CAROLINA POWER AND LIGHT COMPANY

# ERFIS SYSTEM OVERVIEW

BRUNSWICK STEAM ELECTRIC PLANT
EMERGENCY RESPONSE FACILITY INFORMATION SYSTEM
ERFIS

DECEMBER, 1984

GENERAL ELECTRIC

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# 1. INTRODUCTION

## 1.1 PURPOSE AND SCOPE

The purpose of this document is to provide an overview of the computerized Emergency Response Facility Information System (ERFIS) for the Brunswick Steam Electric Plant Units 1 & 2, developed and delivered by General Electric Company.

The ERFIS described herein consists primarily of a data acquisition system, a computer processing system and a display system, which has been designed to aid utilities in complying with NUREG 0737, Supplement 1, and other Nuclear Regulatory Commission (NRC) requirements pertaining to emergency response. The primary function of ERFIS is to make critical plant status information available to plant personnel at all times and provide guidance information during emergency operation. ERFIS also provides supplementary information to aid in plant operation and post event analysis.

## 1.2 SYSTEM OVERVIEW

Figure 1.1 shows the simplified version of the overall system.

The ERFIS is made up of elements of the GE OMNIBUS product family of nuclear power plant information systems. Use of these modular elements provides the ERFIS with a high degree of flexibility as well as a proven design.

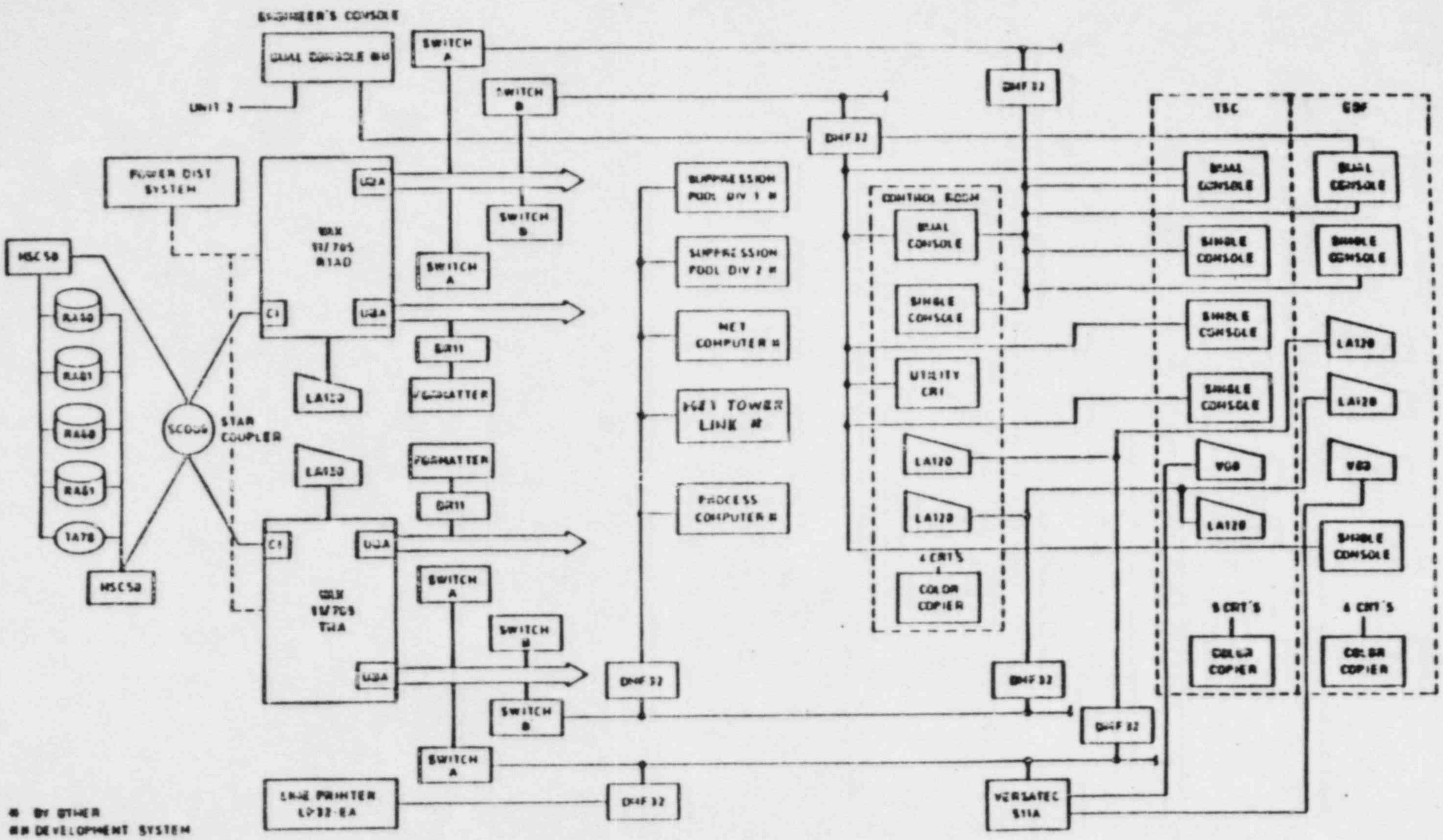
Specifically, ERFIS provides critical plant information and Emergency Procedure Guideline (EPG) information by means of high resolution Intelligent Graphic Display Terminals (IGDTs). The IGDTs are supplied with dynamic data from a redundant central processing system which utilizes Digital Equipment Corp. VAX 11/785 CPUs.

Analog and digital signals are acquired from existing Honeywell 4010 process computer cabinets and field sensors throughout the plant. These signals are scanned and transmitted to the VAX's by the intelligent General Electric Data Acquisition and Control (GEDAC) modules for the ERFIS. Supplementary data is also acquired from the process computer and other computer based plant systems via data links.

Unit 1 and 2 each have separate dual VAX 11/785 based systems with individual data acquisition equipment, control room consoles, and peripherals. The Technical Support Center (TSC) and Emergency Operations Facility (EOF) include a common console which can display information from either Unit 1 or 2.

The ERFIS is configured such that no single failure of a major component (eg. cpu, disk, console, reconfiguration switch) will prevent the primary function from being performed. Data acquisition equipment failures are guarded against failures by duplicating essential sensor inputs. Automatic and manual failover procedures are incorporated.

ERFIS currently does not include process computer functions but expansion capability and spare capacity are included to allow expansion in the future with minimal effort and cost.




* BY OTHER
** DEVELOPMENT SYSTEM

FIGURE 1-1 BRUNSWICK ERFIS / PROCESS COMPUTER

# 2. ERFIS HARDWARE

## 2.1 GENERAL

The ERFIS hardware configuration, typical for one of the units, is shown in Figure 2-1. Table 1 shows the equipment list.

The system consists of three major subsystems:

General Electric Data Acquisition and Control (GEDAC) system developed by Analogic Corp. under General Electric Company specification.

Central Processors and Peripherals from Digital Equipment Corp.

Intelligent Graphics Display Terminals (IGDT) developed by Toshiba Corporation under General Electric Company specification.

