SAFETY PARAMETER DISPLAY SYSTEM

(SPDS)

WATERFORD SES UNIT 3

LOUISIANA POWER & LIGHT COMPANY

NS20076

SAFETY PARAMETER DISPLAY SYSTEM

(SPDS) REPORT

TABLE OF CONTENTS

DETAILED TABLE OF CONTENTS		i
1.	INTRODUCTION	1
2.	PLANT MONITOR COMPUTER	3
3.	SOFTWARE SYTEM DESIGN	16
4.	SPDS PARAMETER SELECTION	27
5.	SPDS DISPLAY HIERARCHY	37
6.	RELIABILITY	154
7.	HUMAN FACTORS ENGINEERING	157
8.	VALIDATION AND VERIFICATION	162
9.	COMPARISON OF THE WATERFORD 3 SPDS WITH THE REQUIREMENTS OF NUREG 0737 SUPPLEMENT 1	167

SAFETY PARAMETER DISPLAY SYSTEM
(SPDS) REPORT

Detailed Table of Contents

		Page
1.	INTRODUCTION	1
2.	PLANT MONITOR COMPUTER	3
2.1	General System Description	3
2.1.1	System Purpose	3
2.1.2	Design Basis	3
2.1.3	System Architecture	4
2.1.4	Functional Overview	6
2.2	Major System Hardware Components	7
2.2.1	Plant Detectors	7
2.2.2	Remote Multiplexer Sites	7
2.2.3	Host Computer Complexes	7
2.2.4	Man - Machine Interfaces (MMI)	12
2.2.5	Machine - Machine Interfaces	13
2.2.6	Host Development System	14
2.3	PMC Software	14
2.4	Power Supply Systems	14
2.4.1	Inverter	14
2.4.2	Static Switch	15
2.4.3	Detector	15
2.4.4	Output/Bypass Breakers	15
3.	SOFTWARE SYSTEM DESIGN	16
3.1	PMC Data Base Organization	16
3.2	PMC Data Base Quality Assessment	20
3.3	SPDS Related Software Packages	21
3.3.1	Emergency Response Facility (ERF) Software	21
3.3.2	Color Graphics System (CGS)	23
3.3.3	QSPDS Communications	23
3.3.4	Radiation Monitor System Communications	24
3.3.5	SPDS Calculation Software	24

			Page
4.	SFDS PARAMETER SELECTION		27
4.1	Containment Control		27
4.1.1		Containment Pressure	27
4.1.2		Containment Temperature	27
4.1.3		Containment Spray Flow	28
4.1.4		Containment Fan Cooler Differential Pressure	28
4.1.5		Containment Hydrogen Concentration	28
4.2	Radioactivity Control		28
4.2.1		Containment Atmosphere Radiation	28
4.2.2		Main Steam Line Radiation	29
4.2.3		Condenser Air Ejector Radiation	29
4.2.4		Plant Stack Radiation	29
4.2.5		Liquid Waste Management Discharge Radiation	29
4.3	Reactivity Control		29
4.3.1		Neutron Flux	30
4.3.2		Control Element Assembly Position	30
4.3.3		RCS Boron Concentration	30
4.3.4		Charging Pump Flow Rate	30
4.3.5		Safety Injection Flow Rate	30
4.4	Core Cooling and RCS Heat Removal		31
4.4.1		Pressurizer Level	31
4.4.2		Pressurizer Pressure	31
4.4.3		Saturation Margin	31
4.4.4		Reactor Vessel Water Level	32
4.4.5		Core Exit Temperature	32
4.4.6		Hot and Cold Leg Temperatures	32
4.4.7		Reactor Coolant Pump (RCP) Current	33
4.4.8		Safety Injection Flow	33
4.4.9		Steam Generator Water Level	33
4.4.10		Steam Generator Pressure	33
4.4.11		Steam Flow Rate	34
4.4.12		Main and Emergency Feedwater Flow Rate	34
4.4.13		Shutdown Cooling Heat Exchanger Flow Rate	34
4.4.14		Shutdown Cooling Heat Exchanger Temperatures	34
4.5	Reactor Coolant System Integrity		35
4.5.1		Pressurizer Level	35
4.5.2		Pressurizer Pressure	35
4.5.3		Containment Sump Level	35
4.5.4		Pressurizer to Quench Tank Line Temperature	35
4.5.5		Quench Tank Level	36
4.5.6		Quench Tank Pressure	36
4.5.7		Secondary Side Radiation	36

		Page
5.	SPDS DISPLAY HIERARCHY	37
5.1	Safety Functions To Be Monitored	37
5.2	Naming, Coloring and Organization of the Displays	37
5.2.1	Display Naming and Recalling	37
5.2.2	Display Coloring	39
5.2.3	Display Organization	40
5.3	Containment Conditions	40
5.3.1	Description of the Data Base Values Used on Containment Conditions	41
5.3.2	Static Illustration of the Containment Conditions Displays and Associated Parameter Listings	44
5.4	Radiation Releases	53
5.4.1	Description of the Data Base Values Used on Radiation Release Maps	54
5.4.2	Static Illustration of the Radiation Releases Displays and Associated Parameter Listings	55
5.5	Reactivity Control	86
5.5.1	Description of the Data Base Values Used on Reactivity Control	86
5.5.2	Static Illustration of the Reactivity Control Displays and Associated Parameter Listings	88
5.6	Core Cooling and RCS Heat Removal	97
5.6.1	Description of the Data Base Values Used on Core Cooling	97
5.6.2	Static Illustration of the Displays for Core Cooling and RCS Heat Removal and Associated Parameter Listings	100
5.7	RCS Integrity	116
5.7.1	Description of the Data Base Values Used on RCS Integrity	116
5.7.2	Static Illustration of the RCS Integrity Displays and Associated Parameter Listings	119
5.8	Parameter Summary Display	142
5.8.1	Description of the Data Base Values Used on the Parameter Summary	142
5.8.2	Static Illustration of the Parameter Summary Displays and Associated Parameter Listings	145

		Page
6.	RELIABILITY	154
6.1	PMC System Failover Capability	154
6.2	AC & DC Power Distribution to the PMC	154
6.2.1	Waterford 3 480VAC Switchgear Bus Configuration	154
6.2.2	Static Uninterruptible Power Supply (SUPS)	154
6.2.3	Battery Backup System	155
6.2.4	Power Distribution	155
6.2.5	Computer Equipment Power Supplies	155
6.3	Reliability of Computer Components	156
7.	HUMAN FACTORS ENGINEERING	157
7.1	PMC Human Factors Review	157
7.1.1	Objectives	157
7.1.2	Scope	157
7.1.3	Human Factors Criteria	157
7.2	Principles Employed During the Development of SPDS Displays	161
7.2.1	Basic Concepts of SPDS Displays	161
7.2.2	Display Design Review	161
8.	VALIDATION AND VERIFICATION	162
8.1	Design, Manufacturing, and Installation	162
8.1.1	Verification	162
8.1.2	Module Validation	162
8.1.3	System Validation	164
8.2	Validation and Verification - System Integration	166
8.2.1	Objective	166
8.2.2	System Definition	166
8.2.3	Methodology	166
9.	COMPARISON OF THE WATERFORD 3 SPDS WITH THE REQUIREMENTS OF NUREG 0737 SUPPLEMENT 1	167

Section 1

INTRODUCTION

The Waterford 3 Safety Parameter Display System (SPDS) design was based on NUREG 0737, Supplement 1 to provide a concise display of critical plant variables to the control room operators to aid them in rapidly and reliably determining the safety status of the plant.

