A
BP 100V 100 AMP 3P 4W	E101468	E101468-1	E101468-1A	E101468-1	E101468-1A	E101468-1A	E101468-1A
BQ 100V 100 AMP 3P 4W	E101469	E101469-1	E101469-1A	E101469-1	E101469-1A	E101469-1A	E101469-1A
BR 100V 100 AMP 3P 4W	E101470	E101470-1	E101470-1A	E101470-1	E101470-1A	E101470-1A	E101470-1A
BS 100V 100 AMP 3P 4W	E101471	E101471-1	E101471-1A	E101471-1	E101471-1A	E101471-1A	E101471-1A
BT 100V 100 AMP 3P 4W	E101472	E101472-1	E101472-1A	E101472-1	E101472-1A	E101472-1A	E101472-1A
BU 100V 100 AMP 3P 4W	E101473	E101473-1	E101473-1A	E101473-1	E101473-1A	E101473-1A	E101473-1A
BV 100V 100 AMP 3P 4W	E101474	E101474-1	E101474-1A	E101474-1	E101474-1A	E101474-1A	E101474-1A
BW 100V 100 AMP 3P 4W	E101475	E101475-1	E101475-1A	E101475-1	E101475-1A	E101475-1A	E101475-1A
BX 100V 100 AMP 3P 4W	E101476	E101476-1	E101476-1A	E101476-1	E101476-1A	E101476-1A	E101476-1A
BY 100V 100 AMP 3P 4W	E101477	E101477-1	E101477-1A	E101477-1	E101477-1A	E101477-1A	E101477-1A
BZ 100V 100 AMP 3P 4W	E101478	E101478-1	E101478-1A	E101478-1	E101478-1A	E101478-1A	E101478-1A
CA 100V 100 AMP 3P 4W	E101479	E101479-1	E101479-1A	E101479-1	E101479-1A	E101479-1A	E101479-1A
CB 100V 100 AMP 3P 4W	E101480	E101480-1	E101480-1A	E101480-1	E101480-1A	E101480-1A	E101480-1A
CC 100V 100 AMP 3P 4W	E101481	E101481-1	E101481-1A	E101481-1	E101481-1A	E101481-1A	E101481-1A
CD 100V 100 AMP 3P 4W	E101482	E101482-1	E101482-1A	E101482-1	E101482-1A	E101482-1A	E101482-1A
CE 100V 100 AMP 3P 4W	E101483	E101483-1	E101483-1A	E101483-1	E101483-1A	E101483-1A	E101483-1A
CF 100V 100 AMP 3P 4W	E101484	E101484-1	E101484-1A	E101484-1	E101484-1A	E101484-1A	E101484-1A
CG 100V 100 AMP 3P 4W	E101485	E101485-1	E101485-1A	E101485-1	E101485-1A	E101485-1A	E101485-1A
CH 100V 100 AMP 3P 4W	E101486	E101486-1	E101486-1A	E101486-1	E101486-1A	E101486-1A	E101486-1A
CI 100V 100 AMP 3P 4W	E101487	E101487-1	E101487-1A	E101487-1	E101487-1A	E101487-1A	E101487-1A
CL 100V 100 AMP 3P 4W	E101488	E101488-1	E101488-1A	E101488-1	E101488-1A	E101488-1A	E101488-1A
CM 100V 100 AMP 3P 4W	E101489	E101489-1	E101489-1A	E101489-1	E101489-1A	E101489-1A	E101489-1A
CN 100V 100 AMP 3P 4W	E101490	E101490-1	E101490-1A	E101490-1	E101490-1A	E101490-1A	E101490-1A
CO 100V 100 AMP 3P 4W	E101491	E101491-1	E101491-1A	E101491-1	E101491-1A	E101491-1A	E101491-1A
CP 100V 100 AMP 3P 4W	E101492	E101492-1	E101492-1A	E101492-1	E101492-1A	E101492-1A	E101492-1A
CQ 100V 100 AMP 3P 4W	E101493	E101493-1	E101493-1A	E101493-1	E101493-1A	E101493-1A	E101493-1A
CR 100V 100 AMP 3P 4W	E101494	E101494-1	E101494-1A	E101494-1	E101494-1A	E101494-1A	E101494-1A
CS 100V 100 AMP 3P 4W	E101495	E101495-1	E101495-1A	E101495-1	E101495-1A	E101495-1A	E101495-1A
CT 100V 100 AMP 3P 4W	E101496	E101496-1	E101496-1A	E101496-1	E101496-1A	E101496-1A	E101496-1A
CU 100V 100 AMP 3P 4W	E101497	E101497-1	E101497-1A	E101497-1	E101497-1A	E101497-1A	E101497-1A
CV 100V 100 AMP 3P 4W	E101498	E101498-1	E101498-1A	E101498-1	E101498-1A	E101498-1A	E101498-1A
CU 100V 100 AMP 3P 4W	E101499	E101499-1	E101499-1A	E101499-1	E101499-1A	E101499-1A	E101499-1A
CV 100V 100 AMP 3P 4W	E101500	E101500-1	E101500-1A	E101500-1	E101500-1A	E101500-1A	E101500-1A

SEE NOTE 1

NOTES:  
1. ALL WIRING TO BE DONE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (NEC) AND THE NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARDS.  
2. ALL WIRING TO BE DONE IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.  
3. ALL WIRING TO BE DONE IN ACCORDANCE WITH THE LOCAL ELECTRICAL CODES.  
4. ALL WIRING TO



# 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	
4BPAIHDH	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