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INNOVATIVE CLEAN COAL TECHNOLOGY (ICCT)

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

Technical Progress Report
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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 (NOx) 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 NOx combustion equipment through the collection and analysis of long-term emissions data. A target of achieving fifty percent NOx 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 NOx 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 NOx reductions of each technology and evaluate the effects of those reductions on other combustion parameters.

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

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

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

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

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TABLE OF ABBREVIATIONS

acfm	actual cubic feet per minute
AMIS	All mills in service
AOFA	Advanced Overfire Air
ASME	American Society of Mechanical Engineers
C	carbon
CAA(A)	Clean Air Act (Amendments)
CEM	Continuous emissions monitor
CFSF	Controlled Flow/Split Flame
Cl	chlorine
CO	carbon monoxide
DAS	data acquisition system
DCS	digital control system
DOE	United States Department of Energy
ECEM	extractive continuous emissions monitor
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ETEC	Energy Technology Consultants
F	Fahrenheit
FC	fixed carbon
FWEC	Foster Wheeler Energy Corporation
Flame	Flame Refractories
GPC	Georgia Power Company
H	hydrogen
HHV	higher heating value
HVT	High velocity thermocouple
ICCT	Innovative Clean Coal Technology
KPPH	kilo pounds per hour
lb(s)	pound(s)
LNB	low NOx burner
LOI	loss on ignition
(M)Btu	(million) British thermal unit
MOOS	Mills out of service
MW	megawatt
N	nitrogen
NO_x	nitrogen oxides
NSPS	New Source Performance Standards
O, O_2	oxygen
OFA	overfire air
PA	primary air
psig	pounds per square inch gauge
PTC	Performance Test Codes

TABLE OF ABBREVIATIONS (continued)

RSD	relative standard deviation
S	sulfur
SCS	specific collection area
SCS	Southern Company Services
SO_2	sulfur dioxide
SoRI	Southern Research Institute
Spectrum	Spectrum Systems Inc.
THC	total hydrocarbons
UARG	Utility Air Regulatory Group
VM	volatile matter

1. INTRODUCTION

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

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

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

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

1. Demonstrate in a logical stepwise fashion the short-term NO_X reduction capabilities of the following advanced low NO_X combustion technologies:

    a. Advanced overfire air (AOFA)
    b. Low NO_X burners (LNB)
    c. LNB with AOFA
    d. Advanced Digital Controls and Optimization Strategies

2. Determine the dynamic, long-term emissions characteristics of each of these combustion NO_X reduction methods using sophisticated statistical techniques.

3. Evaluate the progressive cost effectiveness (i.e., dollars per ton NO_X removed) of the low NO_X combustion techniques tested.

4. Determine the effects on other combustion parameters (e.g., CO production, carbon carryover, particulate characteristics) of applying the NO_X reduction methods listed above.

2. PROJECT DESCRIPTION

2.1. Test Program Methodology

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

Table 1: Work Breakdown Structure

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

* Indicates change from original work breakdown structure.

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

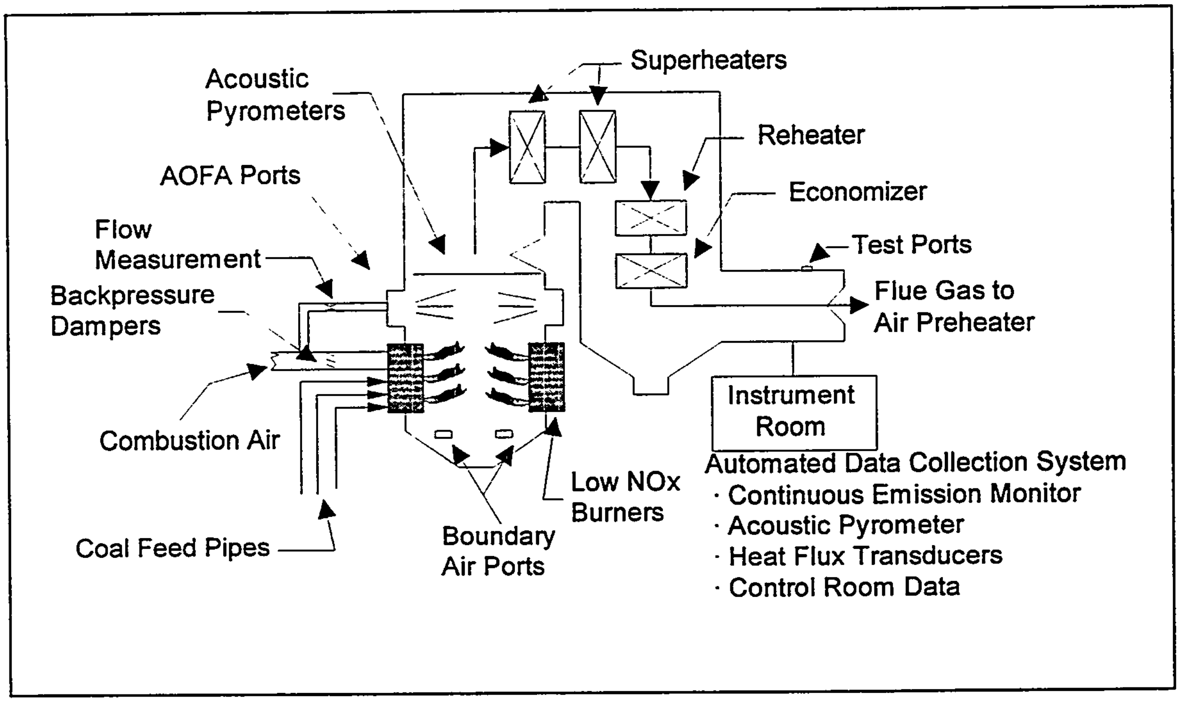

Figure 1: Plant Hammond Unit 4 Boiler

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

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

Table 2: Inputs to Data Acquisition System	
Boiler Drum Pressure	Superheat Outlet Pressure
Cold Reheat Pressure	Hot Reheat Pressure
Barometric Pressure	Superheat Spray Flow
Reheat Spray Flow	Main Steam Flow
Feedwater Flow	Coal Flows
Secondary Air Flows	Primary Air Flows
Main Steam Temperature	Cold Reheat Temperature
Hot Reheat Temperature	Feedwater Temperature
Desuperheater Outlet Temp.	Desuperheater Inlet Temp.
Economizer Outlet Temp.	Air Heater Air Inlet Temp.
Air Heater Air Outlet Temp.	Ambient Temperature
BFP Discharge Temperature	Relative Humidity
Stack NO_X	Stack SO2
Stack O2	Stack Opacity
Generation	Overfire Air Flows

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

2.2. Unit Description

Georgia Power Company's Plant Hammond Unit 4 is a Foster Wheeler Energy Corporation (FWEC) opposed wall-fired boiler, rated at 500 MW gross, with design steam conditions of 2500 psig and 1000/1000°F superheat/reheat temperatures, respectively. The unit was placed into commercial operation on December 14, 1970. Prior to the LNB retrofit, six FWEC Planetary Roller and Table type mills provided pulverized eastern bituminous coal (12,900 Btu/lb, 33% VM, 53% FC, 1.7% S, 1.4% N) to 24 pre-NSPS, Intervane burners. During the LNB outage, the existing burners were replaced with FWEC Control Flow/Split Flame burners. The unit was also retrofit with six Babcock and Wilcox MPS 75 mills during the course of the demonstration (two each during the spring 1991, spring 1992, and fall 1993 outages). The burners are arranged in a matrix of 12 burners (4W x 3H) on opposing walls with each mill supplying coal to 4 burners per elevation. As part of this demonstration project, the unit was retrofit with an Advanced Overfire Air System, to be described later. The unit is equipped with a coldside ESP and utilizes two regenerative secondary air preheaters and two regenerative primary air heaters. The unit was designed for pressurized furnace operation but was converted to balanced draft operation in 1977. The unit, equipped with a Bailey pneumatic boiler control system during the baseline, AOFA, LNB, and LNB+AOFA phases of the project, is being retrofit with a Foxboro I/A distributed digital control system.

2.3. Advanced Overfire Air (AOFA) System

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

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

2.4. Low NO_X Burners

Low NOx 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 NOx 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.

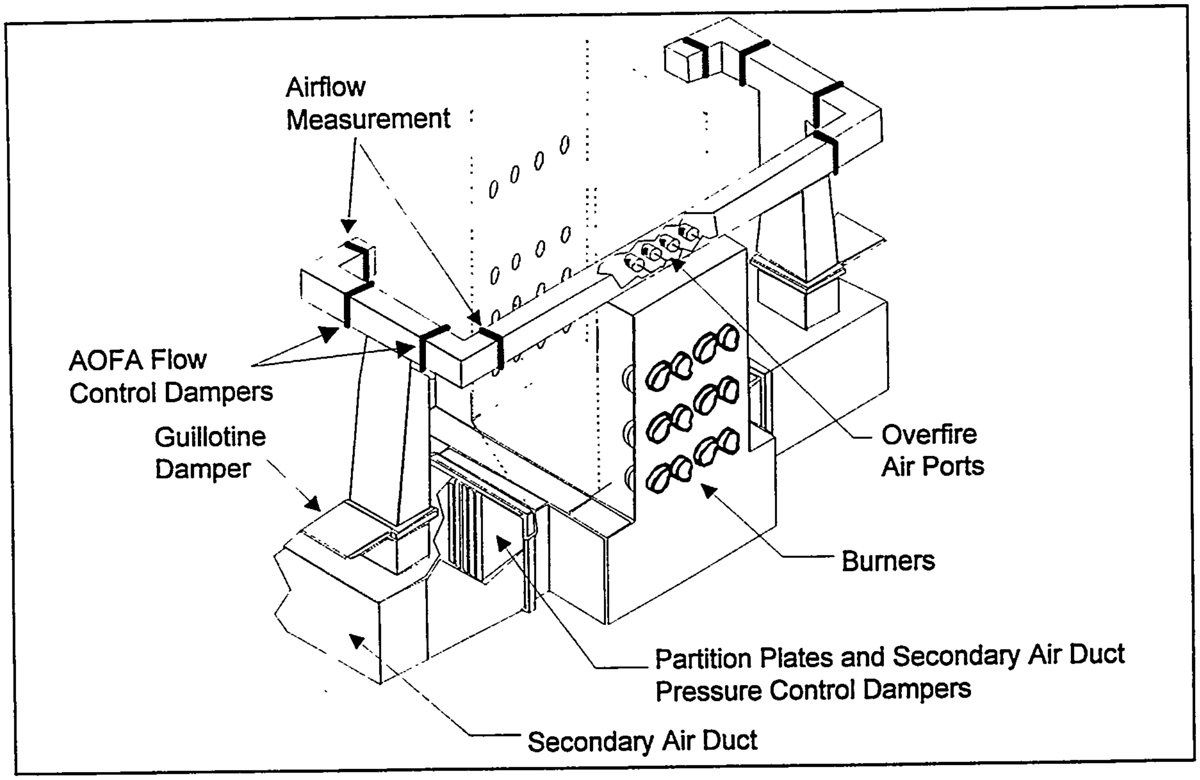

Figure 2: Advanced Overfire Air System

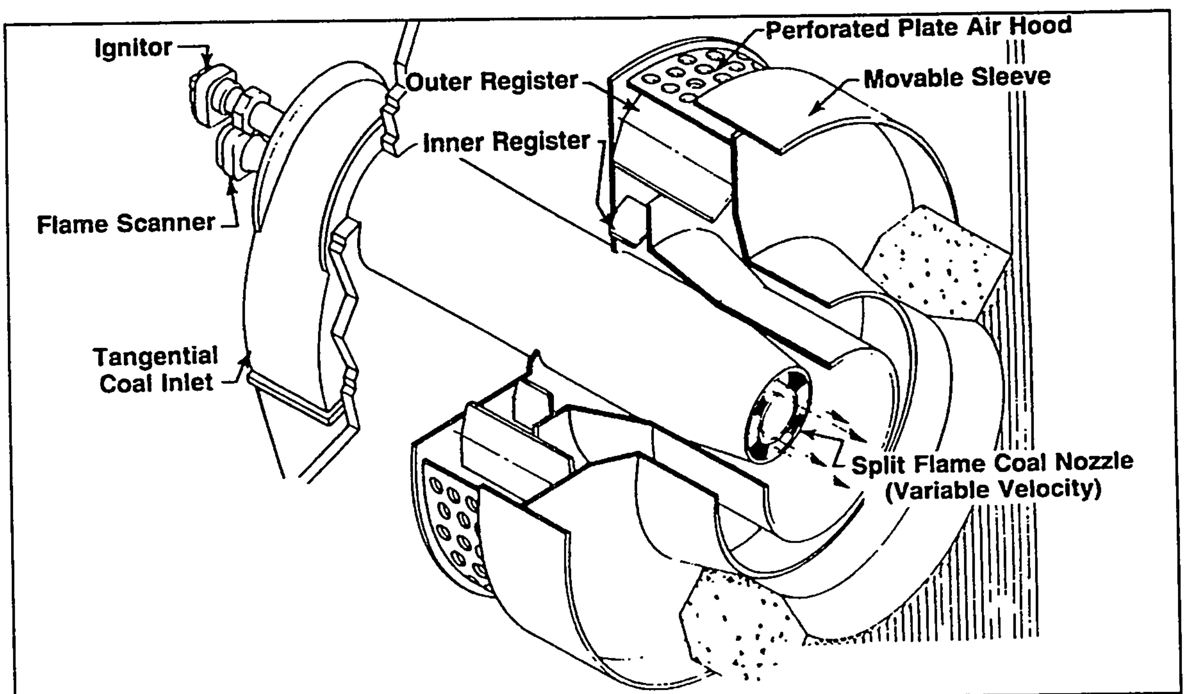

Figure 3: Low NOx Burner Installed at Plant Hammond

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

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

3.2. Current Quarter Activities

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

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

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

* 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 NOx 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 NOx abatement technologies installed at this site (LNB and AOFA). This scope addition will provide documented effectiveness of these control/optimization methods on NOx emissions and boiler efficiency improvements and guidelines for retrofitting boiler combustion controls for NOx 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.

<u>Configuration</u>

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.

<u>Installation, Checkout, Startup, and Tuning</u>

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_2, 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_2 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 NOx 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 NOx 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 NOx 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 NOx Concentric Firing System) and Alabama Power's Gaston Unit 4 (a 250 MW B&W unit with B&W XCL low NOx burners) prior to comprehensive testing at Hammond. Following "re-characterization" of Hammond 4, currently scheduled for August through December 1994, the advanced controls and optimization strategies will be activated and run open-loop. If the results from the open-loop testing warrant, the advanced controls/optimization package will be operated closed-loop with testing (short- and long-term) starting in January 1995 and continuing through March 1995.

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

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

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

Table 5: Digital Control System Configuration Milestones	
June - August 1993	• Finalized Input Output Listing • Developed Functional Drawings • Initiated Logic Development and System Interface
September 1993	• Two Week Configuration Training
September - December 1993	• Developed Configuration • Continued Logic Development and Developed Logic Configuration • Completed All Configuration
January - February 1994	• Began DCS Configuration Checkout • Continued Graphic Linking to Configuration • Configured Data Links and Began Data Link Checkout • Configuration Cleanup
February 22, 1994	• DCS Shipped to Site

Table 6: Digital Control System Installation and Checkout Overview	
Installation	Plant Hammond personnel and local contractor
Checkout team	Plant Hammond I&C Plant Hammond Electrical SCS I&C SCS Electrical
Schedule	Two shifts Cabinet checkout upon release from construction
Checkout	Start date - March 28, 1994 Operation of fans - May 7, 1994 Initial acid wash oil fires - May 14, 1994 Completion date - May 31, 1994
Number of circuits checked	1750
Problems encountered	No major problems

Table 7: Digital Control System Startup and Tuning Timeline	
Unit initially tied unit on-line	June 4, 1994
Unit off-line for turbine inspection	June 7, 1994
Unit back on-line	June 12, 1994
All loops in automatic except final superheat steam temperature, air, O_2, fuel, throttle pressure, and overfire air.	June 13, 1994
Final superheat steam temperature in automatic	June 14, 1994
Automatic air flow control and excess oxygen control	June 15, 1994
Automatic fuel control and throttle pressure control	June 16, 1994
Turbine EH controls interface tuning	June 23, 1994
Boiler/turbine load ramp testing and remote dispatch	June 29, 1994
Overfire air dampers in automatic	July 26, 1994

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

Table 9: Function of Application Processors

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

Table 10: Fieldbus Module Descriptions

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

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

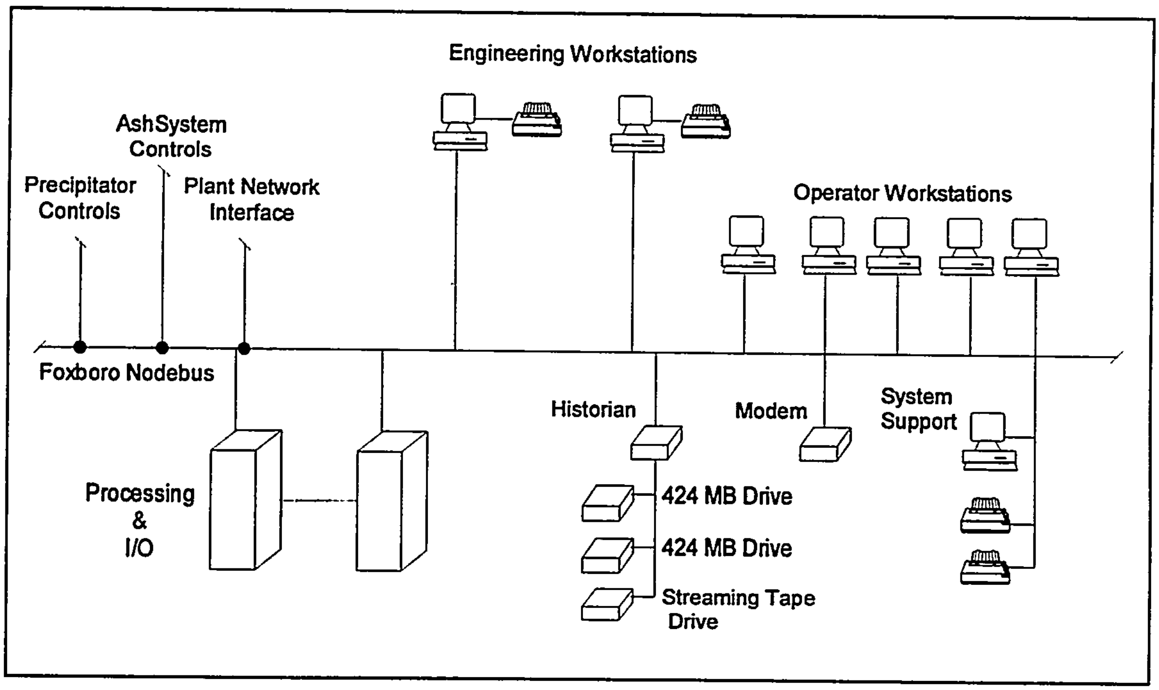

Figure 4: Unit 4 DCS Overview

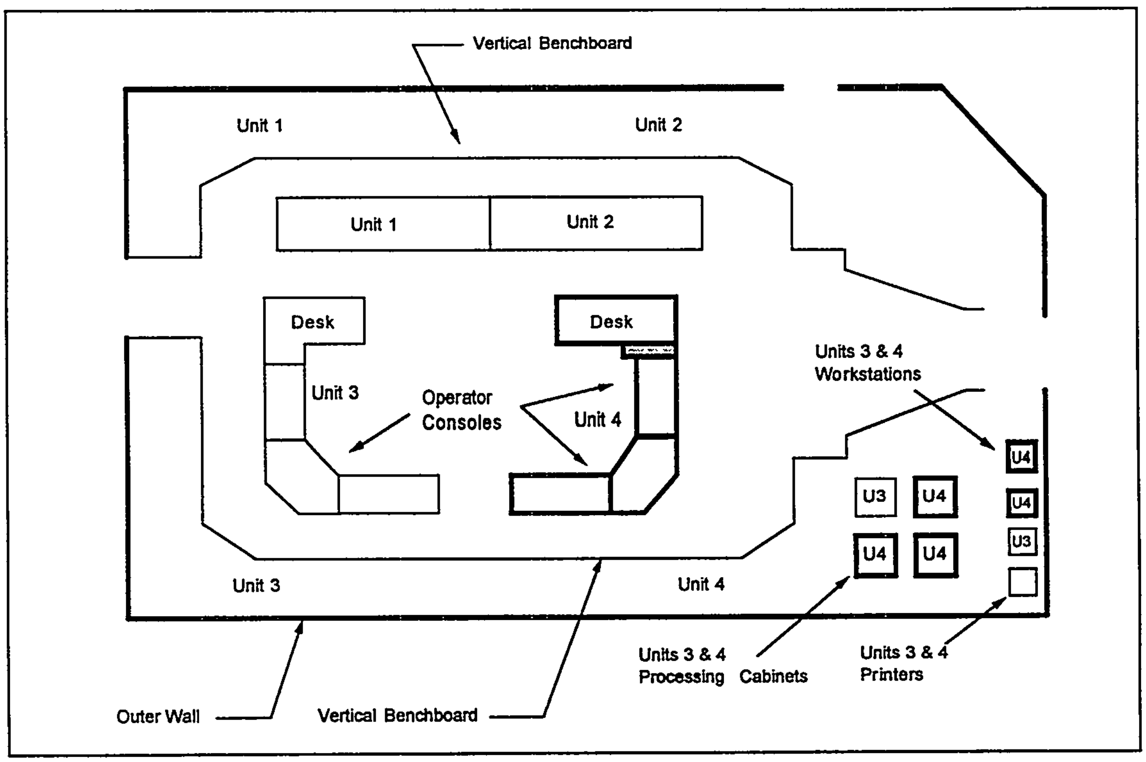

Figure 5: Unit 1-4 Control Room Layout as Currently Implemented

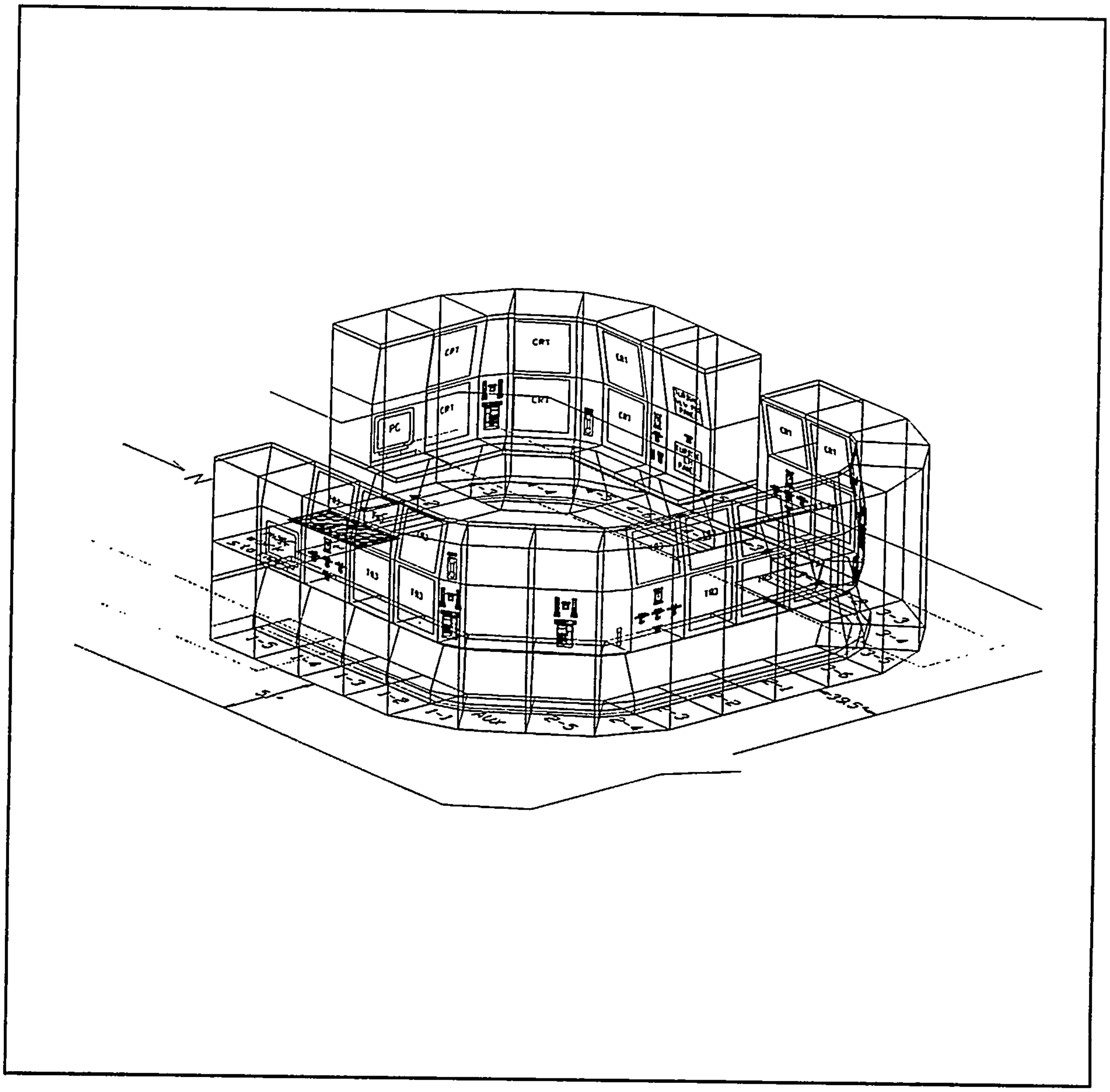

Figure 6: Unit 1-4 Control Room Layout (Planned)