The SPDS Function of the Waterford SES 3 Plant Monitor Computer was a feature added to the basic PMC function of Scanning and Alarming. SPDS enhances the transfer of plant data to locations remote from the control room. This will facilitate management tracking of unexpected operational occurences without requiring presence in the control room. The power plant operator, by using the PMC SPDS Functions, will be able to rapidly obtain an overview of the five critical safety functions previously specified. It will not replace control panel monitoring, nor provide canned responses to plant transients. As with the rest of the PMC, the SPDS will act only to monitor and report on occurences it is programmed to interpret.

The basic scanning and alarming function was procured and enhanced by Louisiana Power & Light. The system, as implemented, is a hybrid of products and recommendations made by various vendors, and the standard computer functions performed at other LP&L power plants.

The SPDS Function utilizes several software packages which were developed separately and are used by numerous applications operating on the PMC. The software on the PMC runs under two controlling/operating systems adapted from the Systems Engineering Laboratories provided operating systems (RTM and MPX). PRXCOMM retrieves data from the remote data acquisition computers. CYCLIC converts raw data from the remote computers into Engineering Units Data. QSPDS and the Radiation Monitor System provide data of value to the SPDS Function. QSPDS and RADMON Communication links acquire data from two computer systems (QSPDS and RMS) external to the PMC. These communications programs fill the PMC Data Base with Engineering Units Data values received from the two systems. The CE NUCLEAR EXECUTIVE controls processing which updates the PMC data base with core operating limit and CEA (Control Element Assembly) position data. SPDS Calculation software is provided to summarize some of the SPDS related data available from the PMC data base, so that SPDS displays are not overburdened with numerical data. ERF provides the man-machine interface software used to recall SPDS type data at SPDS stations both inside and remote from the control room. An additional function of ERF is to define, store, and report a predetermined subset of the PMC data base to provide pre- and post-event (reactor/CEA trip) data. The CGS software presents data from the PMC data base and places it on SPDS station CRTs, superimposing it on static screens stored by CGS. CGS incorporates all static and dynamic SPDS screen maintenance functions.

Since the SPDS is a software implementation on the Plant Monitor Computer (PMC) and because of the extensive capabilities of the PMC no additional hardware, save for dedicated SPDS terminals, was necessary. The PMC hardware is described in Section 2 of this report while the supporting PMC software and SPDS implementation are covered in Section 3.

The key SPDS parameters required to assess the safety status of the plant were chosen after an extensive review of the CE Emergency Procedure Guidelines and the Waterford FSAR. These parameters, included in the top level SPDS displays, are described in detail in Section 4.

In order to provide the operator with maximum flexibility a number of additional parameters are included as supplementary information on lower level SPDS displays. The hierarchy of SPDS is explained, and individual displays are described, in Section 5.

Section 6 contains a discussion of PMC reliability.

Human factor engineering has been included in the implementation of the SPDS. A description of the principles employed during the development phase is included in Section 7 as well as the objectives of the human factors review.

Because the SPDS function is primarily implemented through existing PMC software, the Verification and Validation Program for the SPDS will be majorly carried out through PMC startup testing. The V&V Program is addressed in Section 8.

Section 9 provides a summary of the Waterford SPDS compliance with the requirements of NUREG 0737, Supplement 1. Each of the requirements and subrequirements are addressed with a reference to the appropriate section of this report.

The implementation of SPDS has been reviewed against the Waterford FSAR, SER and draft Technical Specifications. It has been determined SPDS implementation will have no adverse impact on the safe operation of existing instrumentation and equipment. Nor will the addition of SPDS affect any FSAR analyses or Technical Specifications. On the contrary, SPDS is expected to provide a positive enhancement to the control room, increasing the operators' capacity for dealing with abnormal situations.

Section 2

PLANT MONITOR COMPUTER

2.1 GENERAL SYSTEM DESCRIPTION

2.1.1 System Purpose

The purpose of the Waterford 3 Plant Monitor Computer (PMC) System is to provide a single, large scale nuclear plant computer system which integrates traditional balance-of-plant computer monitoring and control with extensive nuclear applications software into a cohesive computer-based tool for plant operations.

The basic LP&L system requirements, are as follows:

a. Scanning and Alarming of Live Plant Data
b. Alarm Presentation and Logging to Operators via CRTs and Hardcopy Output
c. Periodic and Historical Logging of Selected Plant Data
d. Closed-Loop (Direct-Digital) Control of Selected Balance of Plant Process Loops
e. Analytic Studies (Applications Programs) Based Upon Live and Historical Plant Data

The intent of the Waterford 3 PMC System is to provide a computer system not only capable of addressing LP&L system requirements, but able to handle the large number of raw inputs (6000-8000 plus a like number of internally "computed values").

2.1.2 Design Basis

The primary goals, which formed the system design basis, are presented in order of priority:

a. Provide "LP&L Standard" Scanning and Alarming Functions

This goal consisted of providing a computer system connected to sensors throughout the plant that is capable of acquiring live plant data in real time, converting this data to engineering units for storage in a data base, and performing validity and limit check operations on this data. Data which violates limits in a predetermined manner is announced to the operator via CRT and hardcopy devices. Scanning and alarming frequencies are individually selectable by point, and "composed" or algorithmically derived points may be created in this data base.

b. Implement Data Acquisition via Remote Multiplexing

Remote multiplexing for the Waterford 3 PMC System was an essential design requirement owing to cable tray space limitations and the large number of field inputs. Remote multiplexing consists of wiring plant sensors to terminal units distributed throughout the plant, where each terminal unit contains the analog-to-digital convertors, digital I/O, and other plant I/O hardware and communicates all sensor information, usually in parallel with other such terminal units, back to the centrally located (host) computer system.

c. Provide Redundancy to Sensor I/O Termination Level

This design goal indicated that:

1) The host computers, operator interfaces, etc. must be at least singly redundant.

2) Host redundancy should be extended to include the data acquisition environment.

d. Provide Multiple Operator Positions

Additionally, the need for control supervisor consoles and special-purpose computer consoles (i.e., for SPDS) led to a design goal in which a number of operator console positions are permitted, with extensive and complete display and control facilities possible at each general purpose console. Thus each console, including the limited function consoles, is merely a subset of the maximum possible implementation of a single console. Remote (via communications circuits) interface with certain consoles was also required.

e. Provide Interpretive Data Base/Configuration Control

This design goal indicated that the method used to implement and change basic definitions concerning field inputs, scanning and alarming rates, data conversions, logging text, etc., must operate on tables and disc files via a simple "interpretive" editing method. "Hardcoding" of such information so that actual program code must be modified to make such data base changes would not be satisfactory.

f. Provide System Resources for Applications Program Usage

Significant usage of applications type programs was planned for Waterford 3, as well as the execution of nuclear and meteorological programs. Ultimately, as post-TMI-2 initiatives expanded to include Emergency Response Facilities (ERFs) and other applications, satisfying this goal required additional CPU capacity.

2.1.3 System Architecture

2.1.3.1 Table-Driven Real-Time Software

The configuration details of the software operation (how and where sensors are read, how and at what frequency data is converted and alarmed, operator console configuration details, and all data base configuration) must be controlled, not by code or data within the software itself, but by tables and disc files managed by the interpretive data base editor.

2.1.3.2 Multiprocessor Host with Backup Redundancy

It is readily apparent that the performance requirements of this computer system could not be met by a single CPU of any type generally applicable to real-time process control. Initially, two and later three (with the addition of significant post-TMI2 applications programming) 32-bit minicomputers (Gould/SEL 32 Series) in a shared memory configuration were used to form one host computer "complex". This CPU complex, acting as a tightly-coupled multiprocessor, would perform all Waterford 3 host plant computer functions. Since redundancy required, an entire three-CPU backup complex is also present. The "primary" and "backup" designations are arbitrary - either complex is capable of serving in either capacity.

2.1.3.3 Software Separation by Predictability and Applications Orientation

In the primary host complex, the choice of which CPU is used to execute each software task is completely predetermined.