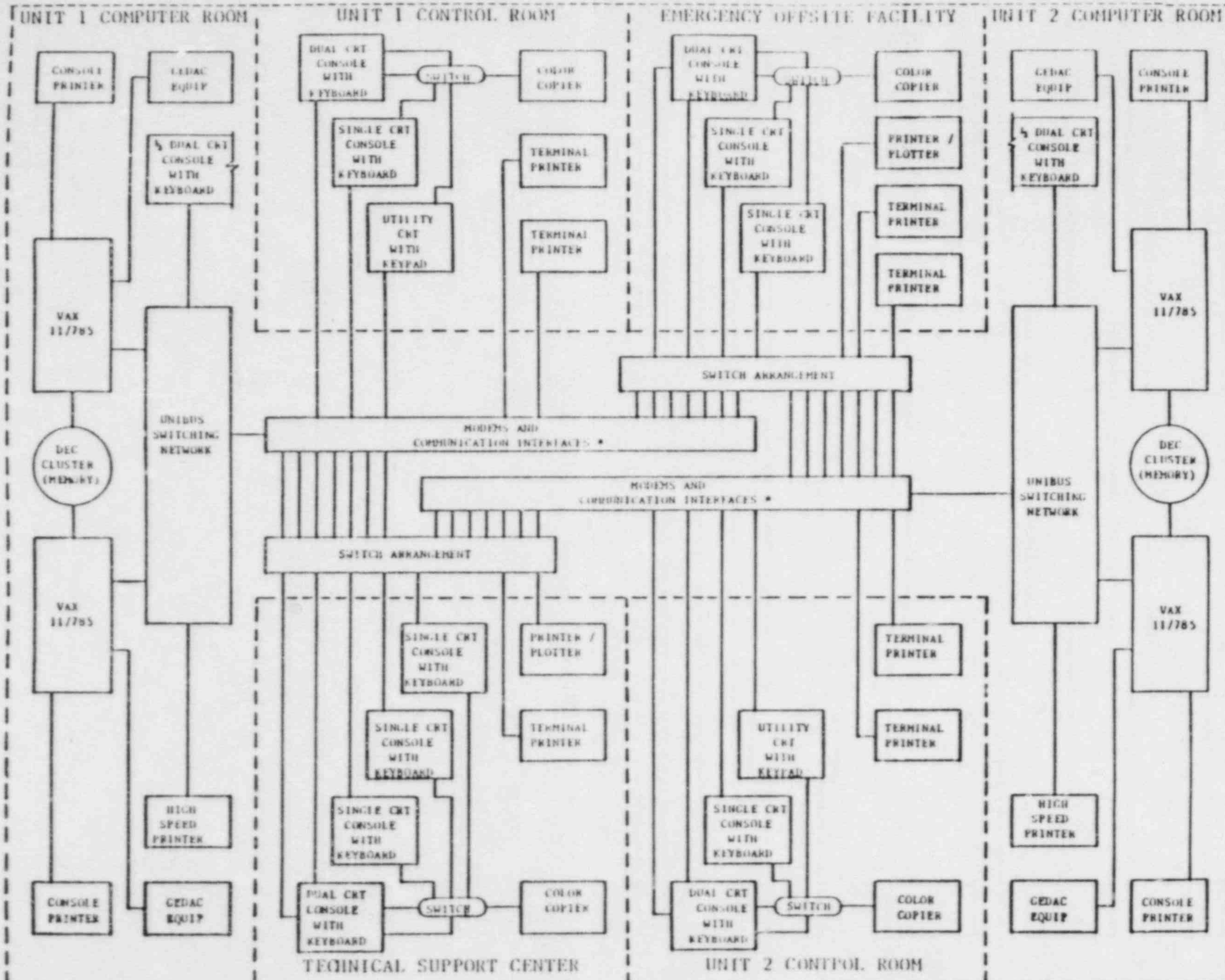
## 2.2 DATA ACQUISITION

### 2.2.1 Description

GEDAC is a microprocessor-based, totally self contained, solid state, high speed, modular system with a flexible structure that can meet adverse application requirements. GEDAC acquires and transmits a wide variety mix of analog and digital signals. The data are gathered at specified identifiable times and transmitted to the host computer.

Hardware for the GEDAC system consists of the numerous functional modules that can be interconnected in a variety of ways to build up a large or small data acquisition and distribution system for both Class 1E and non-1E signals. The major GEDAC modules are:.

a. Analog and digital input/output modules
b. Multiplexer module
c. Power supply module




* INCLUDES INTERFACES TO THE SUPPRESSION POOL MONITORING SYSTEM, THE METEOROLOGICAL COMPUTER AND THE METEOROLOGICAL DATA ACQUISITION SYSTEM.

FIGURE 2-1 BRUNSWICK ERFIS HARDWARE CONFIGURATION

d. Data formatter

e. GEDAC 5500 chassis with cards

f. Multiline driver (splitter)

### 2.2.2 Process I/O Subsystem

The GEDAC process I/O subsystem will collect analog, digital status, pulse and sequence-of-events inputs. The types and quantities of process inputs to Unit 1 and Unit 2 are those that support the Safety Parameter Display System (SPDS) displays as well as other functions, such as, the meteorological data. The GEDAC subsystem also includes the capability to generate analog and digital outputs for trend recorders digital indicators and annunciators in the control room.

The Data Acquisition System (DAS) configuration is hierarchical instead of loop oriented. Figure 2-2 shows Brunswick ERFIS data acquisition. The order is sensors, Input/Output Modules (IOM), multiplexers, formatters and central processors. Each processor interfaces to GEDAC through dedicated single-ported formatters. This provides a high degree of separation and independence as opposed to multiple processors and multiplexers configured on a highway or loop. IOMs scan, digitize and transmit sensor data to centrally located multiplexers. The IOMs provide multiple output ports to allow redundant routing of process data via multiplexers and formatters associated with each CPU. Each multiplexer is connected to a formatter for a given CPU. This provides independent and separate paths for the same IOM data to reach each of the two CPU's.

Two classes of DAS equipment are utilized in the system; those that meet Class 1E requirements (GEDAC 4800 Series) and those that are non-1E equipment (GEDAC 5500 Series). The GEDAC 4800 provides Input/Output Modules (IOMs) which may be located in racks within control panels to eliminate the need to bring sensor wiring to a central location. The GEDAC 5500 provides I/O cards mounted in a chassis which may be mounted within existing panels or in a centralized cabinets. Each IOM or I/O

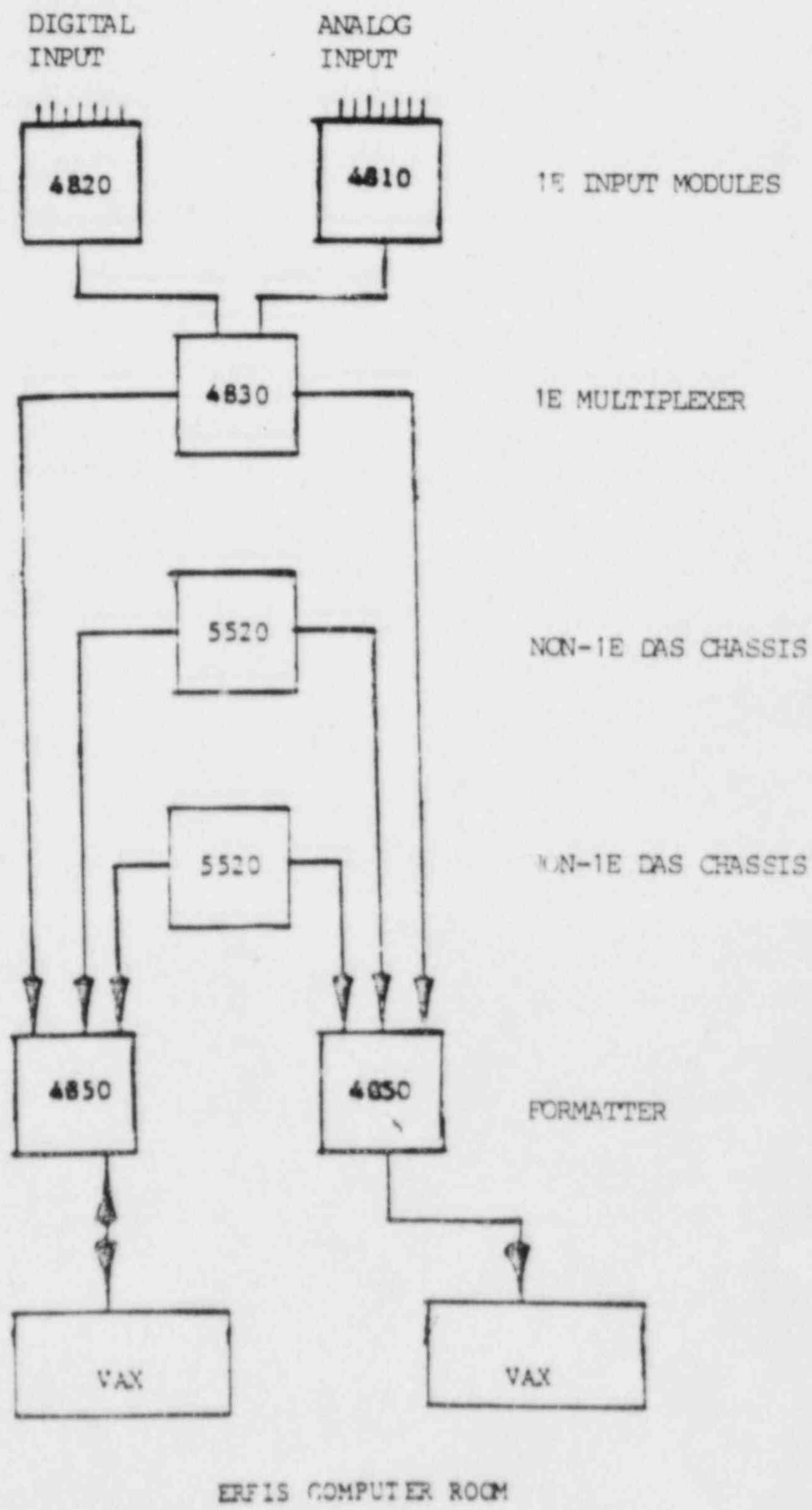



FIGURE 2-2 ERFIS DATA ACQUISITION

card will typically handle eight (8) analog or 16 digital signals. Up to eight I/O modules (IOMs) may be connected to each multiplexer. Each GEDAC 4800 formatter will accommodate up to 16 multiplexers.

Thus each formatter can handle up to 1024 analog inputs or 2048 digital inputs or an equivalent combination of analog and digital inputs. Multiple formatters may be connected to each CPU to obtain a higher point capacity.