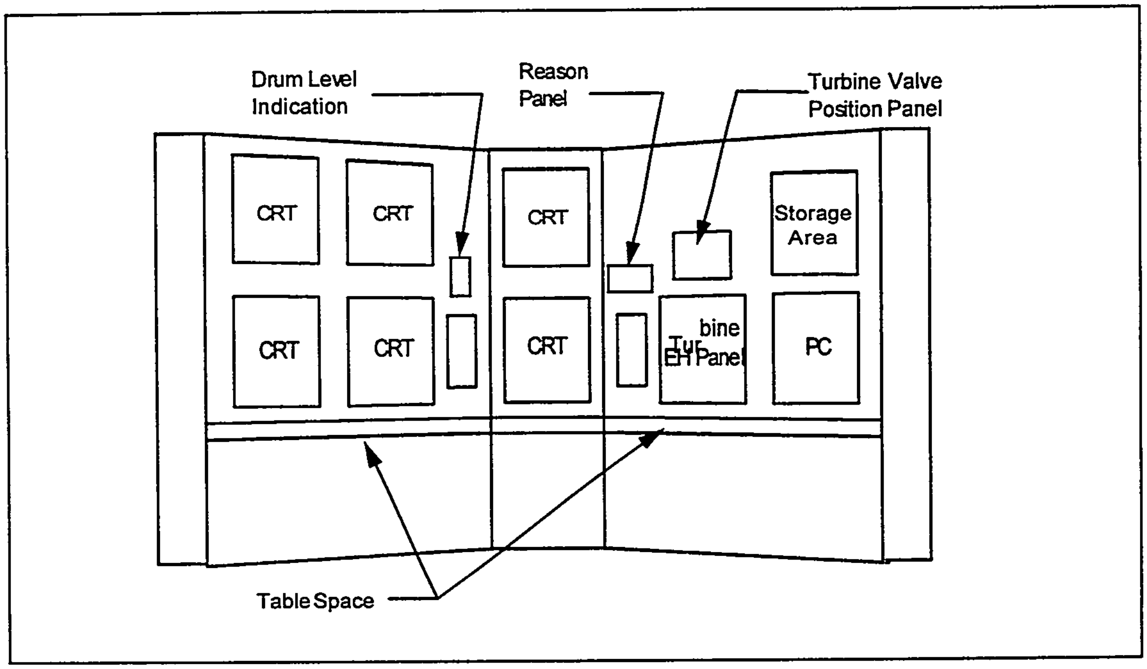

Figure 7: Unit 4 Benchboard

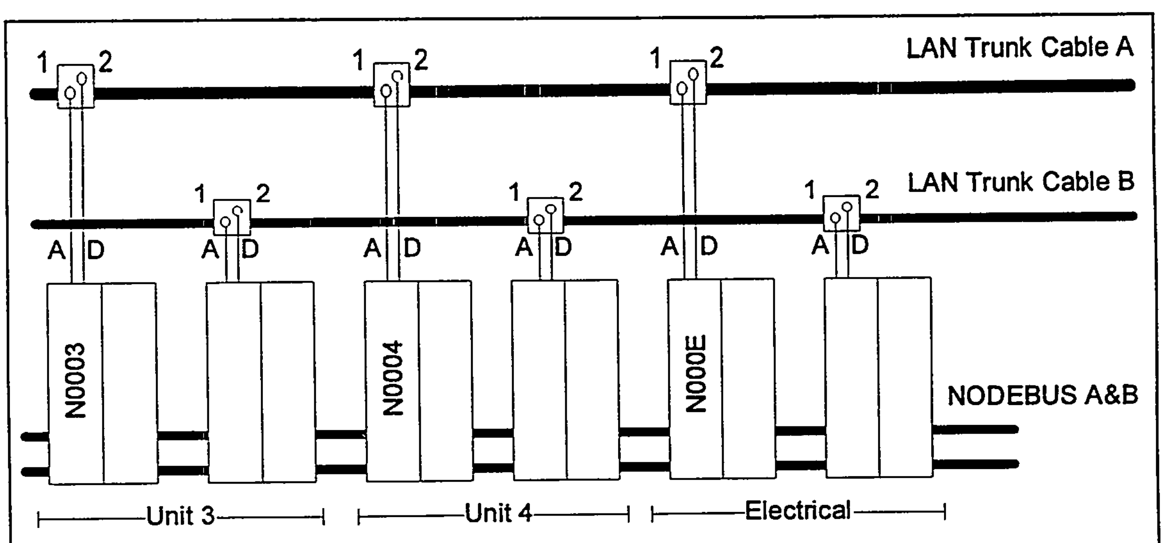

Figure 8: DCS Network

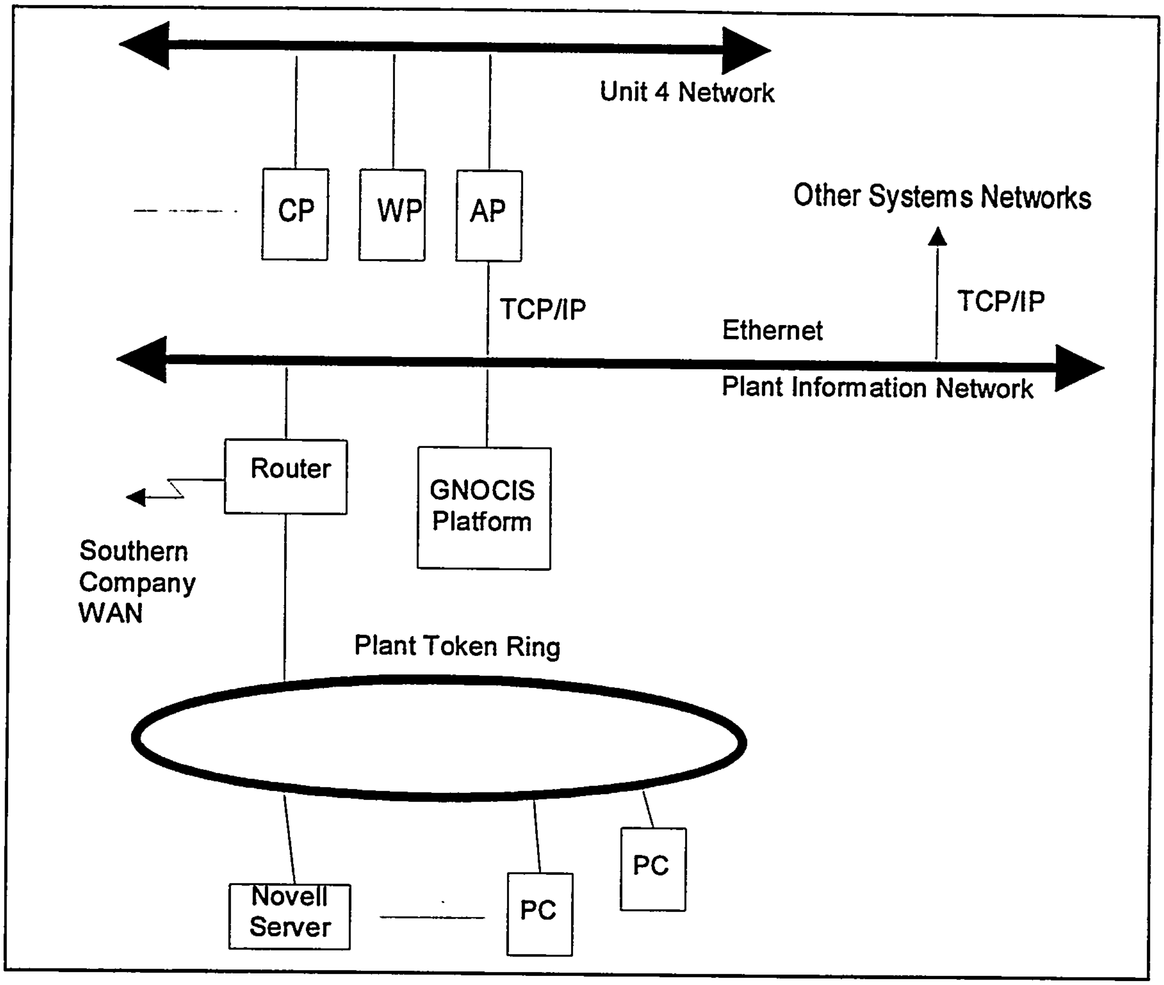

Figure 9: Hammond Plant Network

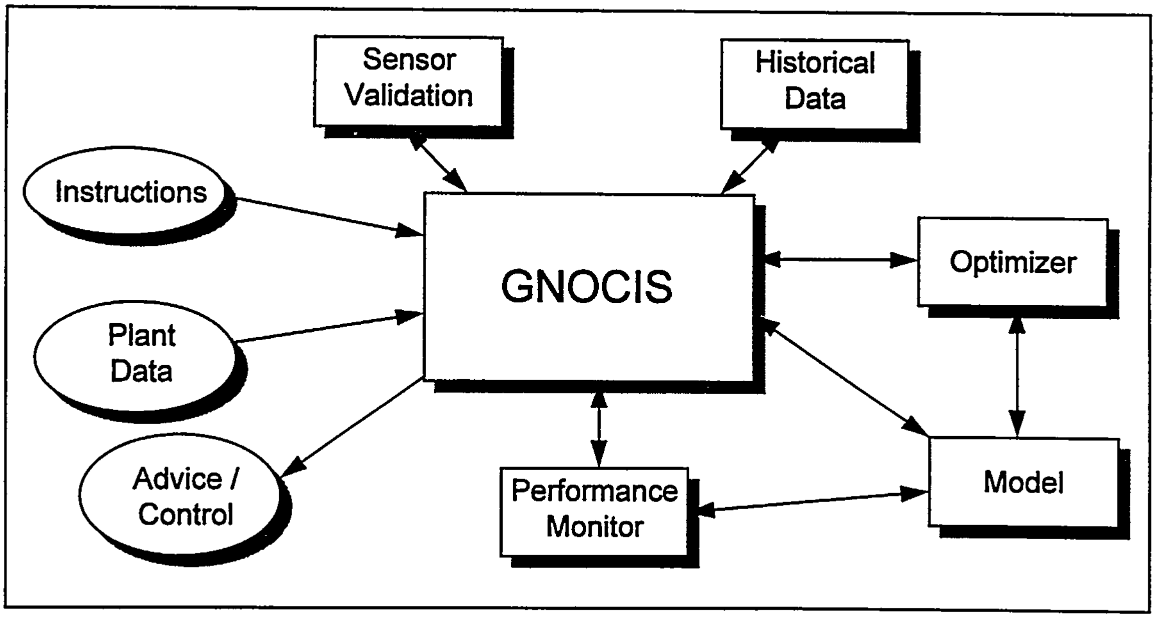

Figure 10: GNOCIS Major Elements

4. FUTURE PLANS

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

Table 12: Future Plans

Quarter	Activity
Third Quarter 1994	• Re-Baseline Unit
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 NOx 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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6. Holmes, R., Squires, R., Sorge, J., Chakraborty, R., McIlvried, T., "Progress Report on the Development of a Generic NOx Control Intelligent System (GNOCIS)," EPRI 1994 Workshop on NOx Controls for Utility Boilers, May 11-13, 1994, Scottsdale, Arizona.

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

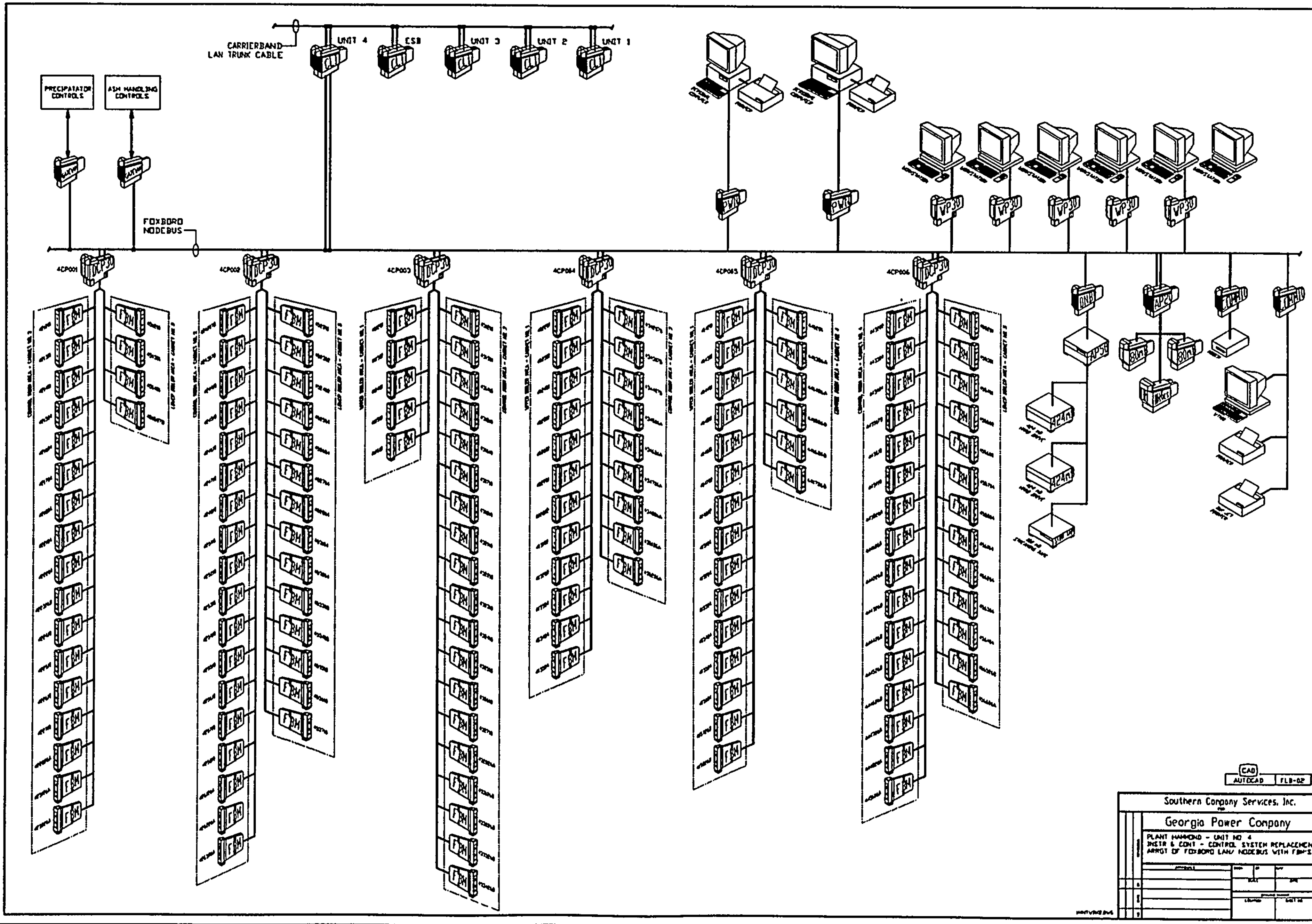
I/O

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



CARRIERBAND
LAN TRUNK CABLE
UNIT 4
ESB
UNIT 3
UNIT 2
UNIT 1
PRECIPATATOR CONTROLS
ASH HANDLING CONTROLS
FOXBORO NODEBUS
4CP001
4CP002
4CP003
4CP004
4CP005
4CP006
DCP30
FBM
VP30
PW
AP20
AP50
CAD
AUTOCAD
FLB-02
Southern Company Services, Inc.
Georgia Power Company
PLANT HAMMOND - UNIT NO 4
INSTR & CONT - CONTROL SYSTEM REPLACEMENT
ARRGT OF FOXBORO LAN/ NODEBUS WITH FBM'S

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 fame 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
BFPs 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

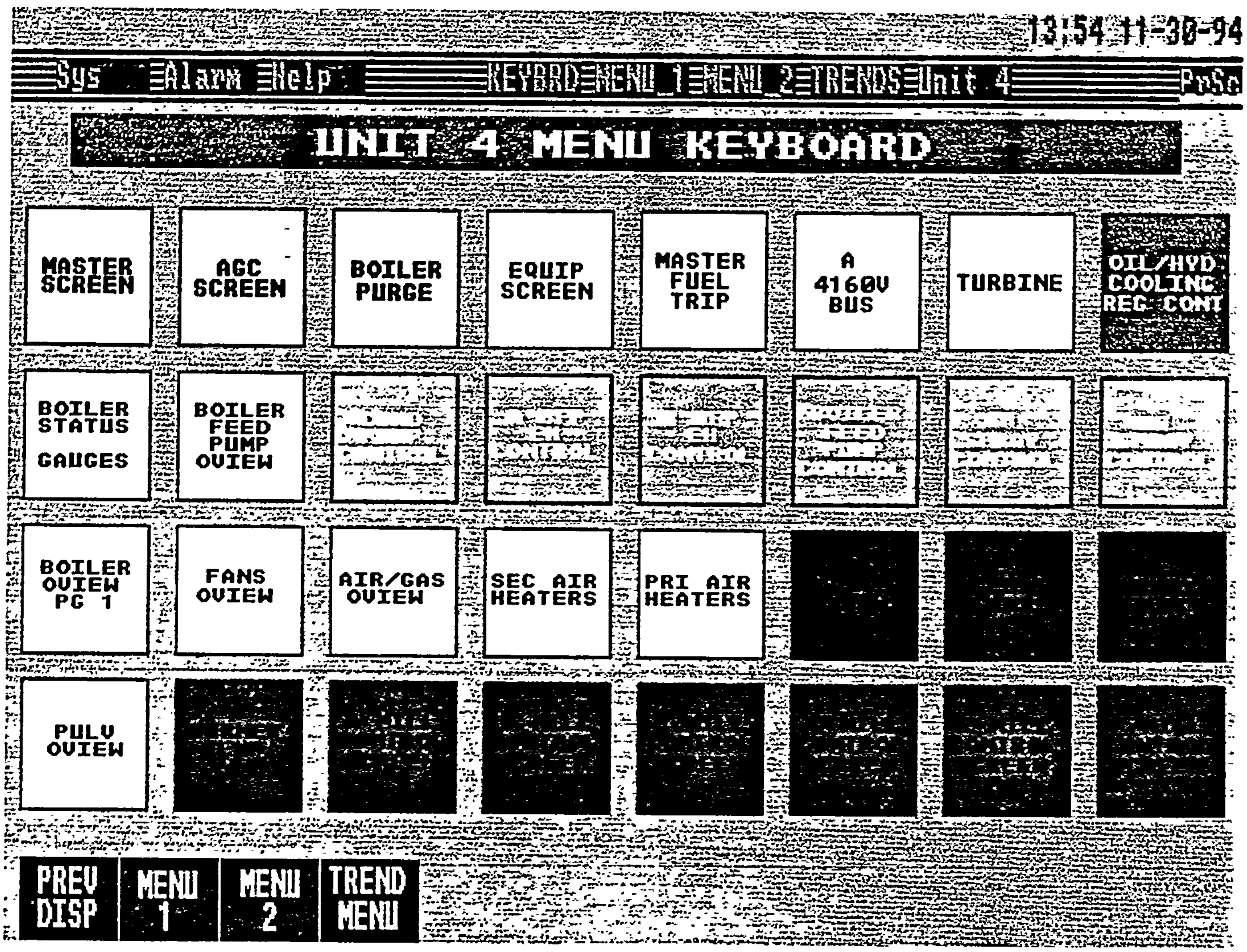
Hammond Unit No. 4
Control System Replacement
Control Processor Functional Arrangement