CPU 1 is dedicated to the execution of critical, real-time tasks whose timing is crucial and whose execution predictability is high. This CPU primarily executes remote multiplexer communications software and the cyclic processor (data conversion, limit checking, and alarm detection). Owing to the predictable, repetitive nature of these functions, this CPU can be loaded heavily and still be properly responsive.

CPU 2 is dedicated to the execution of relatively time-critical software whose execution predictability is poor. These tasks can be expected to have a low "duty cycle", with high peak demands. Balance-of-plant man-machine interface software, including CRT and hardcopy output devices, operator console servicing, logging and spooling are the primary software functions in this group.

CPU 3 is dedicated to the execution of complex, calculation-intensive applications programs and computerized emergency planning software, including SPDS functions.

2.1.3.4 Shared Memory Data Structures

The primary method of communication of data and requests among the three CPU's of a complex are data structures and queues residing in memory shared among all three processors. This includes raw and engineering units data bases and alarming and spooling queues.

2.1.3.5 Man-Machine Interfaces via Serial Data Paths

Interchangeability of hardware, and distance requirements dictate standard asynchronous serial communications lines and serial RGB video lines for operator/display/hardcopy interfaces.

2.1.3.6 Table Generation and Editing

All remote multiplexer and point data base creation and modification are performed either by a batch interpreter task called PRXEDIT, or interactively for dynamic CRT mimic diagrams via a task called CRTEDIT.

2.1.3.7 Dual-Redundant Remote Multiplexer Sites

A remote multiplexer site is configured with two 16-bit mini-computers as the controlling elements. Each minicomputer has a separate serial communications path to the host computers and a complete complement of sensor I/O equipment (A/D converters, etc.) In normal operation, each minicomputer system transmits half of the plant sensor data back to the host, with the other minicomputer system transmitting the other half. Upon the failure of a minicomputer, communications channel, or I/O equipment, the remaining functioning minicomputer system transmits all site data.

2.1.4 Functional Overview

The following list enumerates the basic capabilities of the Waterford 3 PMC.

2.1.4.1 Data Acquisition

Digital Inputs	-	Dry Contacts and Voltage Levels
Analog Inputs	-	13 or 15 Bit Integrating A/D Converters, Thermocouple, 4-20 mA, RTD Inputs
Sequence of Event	-	Special Digital Inputs with 6-8 msec. Inter-Event Timing Resolution.
Special Interfaces	-	Analog and Digital Outputs for Annunciators, Chart Recorders and Direct Digital Control. Interfaces to Combustion-Engineering-Auxiliary Protection-Cabinet Multiplexers.

2.1.4.2 Data Management

Software task PRXCOMM maintains the raw sensor input data base where all plant data is refreshed every half-second. Task CYCLIC performs conversions to engineering units, maintains the converted data base, and performs alarm and limit checking according to periodic rates defined in the data base.

2.1.4.3 Operator Displays

CRT displays (up to four per operator position) and hardcopy printers provide the following types of displays:

CRT Alarm Screen	-	Continous Current Alarm Display
CRT Mimics	-	Dynamic Pictorial or Piping Type Demand Displays
CRT Point Group Displays	-	Dynamic Tabular Displays of Selected Print Data
CRT Trends	-	CRT Trend Per Equivalent Displays
Printer	-	Hardcopy Newspaper (Any Logged Event), Demand and Periodic Logs

2.1.4.4 Operation Control

An 8- by 32-character plasma display unit and one or two associated keyboards provide the operator control interface at each operating position.

2.1.4.5 Message Logging and Spooling

A comprehensive set of spooling services and tasks provide message routing and spooling of both single-line and text file message items to users in all CPUs.

2.1.4.6 Data Base and Display Editing

Configuration control for remote multiplexers, addressable point data, and point information for CRT tabular and mimic display data is provided via the batch task PRXEDIT. Static mimic diagrams are built by the interactive task CRTEDIT.

2.2 MAJOR SYSTEM HARDWARE COMPONENTS

2.2.1 Plant Detectors

The plant detectors used at Waterford 3 are those included in the FSAR and other submittals, describing the temperature, pressure, flow, level, position, etc. of safety and non-safety-related systems. These transducer/detector signals are sent directly and indirectly to the multiplexer sites for subsequent processing as information to the PMC System Software. The PMC is suitably isolated from electrical or electronic interference with equipment and sensors that are in use for safety systems as explained in the Waterford FSAR (Section 8.3.1.2.13f).

2.2.2 Remote Multiplexer Sites

A Remote Multiplexer Site is the physical location of a Remote Multiplexer Unit. These sites establish the electrical connection between field instrumentation and the PMC. The two-fold purpose for these remote sites is (1) to meet the overall plant requirement of numerous field inputs to be monitored with limited cable tray space allocations and (2) to establish reliability by providing redundant data acquisition hardware and communications (data paths) to the host computer complex.

There are two Electronics Bays, A and B. Each electronics bay (or half site) has access to each of the field inputs/outputs and an independent communications path to the host. Under normal conditions each bay is responsible for approximately half of the field inputs. In the event of a failure of equipment or communications link to one half-site, its partner is capable of assuming the responsibility of the field inputs/outputs. See Figure 2.2. There are a maximum of 32 remote sites that can be established for Waterford 3, with 28 presently implemented.

2.2.3 Host Computer Complexes

2.2.3.1 Overview

Six Gould/SEL 32 Series 32-bit minicomputers form the nucleus of the Host Computer System. These machines are arranged in a dual triad. Each of these triple-CPU arrangements is referred to as a Host "complex" and consists of two 32/55 CPUs and a 32/7780 CPU. These three CPU's share data via large global core resident data bases contained in memory accessible to all

three CPUs. System I/O devices, not duplicated in the other complex are accessed via peripheral switches. The details of these CPU hardware configurations are presented in the following subsections.

A specific "division of work" philosophy exists for the three CPUs within a complex. The pair of 32/55 CPUs perform virtually all of the critical real-time data acquisition, conversions, alarm and limit checking, man-machine interfacing, and display presentation. The 32/7780 (CPU 3) performs intensive applications program work, such as SPDS. Work is further divided between the two 32/55s such that one of them (CPU-1) performs those tasks in which loading is regular and predictable (remote multiplexer communications, data acquisition, conversion, alarming and limit checking) and can thus be "loaded" to a high average level. The other 32/55 (CPU 2) is reserved for software (primarily man-machine interfacing and display generation) that generally is characterized has having high peak execution requirements, but low average demand. See Figure 2.1.

2.2.3.2 Central CPU Triad

Components described in this section are presented for reference purposes only. Each component is a Gould, SEL Series 32 product.

a. General Configuration for the 32/55s (CPUs 1 and 2)

(1) Central Processing Unit (CPU) Model 2000

(2) 64K Words Private Memory Eight 8K word, 600-nsec Core Memory Model 2152

(3) Memory Bus Controller (MBC), Model 2162

(4) Memory Bus Adapter (MBA) Model 2178 (For Shared Memory Port)

(5) Real-Time Option Module (RTOM), Model 2345

(6) System Control Panel Interface (SCP), Model 2142 (For Front Panel)

(7) Teletype, Line Printer, Card Reader Controller (TLC), Model 9005

(8) Magnetic Tape Driver Controllers (MTC), Model 9013

(9) High Speed Data Interface (HSD), Model 9131 (For Bulk Memory)

b. Specific Configurations:

(1) CPU 1

Four General Purpose Multiplexer Controller (GPMC), Model 9104

(2) CPU 2

Two GPMC, Model 9104

Moving Head Disc Controller (HDC), Model 9010

c. Configuration for the 32/7780 (CPU 3)

(1) Central Processing Unit (CPU), Model 2005

(2) Internal Processing Unit (IPU), Model 2005

(3) High Speed Floating Point (HSFP), Model 2341
(One for Each CPU and IPU)