GEDAC IOMs, multiplexers and formatters are interconnected via fiber optic or electrical cables which carry serial digitized data. Field addition of multiplexers and IOMs involves only mounting of modules, termination of signals, and interconnection of modules via a single fiber optic or electrical cable.

### 2.2.3 ERFIS Data Acquisition Signals

The system consisting of both class IE and non-IE signals scans and monitors over 900 signals providing data for both SPDS and non-SPDS functions.

## 2.3 CENTRAL PROCESSORS AND PERIPHFRALS

ERFIS Computer system is a VAX cluster configuration with two DEC VAX 11/785 computers. The CPUs, disks, and magnetic tape are interconnected through a star coupler and redundant HSC 50 intelligent I/O server. The star coupler is a passive dual path device which provides a VAX to VAX communication link and data transfer between either VAX and the dual ported disks and magnetic tape unit connected to the HSC 50s. The system combines a 32-bit architecture, high-speed, high-throughput, efficient memory management and a virtual memory operating system to provide essentially unlimited program address space and superior performance.

a. Central Processing Unit

The VAX-11/785 processor provides 32-bit addressing, sixteen 32-bit general registers and 32 interrupt priority levels. The instruction set operates on integer, floating point, character and packed decimal strings and bit fields. The instruction set supports nine fundamental addressing modes.

The processor includes a 32 KB two-way set associated cache memory access time. The processor's memory management includes four hierarchical processor access modes that are used by the operating system to provide read/write page protection between user software and system software.

b. Data-Throughput

VAX-11/785 includes many features that support high data throughput, including high speed computer interconnect (CI) for clustered peripheral controllers, buffered direct memory access for the UNIBUS peripherals and 64-bit data transfers and prefetching.

The operating system supports the hardware througnput in its I/O request processing software. The software uses the processor's multiple hardware priority levels to increase I/O response time and keeps each disc controller as busy as possible by overlapping seek requests with I/O transfers.

c. Main Memory

The main memory for VAX-11/785 is built using 64K MOS RAM chips and is organized in 72-bit words (64 bits for data and 8 for Error Correcting Code [ECC]). Each ERFIS VAX is provided with 8 megabytes capacity. Each memory controller includes a request buffer that substantially increases overall system throughput and eliminates the need for interleaving in most applications.

d. Disc Memory

Two types of disk memories are supplied for ERFIS system, the DEC RA60 and RA81. The DEC RA60 is a high capacity, rack mountable, removable-media disk with 205MB of formatted capacity. It has a peak transfer rate of 1.98MB with an average access time of 50 msec. The DEC RA81 is a high capacity, rack mounted, Winchester disk with 456 MB of formatted capacity. It has a peak transfer rate of 2.2 MB with an average access time of 36.3 msec. Both disks are highly reliable, have a 170-BIT error correction and dynamic defect re-allocation on spare sectors.

e. Magnetic Tape

Magnetic Tape units are manufactured by DEC model TA78, with the following features:

1. Program-selectable recording at 1600 bpi or 6250 bpi
2. 9-track
3. Read/write speed of 125 inch/second
4. Automatic tape threading
5. Internal microprocessor - controlled diagnostics

f. Line Printers

The line printers supplied with the system are manufactured by DEC, model LP32EA, and features:

1. 600 lines per minute, 64 character set
2. 445 lines per minute, 96 character set plotting speed
3. Form thickness adjustment

4. 64-character ASCII set
5. Line width of up to 132 characters
6. A choice of 6 or 8 lines to an inch selected by the operator or under program control

g. Matrix Printer

LA120 dot matrix printer/plotters are manufactured by DEC and feature:

1. 180 characters per second
2. 16.7 inch per minute plotting
3. 96 character ASCII set
4. A choice of 6 or 8 lines to an inch selected by the operator or under program control
5. Stand-alone installation
6. Transparent cover to protect from dust and reduce noise

h. System Console

The processor's console consists of an intelligent micro-computer (LSI-11) with 16K bytes of read/write memory and 8K bytes of ROM, and RX01 floppy disc and a terminal for local operations and port for remote diagnosis. The console operator uses keyboard commands for diagnosis, bootstrapping and incorporating software maintenance modifications.

i. Printer/Plotter

The plotter is Model V80 manufactured by Versatec with the following features:

1. Printing speed 1000 lines per minute, 132 characters/line
2. 200 points per inch resolution
3. 1.2 inches per second plotting speed
4. Tabletop or stand-alone capability

## 2.4 INTELLIGENT GRAPHIC DISPLAY SYSTEM

The Graphic Display System consists of Intelligent Graphic Display Terminals (IGDTs) to serve the function of display generators and consoles. The resolution of these full graphics color units is 1024 by 768 pixels. The IGDTs have much more capability than display generators. They are microprocessor based units that have .. graphic display software and display format descriptions stored in semi-conductor bulk memory. The IGDTs translate variables supplied by the VAX to update dynamic fields on displays and output the static portion of the formats from local memory when a picture switch is activated by the operator. There is also local graphics editor software on the graphics development IGDT to construct formats and upload them to the VAX for distribution to other IGDTs.

The IGDT is the primary user interface for the ERFIS. The display system configurations for ERFIS are provided in singular or double consoles, or a tabletop-mounted configuration. The console contains all portions of the display system (CRT, keyboards, local processor and cables) all in a compact console housing The following features are provided:

a. <u>Color CRT</u>

All color graphic CRTs are high resolution (1024 by 768 minimum), nonglare, 20-inch, raster scan-type color video monitors. The CRTs have capability for 16 colors but the SPDS displays will be designed with the eight major colors.

b. <u>Keyboard</u>

Keyboards are standard alphanumeric keys, dedicated function keys (such as Page forward, Page back, etc.) and 32 operator assignable function keys which are generally reserved for top-level SPDS displays and other high-priority plant unique displays.

c. Display Generation

The display system consists of an intelligent termin. with 4 MBytes of local memory which has the capacity to sto: all of the SPDS displays plus 200 additional displays. Dis; ays can accommodate 96 characters per line and 42 lines per :reen.

d. Color/Video Copier

A color video hard copy unit and interface is provid to copy any of the video displays provided with the system. opy size will be 8 1/2 x 11" and will allow copy of character: or graphics. An input buffer is provided which reduces RT lockup to 50 miliseconds. A color copy will be produced in -3.5 minutes depending on the image density. The color co er is Model TEK 4695 manufactured by Tektronic Company.

## 2.5 OTHER EQUIPMENT

a. DT07 UNIBUS Switch

The DEC-DT07 Switch allows a section of the standard NIBUS together with all of its peripherals, to be switched betw n two central processors. The DT07 can be operated either prog mmably by the two computers in the system or manually with control nel switches. DT07 has a dead man timer which automatically ansfers the UNIBUS section from the failed VAX to the good VAX. combination of hardware and software features allows switching t be performed automatically in the event of a computer failur

b. HSC50 Hierarchial Storage Controller

The HSC50 is a self-contained intelligent mass stora sub-system that connects the two host processors via the Star oupler to a set of mass storage disks or tapes. The HSC50 communic es with host CPU's by way of the computer interconnect(CI) and use Digital's Mass Storage control Protocol for host communic ions. The HSC50 offloads utility operations such as disk shadow g, volume image copying and image backups from the host by performing these operations itself. To maximize througput, the HSC50 handles multiple drives and optimizes the physical operations such as track seeks and rotational positioning.

c. SC008 Star Coupler

The star coupler serves as the common central connecting point for all elements on the Computer Interconnect (CI). The star coupler is an RF-transformer-coupled dual-path passive device that connects up to 10 CI nodes. The unit distributes the signals and provides signal isolation between paths and noise isolation.

d. Computer Interconnect (CI)

The CI is a high-speed fault-tolerant dual path bus. It allows processor nodes and intelligent I/O subsystems to be connected in a computer room environment. A system of up to 16 nodes that allows any VAX processor node in the cluster to talk to any other VAX processor or node. A node is either a VAX processor or an intelligent I/O system like HSC50.

e. Communication Links

Communication channels are provided with ERFIS system to provide other CPU and data acquisition system data. The data supplied through the communication channels are meteorological computer, process computer, suppression pool computer and meteorological data acquisition system.