Control Processor 8

Burner Thermocouple Inputs
Burner Temperature Alarms

Appendix D

Operator Control Graphics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Alarm
Help
KEYBRD
MENU_1
MENU_2
TRENDS
Unit 4
PrSc
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 OVIEW
BOILER OVIEW PG 1
FANS OVIEW
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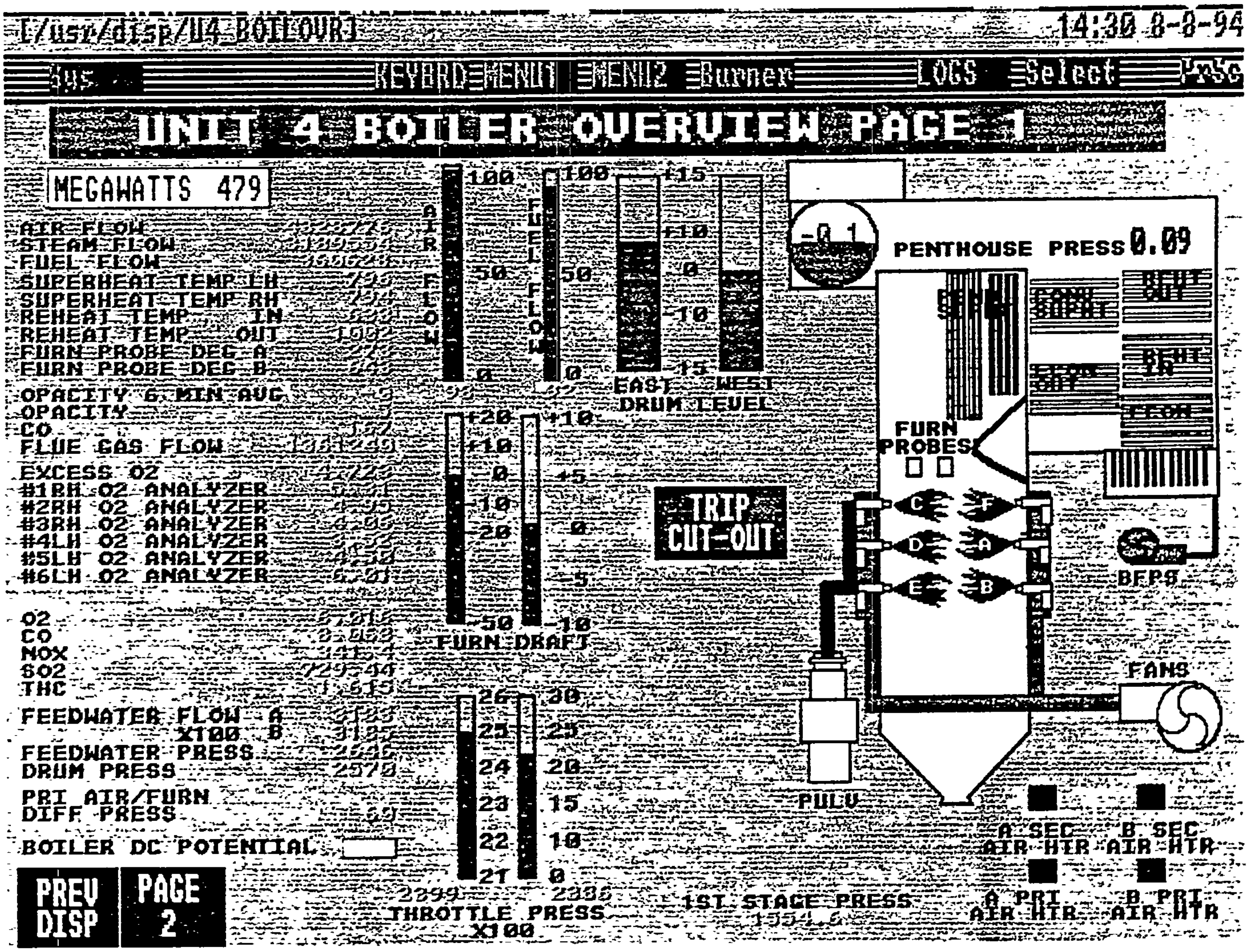
PRI AIR HEATERS
PULV OVIEW
PREV DISP
MENU 1
MENU 2
TREND MENU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KEYBRD MENU1 MENU2 Burner LOGS Select
UNIT 4 BOILER OVERVIEW PAGE 1
MEGAWATTS 479
AIR FLOW
STEAM FLOW
FUEL FLOW
SUPERHEAT TEMP LH
SUPERHEAT TEMP RH
REHEAT TEMP IN
REHEAT TEMP OUT
FURN PROBE DEG A
FURN PROBE DEG B
OPACITY 6 MIN AVG
OPACITY
CO
FLUE GAS FLOW
EXCESS O2
#1RH O2 ANALYZER
#2RH O2 ANALYZER
#3RH O2 ANALYZER
#4LH O2 ANALYZER
#5LH O2 ANALYZER
#6LH O2 ANALYZER
O2
CO
NOX
SO2
THC
FEEDWATER FLOW A
X100 B
FEEDWATER PRESS
DRUM PRESS 2570
PRI AIR/FURN
DIFF PRESS
BOILER DC POTENTIAL
AIR FLOW
FUEL FLOW
EAST WEST
DRUM LEVEL
FURN DRAFT
THROTTLE PRESS
X100
1ST STAGE PRESS
PENTHOUSE PRESS 0.09
FURN
PROBES
TRIP
CUT-OUT
BFPS
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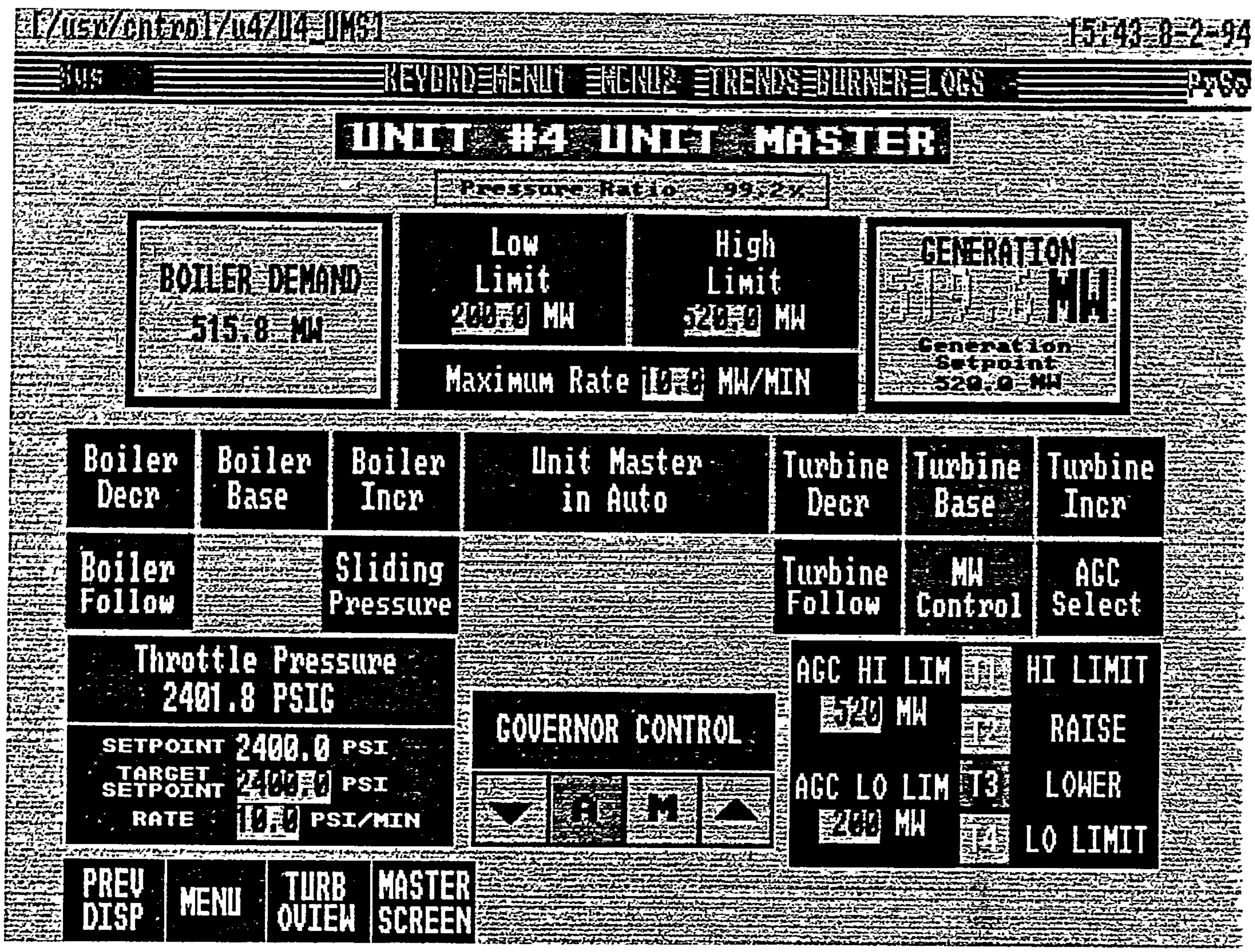

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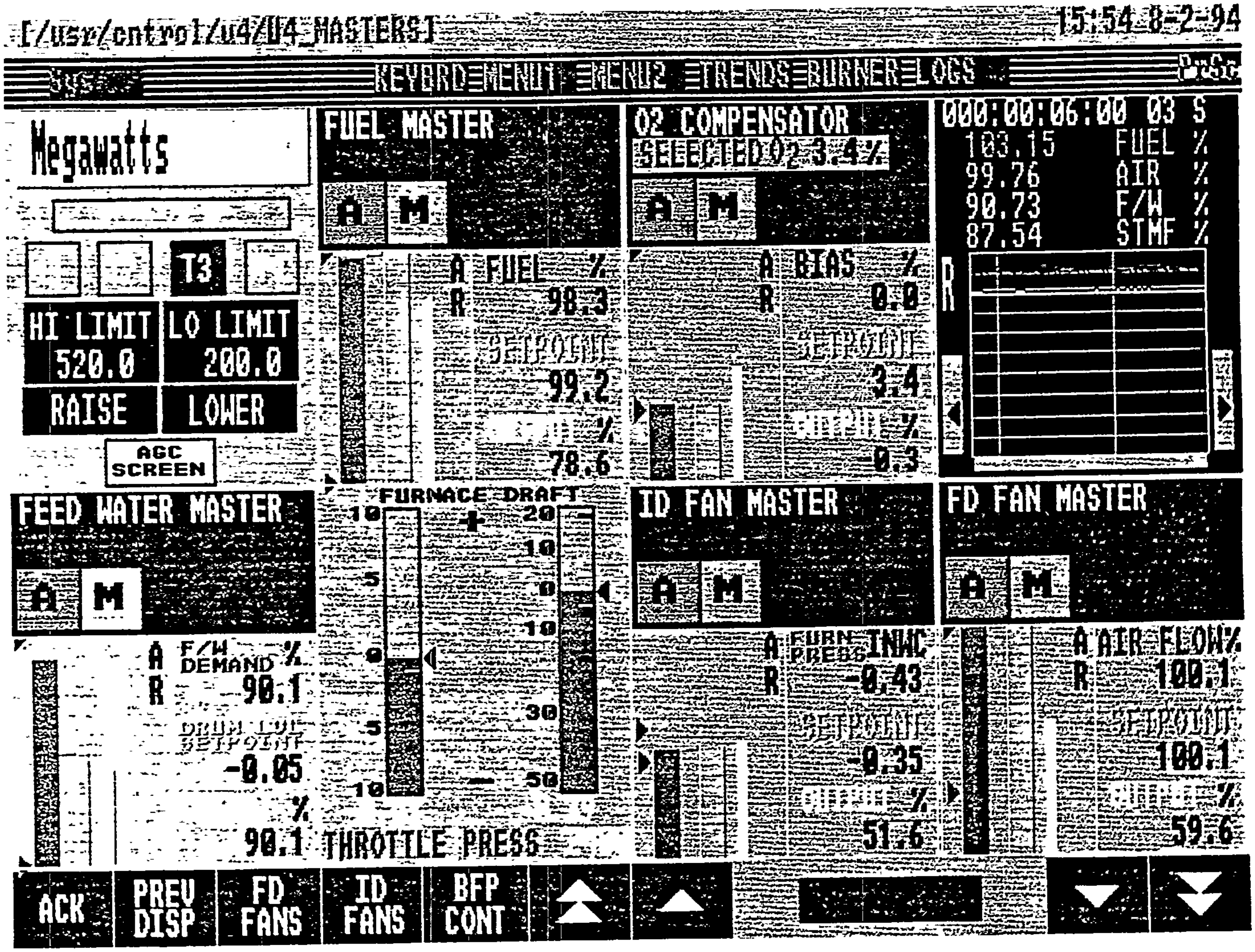
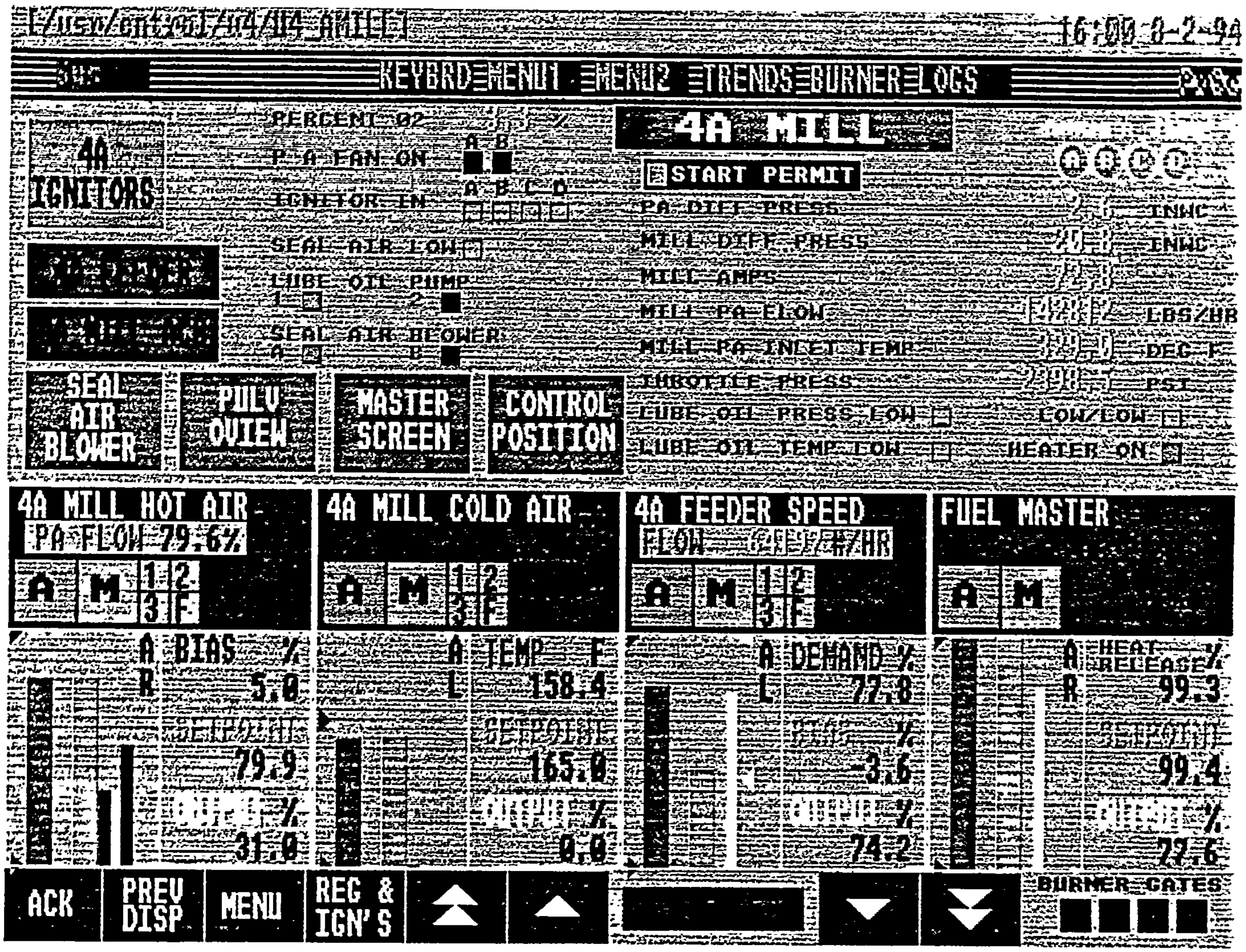
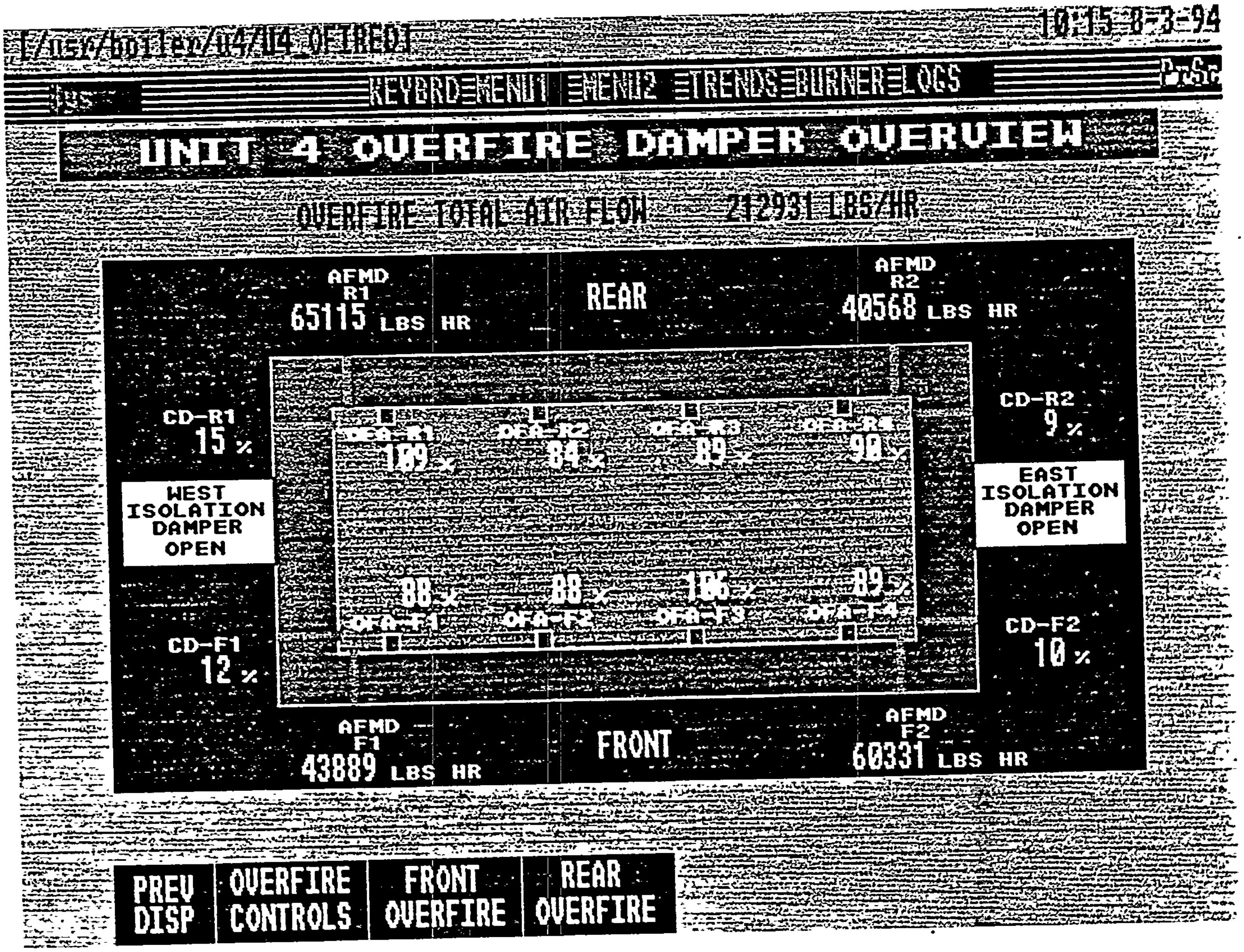
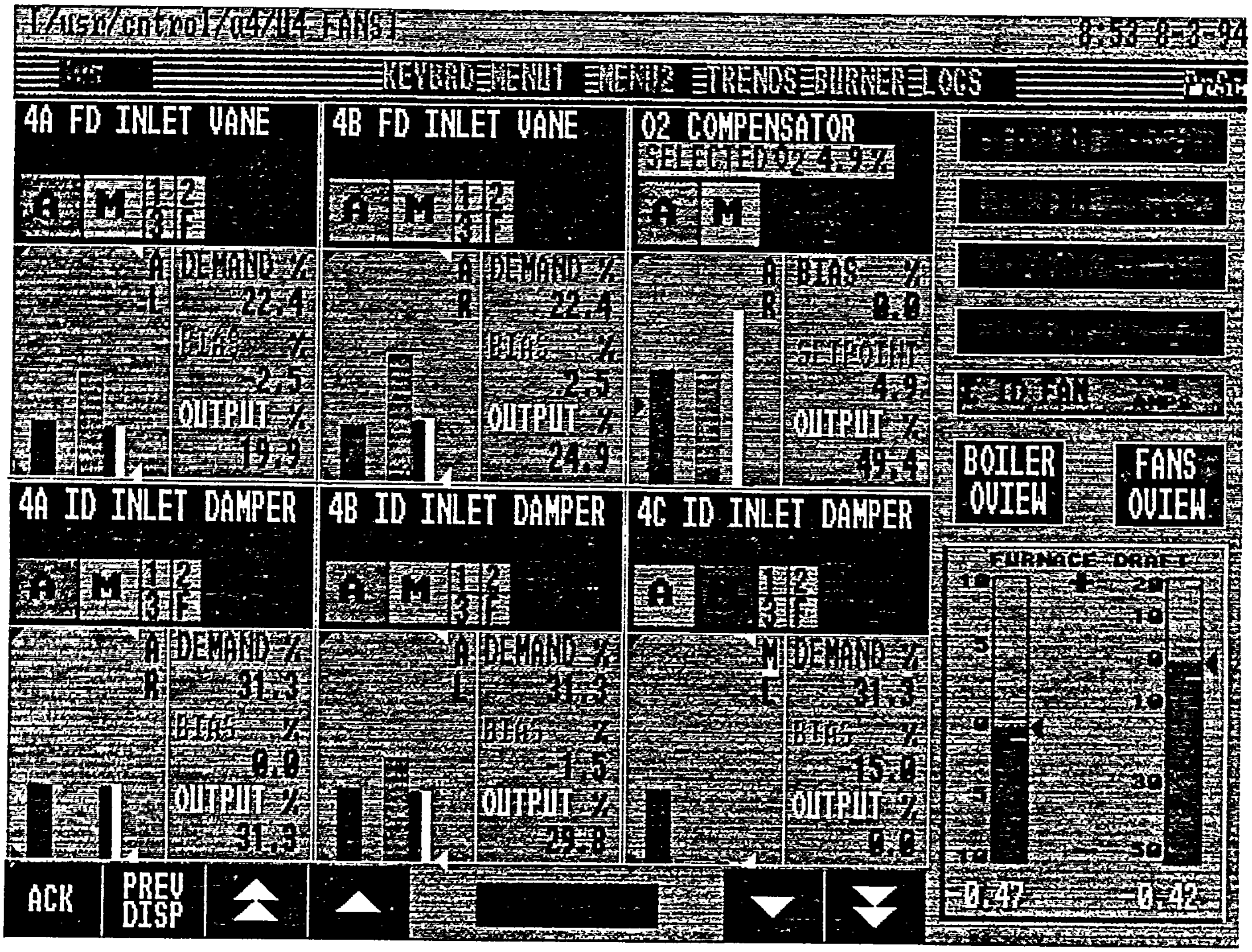
BOILER DEMAND
515.8 MW
Low Limit
200.0 MW
High Limit
520.0 MW
Maximum Rate 10.0 MW/MIN
GENERATION
MW
Generation Setpoint
520.0 MW
Boiler Decr
Boiler Base
Boiler Incr
Unit Master in Auto
Turbine Decr
Turbine Base
Turbine Incr
Boiler Follow
Sliding Pressure
Turbine Follow
MW Control
AGC Select
Throttle Pressure
2401.8 PSIG
SETPOINT 2400.0 PSI
TARGET SETPOINT 2400.0 PSI
RATE 10.0 PSI/MIN
GOVERNOR CONTROL
A
M
AGC HI LIM
520 MW
AGC LO LIM
200 MW
T1
T2
T3
T4
HI LIMIT
RAISE
LOWER
LO LIMIT
PREV DISP
MENU
TURB OVIEW
MASTER SCREEN