(4) Scientific Accelerator (SA), Model 2343
(One for Each CPU and IPU; Implemented by WCS,
Model 2344)

(5) 4M Byte Private Memory

(16 - 256K Byte, 600-nsec MOS Memory Model 2379)

(6) Memory Bus Controller (MBC), Model 2382
(For 256K Byte MOS Memory Boards)

(7) Memory Bus Adaptor (MBA), Model 2178
(For Access to Shared Memory)

(8) Real-Time Option Module (RTOM), Model 2345

(9) System Control Panel Interface (SCP), Model 2142

(10) Teletype, Line Printer, Card Reader Controller (TLC),
Model 9005

(11) Low Speed Magnetic Tape Processor (LSTP), Model 8020

(12) High Speed Data Interface (HSD), Model 9131
(For Access to Bulk Memory)

(13) Disc Processor II, Model 8055

(14) General Purpose Multiplexer Controllers (GPMC),
Model 9103

The GPMCs, found in each CPU, provide multiplexed serial I/O channels to and from the Host computer. Each GPMC is configured with 16 subchannels or ports. Each subchannel is driven by a serial controller known as a General Purpose Device Controller (GPDC). The GPDC is a standard SEL product (Model 9106) that is available in several difference configurations including the capability to customize for the user's specific device. Various configurations are utilized in the PMC design.

The operator's console is a CRT/keyboard device which serves as the interface between the computer operator and that machine's operating system. Via this console, commands are entered to exercise complete system control.

The operating systems (PRX/RTM and MPX) are "disc oriented" and, therefore, require at least one disc device. Physical devices vary for each machine but are defined to the respective operating systems as follows:

CPU 1 (PRX/RTM) - DataRam Bulk Memory 6M Byte Unit (System)

CPU 2 (PRX/RTM) - Control Data 80M Byte Moving Head Disc (System)
DataRam Bulk Memory 6 M Byte Unit*

CPU 3 (MPX) - Control Data 80M Byte Moving Head Disc (System)

- Control Data 300M Byte Moving Head Disc
DataRam Bulk Memory 6M Byte Unit

* The Dataram Bulk Memory Unit is a semi-conductor memory system that emulates a disc device. It is not an extension of addressable memory, rather it is configured to the operating systems to be a fixed-head disc device.

The multiplexed I/O channels represent the possible 16 subchannels available to each GPMC described in the CPU triad configuration. These subchannels (GPDC) are serial I/O devices and vary among machines:

CPU 1 - None are defined to the operating system

CPU 2 - Serial Line Hardcopy Loggers
- Herco Console Drivers
- Aydin Display Generator Drivers
- Terminal Support System

CPU 3 - Serial Line Hardcopy Loggers
- Herco Console Drivers
- Aydin Display Generator Drivers
- Terminal Support System

The configuration for shared memory is as follows:

a. 64K Words of Shared Memory (Eight 8K Word Core, 600-nsec Memory, Model 2152)

b. Memory Bus Controller (MBC), Model 2162 (One MBC) per Port to Shared Memory)

2.2.3.3 Peripheral Switch

The Peripheral Switch is a 16-port switch, with each port independently selectable from up to 16 drivers (CPUs). At Waterford 3, the PMC multiport switch system consists of symetrically dual universal chassis, control panel, power supplies and switch modules.

Four types of switch modules are employed to provide intra-complex peripheral selection and complex-to-complex interface failover by either manual or dynamic CPU 3 control. The line printer, card reader, and magnetic tape drives are intra-complex selectable; the Data Acquisition Interfaces, Man-Machine Interfaces, and Remote Data Link/Display Systems can be routed universally to either complex.

2.2.3.4 Operating Systems Devices

Each machine's operating system is configured with the following general devices:

Operator's Console	Lear-Seigler ADM-3A or Equivalent
Card Reader	Documation 1000 Cards per Minute Reader Provided by SEL as Part of the Series 32 Product Line.
Line Printer	Data Products 600-Lines-per-Minute Hardcopy Device Provided by SEL as Part of the Series 32 Product Line.
Magnetic Tape Drives (2)	Pertec Dual-Density 75 IPS Drives Provided by SEL as a Part of the Series 32 Product Line.
Disc Device(s)	Offline Storage-Physical Device Varies Among Machines.
Multiplexed I/O Channels (Serial I/O)	As Per Machine Configuration

One card reader, line printer, and pair of tape drives support each CPU triad. Access to these devices is selectable via the Peripheral Switch.

2.2.3.5 Communications Drivers

The Communication Interfaces are the link between the Host and the remote multiplexer units. The devices are GPDC-type Asynchronous Communications Error-Checking (ACE) Interfaces manufactured by SEL. These interfaces (model 73-9045) were a custom product developed by SEL at the request of LP&L in order to support GPMC/GPDC handling of serial asynchronous lines. The ACE interfaces employ a hardware selectable BCH-error encoding technique for transmission error detection.

The ACE is a GPDC of a GPMC within the Host on the uplink side and connects to CPI modems for the downlink (to remote) side via hardwired communication lines. The connection to the GPMC is via the Peripheral Switch which is selectable between complexes. There is one ACE with BCH enabled for each communications link (i.e., remote half-site) within the PMC configuration.

2.2.4 Man-Machine Interfaces (MMI)

2.2.4.1 Overview

The MMIs are those which provide visual information (displays) or a location where an operator may instruct the PMC to perform specific functions. This interaction is usually at an ASCII keyboard console location. The MMI's which interface with the Waterford PMC are numerous. This section will only deal with the SPDS.

2.2.4.2 Emergency Response Facilities (ERFs)

The ERF stations allow an operator to generate and display color graphic images that relay the status of critical plant operational systems. The operator may generate and receive reports at that station pertaining to point values and status over a given time interval.

ERF stations are configured from the following list of hardware:

a. Herco console (at least one) driven by an ALIM GPDC. From here, the operator may control display and hardcopy output of the ERF system through command menus.

b. Color graphic AYDIN CRT (at least one) driven via an AYDIN 5215 Display Generator (AYDIN/SEL GPDC) in a local configuration or an AYDIN 5217 Display Generator (ALIM/modem) in a remote configuration.

c. Video copier dedicated to a physical CRT device (optional)

d. TI 810 hardcopy loggers driven by an ACE GPDC (optional)

There are four ERF station designations. The nomenclature for these stations is: Emergency Operations Facility (EOF), Backup EOF (BEOF), Technical Support Center (TSC), and the Main Control Room (MCR). The equipment for each station includes:

a. EOF: 2 HERCOs, 2 Loggers, 3 AYDIN CRTs, 3 AYDIN 5217s and Modems (Remote Configuration) - 1 station for SPDS and 1 station for dose assessment.

b. BEOF: 1 HERCO, 1 Logger, 1 AYDIN CRT, 1 AYDIN 5217, and Modems (Remote Configuration)

c. TSC: 2 HERCOs, 2 Loggers, 3 AYDIN CRT's , and a Video Copier (Local Configuration) - 1 station for SPDS and 1 station for dose assessment.

d. MCR: 1 HERCO, 2 AYDIN CRT's, and a Video Copier (Local Configuration)

Data links to all of these stations are complex selectable via the Peripheral Switch with the exception of the dual-ported AYDIN 5215s which drives the local configuration CRTs.

2.2.4.3 Safety Parameter Display System (SPDS) Displays

The Safety Parameter Display System dedicated display devices are color graphic AYDIN monitors. Two dual-ported AYDIN 5215 display generators provide display selectable color video information for the monitors in the TSC and the operations station CP-9 (MCR). AYDIN 5217 display generators in the EOF and BEOF from modem data links are used because of their remote location from the PMC.