TABLE 1

BRUNSWICK ERFIS EQUIPMENT LIST
(FOR UNIT 1 AND UNIT 2)

| ITEM | QTY | MODEL NUMBER | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | DEC 785CA-AE | Vax 11/785 2MB (64K chip) Star Coupler and Data Channel |
| 2 | 2 | DEC 785CA-AP | VAX 11/785 2MB (64K chip) |
| 3 | 2 | DEC TA78BF | Dual ACC Mag Tape |
| 4 | 4 | DEC RA60-CA | 205 MB Removable Media Disk |
| 5 | 4 | DEC RA81-AA | 456MB Winchester Disk |
| 6 | 2 | DEC HSC5X-CA | Tape Formatter Data Channel |
| 7 | 11 | DEC LA120-DA | Terminal Printer, KSR |
| 8 | 4 | DEC MS780-FC | 6MB ECC/64K/MOS Memory |
| 9 | 4 | DEC FP785-AA | Floating Point Accelerator |
| 10 | 8 | DEC DT07-DR | Radial UNIBUS Switch 2-Port |
| 11 | 10 | DED DMF32-LP | Multipurpose Communications I/F |
| 12 | 4 | DEC DR11-W | General Purpose DMA I/F |
| 13 | 4 | DEC DW780-AA | UNIBUS Adaptor |
| 14 | 4 | DEC BA11-KU | Expander Box |
| 15 | 4 | DEC DD1-DK | Expansion Backplane |
| 16 | 4 | DEC H9652-MF | UNIBUS Expansion Cabinet |
| 17 | 2 | DEC PDP11/24 | Minicomputer Interface |
| 18 | 1 | DEC LP32-EA | Line Printer |
| 19 | 2 | Versatec V80-311 | 1000 lpm, 200 ppi Printer/Plotter |
| 20 | 2 | Versatec V80-27 | Floor Stand for V80 |
| 21 | 2 | Versatec V80-90 | Accessory Kit |

TABLE 1 (Cont'd)

| ITEM | QTY | MODEL NUMBER | DESCRIPTION |
|---|---|---|---|
| 22 | 2 | DEC | Power Distribution System |
| 23 | 19 | Toshiba 4000X | Graphics Display Subsystem |
| 24 | 12 | Toshiba PRL 8305A | keyboard with Function Deys |
| 25 | 3 | Toshiba | MKZ8403A Slimline Floppy Disk Drives with Portable Carrier |
| 26 | 19 | Toshiba PPL83505A | Color Monitor 20" |
| 27 | 1 | Toshiba | Graphic Development Subsystem |
| 28 | 2 | Ampex | UNIBUS Controller |
| 29 | 5 | GE | Dual CRT Console |
| 30 | 7 | GE | Single CRT Console |
| 31 | 5 | Toshiba | Keyboard Switch |
| 32 | 9 | GE | CRT Switch |
| 33 | 9 | Lightwave | RS232 to FOC Converters (Pairs) |
| 34 | 4 | TEK 4695 | Color Copier |
| 35 | 4 | 4850 Analogic | Formatters |
| 36 | 38 | 4851 Analogic | Formatter I/O Cards |
| | | | 4800 SERIES |
| 37 | 15 | 4840 Analogic | 7 Module Racks |
| 38 | 13 | 4841 Analogic | 2 Module Racks |
| 39 | 13 | 4860 Analogic | Power Supplies |
| 40 | 28 | 4810 Analogic | Analog Input Modules |
| 41 | 42 | 4820 Analogic | Digital Inpur Modules |
| 42 | 10 | 4830 Analogic | Multiplexers |

TABLE 1 (Cont'd)

5500 SERIES

| | | | |
|---|---|---|---|
| 43 | 9 | 5520 Analogic | Chassis |
| 44 | 2 | 5560 Analogic | Expansion Chassis |
| 45 | 34 | AC4050 Analogic | Low Level Analog Input Cards |
| 46 | 16 | AC4600 Analgoic | Temperature Cards |
| 47 | 58 | DC6200 Analogic | Digital Cards |
| 48 | 8 | AC1562 Analogic | Analog Output Cards |
| 49 | 8 | DC6600 Analogic | Digital Output Cards |

# 3. ERFIS SOFTWARE

## 3.1 GENERAL

ERFIS uses common system software together with applications software to achieve its functions. This section briefly describes these software elements.

Major software subsystems are as follows:

| Name | Function | Type | Source |
|---|---|---|---|
| VAX/VMS | Operating System | System | DEC |
| HABITAT | Data Base Management System | System | ESCA |
| CDCI | Common Data and Control Interface | Application | GE |
| TRA | Transient Recording & Analysis | Application | GE |
| RTAD | Real Time Analysis and Display | Application | GE |
| PLA | Process Log and Alarm | Application | GE |

## 3.2 SOFTWARE REQUIREMENTS

All software meets the following general design requirements:

a All VAX software is written in either VAX-11 FORTRAN or Digital Command Language (DCL) with the exception of a limited number of time-critical functions such as the DAS drivers which are written in VAX MACRO.

b. The software system is modular in design to minimize the time and complexity involved in making a change to any program.

c. All software is maintained in patch-free source code form on magnetic tape including libraries and programs required to perform a complete system recompile.

d. All software is compiled, linked, tested, installed and started via COMMAND FILE PROCEDURES. The procedures are entirely inclusive with options and the data necessary to convert a source code module into an executable module.

e. All software will have error handlers that will diagnose the error that has occurred. No illegal response to a prompt will result in fatal termination of a function. The function will either re-prompt or allow the function to proceed.

## 3.3 SYSTEM SOFTWARE

System software has been designed to incorporate common software elements having great versatility to enhance the capability for expansion. The system software has been modularized so that it can be adapted to a wide variety of applications with a minimum of modifications. Following is a description of these common elements.

### 3.3.1 VAX/VMS Operating System

VAX/VMS is a comprehensive, fast and convenient operating system which includes a variety of system management routines, software development tools, a file management system and other facilities. It supports several languages and provides great latitude in the degree of user control of computer operation.

The system provides an efficient and transparent system management capability for the control of critical operations. Because it is a virtual memory system, (VMS), processes need not reside entirely in physical memory to execute. VMS uses a 32-bit address to provide an extensive virtual address space for user processes. Portions not required at a given time can reside on secondary (disk) storage. Paging automatically transfers program from disk memory into main memory as needed so that programmers can write as if a program was entirely in physical memory. This simplifies software implementation and provides efficient use of main memory. Thirty-two priority levels are available to allot CPU time and memory residency for varying process criticalities.

VAX/VMS provides a wide variety of tools to simplify software development such as the symbolic debugger for debugging either FORTRAN or assembler languages using the same statement numbers and symbols used in the source code. Other such tools include an interprocess communication and control capability and a library of several hundred general-purpose programming routines. A record management system provides a choice of file organizations and access modes to accommodate a variety of types of data bases. Other facilities include a common command language for both batch and interactive processes and support for many high-level languages and a query language.

VMS includes the following components.

- o Virtual memory manager
- o Swapper
- o System services
- o I/O Device drivers
- o User authorization control program
- o Job initiator and symbiant manager
- o Account manager
- o Operator Communications Manager
- o Error logging and print utility
- o Digital Command Language (DCL) command interpreter
- o Monitor Console Routine (MCR) command interpreter
- o Interactive and batch editors
- o MACRO assembler

- Cross-referencing linker
- Library maintenance utility
- Common Run-Time Procedure Library
- Symbolic debugger
- Record Management Services (RMS)
- Files-11
- Sort utility
- Software maintenance release update utility
- RSX-11 development package, which includes a MACRO-11

In addition, VMS contains a utility function, MONITOR, which is a system management tool that presents information on operating system performance. This function helps the system manager to tune the system for optimum performance.

### 3.3.2 DECnet-VAX

With DECnet-VAX, a suitable configured VAX/VMS system can participate as a routing or end node in DECnet computer networks. The DECnet-VAX software, when installed on a VAX/VMS system, allows communication between different, networked systems that use the same products.

### 3.3.3 VAX FORTRAN

VAX FORTRAN is an optimizing FORTRAN compliler designed to achieve high exectuion speed. It is an implementation of full-language FORTRAN-77, which is based on ANSI FORTRAN X3.9-1978. The sharable, reentrant compiler takes full advantage of the VAX floating point and character instruction set and the VAX/VMS virtual memory operating system. It includes switch-selectable support for programs conforming to the previous standard, ANSI X3.9-1966.

VAX FORTRAN also provides a number of extensions beyond the current ANSI standard, including language elements for keyed and sequential access to VAX RMS multikey ISAM files and a set of data types beyond those specified for full language FORTRAN-77.

### 3.3.4 HABITAT Data Base Management System

HABITAT is a data base system designed especially for VAX computers to provide efficient processing for engineering applications. It creates a total environment for the development and implementation of large software systems which involve man/machine interface and complex mathematics in engineering programming.

HABITAT is composed of many parts of which man/machine interface and data base management are the two most visible. It is designed to achieve three primary goals:

a. Simplify and structure initial programming for a complex system so that future user coding additions for sophisticated analytical functions may be performed by application engineers and analysts rather than a separate programming staff.

b. Provide and maintain a software environment that promotes efficient mathematical computation.

c. Integrate man and machine with the application operational process rather than have isolated tasks in the same machine.