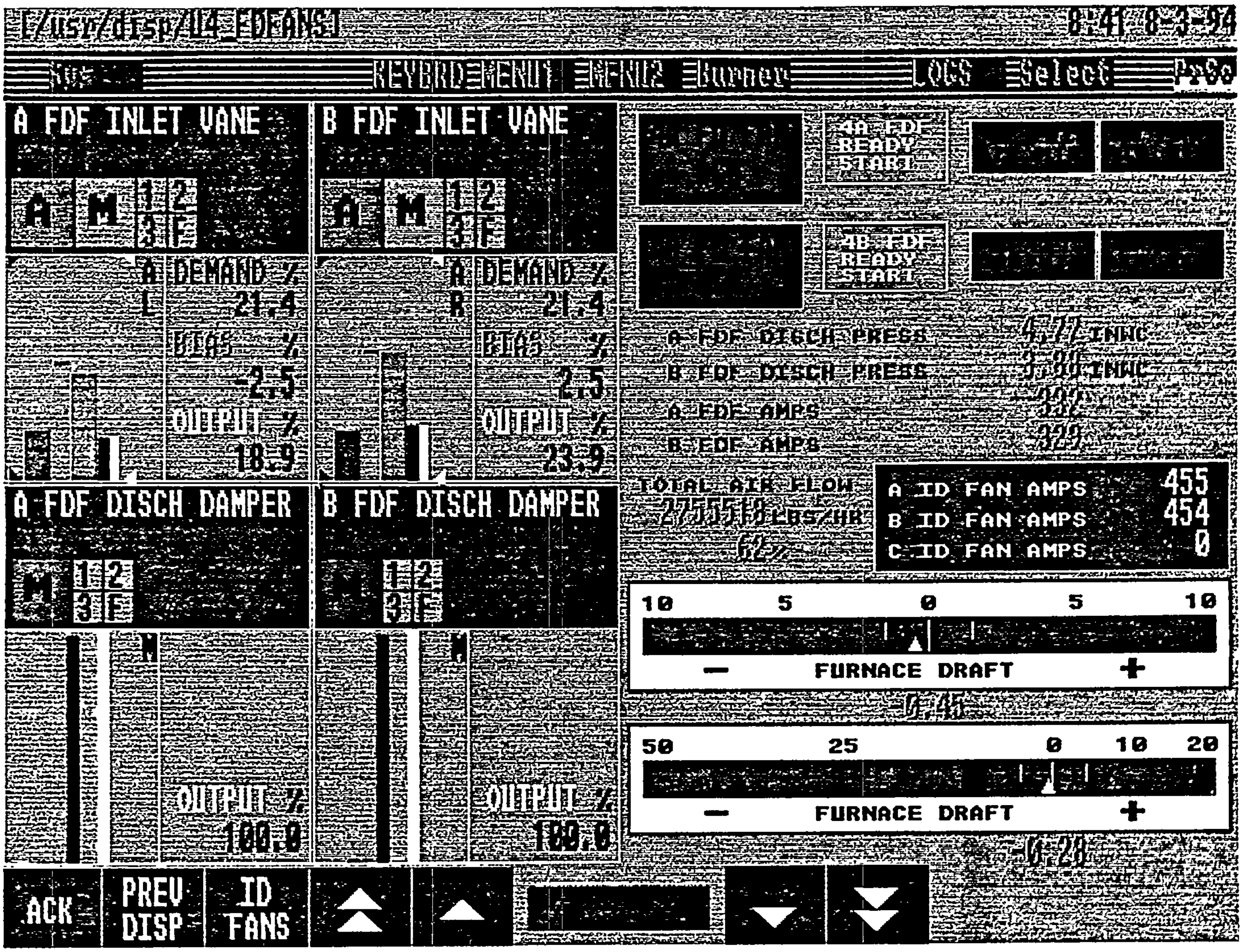

[/usr/cntrol/u4/U4_MASTERS]
15:54 8-2-94
KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
Megawatts
T3
HI LIMIT
520.0
LO LIMIT
200.0
RAISE
LOWER
AGC SCREEN
FUEL MASTER
A
M
A FUEL %
R 98.3
SETPOINT
99.2
%
78.6
O2 COMPENSATOR
SELECTED O2 3.4 %
A BIAS %
R 0.0
SETPOINT
3.4
OUTPUT %
0.3
000:00:06:00 03 S
103.15 FUEL %
99.76 AIR %
90.73 F/W %
87.54 STMF %
FEED WATER MASTER
F/W DEMAND %
90.1
DRUM LVL SETPOINT
-0.05
%
90.1
FURNACE DRAFT
THROTTLE PRESS
ID FAN MASTER
FURN PRESS INWC
-0.43
SETPOINT
-0.35
OUTPUT %
51.6
FD FAN MASTER
AIR FLOW%
100.1
SETPOINT
100.1
OUTPUT %
59.6
ACK
PREV DISP
FD FANS
ID FANS
BFP CONT

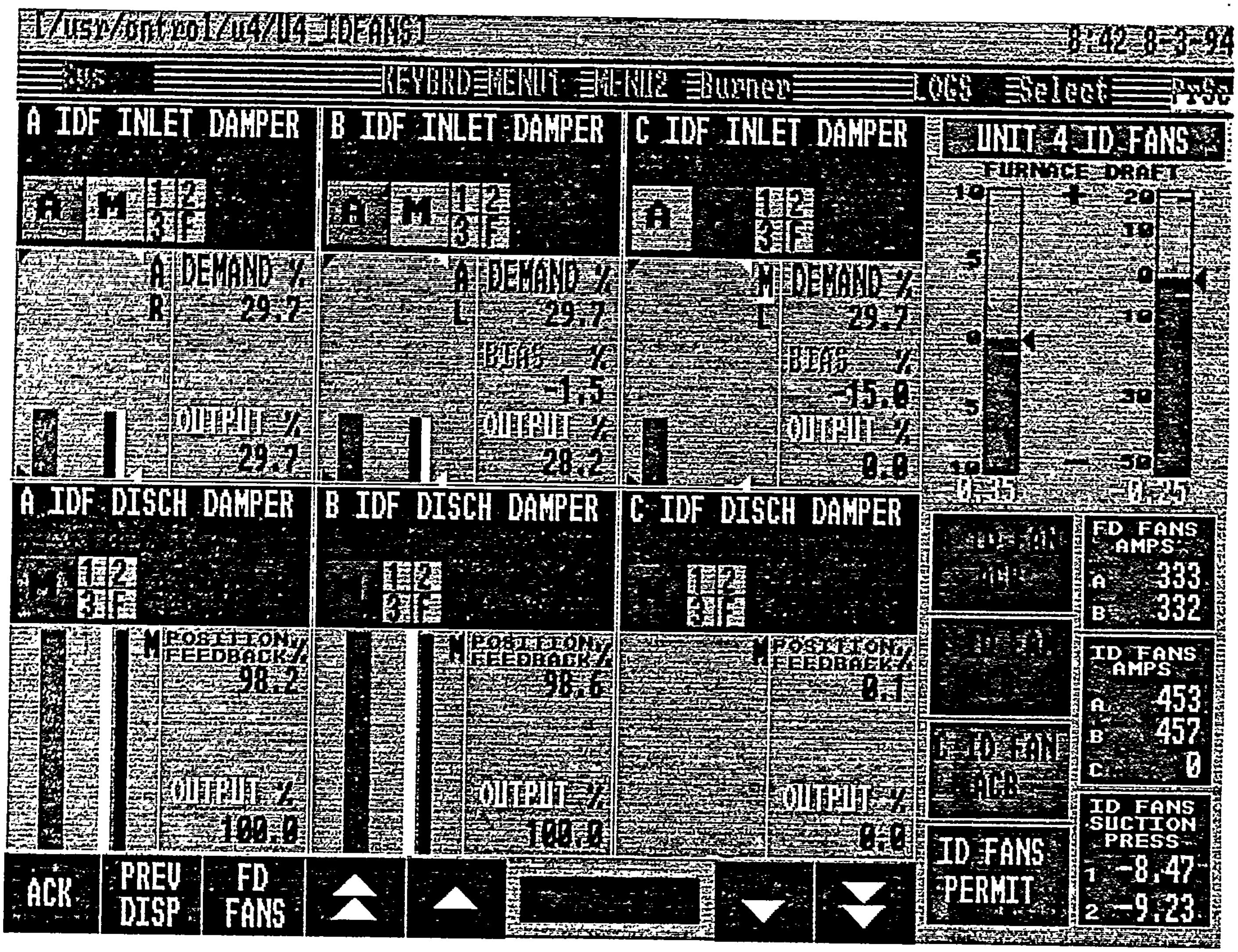

16:00 8-2-94
KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
4A IGNITORS
PERCENT O2
P A FAN ON
IGNITOR IN
SEAL AIR LOW
LUBE OIL PUMP
SEAL AIR BLOWER
4A MILL
START PERMIT
PA DIFF PRESS
MILL DIFF PRESS
MILL AMPS
MILL PA FLOW
MILL PA INLET TEMP
THROTTLE PRESS
LUBE OIL PRESS LOW
LUBE OIL TEMP LOW
LOW/LOW
HEATER ON
INWC
LBS/HR
DEG F
PSI
SEAL AIR BLOWER
PULV OVIEW
MASTER SCREEN
CONTROL POSITION
4A MILL HOT AIR
PA FLOW 79.6%
BIAS %
5.0
79.9
31.0
4A MILL COLD AIR
TEMP F
158.4
SETPOINT
165.0
OUTPUT %
0.0
4A FEEDER SPEED
DEMAND %
77.8
-3.6
OUTPUT %
74.2
FUEL MASTER
HEAT RELEASE %
99.3
SETPOINT
99.4
27.6
ACK
PREV DISP
MENU
REG & IGN'S
BURNER GATES


10:15 8-3-94
KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
UNIT 4 OVERFIRE DAMPER OVERVIEW
OVERFIRE TOTAL AIR FLOW 212931 LBS/HR
AFMD R1
65115 LBS HR
REAR
AFMD R2
40568 LBS HR
CD-R1
15 %
CD-R2
9 %
OFA-R1
OFA-R2
84 %
OFA-R3
89 %
OFA-R4
90 %
WEST ISOLATION DAMPER OPEN
EAST ISOLATION DAMPER OPEN
88 %
88 %
89 %
OFA-F1
OFA-F2
OFA-F3
OFA-F4
CD-F1
12 %
CD-F2
10 %
AFMD F1
43889 LBS HR
FRONT
AFMD F2
60331 LBS HR
PREV DISP
OVERFIRE CONTROLS
FRONT OVERFIRE
REAR OVERFIRE

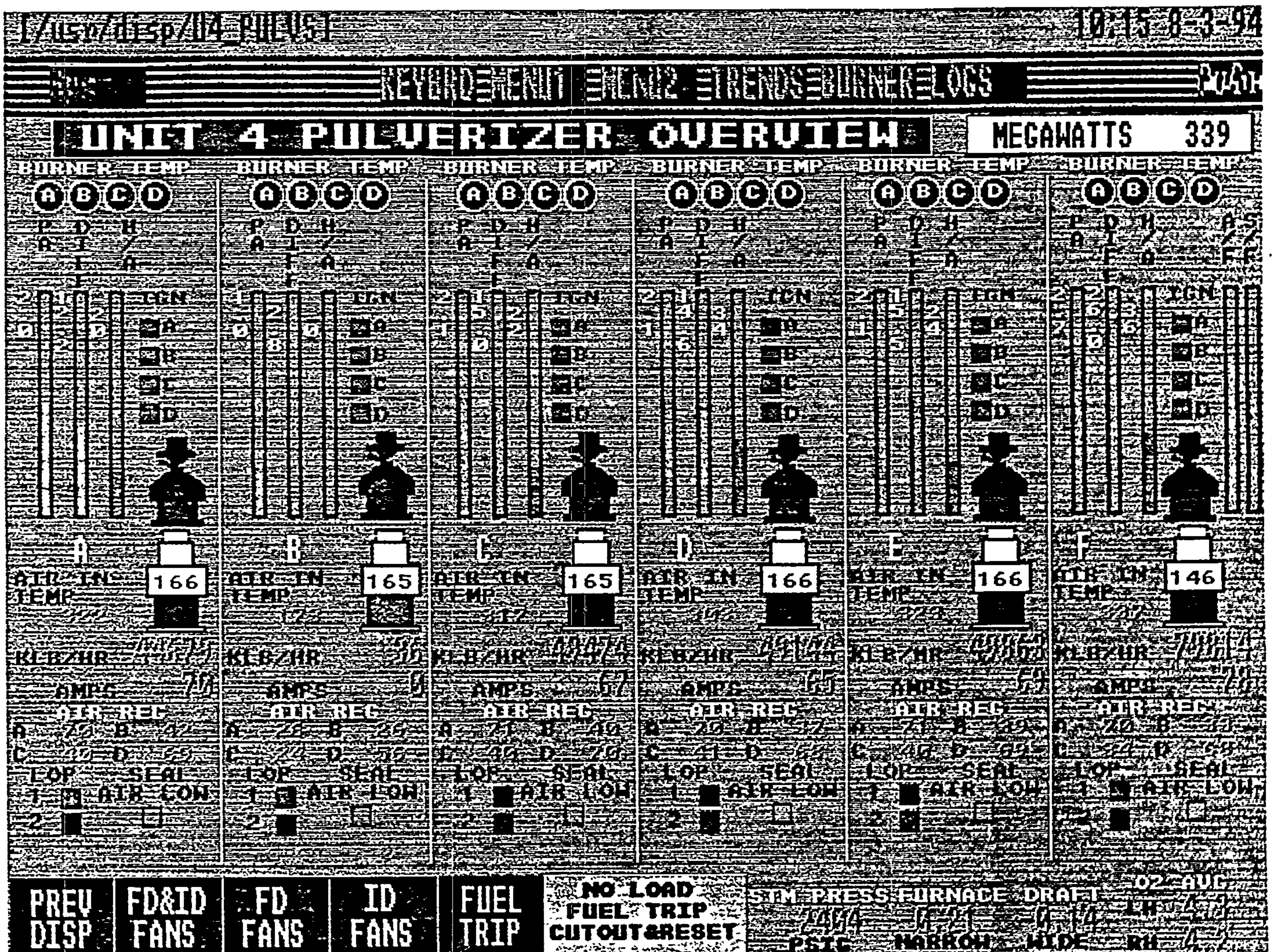


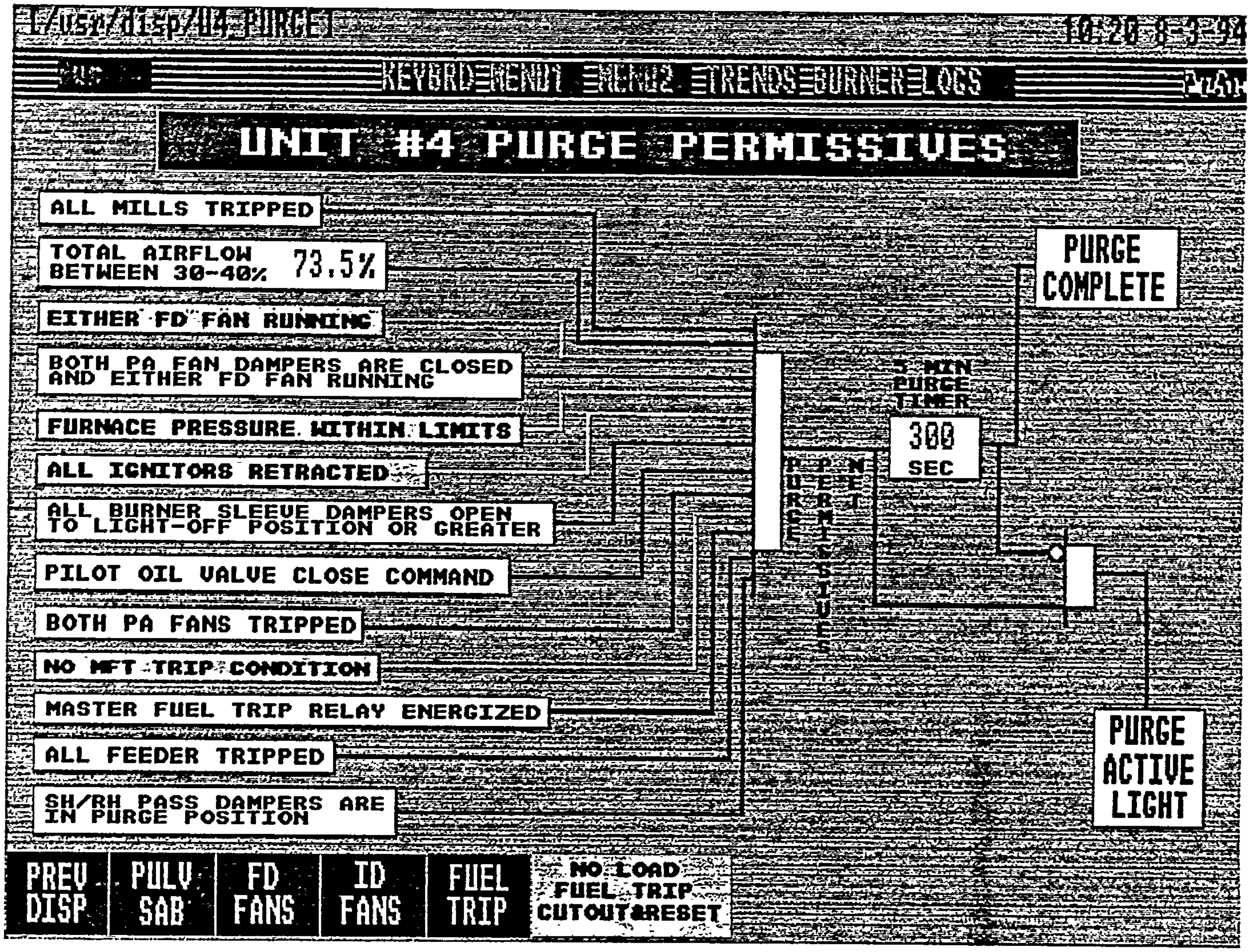
KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
4A FD INLET VANE
A
M
DEMAND %
22.4
BIAS %
-2.5
OUTPUT %
19.9
4B FD INLET VANE
A
M
DEMAND %
22.4
BIAS %
2.5
OUTPUT %
24.9
O2 COMPENSATOR
A
M
BIAS %
0.0
SETPOINT
4.9
OUTPUT %
49.4
BOILER OVIEW
FANS OVIEW
4A ID INLET DAMPER
A
M
DEMAND %
31.3
BIAS %
0.0
OUTPUT %
31.3
4B ID INLET DAMPER
A
M
DEMAND %
31.3
BIAS %
-1.5
OUTPUT %
29.8
4C ID INLET DAMPER
A
DEMAND %
31.3
BIAS %
-15.0
OUTPUT %
0.0
FURNACE DRAFT
-0.47
-0.42
ACK
PREV DISP