Display selection is accomplished by use of a HERCO console adjacent to each monitor.

The SPDS is a component of the ERF.

2.2.5 Machine-Machine Interfaces

2.2.5.1 Overview

This section highlights selected machine-to-machine interface connections to the PMC that bear on the SPDS function.

2.2.5.2 Radiation Monitoring

General Atomics Radiation Monitoring System in the Computer Room provides radiation and data from the dual DEC PDP 11/34 CPUs to CPU #3 through ALIM channel of the GPDC chassis. Limited Distance Modems are used as an interface to convert a current loop to RS232 data link. RS232 Peripheral Switch modules provide complex capability.

2.2.5.3 Qualified Safety Parameter Display System (QSPDS)

The QSPDS is a stand-alone IEEE Class 1-E machine. This system monitors Class 1-E signals so that plant operators may monitor the safety status of the plant particularly from the viewpoint of inadequate core cooling. Systems monitored by the QSPDS include:

a. Subcooled Margin Monitor (Saturation/Superheat Margin Measurement)

b. Heated Junction Thermocouple System (Reactor Vessel Level)

c. Core Exit Thermocouples (Coolant Temperature Exiting the Core)

This system interfaces to the host complex (CPU #3) via two independent fiber optic channels and an asynchronous serial I/O channel (ALIM) at the host.

The GPDC configuration uses four ALIM/GPDC channels however as a result of a unique cable configuration, only two Peripheral Switch channels are required. This link is complex selectable.

2.2.6 Host Development System

2.2.6.1 Overview

The Host Development System provides a limited PMC mockup suitable for design development and debug of PMC related software. This installation is located on the plant site away from the plant island. It is totally isolated from the PMC installation and is not capable of performing any plant operations oriented function nor interfering with the PMC. The advantage of this system is to relieve the back-up complex of the PMC from development responsibilities.

2.2.6.2 Configuration

The Host Development System is a CPU triad configured to reflect the PMC triads. Peripheral equipment is also identical with the following exceptions and enhancements.

a. One Fully Supported HERCO Console Station

b. One Fully Supported ERF Station

c. Enhanced TSS system for Both CPU 2 and CPU 3 to Support Software Development and Management

d. Dedicated 1000 line per minute Line Printer for CPU 3

e. Switchable (Peripheral Switch) 600 line per minute Line Printer Between CPU 1 and CPU 2

f. Mockup Remote Site to Allow Forced Instrument or Manual Event Stimulation

2.3 PMC SOFTWARE

The PMC software packages applicable to the SPDS function are discussed in Section 3 of this report.

2.4 POWER SUPPLY SYSTEMS

The following sections describe the major components of the Power Supply configuration. See also Section 6 on PMC reliability.

2.4.1 Inverter

The inverter changes the DC output of the recitfier or battery to AC power which meets load requirements.

The rectifier is the normal DC source for the inverter. In the event the rectifier fails, the external battery will supply the DC power necessary. Should the rectifier output become unavailable for an extended period of time, the inverter will be automatically shut down when the external battery is discharged to a predetermined voltage level.

Inverter operating frequency is phase locked with the reserve AC source as long as the reserve source frequency is within a predetermined tolerance. In the event the reserve source frequency goes out of tolerance, the inverter will phase lock to an internal crystal oscillator.

The inverter AC output is applied to the static switch as one of its two AC input sources.

2.4.2 Static Switch

The static switch selects one of the two AC voltage sources connected to it and applies the selected source to the external load. The two AC sources connected to the static switch are the inverter AC output and the external reserve AC input. Under normal conditions the static switch will apply inverter AC output to the load.

In the event the inverter output becomes unavailable or goes out of specifications or tolerance, the static switch will transfer to the reserve AC voltage source without interruption. When the inverter output returns to within specification tolerance, the static switch will retransfer, applying inverter AC power to the load.

The automatic transfer to the reserve AC source is inhibited in the event the reserve AC source is not within specification tolerance or if the inverter AC output and reserve AC input are not in phase.

2.4.3 Detector

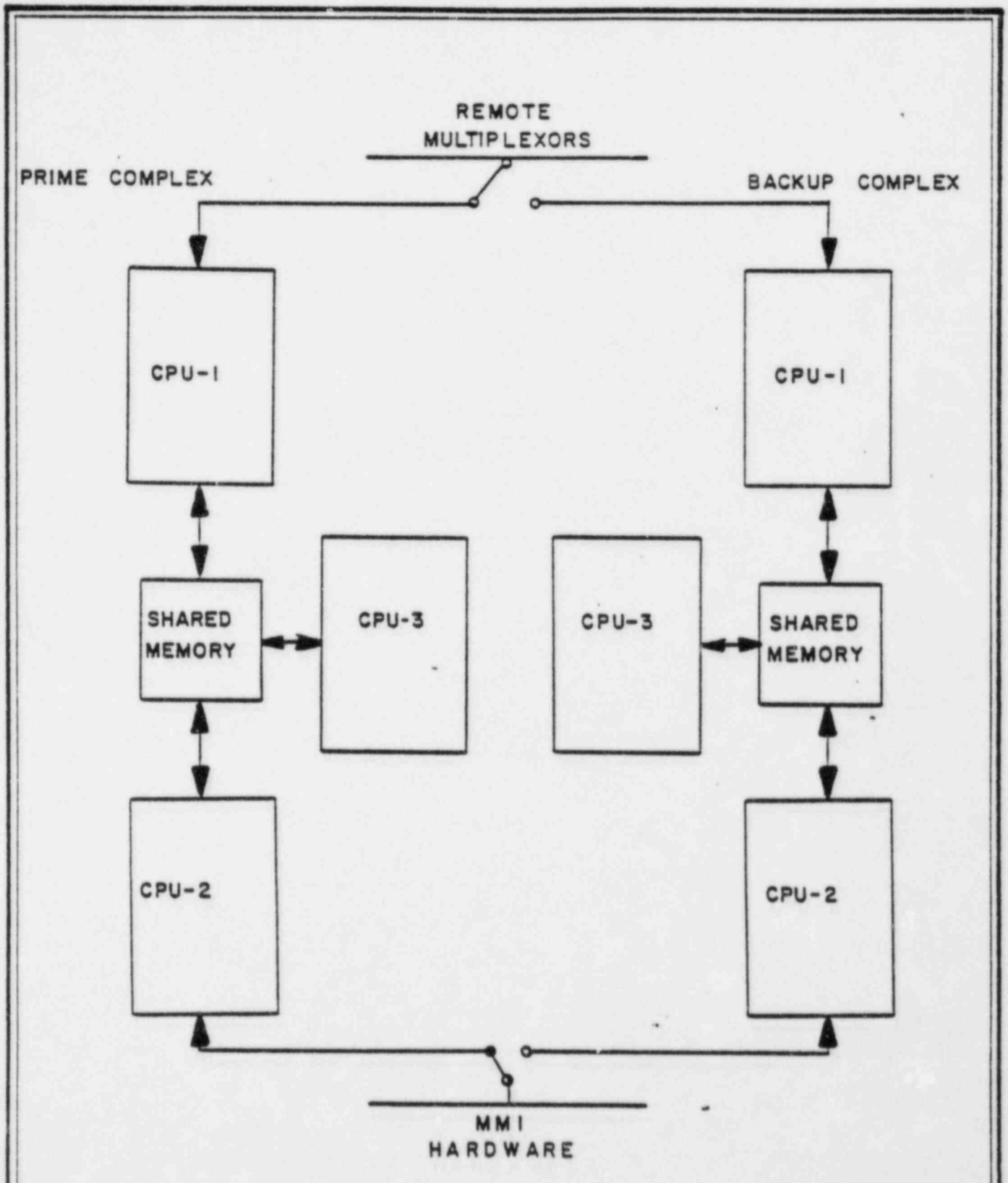
The detector assembly monitors various conditions within the Uninterruptible Power Supply (UPS) system and generates certain control signals which affect the operation of the system. These control signals are:

a. Rectifier High DC Shutdown
b. Inverter Operate/Standby Control Signals
c. Inverter Low DC Shutdown
d. Inverter Overload Shutdown
e. Inverter Overtemperature Shutdown
f. Static Switch Phase Lock Transfer Inhibit
g. Static Switch Reserve Voltage High/Low Transfer Inhibit

In addition, the detector assembly controls operation of the alarm indicators, on the UPS cabinet front panel, and of the summary alarm relay to be used for remote alarming.