#### 3.3.4.1 HABITAT Components

HABITAT is composed of five major subsystems that form layer of programming underneath the VAX/VMS executive operating system. The major elements of HABITAT consist of the following:

a. PHOENIX

PHOENIX is the data base manager and data base definition tool providing virtual memory resident, permanent data structures for communication among programs and between programs and displays. It allows for easy and prompt displays of data through its data classification into a pre-specified format composed of a unique hierarchy of tiers of data elements.

b. EASEL

EASEL is a picture compiler used to define man/machine communication. In HABITAT, data is transmitted to or accepted from the human user through EASEL-created displays on CRTs and other I/O devices.

c. FLO

FLO provides packaged commands for installing FORTRAN programs in HABITAT, and for maintaining the source code and documentation which support the programs.

d. RAPPORT

RAPPORT is the on-line manager of man/machine activities, handling the construction of display/pages, entry of data from display pages and processing of commands such as function key actions.

e. PAN

PAN is the traffic manager for application program activities, handling their initiation, termination and any operator communications.

3.3.4.2 HABITAT Benefits

Some of the advantages and benefits derived from the use of HABITAT are as follows:

a. Separation of data base and instructions development thus reducing development effort and facilitating a well structured design.

b. Provides a common focus and means of information exchange for program developers.

c. Aids maintenance and helps avoid errors due to unexpected effects of data base structure changes on existing program operation by detecting inconsistencies between programs and data base versions.

d. Enforces a common discipline for data base definition during development and maintenance phases.

e. Ease of system enchancement via HABITAT tools for data base (PHOENIX) and MMI (EASEL) definition.

f. Realtime performance realization through use of VMS mapping facilities for data base access.

## 3.4 APPLICATION SOFTWARE

The application Software is divided into 4 major segments; CDCI, RTAD, TRA, and PLA. The major Application Software segments are further subdivided into major functions or components. This segmentation is based on functional content and structure for configuration management of the software modules.

The CDCI, RTAD, and IGDT software are used to produce the ERFIS Emergency Procedure Guideline (EPG) displays. CDCI and TRA software produce the pre and post event analysis reports. PLA and CDCI software perform the supplementary point processing, alarm, log and display functions.

The following is a description of the software:

3.4.1 Common Data and Control Interface (CDCI)

The CDCI Subsystem acquires and records plant sensor data, and controls the flow of data from the DAS to the components of TRA, RTAD, PLA and other subsystems to which it is interfaced.

3.4.1.1 DAS Interface Software

Raw data is acquired from the GEDAC formatters by CDCI. The data is routed to disk for historical use by the TRA and to buffers in main memory for use of realtime point data processing by PLA. A major element is Central Data Acquisition (CDA) which handles the host processor interface with the DAS. It performs the following functions:

a. Acquires and stores sensor input readings from formatters;

b. Receives and processes DAS diagnostic messages;

c. Processes user commands which control DAS operation, scan recording and event monitoring;

d. Processes output requests to drive trend recorders and operate digital contacts.

3.4.1.2 Man/Machine Interface (MMI)

Two modes of MMI are utilized; graphic and non-graphic. The graphic mode utilizes the RTAD software segments and graphic processing capabilities of the IGDT. Non-graphic mode is implemented using HABITAT, the Video Terminal (VT) emulation capabilities of the IGDT or an actual VT type device, and CDCI and PLA software.

In addition, communication at the VMS DCL level is accomplished by logging in as a VMS user.

The CDCI man/machine interface provides the Main Menu for personnel to select other man/machine interface functions for CDCI, RTAD support, PLA and TRA. The man/machine interface functions packaged in the CDCI are:

a. The DAS Control Interface Service function allows user to establish functions and set up operation for central processing such as loading a new sample plan or starting and stopping processing.

b. The System Status Service function provides the user display or hardcopy outputs for DAS diagnostics and Bad Point IDs.

c. The Analysis Function Interface provides the ability to select functions and enter user options for the Transient Recording and Analysis (TRA).

d. The RTAD Function Interface enables the user to perform support functions for the RTAD such as definition of terminal authorization for displays and request reports of display definitions.

e. Help functions are included that can be entered via poke point selection from other man/machine interface displays.

### 3.4.1.3 Configuration Processing

ERFIS Configuration Processing includes Data Base Editing, Validation and Generation software.

The Data Base Edit function allows user to:

a. modify the number of GEDAC modules and the module strapping and interconnection information in the data base;

b. modify, generate and list the Point Definition Data Base and the Sample Plan;

c. Generate or list the contents of the Formatter Data Base.

3.1.4.4 Event Monitor

Event Monitor detects the occurence of trips, sequence-of-events and log triggers and activates processes assigned to handle these occurences.

3.1.4.5 Data Retrieval

Raw point data is stored in system buffers and on the recording disk. The Data Retrieval software accesses and processes this data on request from another software process. It performs the following:

a. Point Validation and Conversion - performed for each measured analog and digital input point, as appropriate, and consists of the following operations:

- Bad Point Check
- Filtering
- Sensor Range Check
- Engineering Units Conversion
- Special Validation

b. Composed Point Calculations - performed for selected digital or analog input points. Simple combining of points using up to 30 operators (i.e. EQUAL TO, AND, SQUARE ROOT, etc.) and operands (Other points or constants).

c. RTAD Display Algorithms - evaluates display algorithms using routines developed for generating SPDS variables.

3.1.4.5 Raw Data Management

The CDCI handles automatic archiving of processed historical data from disk to magnetic tape and manual reload of magnetic tape history for disk review.

3.4.2 Real Time Analysis and Display (RTAD)

The RTAD operates on processed realtime point data changes. It distributes this point value and status data to the IGDT for translation and video update.

The role of the RTAD is as follows:

a. executes data processing by applying CDCI (Data Retrieval) to real time data to prepare it for RTAD outputs;

b. performs display processing by manipulating and transferring data from storage to the IGDT;

c. provides display editing capabilities so user can build, modify, add to or delete displays in the system (resident in IGDT);

d. responds to changes in display selection from the IGDT.

### 3.4.3 Process Log and Alarm (PLA)

The PLA software performs point processing. Realtime data is processed by the PLA utilizing components of the CDCI. The PLA produces a live data base of measured and derived point values and status. This data base is used by the PLA for logs and non-graphic displays and RTAD as a source of values and status for graphic displays. Logs are produced by the PLA and output via the CDCI and VMS. The definitions of logs are contained in a data base that is constructed using log editing capabilities. Non-graphic displays, such as alarms, summaries and group displays, are generated by the PLA software.

The following paragraph describes the general capabilities of the PLA function.

#### 3.4.3.1 Point Processing and Calculation

a. Analog Processing - All analog variables are converted to engineering units and alarm checked at their specified processing rates. The values and statuses are updated in the point definition data base.

b. Digital Processing - All digital variables are alarm checked at their specified processing rates. The states and statuses are updated in the point definition data base.

c. Composed Point Processing - Points which are functions of the points are derived at their specified processing rates. The values, states, and statuses are updated in the point definition data base.

d. Transformed Variable Calculations - Performed by transforming analog points using special calculations (i.e. rate of change, periodic weighted average, etc.).

e. Pulse Input Accumulation and Conversion - Conversion of pulse inputs to engineering units and alarm checking is performed every minute.

3.4.3.2 Alarm Log and Display (ALD)

The ALD software performs the following:

a. Alarm Log for printing record of all point alarms and return-to-normal occurrences.

b. Alarm Display of point alarms and nonpoint alarm messages giving alarm status and priorities.

3.4.3.3 Group Point Display

Group Point Display provides and updated display of analog and digital values giving alphanumeric tabulation of selected point information.

3.4.3.4 Log Generation and Reporting (LGR)

The LGR produces the following logs:

a. Special Logs of up to 40 groups of 32 points each which provide trends of selected point groups.

b. Sequence-of-Events (SOE) Log of 1ms resolution for printing all changes of state to assist malfunction diagnoses.

c. Post Trip/Scram Logs provide printing of pre and post trip readings for selected points to be printed after either turbine trip or scram.

d. Plant Periodic Logs for hourly, daily and monthly printing of up to 192 selected points.

3.4.3.5 Man/Machine Interface

The PLA application software operator interface functions include menu-based services for assisting the user in selecting points and groups and providing a variety of logs and alarm-based displays. The functions are selected from the CDCI System Function Main Menu. The available services include:

a. Point Data Service
b. Log Editor/Generator
c. Log Services
d. Group/Point Display Service
e. Alarm Services
f. Summary Services
g. Trend Pen Services

3.4.4 Transient Recording and Analysis (TRA)

Reporting and analysis of transient data is acomplished by the TRA using realtime or historical data supplied by the CDCI. The man/machine interface software for the TRA is part of the CDCI. The displays and interface to the video are done via HABITAT. The TRA provides the ability to record and analyze transient raw data at time resolutions on the order of 2ms to 1 second.

The point data, events and selected logs are recorded on disk in a separate area from the raw transient data. This software records operational events as they occur and measured and derived point readings at the frequency at which processing is performed in realtime or slower.