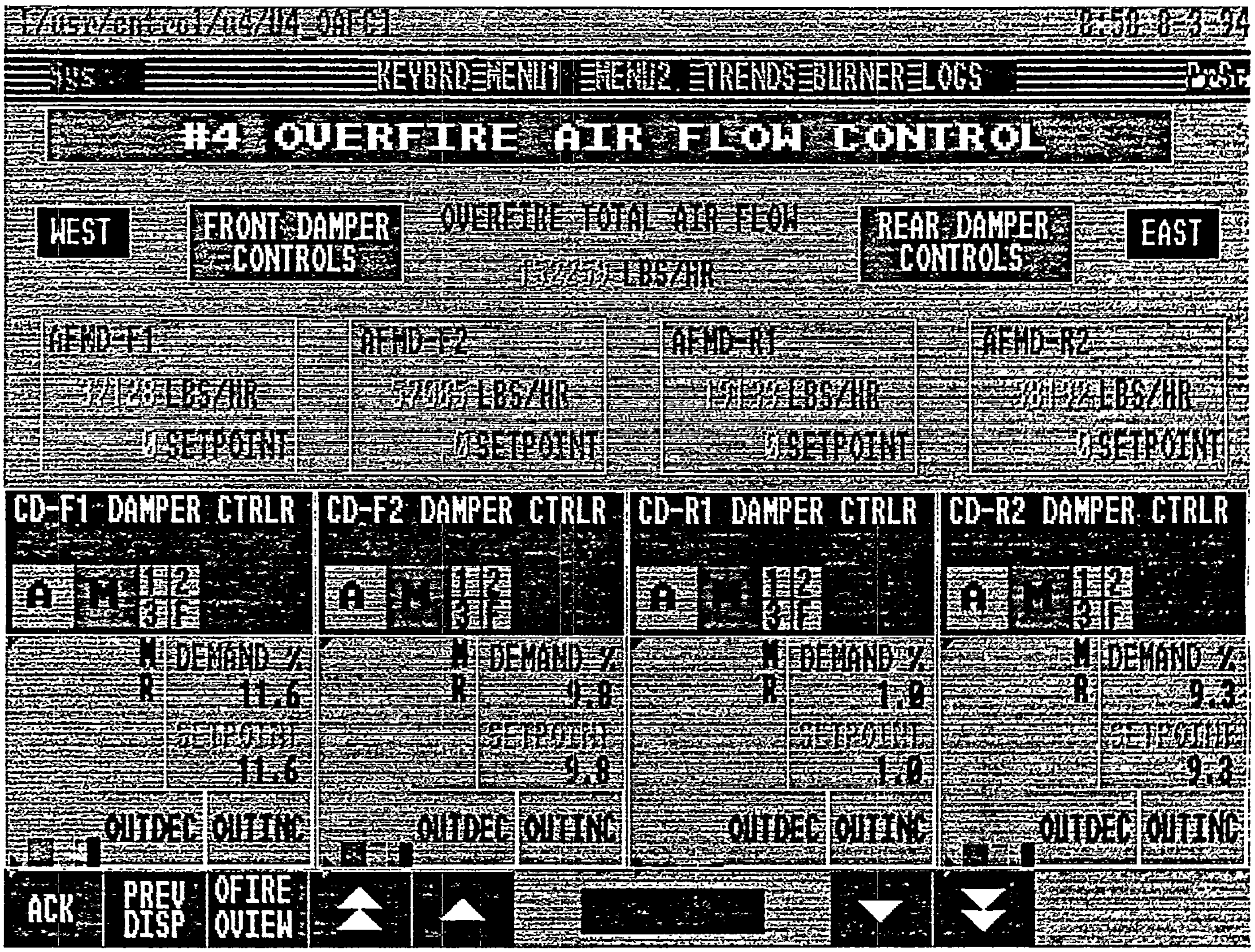

[/usr/disp/04_FDFANS]
8:41 8-3-94
KEYBRD MENU1 MENU2 Burner LOGS Select
A FDF INLET VANE
B FDF INLET VANE
4A FDF READY START
4B FDF READY START
DEMAND %
21.4
BIAS %
-2.5
2.5
OUTPUT %
18.9
23.9
A FDF DISCH PRESS
B FDF DISCH PRESS
A FDF AMPS
B FDF AMPS
INWC
TOTAL AIR FLOW
LBS/HR
A ID FAN AMPS 455
B ID FAN AMPS 454
C ID FAN AMPS 0
A FDF DISCH DAMPER
B FDF DISCH DAMPER
10 5 0 5 10
FURNACE DRAFT
50 25 0 10 20
FURNACE DRAFT
OUTPUT %
100.0
ACK
PREV DISP
ID FANS

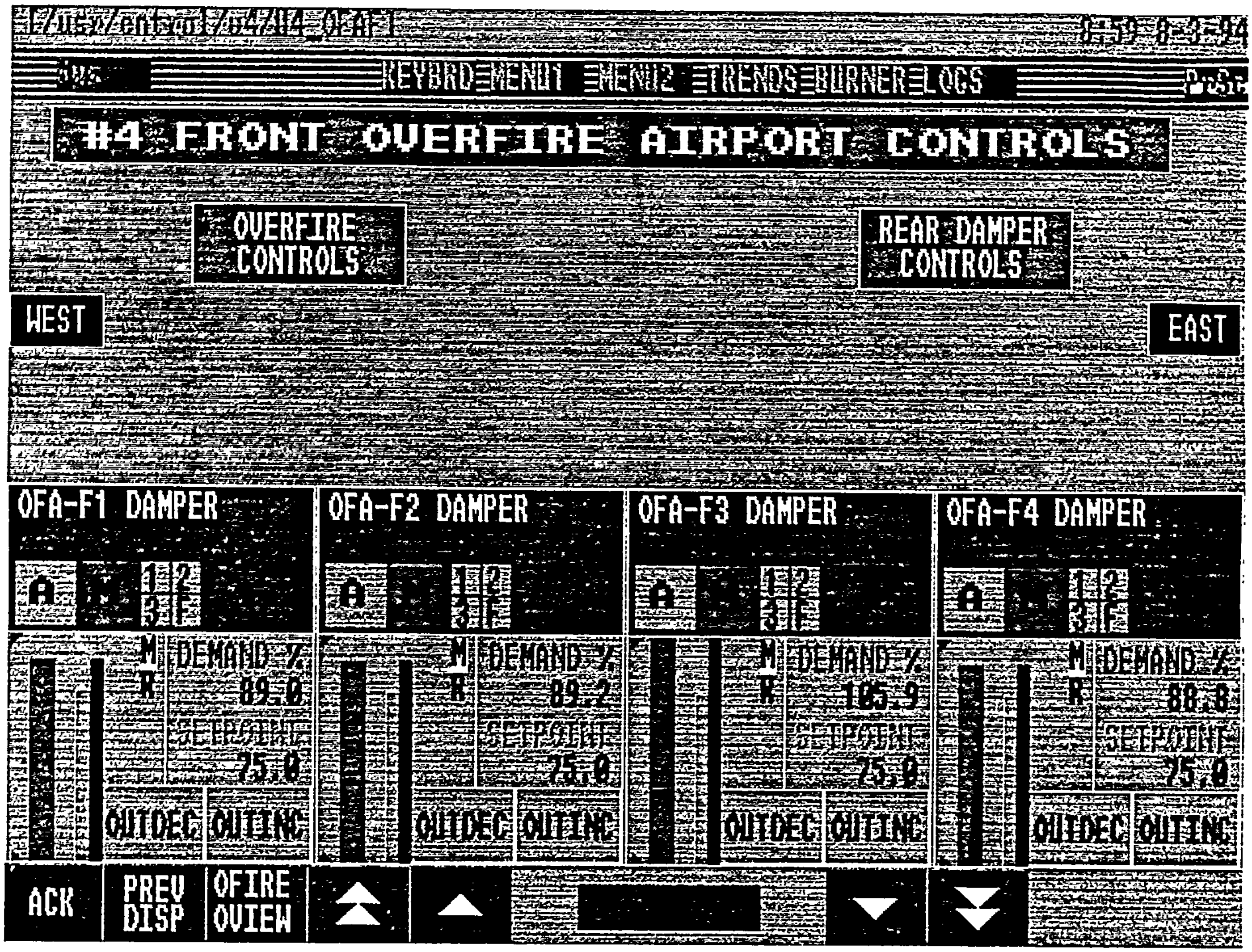


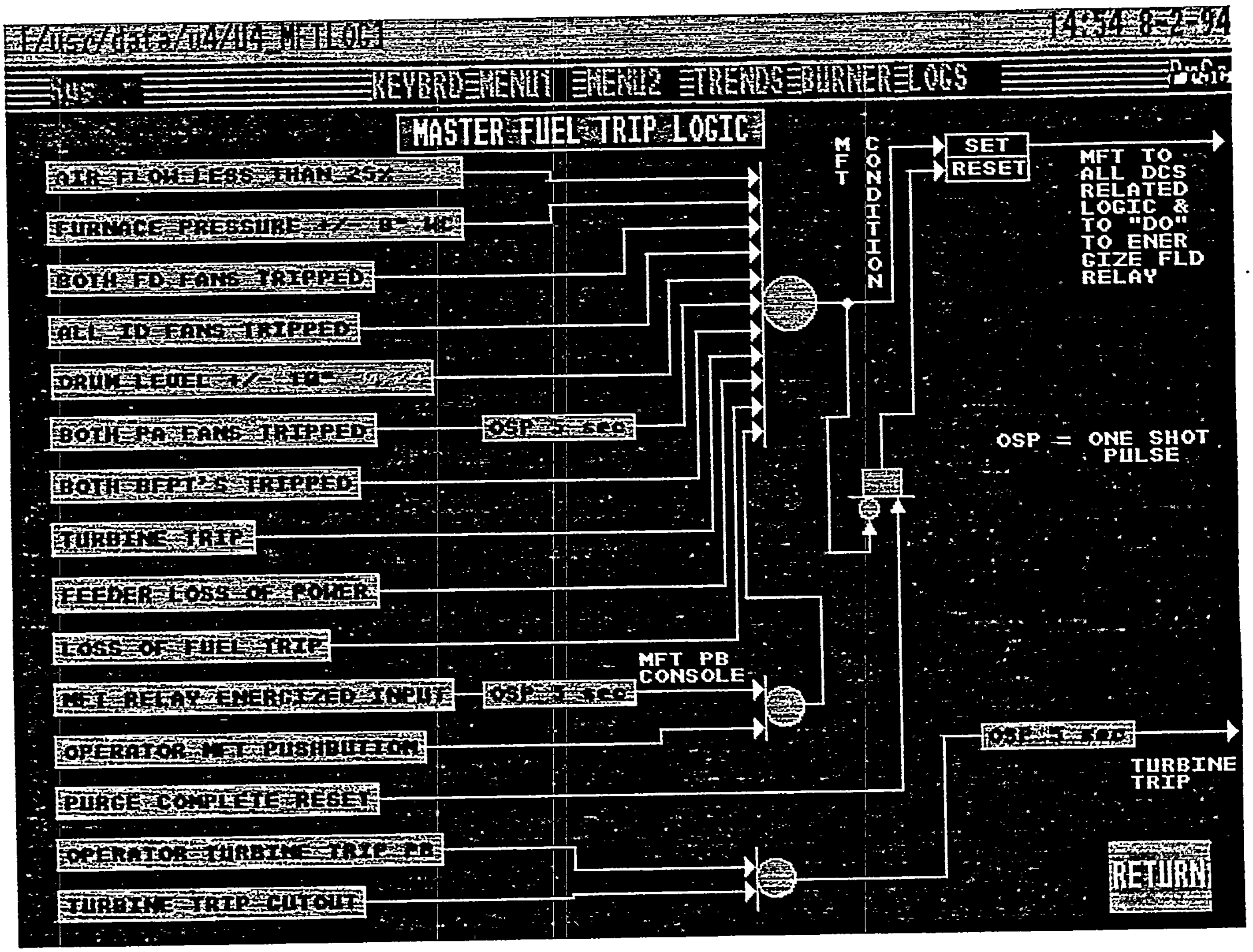
KEYBRD MENU1 MENU2 Burner
LOGS Select
8:42 8-3-94
A IDF INLET DAMPER
B IDF INLET DAMPER
C IDF INLET DAMPER
UNIT 4 ID FANS
FURNACE DRAFT
DEMAND %
29.7
29.7
29.7
BIAS %
-1.5
-15.0
OUTPUT %
29.7
28.2
0.0
A IDF DISCH DAMPER
B IDF DISCH DAMPER
C IDF DISCH DAMPER
POSITION FEEDBACK %
98.2
98.6
0.1
OUTPUT %
100.0
100.0
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
ID FANS PERMIT
ACK
PREV DISP
FD FANS

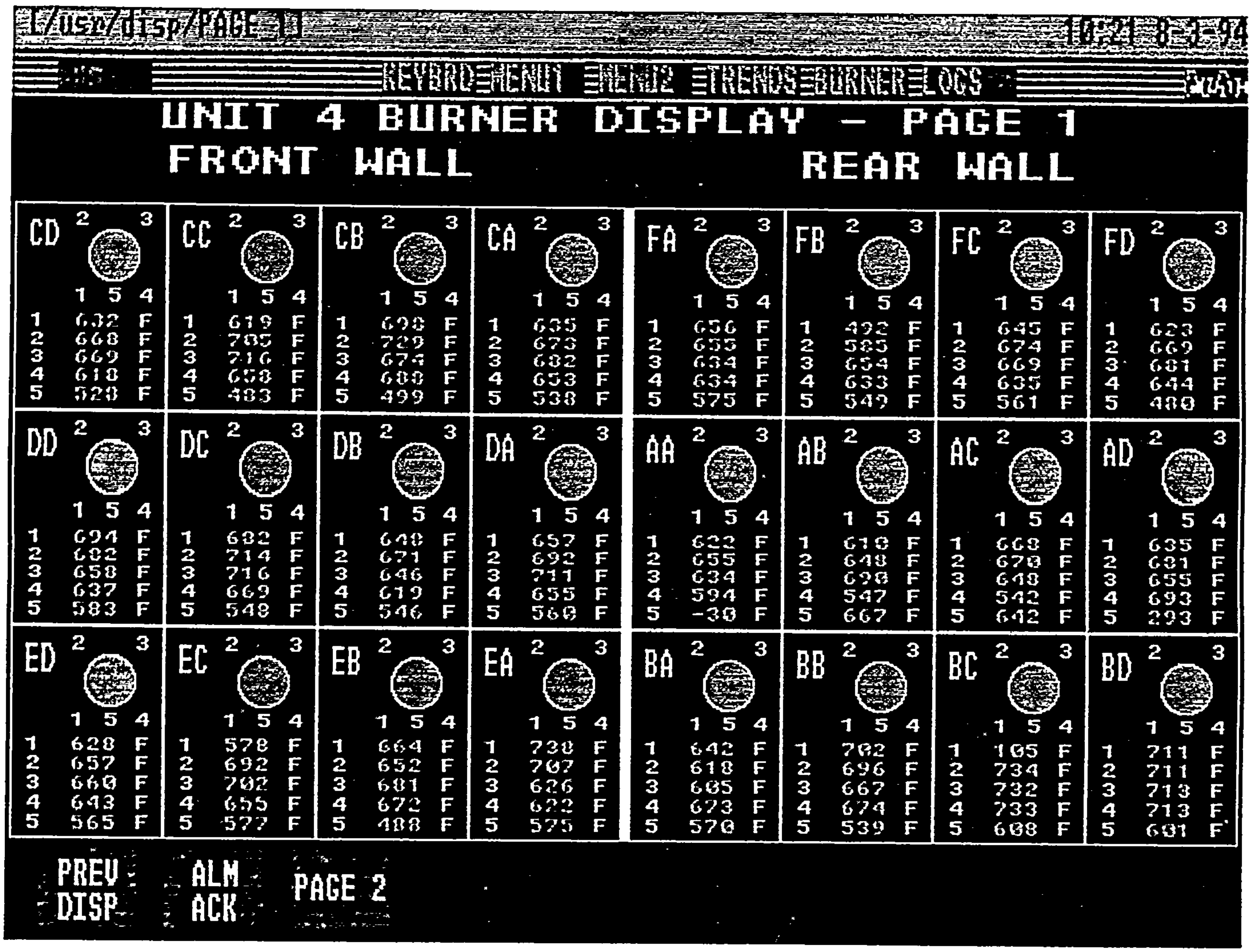

10:15 8-3-94
KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
UNIT 4 PULVERIZER OVERVIEW
MEGAWATTS 339
BURNER TEMP
IGN
A
B
C
D
E
F
AIR IN TEMP
166
165
165
166
166
146
KLB/HR
AMPS
AIR REG
LOP SEAL
AIR LOW
PREV DISP
FD&ID FANS
FD FANS
ID FANS
FUEL TRIP
NO LOAD FUEL TRIP CUTOUT&RESET
STM PRESS FURNACE DRAFT
O2 AVG
PSIG NARROW WIDE


10:20 8-3-94
KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
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 PERMISSIVE
NET
5 MIN PURGE TIMER
300 SEC
PURGE COMPLETE
PURGE ACTIVE LIGHT
PREV DISP
PULV SAB
FD FANS
ID FANS
FUEL TRIP
NO LOAD FUEL TRIP CUTOUT&RESET


KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
#4 OVERFIRE AIR FLOW CONTROL
WEST
FRONT DAMPER CONTROLS
OVERFIRE TOTAL AIR FLOW
LBS/HR
REAR DAMPER CONTROLS
EAST
AFMD-F1
LBS/HR
SETPOINT
AFMD-F2
LBS/HR
SETPOINT
AFMD-R1
LBS/HR
SETPOINT
AFMD-R2
LBS/HR
SETPOINT
CD-F1 DAMPER CTRLR
DEMAND %
11.6
11.6
OUTDEC OUTINC
CD-F2 DAMPER CTRLR
DEMAND %
9.8
SETPOINT
9.8
OUTDEC OUTINC
CD-R1 DAMPER CTRLR
DEMAND %
1.0
SETPOINT
1.0
OUTDEC OUTINC
CD-R2 DAMPER CTRLR
DEMAND %
9.3
9.3
OUTDEC OUTINC
ACK
PREV DISP
OFIRE OVIEW

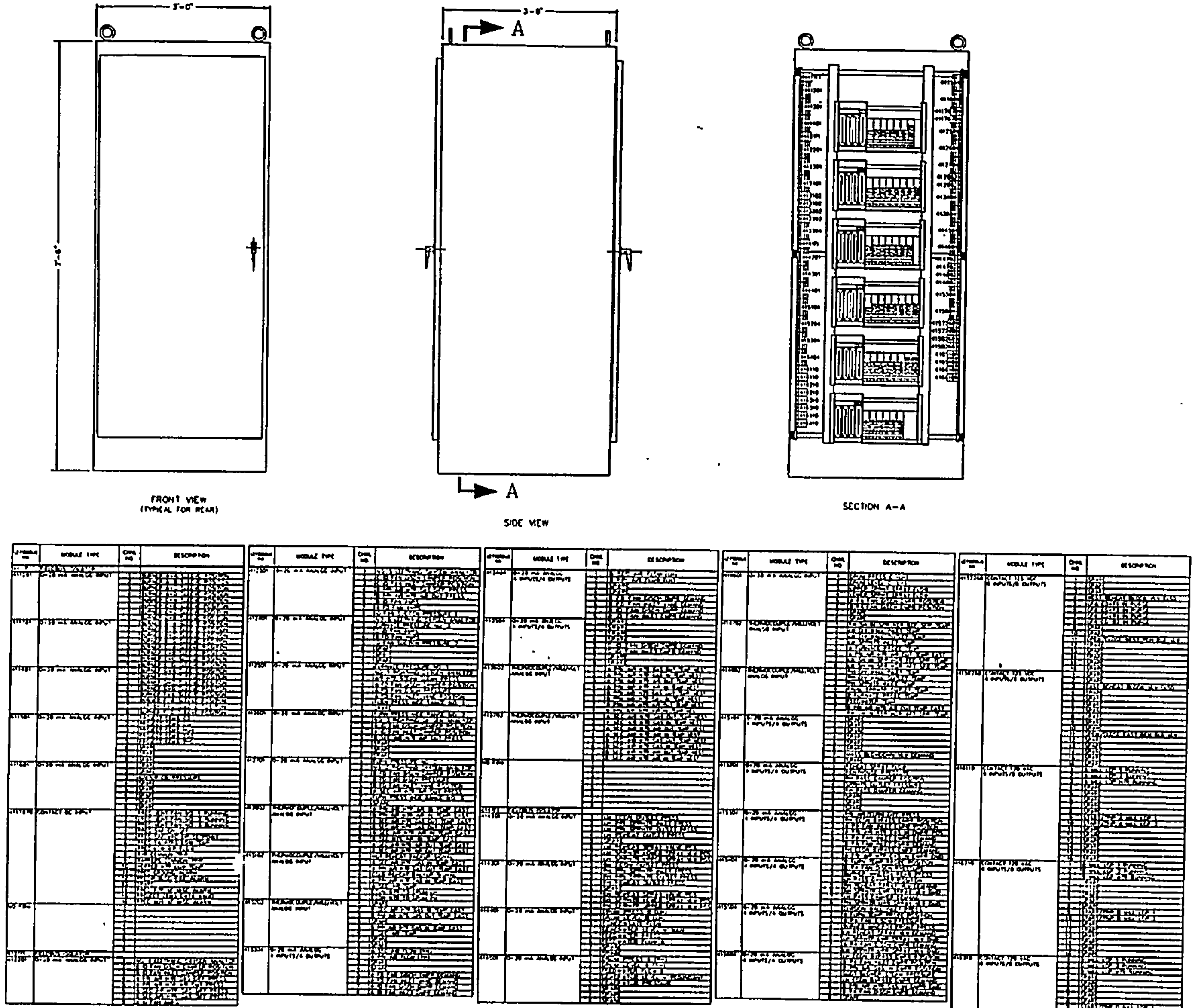

KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
#4 FRONT OVERFIRE AIRPORT CONTROLS
OVERFIRE CONTROLS
REAR DAMPER CONTROLS
WEST
EAST
OFA-F1 DAMPER
OFA-F2 DAMPER
OFA-F3 DAMPER
OFA-F4 DAMPER
DEMAND %
89.0
89.2
105.9
88.8
SETPOINT
25.0
OUTDEC
OUTINC
ACK
PREV DISP
OFIRE OVIEW

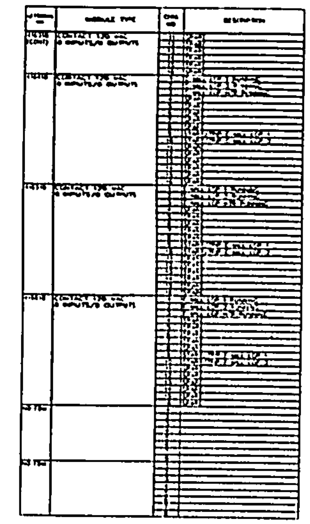

KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
MASTER FUEL TRIP LOGIC
AIR FLOW LESS THAN 25%
FURNACE PRESSURE +/- 8" WC
BOTH FD FANS TRIPPED
ALL ID FANS TRIPPED
DRUM LEVEL +/- 10"
BOTH PA FANS TRIPPED
OSP
BOTH BFPT'S TRIPPED
TURBINE TRIP
FEEDER LOSS OF POWER
LOSS OF FUEL TRIP
MFT RELAY ENERGIZED INPUT
OSP
MFT PB CONSOLE
OPERATOR MFT PUSHBUTTON
PURGE COMPLETE RESET
OPERATOR TURBINE TRIP PB
TURBINE TRIP CUTOUT
MFT CONDITION
SET
RESET
MFT TO ALL DCS RELATED LOGIC & TO "DO" TO ENER GIZE FLD RELAY
OSP = ONE SHOT PULSE
OSP
TURBINE TRIP
RETURN

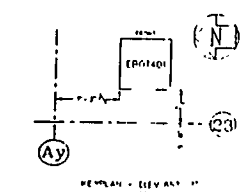

KEYBRD MENU1 MENU2 TRENDS BURNER LOGS
UNIT 4 BURNER DISPLAY - PAGE 1
FRONT WALL
REAR WALL
CD 1 632 F 2 668 F 3 669 F 4 618 F 5 520 F
CC 1 619 F 2 705 F 3 716 F 4 658 F 5 483 F
CB 1 698 F 2 729 F 3 674 F 4 688 F 5 499 F
CA 1 635 F 2 673 F 3 682 F 4 653 F 5 538 F
FA 1 656 F 2 655 F 3 634 F 4 634 F 5 575 F
FB 1 492 F 2 585 F 3 654 F 4 633 F 5 549 F
FC 1 645 F 2 674 F 3 669 F 4 635 F 5 561 F
FD 1 623 F 2 669 F 3 681 F 4 644 F 5 480 F
DD 1 694 F 2 682 F 3 658 F 4 637 F 5 583 F
DC 1 682 F 2 714 F 3 716 F 4 669 F 5 548 F
DB 1 648 F 2 671 F 3 646 F 4 619 F 5 546 F
DA 1 657 F 2 692 F 3 711 F 4 655 F 5 560 F
AA 1 622 F 2 655 F 3 634 F 4 594 F 5 -30 F
AB 1 618 F 2 648 F 3 698 F 4 547 F 5 667 F
AC 1 668 F 2 670 F 3 648 F 4 542 F 5 642 F
AD 1 635 F 2 681 F 3 655 F 4 693 F 5 293 F
ED 1 628 F 2 657 F 3 660 F 4 643 F 5 565 F
EC 1 578 F 2 692 F 3 702 F 4 655 F 5 577 F
EB 1 664 F 2 652 F 3 681 F 4 672 F 5 488 F
EA 1 738 F 2 707 F 3 626 F 4 622 F 5 575 F
BA 1 642 F 2 618 F 3 605 F 4 673 F 5 570 F
BB 1 702 F 2 696 F 3 667 F 4 674 F 5 539 F
BC 1 105 F 2 734 F 3 732 F 4 733 F 5 608 F
BD 1 711 F 2 711 F 3 713 F 4 713 F 5 601 F
PREV DISP
ALM ACK
PAGE 2

Appendix E

I/O Cabinet Arrangement Drawings







NOTES.

1. CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING NEMA 12 ENCLOSURE (MODEL NO A-90363U/SGA)
2. THE ALPHA CHARACTER AT THE END OF SOME OF THE LETTERBUG NUMBERS IS THE TERMINAL CABLE DESIGNATION

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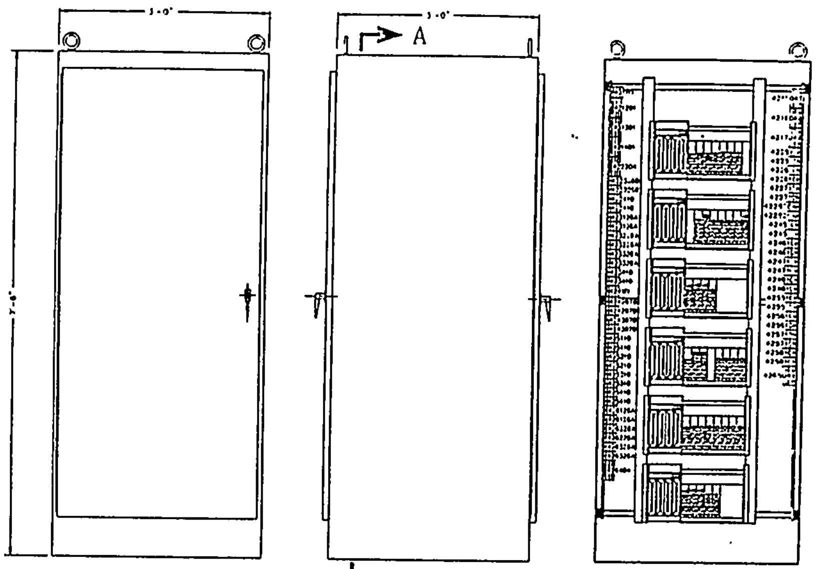
Southern Company Services Inc

Georgia Power Company

PLANT HAMMOND - UNIT NO 4
INSTR & CONT - CONTROL SYSTEM REPLACEMENT
I/O CABINET NO 1 UPPER BOILER AREA
ARRANGEMENT

10-201 | H-8170



FRONT VIEW
(TYPICAL FOR REAR)

SIDE VIEW

SECTION A-A

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

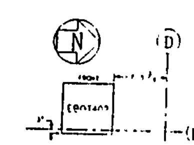
LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]



KEYPLAN - ELEV [illegible]
(NO SCALE)

NOTES.

1 CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING NEMA 12 ENCLOSURE (MODEL NO A-[illegible])

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

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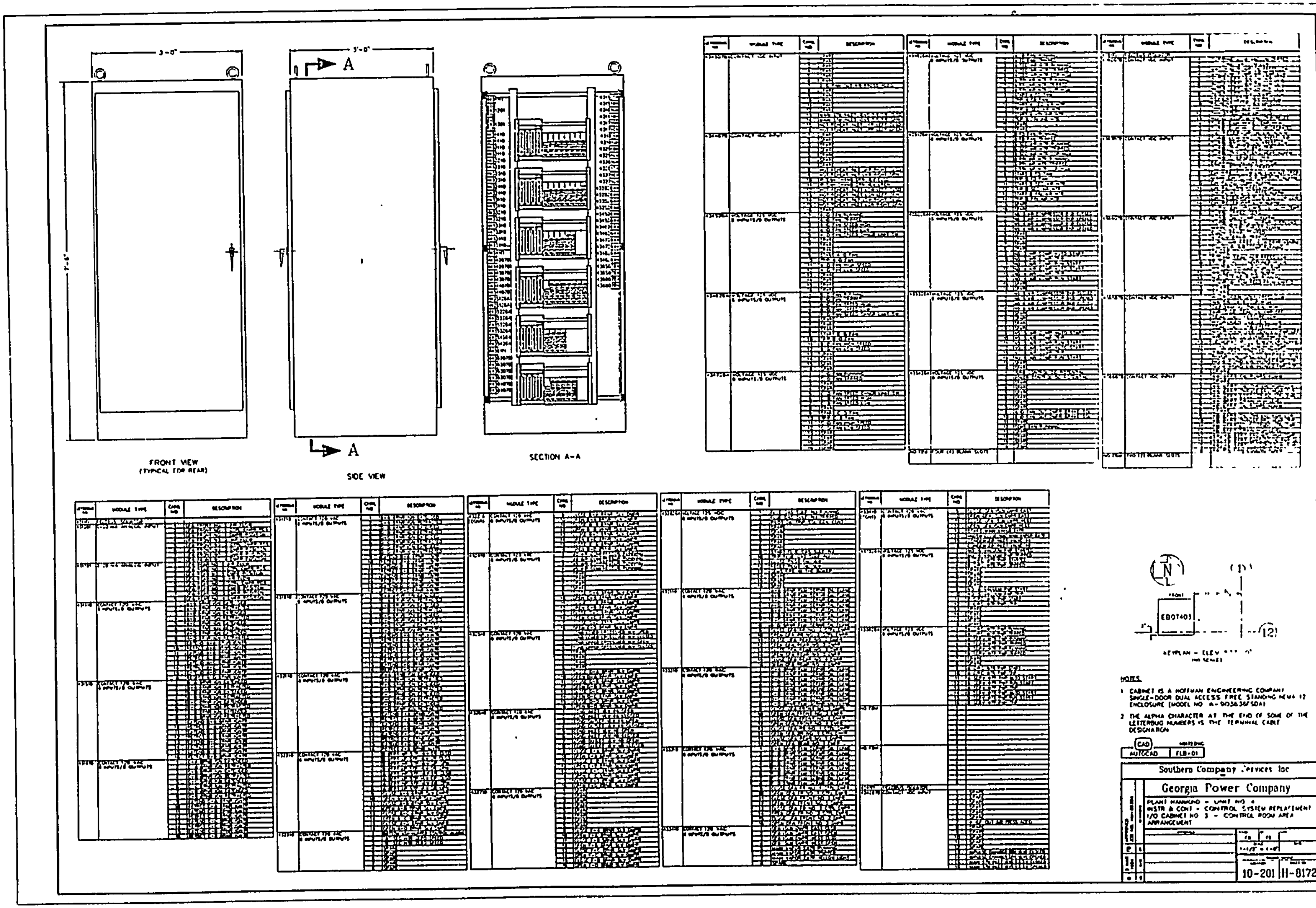
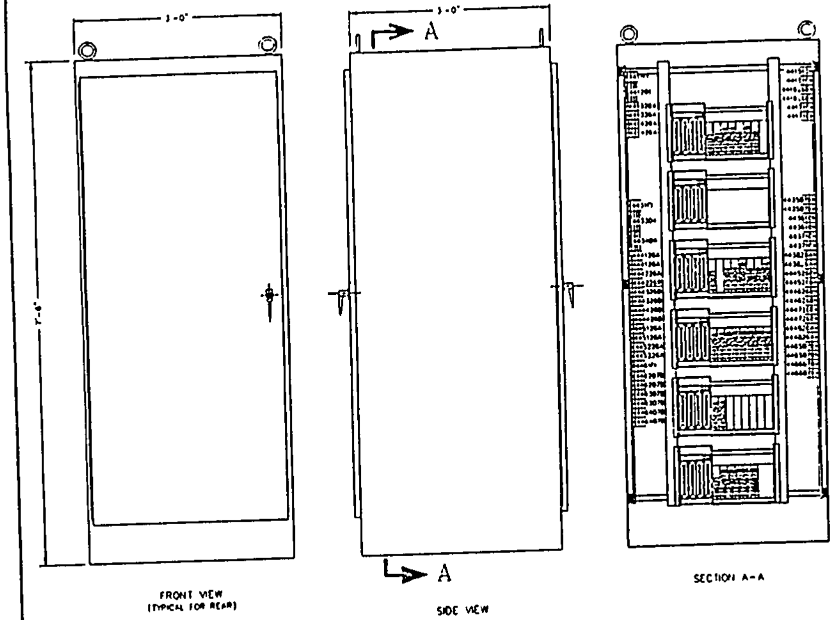
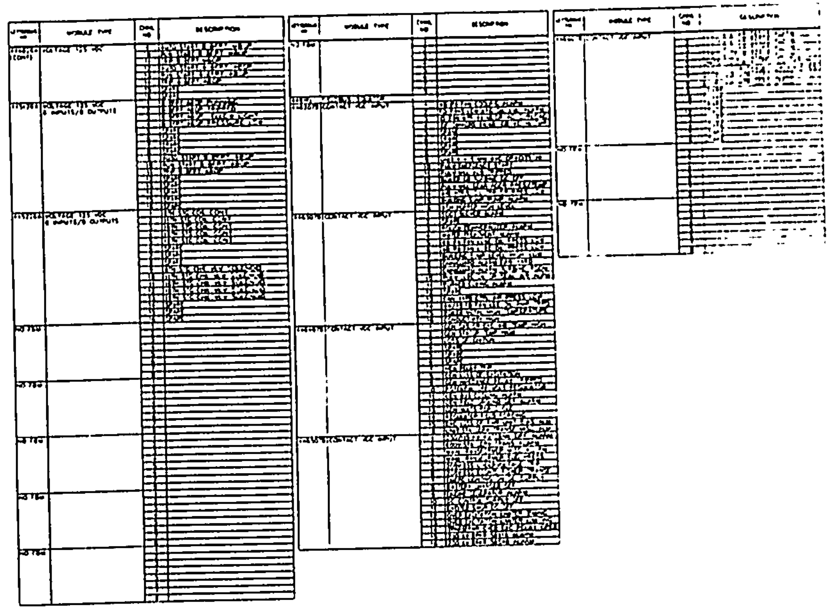
PLANT HAMMOND - UNIT NO 4
INSTR & CONT - CONTROL SYSTEM REPLACEMENT
I/O CABINET NO 2 - CONTROL ROOM AREA
ARRANGEMENT

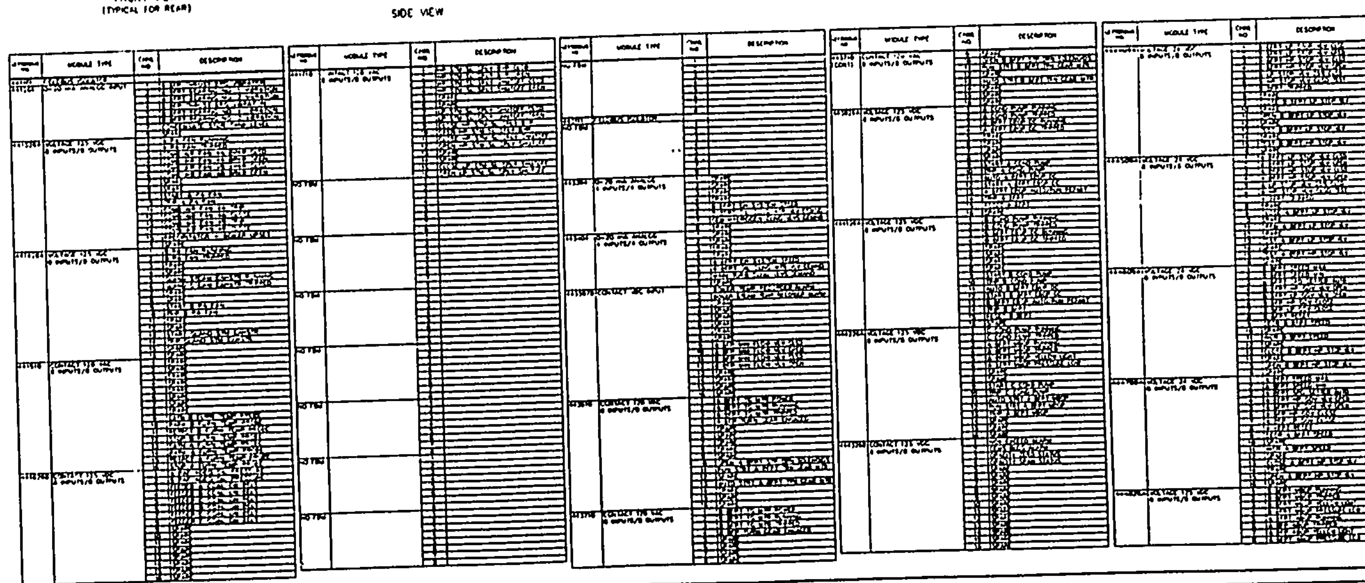
10-201 | H-8171

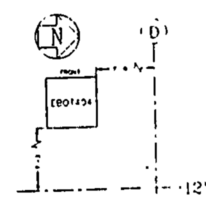


3'-0"
7'-6"
FRONT VIEW
(TYPICAL FOR REAR)
A
A
SIDE VIEW
SECTION A-A
MODULE TYPE
DESCRIPTION
EBOT403
(12)
NOTES
1 CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING NEMA 12 ENCLOSURE (MODEL NO A-9036 36FSDA1)
2 THE ALPHA CHARACTER AT THE END OF SOME OF THE LETTERBUG NUMBERS IS THE TERMINAL CABLE DESIGNATION
CAD
AUTOCAD
FLB-01
Southern Company Services Inc
Georgia Power Company
PLANT HAMMOND - UNIT NO 4
INSTR & CONT - CONTROL SYSTEM REPLACEMENT
I/O CABINET NO 3 - CONTROL ROOM AREA
ARRANGEMENT
10-201
H-8172









KEYPLAN - E.L. 377'-0"
(NO SCALE)

NOTES

1. CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING NEMA 12 ENCLOSURE (MODEL NO. A-903638FCA)
2. THE ALPHA CHARACTER AT THE END OF SOME OF THE LETTERBUG NUMBERS IS THE TERMINAL CABLE DESIGNATION

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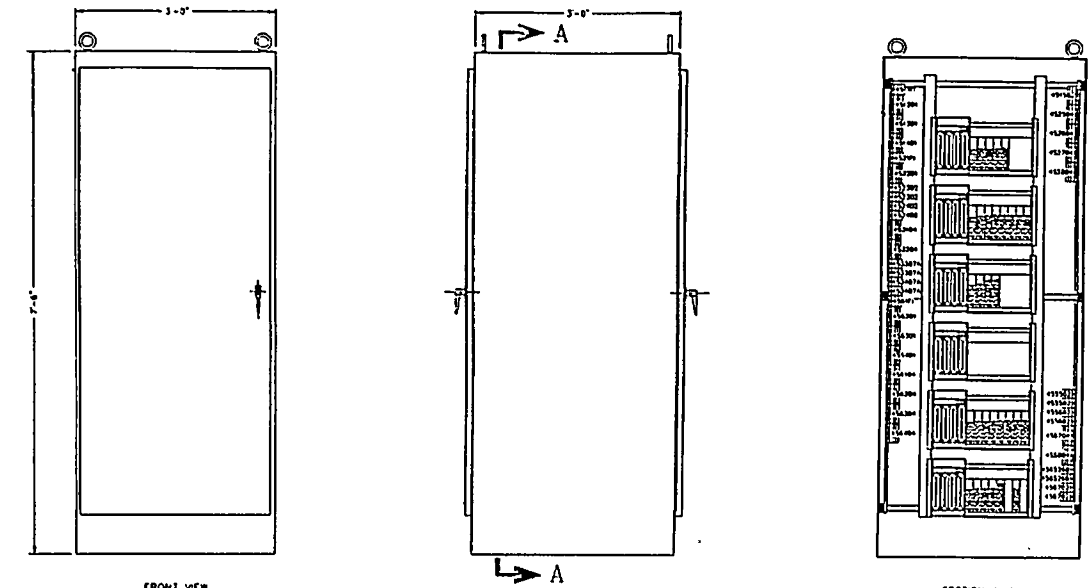
Georgia Power Company

PLANT HAMMOND - UNIT NO. 4
INSTR & CONT - CONTROL SYSTEM REPLACEMENT
I/O CABINET NO. 4 - CONTROL ROOM AREA
ARRANGEMENT

1-1/2" = 1'-0"

10-201 | H-8173

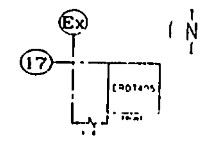


FRONT VIEW
(TYPICAL FOR REAR)

SIDE VIEW

SECTION A–A

LETTERBUG NO	MODULE TYPE	CHNL NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]



KEYPLAN – ELEV [illegible]
(NO SCALE)

NOTES

1 CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING NEMA 12 ENCLOSURE (MODEL NO A-903830FSOA)

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

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Southern Company Services Inc

Georgia Power Company

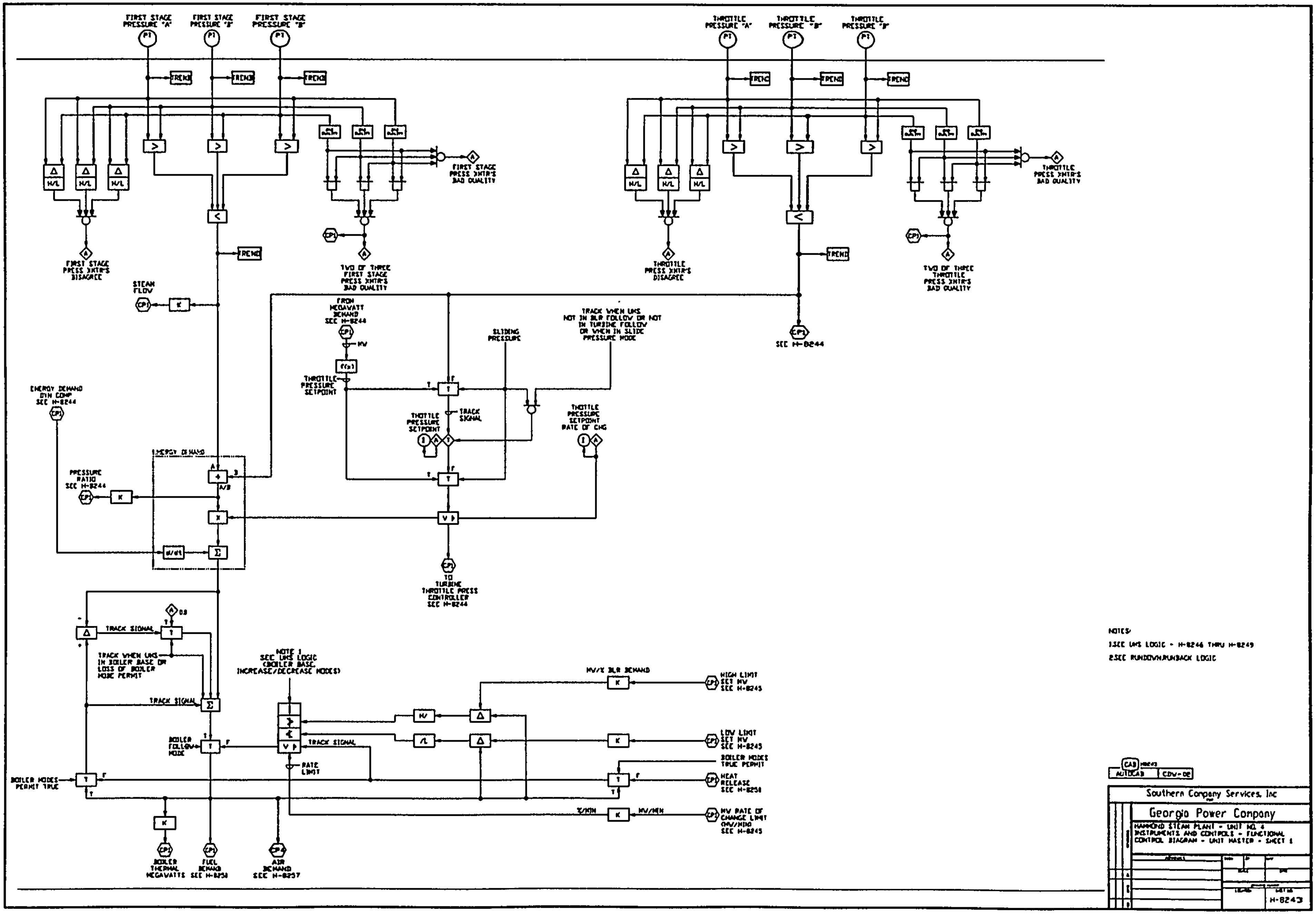
PLANT HAMMOND – UNIT NO 4
INSTR & CONT – CONTROL SYSTEM REPLACEMENT
I/O CABINET NO 5 – LOWER BOILER AREA
ARRANGEMENT