2.4.4 Output/Bypass Breakers

Circuit breakers, located at the output of the UPS System, are used to provide a power application-system isolation function. Several closure configurations can be achieved to maintain application of power to the system load for a variety of conditions; such as, normal system opertaion, maintenance, test, and alignment. A switching procedure is established which will ensure maximum protection to both the UPS system and the load.



PRIME AND BACKUP COMPLEX CONFIGURATION

FIGURE 2.1

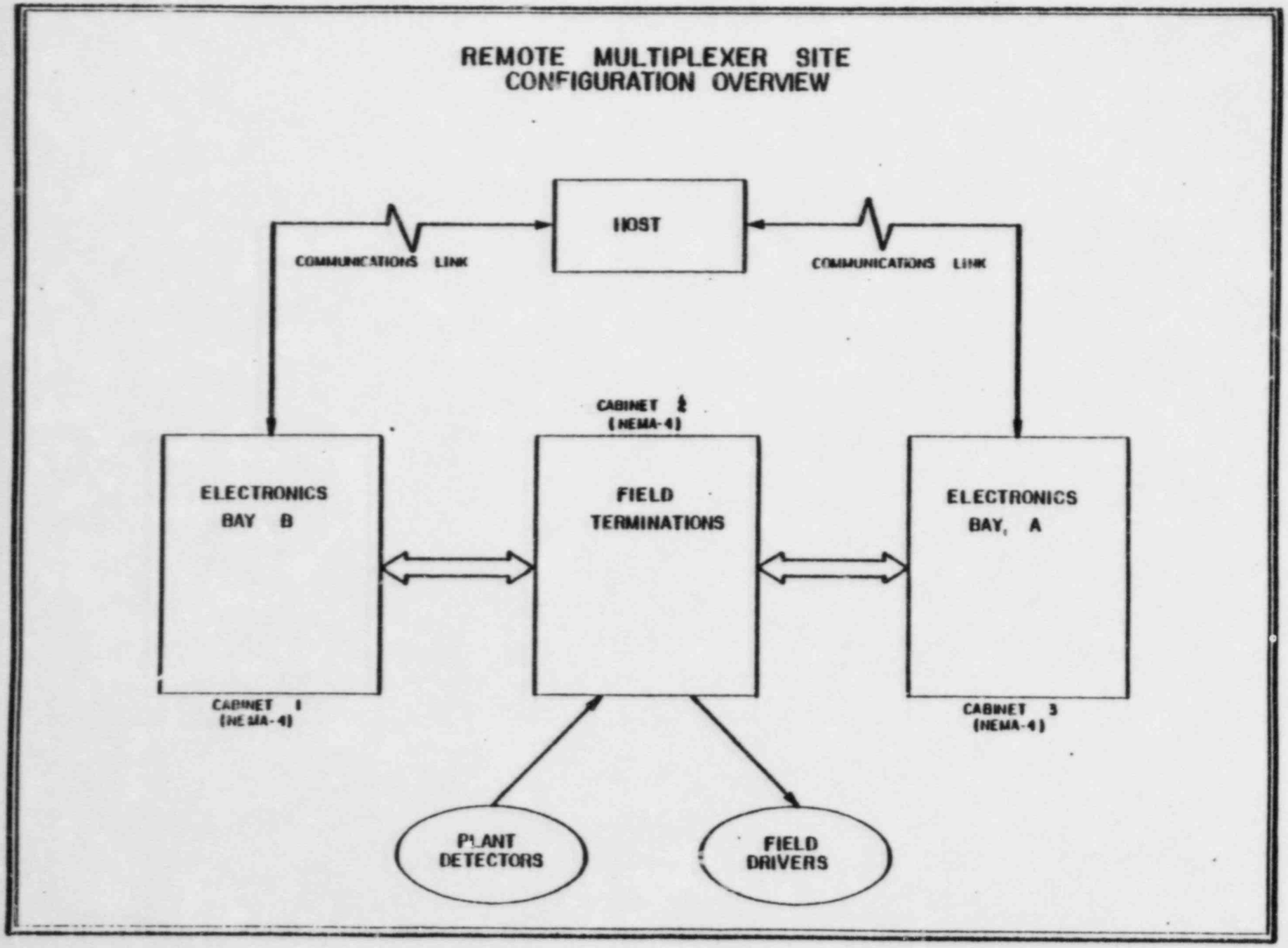

REMOTE MULTIPLEXER SITE
CONFIGURATION OVERVIEW
HOST
COMMUNICATIONS LINK
COMMUNICATIONS LINK
CABINET 2
(NEMA-4)
ELECTRONICS
BAY B
FIELD
TERMINATIONS
ELECTRONICS
BAY, A
CABINET 1
(NEMA-4)
CABINET 3
(NEMA-4)
PLANT
DETECTORS
FIELD
DRIVERS

FIGURE 2.2

Section 3

SOFTWARE SYSTEM DESIGN

3.1 PMC DATA BASE ORGANIZATION

The Plant Monitoring Computer (PMC) uses an enhanced version of the control/operating package of programs provided by System Engineering Laboratories (SEL) with their computers. This package allows the computer system to access its memory and other devices within the system. LP&L has named this package the Process Real Time Executive (PRX), which is a modification of the SEL Real Time Monitor (RTM 6.0) operating system.

In order for the Process Real Time Executive (PRX) software system to process the raw field input data (sent as binary numbers from the remote data acquisition computers), a set of system files must be initialized with data that describes each field input. The information in these files is used to determine if the field data is within acceptable instrument limits and is used to convert the field data into meaningful information for alarming, triggering, program actions, logs and reports.

This collection of data consists of fourteen disk files and one core partition (which is only present after operating system initialization), collectively referred to as the Point Data Base. This collection of data is set with a file (modelled after "data base point definition cards") created by computer operators using:

- PRXEDIT
- System Bootstrap Procedure
- Startup Command File

The Point Data Base is initialized and maintained by the PRXEDIT program. The PRXEDIT program is an overlaid background processor with limited online editing capabilities. The PRXEDIT program accepts card (image) inputs containing command verbs and parameters. These command verbs and parameters define point data base tables, point English description, point processing (e.g. floating point calculation), remote hardware description (i.e. what remote data acquisition computer printed wire board the field input is connected to), and global data.

The fourteen files are distributed between the following devices:

Bulk Memory Unit:

PRXPTID - Point ID Cross-Reference File

This file is used to determine the point definition control word (PDFCW) or a point, given its internal point ID format. The PDFCW contains the point definition number (pdf#). The pdf# is used to access other Point Data Base files. The file also contains the point ID's relative transfer address, to where the point value is located. Access to the PRXPTID file is done by converting the nine-character ASCII point ID into a compressed internal ID (hash key word).

PRXPDESC - Point Description File

Every point ID has an associated point description file entry. This file contains the point description, the nine-character ASCII point ID, the engineering units code, state message codes, and other information defining the point ID. The pdf# is used to access this table.

PRXGFILE - Point Dimension File

The PRXGFILE contains static global data. This global data consists of the following:

- engineering units
- digital state messges
- conversions/special calculation program names
- deadband values (only certain values can be used)
- significant delta values

PRXPTADR - Point Address File

This file contains the point transfer address and raw data address used to access the point value in the raw or converted data base. The pdf# is used to access this file.