The TRA performs either real-time or historical data analysis as follows:

a. calculates Conversion Constants used to convert raw data to engineering units;

b. generates either Time History plots or tabular trends for selected data;

c. does statistical or Fourier analyses;

d. provides First Function versus Second Function plots;

e. provides delta (significant change) recording of selected signals;

f. does Sequence-of-Events recording including timing and sequence of occurrence;

g. generates plotter commands to produce hard copy plots.

h. provides for review and reporting of selected events from the historical files.

# 4. ERFIS FUNCTIONS

## 4.1 GENERAL

ERFIS performs the following functions:

a. Data Acquisition
b. System Variable Processing
c. SPDS - Safety Parameter Display System
d. Technical Support Center (TSC) and Emergency Operations Facility (EOF) Support
e. CRT Trending and Plotting
f. Monitoring and Alarming
g. Logging
h. Console Functions
i. Engineers Console Functions
j. Historical Data Storage and Retrieval
k. Alarm Display
l. Graphic Displays
m. Configuration Control

## 4.2 Data Acquisition

ERFIS acquires data from the following sources:

a. Plant Sensors
    1. Analog Sensors
    2. Digital Sensors
        a. Status
        b. Pulses from energy metering devices
        c. Sequence-of-events

b. Process Computer

c. Meteorological Computer

d. Meteorological Data Acquisition System

e. Suppression Pool Div 1 and 2 Computers

4.2.1 Analog Data Acquisition

Analog data is collected by ERFIS at selectable sample intervals of 1.0, .5, .1, .04, .02, .01, and .004 seconds.

4.2.2 Digital Data Acquisition

Digital data collection is performed by ERFIS at selectable intervals of 1.0, .5, .1, .04, .02, .01, .004, .002, and .001 seconds.

4.2.3 Sequence-of-Events Data Acquisition

ERFIS acquires sequence-of-events inputs to enable a resolution of 1 millisecond with respect to relative order of occurrence.

4.2.4 Pulse

ERFIS acquires pulse input digital changes from KWH metering equipment.

4.2.5 Telemetered inputs

ERFIS acquires data for the process computer, meteorological, and suppression pool via data links.

4.3 System Variable Processing

ERFIS performs real time processing of measured and pseudo system variables. System variables are defined to be measured or derived variables which are assigned alphanumeric point identification.

4.3.1 Measured Point Processing

ERFIS processes measured analog, digital points, and pulse inputs.

4.3.1.1 Measured Analog Processing

ERFIS validates, converts to engineering units, and alarm checks measured analog inputs in real time at selectable intervals of 1, 2, 5, 10, 30 and 60 seconds. At least 400 points per second can be processed by EFRIS in real time.

4.3.1.2 Measured Digital Processing

All measured digitals are validated and checked for alarm by ERFIS every second.

4.3.1.3 Pulse Inputs

ERFIS validates and accumulates pulse counter digital input changes of state. Every one (1) minute, ERFIS computes the pulse rate (i.e. power), and updates the one minute, hourly, daily and monthly accumulators (i.e. energy).

4.3.2 Pseudo Point Processing

ERFIS performs processing of composed points, transformed variables, and calculated variables.

4.3.2.1 Composed Point Processing

Composed points are variables which are logical or arithmetic combinations of other system variables. ERFIS calculates, validates, and alarm checks up to 2000 composed points at the specified processing interval for each point. At least 400 composed points per second can be processed by ERFIS. Both composed analog and composed digital (i.e. Boolean) variables are provided.

4.3.2.2 Transformed Variable Processing

Transformed variables are time related functions of another system variable that are calculated periodically. EPFIS calculates, validates and alarm checks up to 1000 transformed variables at time interval over which the transformation is to be performed (i.e. 1 minute, 10 minutes, 1 hour, 1 day, 1 month). Intermediate accumulation of data is performed at appropriate subintervals. Transformations provided are rate of change, integration, smoothed, sum, average, function weighted average, maximum and minimum.

4.3.2.3 Calculated Variable Processing

Points for which values are computed by ERFIS application programs or are received from other external systems, via communication links, are classified as calculated variables. ERFIS provides for up to 400 calculated analog and 200 calculated digital values. All calculated variables can be validated and alarm checked by ERFIS.

4.3.3 System Constants and Flags

ERFIS provides up to 600 system constants and 400 system flags that can be defined and given point identifications.

4.4 SPDS - Safety Parameter Display System

ERFIS continually monitors critical plant system variables and displays information to the plant operators in the following functional areas of plant operation:

a. Reactivity Control
b. Reactor Core Cooling and Heat Removal
c. Reactor Coolant System Integrity
d. Radioactivity Release
e. Containment Integrity

The information is represented by color coded status indicators, bar graphs, trend plots, 2D plots, digital values and textual descriptions.

SPDS displays can be called up from any authorized console by means of dedicated function buttons, entry of a display ID, or activation of a poke point.

## 4.5 Technical Support Center and Emergency Operations Facility

ERFIS provides consoles and peripherals in the TSC and EOF locations which can be given permission to access the same system information as an operator from the control room console.

## 4.6 CRT Trending and Plotting

ERFIS provides the ability to call up displays which show dynamically updated trends of the most recent 30 minutes of data. The types of trend displays are:

a. X-T Trend
b. X-Y Trend

## 4.7 Monitoring and Alarming

ERFIS performs system variable alarm monitoring and generates alarm messages. Alarm messages are printed and displayed. Analog and digital alarm processing is performed as part of the System Variable Processing (see 4.2).

The following checks are performed by ERFIS:

a. Analog Input Alarm Checks
   1. Validity
   2. Reasonability limits
   3. Warning limits
   4. Operating limits
   5. Significant (re-alarm)
   6. Deadband
   7. Cutout
   8. Operator Inhibit
   9. Variable limits

b. Digital Input Alarm Checks

1. Validity
2. Alarm state
3. Cutout
4. Operator inhibit

c. Pulse Input Alarm Checks

1. Validity
2. Warning rate limit
3. Operating rate limit
4. Significant (re-alarm)
5. Deadband
6. Cutout
7. Operator inhibit
8. Variable limits

4.7.1 Analog Alarm Processing

ERFIS alarm processes measured and pseudo analog points.

4.7.1.1 Fixed limits

High and low reasonable (sensor) limits, warning limits, and operating limits checks are performed by ERFIS for all measured and pseudo analog points.

4.7.1.2 Variable limits

ERFIS calculates variable limits and uses the values instead of fixed operating limits for points which have variable limits assigned.

4.7.1.3 Alarm Deadbands

ERFIS provides deadbanding for all alarm limits in order to prevent cyclic alarming.

4.7.1.4 Significant Alarming

ERFIS provides realarming, as significant changes further away from or towards the operating range occur, for designated points which are in alarm.

4.7.1.5 Alarm Cutout

ERFIS includes checks to suppress alarm notification for designated points based on the state of a specified digital input.

4.7.1.6 Operator Controls

ERFIS bypasses alarm checks for points deleted from processing, but not substituted or deleted from alarm check, by the operator.

4.7.2 Digital Alarm Processing

ERFIS alarms measured and pseudo digital points.

4.7.2.1 Alarm State

ERFIS checks digital points for changes to and from the specified alarm state.

4.7.2.2 Alarm Cutout

ERFIS suppresses alarm notification for digital inputs that have cutout conditions satisfied.

4.7.2.3 Operator Controls

ERFIS bypasses alarm checks for digital points that are deleted from processing and not substituted or deleted from alarm check by the operator.

4.7.2.4 Pulse Input Alarm Processing

ERFIS checks pulse input rate values against specified rate limits.

4.8 Logging

ERFIS includes the following logs:

a. Special (i.e. group) Logs
b. Post Trip/Scram Logs
c. Plant Periodic Log
    1. Hourly Log
    2. Daily Log
    3. Monthly Log
d. Sequence-of-Events Log

4.9 Console Functions

The ERFIS provides console functions to perform the following:

a. Data Acquisition Control
b. Tabular Trend Report
c. Time History Plot
d. Empirical Calculation of Conversion Constants
e. Statistical Analysis Report
f. Raw Data Management
    1. Archive
    2. Reload
g. Point Data Display/Change
h. Group Point Display
i. Special Logs.
j. Post Trip/Scram Logs

k. Plant Periodic Logs
   1. Hourly
   2. Daily
   3. Monthly

l. Graphic Displays

m. Summarys

n. Trend Pen

o. System Status Display

p. Alarm Display
   1. Display Callup
   2. Acknowledge Alarms
   3. Category Callup
   4. Paging

q. SPDS Display

4.10 Engineers Console Functions

The ERFIS Engineers Console is provided with the functions available from the operators console plus the following:

a. Configuration Processing
   1. DAS Hardware Editor
   2. Sample Plan Editor
   3. Point Definition Data Base Editor
   4. Event Monitor Data Base Editor

b. Log Generator/Editor
   1. Special Log Editor
   2. Periodic Log Editor
   3. Post Trip/Scram Log Editor

4.11 Historical Data Storage and Retrieval

ERFIS performs historical data storage and retrieval functions as follows:

a. Historical Data Storage - ERFIS performs the following types of historical data storage:

1. Scan Data:
Raw data collected and time tagged at scan mode sample plan frequencies.

2. Delta Data:
Raw data changes collected and time tagged at delta mode sample plan frequencies.

3. Engineering Unit (EU) Data:
Measured and derived EU data collected and time tagged at processing class frequencies.

4. Transaction Data:
Alarms and operator point data changes recorded at time of occurrence.

5. Archival Storage:
Historical data transferred to magnetic tape.

b. Retrieval and Analysis - The following retrieval functions are performed by ERFIS:

1. Tabular Trend:
Printed or displayed tabular trend of specified variables over a designated interval.

2. Time History Plot:
Plotted trend of specified variables over a designated interval.

3. First vs. Second Function Plot:
Plot of one variable vs. another.

4. Statistical Analysis:
Computation and printed report of statistical quantities for a specified variable over a specified time interval.