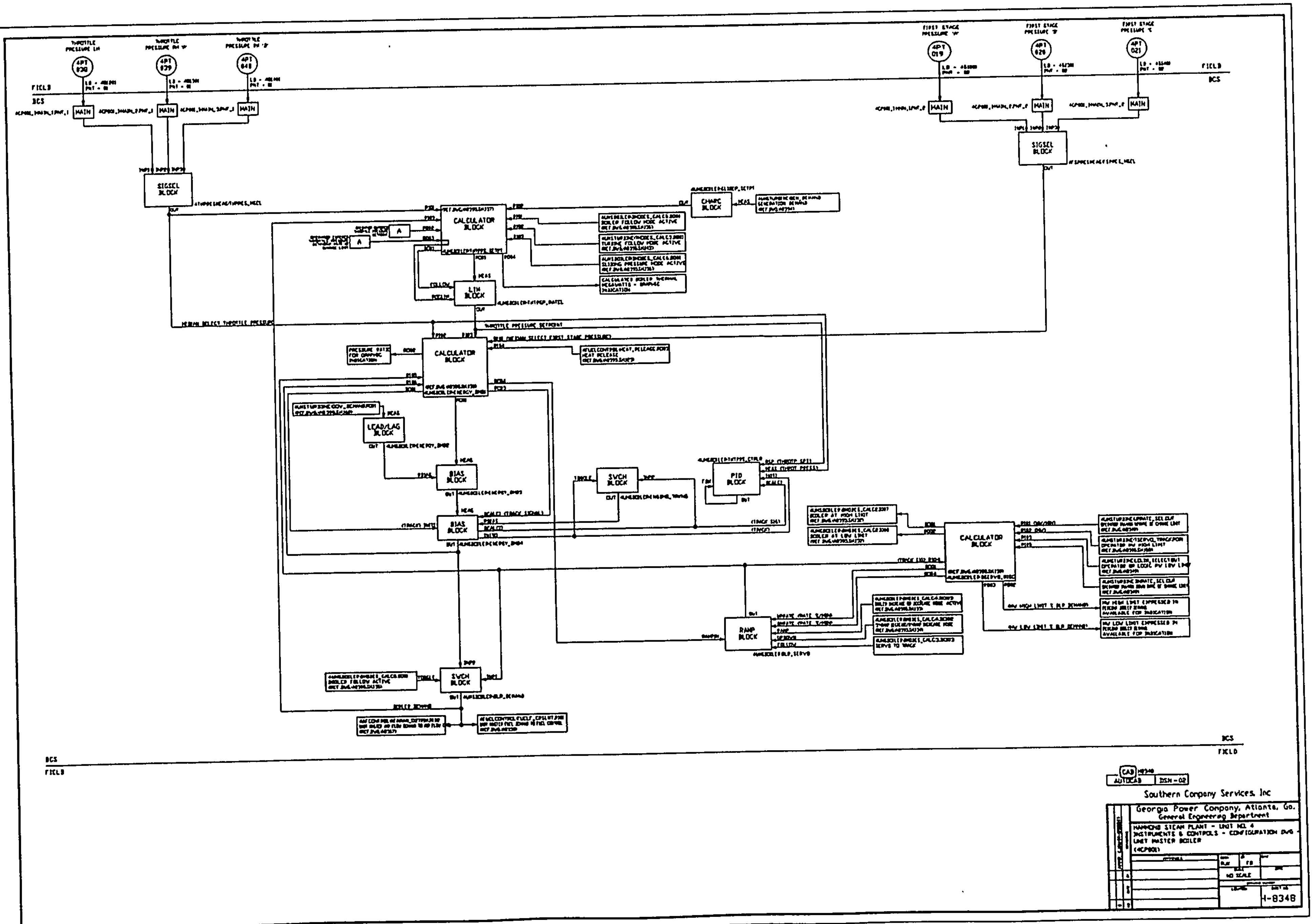
1 1/2" = 1'-0"

10-201 H-8174

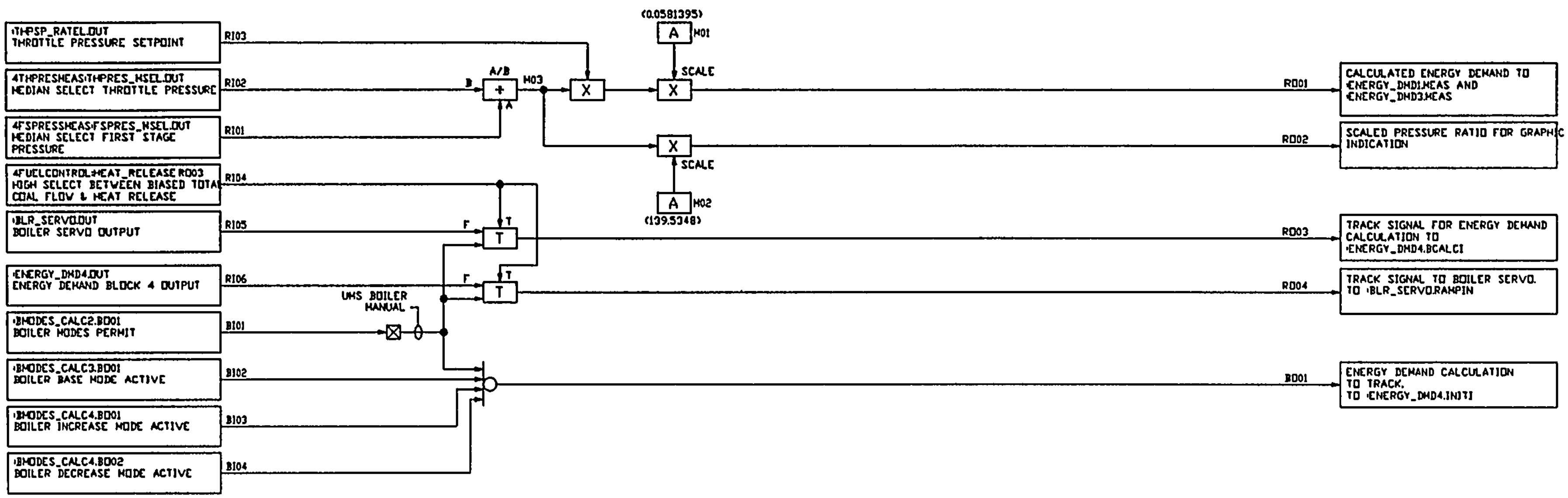
Appendix F

Example DCS Documentation


FIRST STAGE PRESSURE "A"
FIRST STAGE PRESSURE "B"
FIRST STAGE PRESSURE "B"
THROTTLE PRESSURE "A"
THROTTLE PRESSURE "B"
THROTTLE PRESSURE "B"
TREND
FIRST STAGE PRESS XMTR'S BAD QUALITY
FIRST STAGE PRESS XMTR'S DISAGREE
TWO OF THREE FIRST STAGE PRESS XMTR'S BAD QUALITY
THROTTLE PRESS XMTR'S BAD QUALITY
THROTTLE PRESS XMTR'S DISAGREE
TWO OF THREE THROTTLE PRESS XMTR'S BAD QUALITY
STEAM FLOW
SEE H-8244
FROM MEGAWATT DEMAND SEE H-8244
THROTTLE PRESSURE SETPOINT
SLIDING PRESSURE
TRACK WHEN UMS NOT IN BLR FOLLOW OR NOT IN TURBINE FOLLOW OR WHEN IN SLIDE PRESSURE MODE
TRACK SIGNAL
THROTTLE PRESSURE SETPOINT RATE OF CHG
ENERGY DEMAND DYN COMP SEE H-8244
ENERGY DEMAND
PRESSURE RATIO SEE H-8244
TO TURBINE THROTTLE PRESS CONTROLLER SEE H-8244
TRACK WHEN UMS IN BOILER BASE OR LOSS OF BOILER MODE PERMIT
NOTE 1 SEE UMS LOGIC (BOILER BASE INCREASE/DECREASE MODES)
MW/X BLR DEMAND
HIGH LIMIT SET MW SEE H-8245
LOW LIMIT SET MW SEE H-8245
BOILER MODES TRUE PERMIT
HEAT RELEASE SEE H-8258
MW RATE OF CHANGE LIMIT (MW/MIN) SEE H-8245
MW/MIN
%/MIN
RATE LIMIT
BOILER FOLLOW MODE
BOILER MODES PERMIT TRUE
BOILER THERMAL MEGAVATTS
FUEL DEMAND SEE H-8258
AIR DEMAND SEE H-8257
NOTES:
1.SEE UMS LOGIC - H-8246 THRU H-8249
2.SEE RUNDOWN/RUNBACK LOGIC
AUTOCAD
CDV-DE
Southern Company Services, Inc
Georgia Power Company
HAMMOND STEAM PLANT - UNIT NO. 4
INSTRUMENTS AND CONTROLS - FUNCTIONAL
CONTROL DIAGRAM - UNIT MASTER - SHEET 1
H-8243


THROTTLE PRESSURE
FIRST STAGE PRESSURE
4PT 030
4PT 039
4PT 048
4PT 019
4PT 020
4PT 021
FIELD
DCS
MAIN
SIGSEL BLOCK
CALCULATOR BLOCK
CHARC BLOCK
LTH BLOCK
LEAD/LAG BLOCK
BIAS BLOCK
SWCH BLOCK
PID BLOCK
RAMP BLOCK
MEDIAN SELECT THROTTLE PRESSURE
THROTTLE PRESSURE SETPOINT
PRESSURE RATIO FOR GRAPHIC INDICATION
BOILER DEMAND
CAD
AUTOCAD
DSN-02
Southern Company Services, Inc
Georgia Power Company, Atlanta, Ga.
General Engineering Department
HAMMOND STEAM PLANT - UNIT NO. 4
INSTRUMENTS & CONTROLS - CONFIGURATION DWG -
UNIT MASTER BOILER
(4CP801)
NO SCALE
H-8348

BOILER MODES, ENERGY DEMANDS



4UMSBOILER:ENERGY_DMD1

REV	DATE	BY	DESCRIPTION	APPR 1	APPR 2	APPR 3	APPR 4	APPR 5
0	15 DEC 94	DSN	APPROVED JOB NO HM-89204					

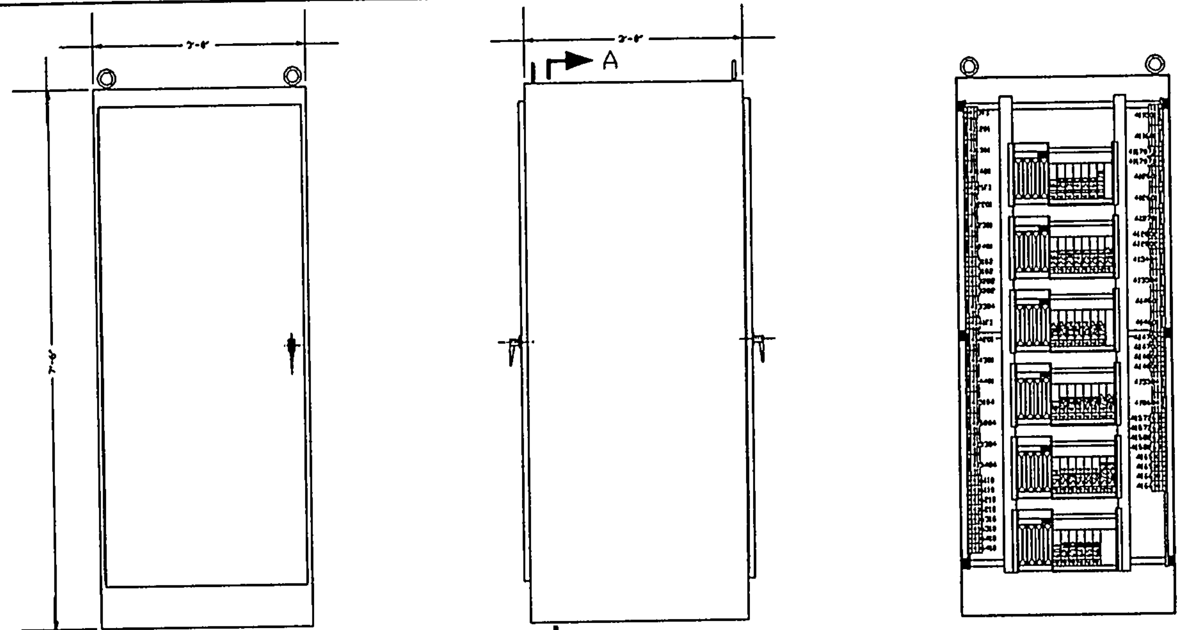
REMARKS

CAD 138 AUTOCAD 12c2 DSN-03

Southern Company Services, Inc. FOR Georgia Power Company

PLANT HAMMOND - UNIT NO. 4
INSTRUMENTS & CONTROLS
BOILER MODES, ENERGY DEMAND
4UMSBOILER:ENERGY_DMD1

DESIGNED RJK		DRAWN FB		
TYPED N/A		CHECKED		
SCALE NO SCALE		CONTINUED ON SHEET		
	PROJ I D	DRAWING NUMBER	SHEET	REV
		138	1	0

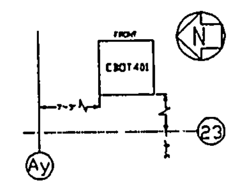


FRONT VIEW
(TYPICAL FOR REAR)

SIDE VIEW

SECTION A-A

LETTERBUG NO.	MODULE TYPE	CABL NO.	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]



KEYPLAN - ELEV 657'-3"
(NO SCALE)

NOTES:

1. CABINET IS A HOFFMAN ENGINEERING COMPANY SINGLE-DOOR DUAL ACCESS FREE STANDING NEMA 12 ENCLOSURE (MODEL NO A-903636FSDA)
2. THE ALPHA CHARACTER AT THE END OF SOME OF THE LETTERBUG NUMBERS IS THE TERMINAL CABLE DESIGNATION

CAD H8170
AUTOCAD | CDV-01

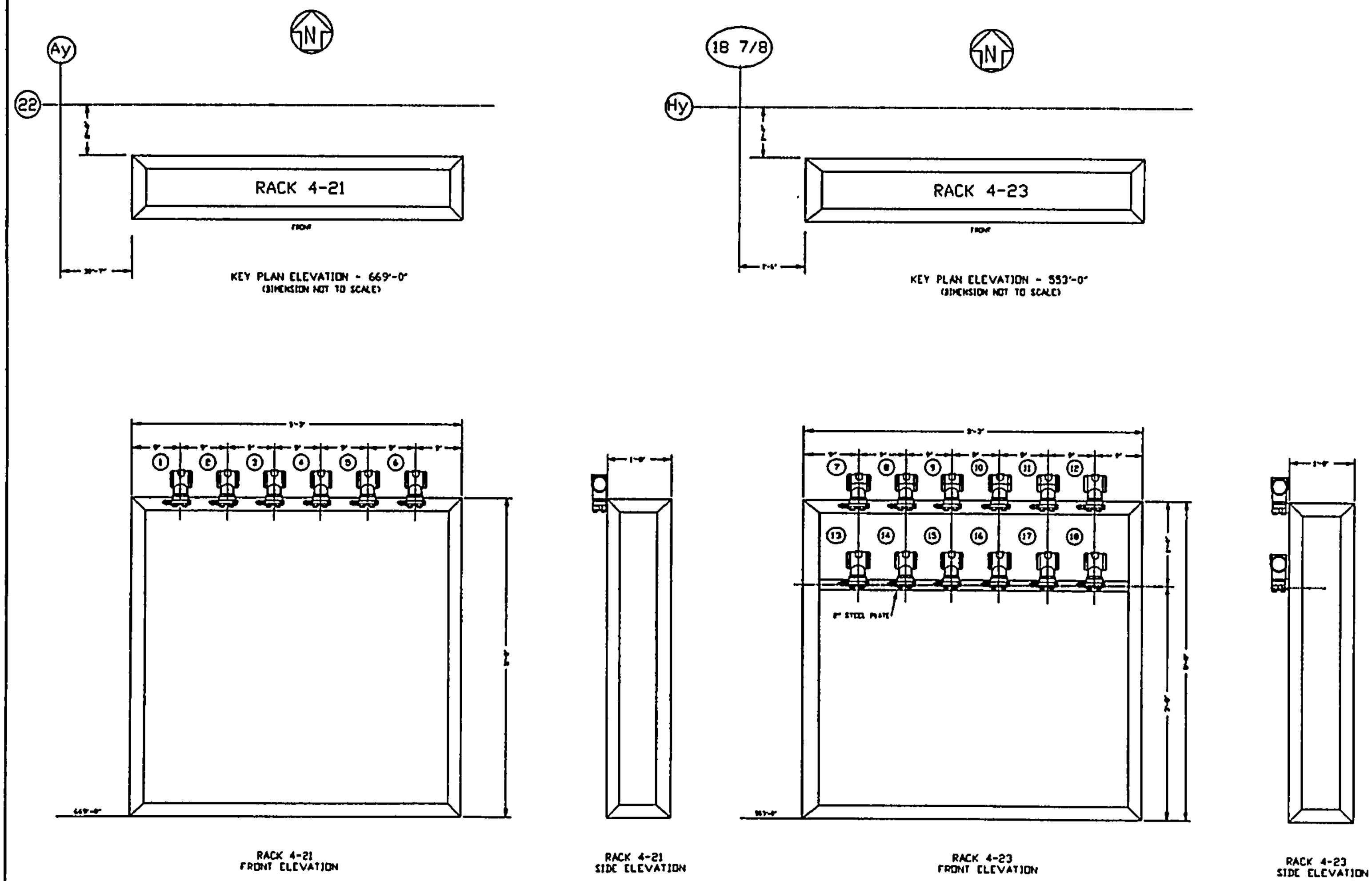
Southern Company Services, Inc.

Georgia Power Company, Atlanta, Ga.
General Engineering Department

PLANT HAMMOND - UNIT NO. 4
INSTR & CONT - CONTROL SYSTEM REPLACEMENT
I/O CABINET NO. 1 - UPPER BOILER AREA
ARRANGEMENT

1-1/2" = 1'-0"

10-201 | H-8170



TRANSMITTER LIST				
RACK NO.	ITEM NO.	[illegible]	[illegible]	[illegible]
4-21	1	[illegible]	[illegible]	[illegible]
4-21	2	[illegible]	[illegible]	[illegible]
4-21	3	[illegible]	[illegible]	[illegible]
4-21	4	[illegible]	[illegible]	[illegible]
4-21	5	[illegible]	[illegible]	[illegible]
4-21	6	[illegible]	[illegible]	[illegible]
4-23	7	[illegible]	[illegible]	[illegible]
4-23	8	[illegible]	[illegible]	[illegible]
4-23	9	[illegible]	[illegible]	[illegible]
4-23	10	[illegible]	[illegible]	[illegible]
4-23	11	[illegible]	[illegible]	[illegible]
4-23	12	[illegible]	[illegible]	[illegible]
4-23	13	[illegible]	[illegible]	[illegible]
4-23	14	[illegible]	[illegible]	[illegible]
4-23	15	[illegible]	[illegible]	[illegible]
4-23	16	[illegible]	[illegible]	[illegible]
4-23	17	[illegible]	[illegible]	[illegible]
4-23	18	[illegible]	[illegible]	[illegible]

NOTES:

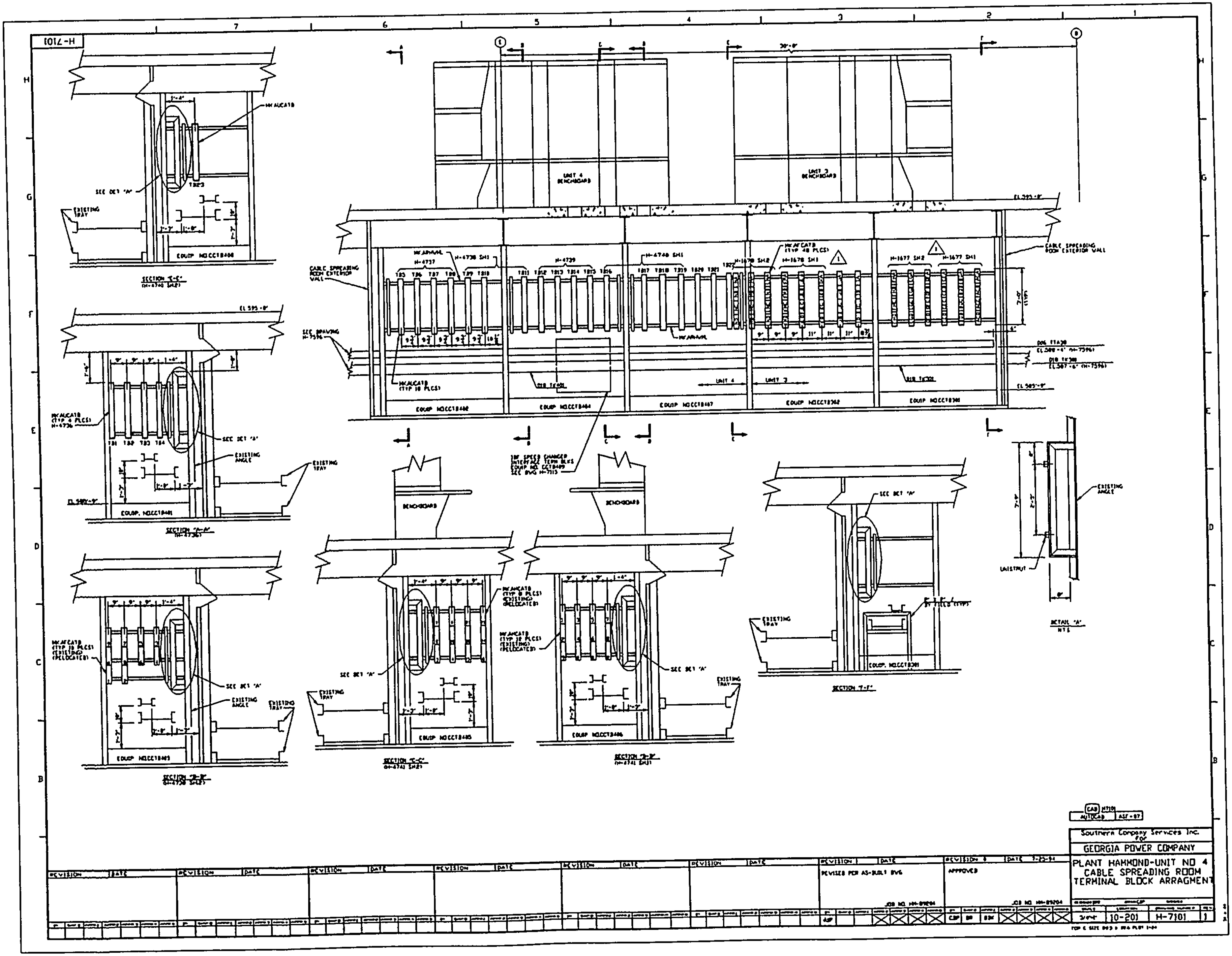
1 ALL RACKS TO BE WELDED CONSTRUCTION OF [illegible] ANGLES UNLESS OTHERWISE DESIGNATED

CAD
AUTOCAD | SJW-02

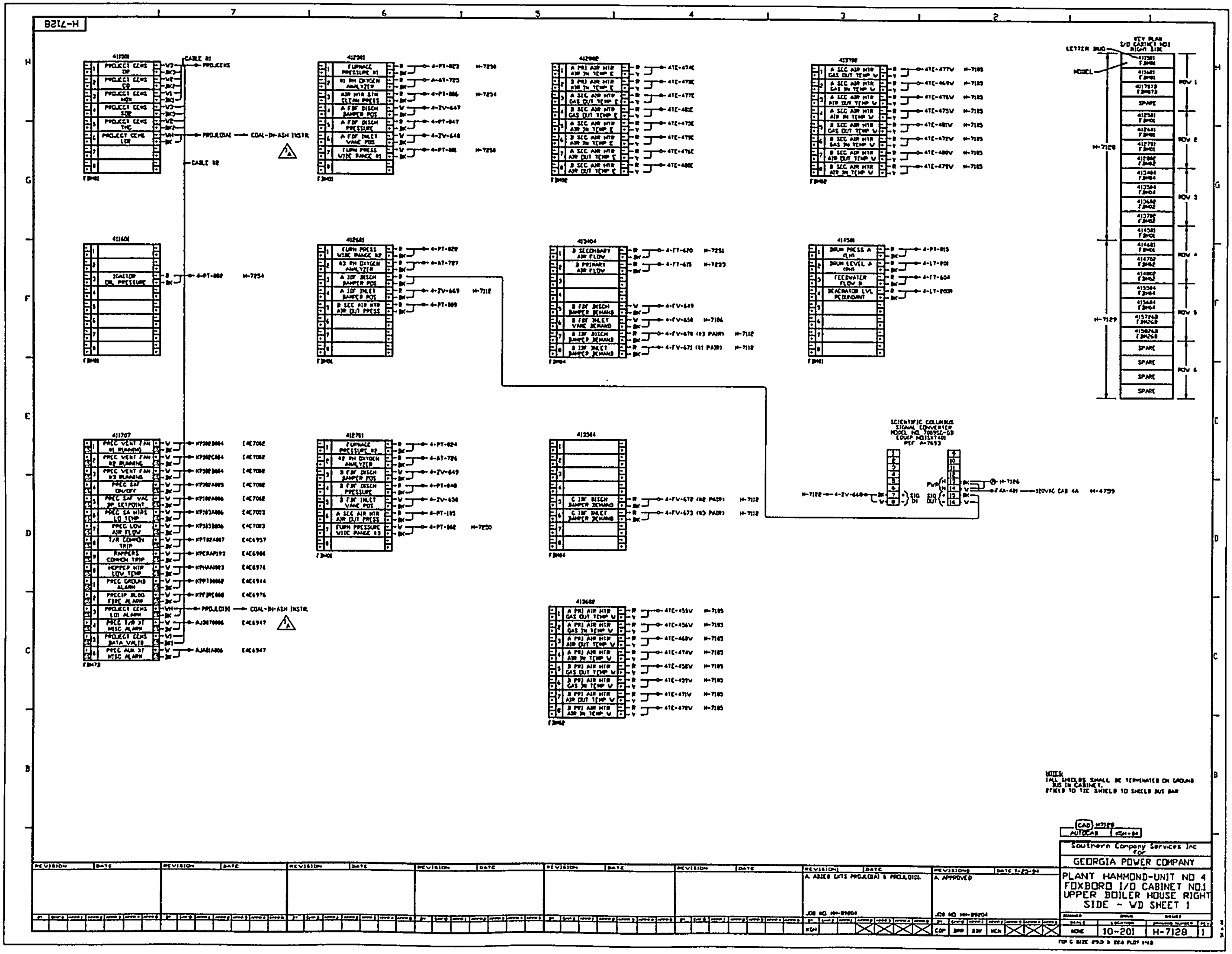
Southern Company Services, Inc.