PRXMXLDP - Point Load Parameter Data File

This file tells the remote multiplexer how to process the various analog and digital (including sequence-of-events) field inputs used in the PMC System.

PRXCPGEN - Cyclic Generator File

PRXCPDTA - Cyclic Data Segment File

Shared Memory Unit:

PRXPDEF - Point Parameter Definition File

The PRXPDEF file (PDEF) contains information defining a point. Point description is obtained from point definition cards. Examples of information in this category are listed below:

Cyclic point ID processing for:

- raw data access
- conversion to engineering units from the binary value
- reasonability checks
- action limits
- cutout functions
- alarm limits
- transforming calculations

This file is organized by the "PDEF link." The PDEF link is located in a point ID's PRXPDESC file entry. PRXPDESC is output by PRXEDIT and used as an input to CYCGEN.

PRXDBMAP - Point Allocation and Initialization File

This file contains allocation parameters and maps for shared core and the PRXPDESC file.

MPXDESC - Remote Multiplexer Description File

This file contains information defining remote multiplexer sites and current point hardware assignments. This file is organized by the MPXDESC link. The MPXDESC link is located in a point ID's PRXPDESC entry.

PRXDCOMN - Core Resident Storage (Value, Time, Quality) File

PRXDCOMN is a core partition that contains the shared common data and data tables. Access to the core partition is done using the memory of the machine available to all tasks (a low core address pointer).

PRXCPXFM - Cyclic Transform File

PRXMKSE - SOE (Sequence of Events) Mask File

PRXCPSEQ - Cyclic Sequence File

The PRXCPSEQ file contains the list of points that are to be cyclically processed. The file is organized to allow lists for each of the following cyclic processing functions:

- A list of point IDs with no alignment requirements for each possible cyclic frequency
- A list of point IDs with a required order of cyclic processing ("tie string")
- A list of digital input point IDs connected to a single input multiplexing card that are processed as a group
- A list of digital output point IDs connected to a single output multiplexing card that are processed as a group
- A list of point IDs that are processed at periodic intervals

This file is used by the cyclic processor generation program to develop the sequence of cyclic processing.

Each point ID defined to the system has an entry on the PRXPTID file. The PRXPTID file resides on the bulk memory unit and is accessed through the nine-character ASCII point ID. Each entry contains the following information:

- internal point ID
- forward link
- pdf control word
- point transfer address

The internal point ID provides a unique and identifiable address for each point ID. The internal point ID should be used as a reference to a point whenever a possibility exists that a point may be redefined or relocated. The internal point ID is obtained by hashing the nine-character ASCII point ID. The forward link contains a pointer to the next entry with the same hash code key.

The pdf control word contains a point ID's pdf#. The pdf# is assigned to a point at data base generation time and is used to index through point data base files. The pdf# provides the quickest route to the point value. The pdf control word also indicates time, quality, precision, and storage format.

The point transfer address contains the relative address of the point ID's value. The point ID's value must be core resident.

Each point defined to the system has an entry in the PRXPTADR file. The PRXPTADR file resides on the bulk memory unit. The pdf# is a bias into this file. Each entry contains a point ID's transfer address and raw data buffer address.

Point IDs to be cyclical processed have an entry in the Core Transfer Address Table. The Core Transfer Address Table contains a point ID's direct or indirect transfer address to point value. An indirect transfer address provides linkage to alarm queues and dynamic CRT display queues.

CYCGEN is the CPU 2 activated task that allocates the various files which, when combined together, define all the attributes of the data base at the time of the restart of the PMC. This program provides the interface between the functions of PRXEDIT and CYCLOADR.

The Cyclic Processor Generator (CYCGEN) program is provided to convert the PRXPDEF records generated during data base point definition to cyclic data records. The cyclic data records define the individual point processing sequence, and then spread these records as evenly as can be allowed over the 120-second cyclic period. The functions of the Cyclic Processor Generator program are as follows:

- Ensures alignment of data used as sources for special calculations and cutouts.
- Provides a more balanced CPU 1 loading (relative to not having this attribute) for cyclic processing throughout the two-minute period of cyclic activity.
- Generates point processing records and data files necessary to the cyclic processor activity.

CYCLIC performs the conversion of Raw Data Base information into Engineering Units, compares and sends alarm messages based on limits defined during data base initialization, and places the converted values into the Engineering Units Data Base.

Point processing consists of obtaining the cyclic data record for a point and sequencing through the record calling the appropriate processing subroutines. The subroutines are identified by their ID in each segment of the data record. Point processing involves a call to a source routine and call to a destination routine as minimum processing. The two groupings of point processing performed by the Cyclic Processor are cyclically processed point IDs, and periodically processed points.

Cyclical processed point IDs have an associated processing performed within a factor of 120 seconds (i.e., 1, 2, 3, 5, 10, 15, 30, 60, and 120 seconds). PRX/RTM supports any 14 such cyclic timings. Cyclic point IDs are processed at least once during the 120-second cycle.

Timing for cyclical processed point IDS are synchronized with wall-clock time during Cyclic Processor initialization so that each cyclic 120-second mark occurs on an even 2-minute wall-clock tick. A cyclically processed point ID is processed some time during its specified timing interval; that processing is generally not concurrent with the associated wall-clock time. That is, a 30-second point ID is processed sometime during 30 seconds, but not necessarily on even 30 second increments. The number of 1 second processing frames possible is numerically equal to the specified time interval.

Periodically processed points are processed on the specified wall-clock time. Typical periodic frequencies are two minutes, hourly, and daily. A point processed hourly is processed once every hour on the wall-clock time mark. Periodic processing times have only one allocated time to occur during each period.

3.2 PMC DATA BASE QUALITY ASSESSMENT

The organization of data in the PMC provides for four types of quality. The four types are GOOD, SUSPECT, INSERTED and BAD. The process time and quality of each piece of data is defined within a 32 bit word of memory. (Two bits of the 32 bit word are set aside for the quality indication. The bits are set upon comparing the latest value in the machine to limits defined at the time of (PRXEDIT execution) data base creation. The quality check limits are determined during the engineering review of a data base entry prior to the PRXEDIT execution. Quality tags are set by the programs which place the data into the Engineering Units (Converted) Data Base. CYCLIC is responsible for all remote data acquisition computer input conversion, with the balance of the points being processed by the CE NUCLEAR EXECUTIVE, SPDS Calculation Software, RADMON, and QSPDS communications software.

A data value which has GOOD quality has a value in the normal range. SUSPECT implies that the displayed value is within the response design of the field instrument, but is outside (high or low) of the expected values for the process being measured. The INSERTED quality means that a PMC user has interrupted the normal updating of a data base point, and has fixed the data base value at the displayed value. Lastly, BAD quality is placed on data values which cannot be measured by the field instrument due to its design. When a data base point ID has a BAD quality, a non-displayable number is inserted into that data base value location. Non-displayable numbers appear as asterisks on Plant Monitor Computer displays (CRTs, Plasma Displays, and print-outs).

3.3 SPDS RELATED SOFTWARE PACKAGES

3.3.1 Emergency Response Facility (ERF) Software

3.3.1.1 Man-Machine Interface (MMI)

The ERF MMI performs the following major functions:

- display of the top-level ERF Menu
- display of the Report Generation Menu
- display of the Safety Parameter Display Menu
- display of the Historical Data Collection Menu
- transmission of operator commands to the Color Graphics System, to the Historical Data Collection and Retrieval System and to the Report Generator System.

3.3.1.2 Historical Records Processing

This portion of the ERF package is composed of the Historical Data Collection and Retrieval System (HDCRS) and the Report Generator System (RGS).