5. Alarm History:
   Chronological printed or displayed report of alarm over a specified interval.
6. Point Data Change History:
   Chronological printed or displayed report of operator point data changes over a specified interval.
7. Archival Data Reload:
   Transfer of a specified data set from magnetic tape to disk.

## 4.12 Alarm Presentation

ERFIS performs the following functions associated with alarm presentation:

a. Alarm Display
   1. Priority categorization
   2. Notification of new alarms
   3. Cyclic update of current alarms
   4. Display pages within alarm categories
b. Alarm Log
c. Alarm Annunciation
   1. Audible Alarm
   2. Trouble Light Annunciation
d. Alarm Acknowledgement

## 4.13 Graphic Displays

The ERFIS graphic editing and display capability for customer construction of other displays. ERFIS includes capacity to incorporate 200 flow, electrical, hydraulics, instrumentation and control, or other type of diagrams.

## 4.14 Configuration Control

ERFIS performs the necessary functions to maintain system operability as follows:

a. Interprocessor Communications

b. Restart

   1. Partial Restart

   2. Full Restart

c. CPU Failover

   1. Manual Failover

   2. Automatic Failover

d. Device Failover

   1. Automatic Failover

   2. Manual Restoration

Enclosure 4

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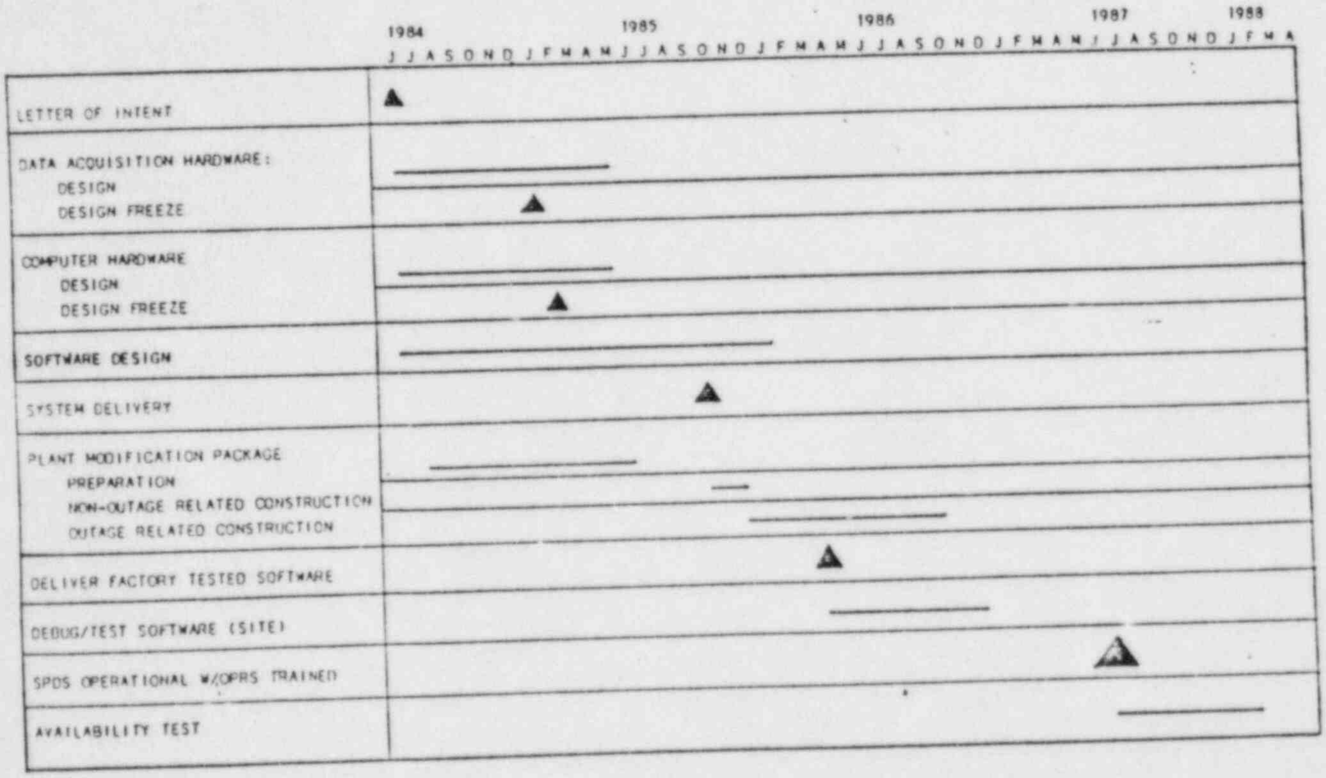
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT - UNIT 2

SAFETY PARAMETER DISPLAY SYSTEM
ENGINEERING & IMPLEMENTATION SCHEDULE




BRUNSWICK-2 (First Brunswick Installation):

1) The outage related construction will be accomplished during the maintenance outage, presently scheduled to begin in December 1985.

2) The installation will be complete with operators trained three months after reload 6, presently scheduled to begin in December 1986.

3) Following this completion, with the unit operational, there will be a six month (4400 hour) test of the system's availability (e.g., downtime, equipment failures, etc.).

Enclosure 5

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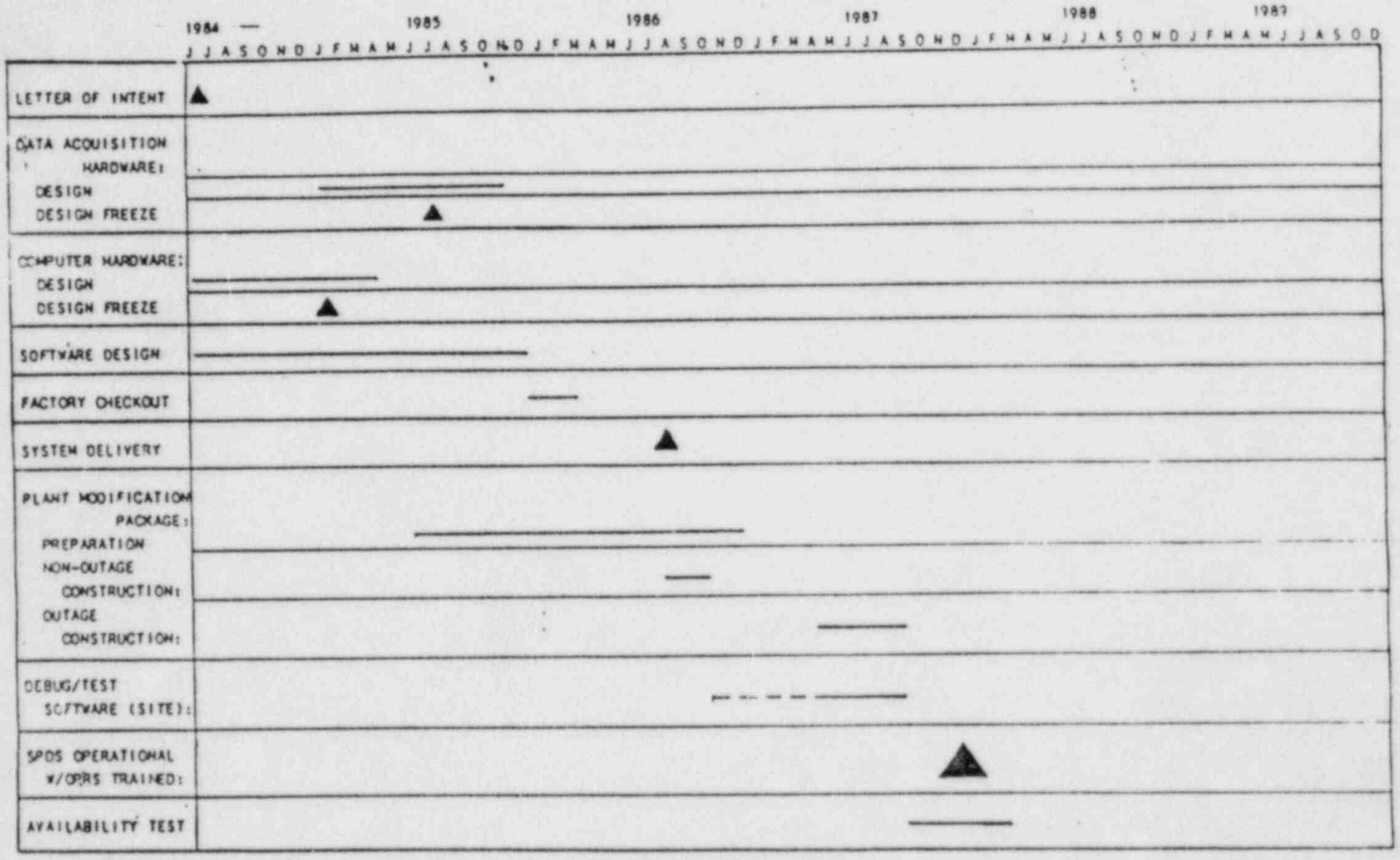
CAROLINA POWER & LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT - UNIT 1

SAFETY PARAMETER DISPLAY SYSTEM
ENGINEERING & IMPLEMENTATION SCHEDULE




BRUNSWICK-1:

1) The outage related construction will be accomplished during reload 5 presently scheduled to begin in April 1987.