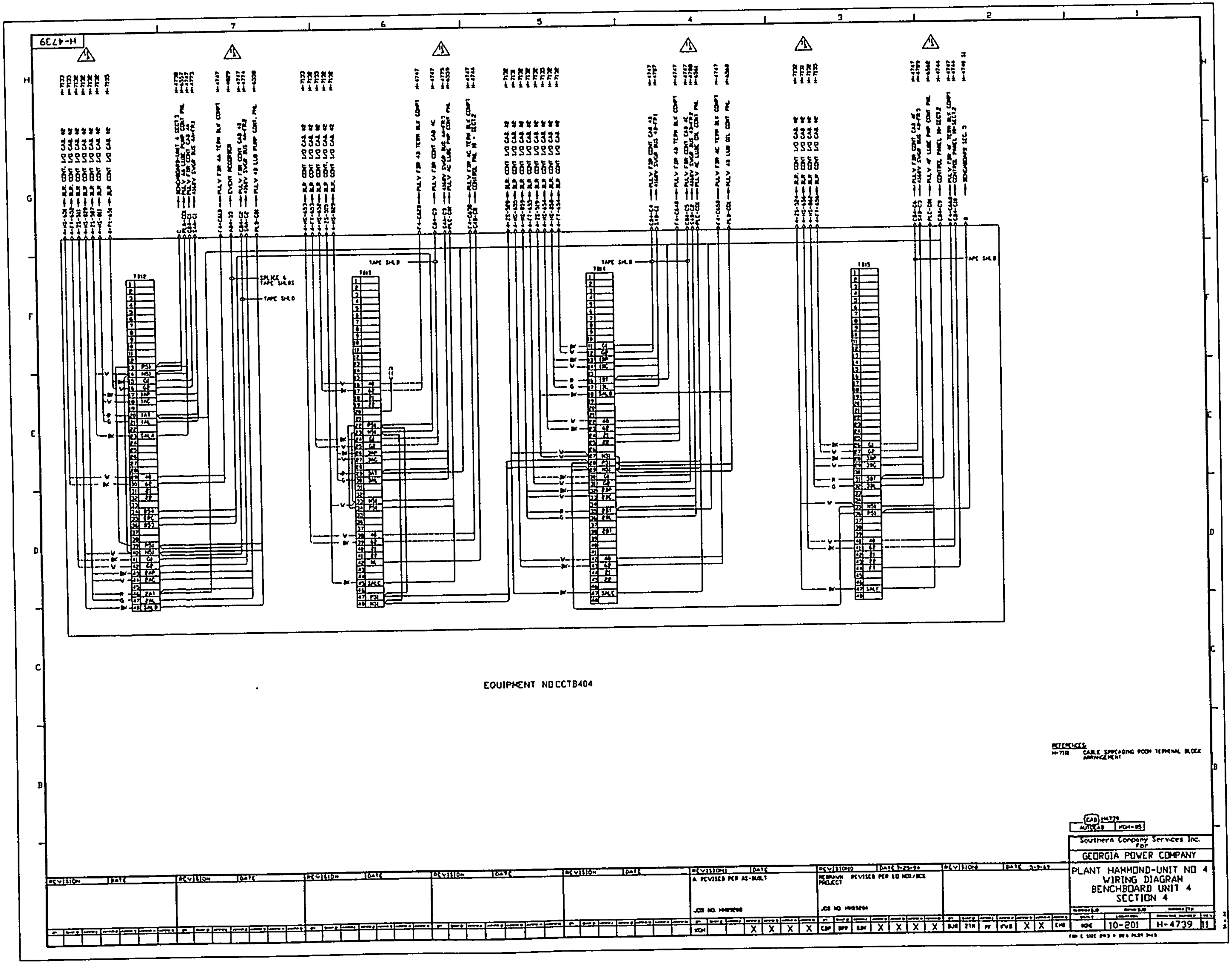
Georgia Power Company

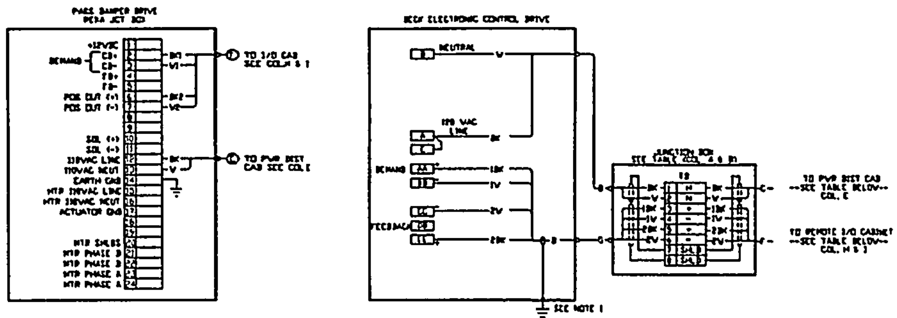
HAMMOND STEAM PLANT - UNIT NO. 4
INSTRUMENTS AND CONTROLS - DETAILS
INSTRUMENT RACKS 4-21 AND 4-23



UNIT 4 BENCHBOARD
UNIT 3 BENCHBOARD
CABLE SPREADING ROOM EXTERIOR WALL
SEE DRAWING H-7596
EQUIP NO.CCT8400
EQUIP NO.CCT8404
EQUIP NO.CCT8407
EQUIP NO.CCT8302
EQUIP NO.CCT8301
UNIT 4
UNIT 3
SECTION "A-A"
SECTION "B-B"
SECTION "C-C"
SECTION "D-D"
SECTION "E-E"
SECTION "F-F"
SEE DET "A"
EXISTING TRAY
EXISTING ANGLE
BENCHBOARD
DETAIL "A" NTS
UNISTRUT
Southern Company Services Inc. for
GEORGIA POWER COMPANY
PLANT HAMMOND-UNIT NO 4
CABLE SPREADING ROOM
TERMINAL BLOCK ARRAGMENT
10-201
H-7101
REVISION
DATE
REVISED PER AS-BUILT DWG
APPROVED
H-7101


H-7128
Southern Company Services Inc
for
GEORGIA POWER COMPANY
PLANT HAMMOND-UNIT NO 4
FOXBORO I/O CABINET NO.1
UPPER BOILER HOUSE RIGHT
SIDE - WD SHEET 1
10-201
H-7128
NOTES:
1. ALL SHIELDS SHALL BE TERMINATED ON GROUND BUS IN CABINET.
2. FIELD TO TIE SHIELD TO SHIELD BUS BAR
SCIENTIFIC COLUMBUS SIGNAL CONVERTER
KEY PLAN I/O CABINET NO.1 RIGHT SIDE
LETTER BUG
MODEL
CABLE #1
CABLE #2
COAL-IN-ASH INSTR
A APPROVED
A ADDED CKTS PROJ.CO(A) & PROJ.LO(D).


H-4739
TB12
TB13
TB14
TB15
TAPE SHLD
SPLICE & TAPE SHLDS
EQUIPMENT NO CCTB404
REFERENCES:
H-7318 CABLE SPREADING ROOM TERMINAL BLOCK ARRANGEMENT
A REVISED PER AS-BUILT
REDRAWN PROJECT REVISED PER LO NOS/BCS
Southern Company Services Inc.
for
GEORGIA POWER COMPANY
PLANT HAMMOND-UNIT NO 4
WIRING DIAGRAM
BENCHBOARD UNIT 4
SECTION 4
10-201
H-4739
11



A	B	C	D	E	F	G	H	I
EQUIPMENT DESCRIPTION	JUNCTION BOX NUMBER	INCOMING POWER CABLE NUMBER (#16 W/SH)	POWER TO DRIVE CABLE NUMBER (PRTV #16 W/SH)	POWER DIST CABINET REFERENCE DRAWING	INCOMING CONTROL CIRCUIT NUMBER	CONTROL CIRCUIT TO DRIVE	FOXBORO I/O CABINET #	REFERENCE DRAWING #
A HOT AIR DMPR JB	EBSS453	EBSS463-1	EBSS463-1A	H-7108	4-FY-627	4-FY-627A	EBOT405	H-7147
B HOT AIR DMPR JB	EBSS454	EBSS463-3	EBSS463-3A	H-7108	4-FY-658	4-FY-658A	EBOT405	H-7147
C HOT AIR DMPR JB	EBSS455	EBSS463-5	EBSS463-5A	H-7108	4-FY-683	4-FY-683A	EBOT405	H-7147
D HOT AIR DMPR JB	EBSS456	EBSS463-7	EBSS463-7A	H-7108	4-FY-641	4-FY-641A	EBOT405	H-7147
E HOT AIR DMPR JB	EBSS457	EBSS463-9	EBSS463-9A	H-7108	4-FY-643	4-FY-643A	EBOT405	H-7147
F HOT AIR DMPR JB	EBSS458	EBSS463-11	EBSS463-11A	H-7108	4-FY-645	4-FY-645A	EBOT405	H-7147
A TEMP AIR DMPR JB	EBSS459	EBSS463-2	EBSS463-2A	H-7108	4-FY-620	4-FY-620A	EBOT405	H-7147
B TEMP AIR DMPR JB	EBSS460	EBSS463-4	EBSS463-4A	H-7108	4-FY-639	4-FY-639A	EBOT405	H-7147
C TEMP AIR DMPR JB	EBSS461	EBSS463-6	EBSS463-6A	H-7108	4-FY-660	4-FY-660A	EBOT405	H-7147
D TEMP AIR DMPR JB	EBSS462	EBSS463-8	EBSS463-8A	H-7108	4-FY-662	4-FY-662A	EBOT405	H-7147
E TEMP AIR DMPR JB	EBSS463	EBSS463-10	EBSS463-10A	H-7108	4-FY-664	4-FY-664A	EBOT405	H-7147
F TEMP AIR DMPR JB	EBSS464	EBSS463-12	EBSS463-12A	H-7108	4-FY-666	4-FY-666A	EBOT405	H-7147
A PRI AIR GAS IN DMPR DR JB	EBSS466	EBSS474-10	EBSS474-10A	H-7107	4-FV-623	4-FV-623A	EBOT401	H-7127
B PRI AIR GAS IN DMPR DR JB	EBSS467	EBSS474-11	EBSS474-11A	H-7107	4-FV-626	4-FV-626A	EBOT401	H-7129
PRI AIR FAN A INLET VANE DR JB	EBSS468	EBSS474-6	EBSS474-6A	H-7107	4-FV-680	4-FV-680A	EBOT401	H-7127
PRI AIR FAN B INLET VANE DR JB	EBSS469	EBSS474-7	EBSS474-7A	H-7107	4-FV-681	4-FV-681A	EBOT401	H-7127
PRI AIR FAN A DISCH DMPR DR JB	EBSS470	EBSS474-8	EBSS474-8A	H-7107	4-FV-621	4-FV-621A	EBOT401	H-7129
PRI AIR FAN A DISCH DMPR DR JB	EBSS471	EBSS474-9	EBSS474-9A	H-7107	4-FV-622	4-FV-622A	EBOT401	H-7129
RH ECON BYPASS DMPR DR JB	EBSS472	EBSS474-1	EBSS474-1A	H-7107	4-FV-630	4-FV-630A	EBOT401	H-7127
LH ECON BYPASS DMPR DR JB	EBSS473	EBSS474-2	EBSS474-2A	H-7107	4-FV-632	4-FV-632A	EBOT401	H-7129
RH PASS DAMPER JCT BOX	* EBOT410	EBSS474-3	EBSS474-3A	H-7107	4-FV-629	4-FV-629A	EBOT401	H-7127
LH PASS DAMPER JCT BOX	* EBOT411	EBSS474-4	EBSS474-4A	H-7107	4-FV-633	4-FV-633A	EBOT401	H-7127
A FDF IN VANE JCT BOX	EBSS484	EBSS474-12	EXISTING	H-7107	4-FV-618 4-FV-648	EXISTING	EBOT401	H-7126/28
B FDF IN VANE JCT BOX	EBSS485	EBSS474-13	EXISTING	H-7107	4-FV-654 4-FV-656	EXISTING	EBOT401	H-7127/28

SEE NOTE 2 (* RH PASS DAMPER JCT BOX, * LH PASS DAMPER JCT BOX)

REFERENCES:
H-7107 PRIMARY AIR BECK DRIVE POWER DISTRIBUTION CABINET
H-7108 PULVERIZER MILL BECK DRIVE POWER DISTRIBUTION CABINET

NOTES:
1. FIELD TO INSTALL COPPER WIRE BOND TO LOCAL GROUND MAT
2. PASS DAMPER DRIVES ARE PCXA DRIVES (ABOVE LEFT DIAGRAM)

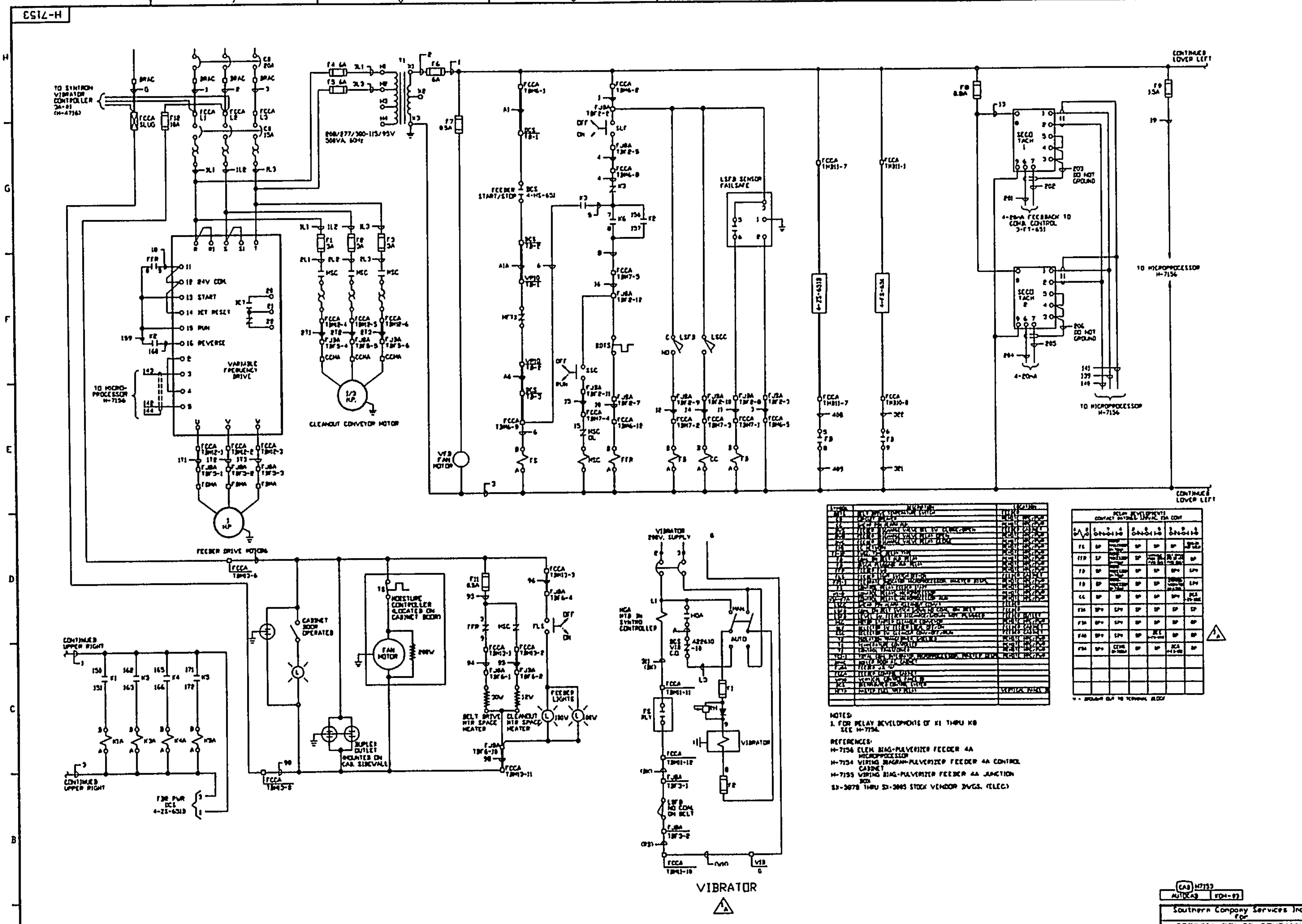
CAD H7106
ACAD CSP-06

Southern Company Services Inc
for
GEORGIA POWER COMPANY
PLANT HAMMOND-UNIT NO 4
WIRING DIAGRAM
BECK CONTROL DRIVES

REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION 0	DATE
														APPROVED	

NONE | 10-201 | H-7106 | 0

H-7153



NOTES:
1. FOR RELAY DEVELOPMENTS OF K1 THRU K8 SEE H-7156.

REFERENCES:
H-7156 ELEM. DIAG.-PULVERIZER FEEDER 4A MICROPROCESSOR
H-7154 WIRING DIAGRAM-PULVERIZER FEEDER 4A CONTROL CABINET
H-7155 WIRING DIAG.-PULVERIZER FEEDER 4A JUNCTION BOX
S3-3078 THRU S3-3085 STOCK VENDOR DWGS. (ELEC)

REVISION	DATE
A REV VIB CONTROL ELEM PER AS-BUILT. USE CONTACT FROM VOLUMETRIC RELAY K4A.	
A APPROVED	7-25-94

Southern Company Services Inc for

GEORGIA POWER COMPANY

PLANT HAMMOND-UNIT NO 4
ELEMENTARY DIAGRAM
PULVERIZER FEEDER 4A
CONTROL

NO SCALE | 10-201 | H-7153 | 1

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	
4APAIDHD	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
4BHTAIRD	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	
4BPAIDHD	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
4CHTAIRD	4C HOT AIR DAMPER DRIVE	H-7223
4CTEMPAD	4C TEMPERING AIR DMPR DRIVE	H-7223
4DHTAIRD	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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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.(
STATUS RFD SAC: SPARE 0 CONTROL ROOM AREA I/O CABINET NO.3 TERM MH 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 MH 0.0
STATUS NF PERCENT FILL 18 TO NODE EBSS427 REHEAT VALVE JCT BOX 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 MH 0.0
STATUS ND PERCENT FILL 12 TO NODE PBWP402 BLR CONT 125VDC DIST CAB 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 MH 0.0
STATUS ND PERCENT FILL 0 TO NODE EIUP001 UNITS 3 & 4 OPERATOR'S CONSOLE UPS 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 MH 0.0
STATUS ND PERCENT FILL 27 TO NODE EBOT401 UPPER BOILER HOUSE I/O CAB NO.1 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 MH 0.0
STATUS ND PERCENT FILL 27 TO NODE EBOT405 LOWER BOILER HOUSE I/O CABINET NO.5 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 MH 0.0
STATUS ND PERCENT FILL 27 TO NODE EBOT402 CONTROL ROOM AREA I/O CABINET NO.2 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 MH 0.0
STATUS ND PERCENT FILL 27 TO NODE EBOT403 CONTROL ROOM AREA I/O CABINET NO.3 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 MH 0.0
STATUS ND PERCENT FILL 27 TO NODE EBOT408 BURNER TEMP CABINET MH/FT 0.00

INCLUDED CIRCUITS BCDC408-R

CABLE CODE	DIAMETER	REQUISIONED	ROUTED	BALANCE
E2A0002C01	0.50	2000	80	1920

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

E2A0002C03	1.27	5000	483	4517

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

E2A0006C03	0.97	2000	45	1955

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

E2A0008C03	0.89	5000	617	4383

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

E2A0010C02	0.62	2000	77	1923

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

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, HYPALO JACKET