2) Prior to the outage the software will be tested on site using simulated inputs (dotted line on scheduled).

3) The installation will be complete with operators trained three months after reload 5 presently scheduled to begin in April 1987.

4) Following completion, the Brunswick-1 system will be tested for availability over a six month period.

Enclosure 6

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## HUMAN FACTORS ENGINEERING (HFE) IMPLEMENTATION

### A. GENERAL

A Human Factors Engineering Implementation plan is a part of the design process for the ERFIS in order to ensure that the ERFIS meets its intended objectives and accommodates its intended users. The activities in the HFE implementation plan are iterative in nature. Designs are developed based on Human Factors Engineering principles, then reviewed to assure that those principles have been properly implemented. Results and recommendations from reviews are then evaluated for impact and action plans are developed for incorporation into the design.

The ERFIS HFE plan is an integral part of the design and review of the system as a whole as well as the design and review of the more detailed aspects of the system. The plan generally consists of activities such as definition of HFE requirements, reviews, testing, analysis, and verification activities. These activities can be separated into the following specific major areas:

1. Definition of System Functional Requirements
2. Task Analysis
3. Man-Machine Interface Development and Review
4. Verification and Validation
5. Personnel Training

The following sections describe in more detail the specific tasks which are performed in order to provide a comprehensive implementation of the overall HFE plan. Specific tasks consist of both plans for future implementation as well as previously performed activities which can be related specifically to the ERFIS.

### B. DEFINITION OF SYSTEM FUNCTIONAL REQUIREMENTS

The first task in the HFE plan is the development of system level requirements. The system level requirements will be based upon:

1. Interfaces to systems outside of the ERFIS
2. Codes, standards, and regulatory requirements
3. Assumptions and constraints
4. Definition of what the ERFIS is to perform and what the user is to perform (functional allocation)
5. Purpose of the ERFIS (mission statement)

The system functional requirements define what the ERFIS is to do, what performance is expected and what part of the system consists of user interaction.

These requirements provide the basis for comparison of other activities. Reviews of the ERFIS are performed against the fulfillment of the requirements developed in this activity. The system level requirements are issued in a controlled document.

C. TASK ANALYSIS

In addition to definition of functional requirements, specific requirements related to the performing of time critical plant procedures are developed. This activity consists of defining the specific requirements related to the performance of the BSEP Emergency Operating Procedures (EOPs).

The task definitions from the BSEP System Function and Task Analysis, a part of the BSEP Control Room Design Review effort, are used to define the specific tasks an operator performs in order to follow the BSEP EOPs. These task descriptions are then used to examine:

1. The content of the BSEP Safety Parameter Displays,

2. The user interface required to access the BSEP SPDS information,

3. The usability of the data for an operator following the EOPs.

The analysis of tasks is used similarly to the system functional requirements, in that, it provides a basis for any review which will compare the actual ERFIS implementation to the fulfillment of its intended purpose. Documentation includes the task descriptions (from the Control Room Design Review) as well as an analysis of the capabilities of the SPDS portion of the ERFIS to aid in the performance of the EOP tasks.

D. MAN MACHINE INTERFACES

1. General

The purpose of the man-machine interface portion of the HFE plan is to assure that the hardware used in the ERFIS is consistent with the intended purpose and function of the system. This assurance results from the use of HFE principles throughout the design process as well as systematic review procedures. The following specific activities are performed in order to implement this purpose.

2. Hardware Location Review

A hardware location design review is performed in order to ensure that the placement of the hardware provides the users with a useable configuration for performing the activities for which the ERFIS was designed. In addition, the review ensures that hardware will not be placed in such a manner as to prevent users and other affected personnel from performing other personnel duties which are unrelated to the use of the ERFIS.

3. MMI Hardware HFE Review

In addition to location, the MMI hardware design is reviewed against an appropriate HFE checklist (such as NUREG 0700, Reference 5) in order to ensure that the hardware properly accommodates the intended user. The review of the hardware design is documented in a checklist fashion with appropriate summaries and conclusions of any notable results.

E. HUMAN FACTORS ENGINEERING VERIFICATION AND VALIDATION

1. General

The "Verification and Validation" activities of the HFE plan are an ongoing part of the entire design process for the ERFIS. Some of the activities in verification and validation must be completed in the early stages of the design process whereas others are completed only in the final stages of the project. The major features of the HFE portion of verification and validation are described below. They include:

a. Test Requirements Development

b. Static HFE Review

c. Dynamic Review

d. Integrated Hardware/Software Validation Test

2. Test Requirements Generation

The development of test requirements is performed parallel to the "Man Machine Interface" activities and the "Training" activities. The system functional requirements are used as the basis for the development of tests and procedures which verify and validate, in general, the ERFIS functions, and specifically the BSEP SPDS displays. These requirements are issued as controlled documents. The implementation of these requirements is performed during the integrated hardware/software test as described below in Section E.5.

3. Static HFE Review

The BSEP SPDS displays are examined in a specific HFE review for comparison to basic human factors principles (such as those defined in NUREG 0700) and a determination of usefulness to the operator by using the tasks from the Control Room Design Review. This type of review was previously performed on the General Electric generic Emergency Response Information System (ERIS) displays using the BWROG Emergency

Procedures Guidelines. The results of the generic study were favorable and useful display improvements are being incorporated into the BSEP SPDS displays.

4. Dynamic Review

An extensive dynamic review was performed on the General Electric generic ERIS displays at the BWR/6 simulator in Tulsa, Oklahoma. This review consisted of a HFE check using a checklist approach similar to that described in Section E.3, the administration of 12 unique simulated transients, operator/system performance evaluations during the transients using the Perry Nuclear Power Plant EOPs and data collection for the measurement of the usefulness of the ERIS SPDS related displays.

In general, the ERIS was perceived by the operators as a significant aid in plant control during emergencies and was judged as presenting an exceptional source of synthesized/centralized information with regards to plant performance. In addition, recommendations from the dynamic review are being incorporated into the ERFIS displays.

5. Final Integration Testing

The final activity in completing the ERFIS design is the integration of hardware/software and the user in a final test scenario. This test, also called "Factor Acceptance Test," verifies that the system has been correctly designed for the user and that ERFIS has met its intended purpose. This test is based on the functional system requirements and the previously developed test plans/procedures.

F. PERSONNEL TRAINING

1. General

Training plans/schedules, courses and course content are developed parallel to the other HFE activities of "Man Machine Interface Development" and "Validation and Verification." Again, training is developed based on the functional system level requirements and specific tasks with respect to the BSEP Emergency Operating Procedures. Basically, there are two major areas of training which are required. They are:

a. Use of ERFIS

b. Integration of the ERFIS into the Brunswick Steam Electric Plant

2. ERFIS Training

Courses are being developed to train the users of the ERFIS in the use of the system, use of man machine interface components, theory of operation, and maintenance. Training plans/schedules use the system functional requirements to define the courses, course content and course outlines for the use of the overall ERFIS.

3. Integration of the ERFIS into the Brunswick Steam Electric Plant

Whereas the courses of Section F.2 are developed for how to use the ERFIS, the courses defined in this section are developed to train users for how to use the ERFIS in relationship to the Brunswick Steam Electric Plant. This training plan uses the tasks from the BSEP EOPs as a basis to train users in the use of the ERFIS with respect to the Emergency Operating Procedures. The courses of this section are developed to build on the courses of Section F.2.

The above training is documented by definition of courses, course content, course outlines, and schedules.

The Human Factors Plan for the ERFIS is developed to fully consider the user as a part of the system as a whole. By assuring that the individual components of the system have been reviewed for HFE considerations and the components have been integrated on the system level, the ERFIS will be a functional and useful system.

Enclosure 7

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