3.3.1.2.1 HDCRS

The first step in using HDCRS is the creation of the Historical Collection Control File. This file defines the time interval between historical records and the number of point IDs to be collected. The file is created using common system functions. When the Historical Collection Control File is complete, the Historical System Generation Task is activated. This task reads the Historical Collection Control File. Data from the Historical Collection Control File is used to size and allocate the Two-Hour History File and the Historical Data Base. Header information is also written in the Two-Hour History File. These functions are performed offline prior to ERF initialization.

The remainder of the HDCRS tasks are online tasks. As shown, when the startup procedure is run, the Collection Control Task is activated. This task reads the header data from the Two-Hour History File and initializes the Collection Control Table. Next, the Collection Control Task activates the Historical Data Collection Task. The Collection Control Task also processes operator commands to add or delete points for historical data collection.

The Historical Data Collection Task reads data from the Converted Engineering Units Data Base. This data is formatted and written to the Two-Hour History File. This file is a circular file sized to hold two hours of data. The Historical Data Collection Task also monitors a point in the Converted Engineering Units Data Base to determine if an event occurs. If an event occurs, the Historical Data Collection Task begins recording the postevent data into the Historical Data Base.

Also, when an event is detected, the Historical Data Collection Task activates the File Copy Task to copy the Two-Hour History File to the Historical Data Base. This pre-event data is copied to the beginning of the Historical Data Base. The postevent data recorded by the Historical Data Collection Task begins immediately after the pre-event data. The

Historical Data Base is sized to hold 14 hours of data. Thus, when the 2 hours of pre-event data plus 12 hours of postevent data have been recorded on the Historical Data Base, the Historical Data Collection Task activates the Archiver Task and begins recording data in the Two-Hour History File.

The Archive Real/Historical Task can be activated by the SPDS user or computer operator or automatically by the Historical Data Collection Task. Automatic task activation of the Archive Historical Task by the Historical Data Collection Task causes a prompt to be sent to the computer operator requesting a magnetic tape to be mounted for the purpose of archiving the 14 hours of data while data is being recorded in the Two-Hour History File. The Archive Real/Historical Task is activated by operator request. The task can provide magnetic tape archival of data contained on either the Two-Hour History File or the Historical Data Base. The computer operator may specify that the archived data be stored at reduced time resolution. All data stored by the Archive Real/Historical Task may be read by the Retrieval Task. SPDS user or computer operator commands cause this task to read data from the magnetic tape archives and write it into the Historical Data Base.

The Collection Information Task is activated by a computer command. This task reads header information from either the Two-Hour History File or the Historical Data Base. A display defining the points that are collected and the time interval between records is produced.

3.3.1.2.2 RGS

Computer operators use editing facilities common to the PMC to create Report Descriptor Files. This file contains commands that define the report contents and format. A command is entered through the PMC operating system, and the Report Compiler is activated. This task reads the Report Descriptor File and verifies that the report generation commands are valid and consistent. Any errors are reported to the operator. These error messages describe the report generation command that caused the error. The operator must use other PMC programs to edit the Report Descriptor File and correct the errors.

If no errors are found, a Compiled Report Descriptor File is created and an entry is made in the RGS Directory File. This file is structured to minimize the processing required by the online report generator tasks.

After the Compiled Report Descriptor File has been created, the report may be activated. Commands entered through the MMI activate either the Real-Time Report Generator or the Historical Report Generator. The Real-Time Report Generator verifies that the menu parameters entered by the operator are correct. Any errors are reported to the operator. If no errors are detected, the operator-specified Compiled Report Descriptor File is read. The data specified in this file is read from the Converted Engineering Units Data Base. This data is formatted as specified in the file and the formatted lines are spooled for output to the specified device. If requested, a cross-reference showing the point description corresponding to each point ID is also printed.

The Historical Report Generator performs the same functions as the Real-Time Report Generator except that the report data is retrieved from the Historical Data Base instead of from the Converted Engineering Units Data Base.

3.3.2 Color Graphics System (CGS)

CGS is a group of tasks for the editing, displaying, and data field refreshment of CRT displays originated by the computer providing SPDS. CGS superimposes a dynamic foreground of information upon a static screen of descriptive information. The dynamic data is retrieved from the Converted Engineering Units Data Base. CGS is able to perform a limited amount of logical decisions, particularly the conditional display of data or symbols. CGS is also designed to provided one-dimensional bar graph representation of a data base value within two limits described at the time of the creation of the display.

CGS is a commercially proven software package that has been adapted to operate in the hardware environment which makes up the PMC.

3.3.3 QSPDS Communications

The QSPDS (described in FSAR Appendix 1.9A) processes, among other inputs, the inadequate core cooling information. The QSPDS Communications program interprets a package of data being transmitted by the Class 1E QSPDS via an optically isolated data link. This program converts the data format sent by the QSPDS to one which can be placed into the PRX format-Converted Data Base. The SPDS display values provided by the PMC are dependent upon receiving data from the QSPDS.

In its transmission to the PMC, the Class 1E QSPDS System provides status (true or false) in the third byte of each message packet. The various messages used by QSPDS Communications Software are:

FAILED SENSOR
DATA OUT OF RANGE
SUSPECT DATA
QSPDS TROUBLE

These messages are logically compared to determine whether a point is GOOD, SUSPECT or BAD. A GOOD value would result from a message which has none of the four messages set to the active (true) condition.

A QSPDS point ID value will have a SUSPECT quality if the following combinations are present (true):

QSPDS TROUBLE
SUSPECT DATA
QSPDS TROUBLE and SUSPECT DATA

A QSPDS point ID value will have a BAD quality if the following combinations are present (true):

DATA OUT OF RANGE
DATA OUT OF RANGE and QSPDS TROUBLE
DATA OUT OF RANGE and SUSPECT DATA
DATA OUT OF RANGE and QSPDS TROUBLE and SUSPECT DATA
any time a FAILED SENSOR MESSAGE is present (true)

3.3.4 Radiation Monitor System Communications

This program interprets a package of data being transmitted by the Radiation Monitoring System (RMS) via a data link. This program converts the data format sent by the RMS to one which can be placed into the PRX format-Converted Data Base. The SPDS display values provided by the PMC are dependent upon receiving data from the RMS.

3.3.5 SPDS Calculation Software

In order to reduce the potentially large number of data values to be presented to the user of SPDS displays, a preprocessing program is implemented. The preprocessor performs a summary function on various combinations of point IDs, and places the results of the function into a PRX Converted Data Base location. The CGS program which provides the SPDS displays to the user is only able to retrieve dynamic values from the Converted Engineering Units Data Base. The preprocessor does not feed CGS directly. Nor does CGS depend on the existence of the preprocessor to display data. CGS is able to use data base values processed by any program stuffing the data base (e.g., CYCLIC, CE NUCLEAR EXECUTIVE, and QSPDS and RADMON Communications).

The analysis made with respect to parameter selection dictated the limiting conditions which should be considered for reactor operations. Since several pieces of data of equal value to the operator are available from the Converted Data Base in a number of cases, the preprocessor provides for the mathematical averaging of a list of values. On some occasions, reactor operators should use the most limiting value of a group of data items while making determinations. Therefore, the preprocessor provides for the determination of a maximum or minimum value of a list of data values.

The preprocessor will only consider point IDs whose quality is either GOOD or INSERTED and adjust itself accordingly when performing AVG, MAX, or MIN operations on groups of data. If the preprocessor fails to find any GOOD or INSERTED qualities in its input group, it will place a BAD quality tag in the data location for the result along with a non-displayable number in the value location.

3.3.5.1 MIN and MAX

The calculation being performed to determine minimum can be summarized as:

C266nn .LE. (ptid-1, or ptid-2, or ptid-3,...., or ptid-N)

"N" is a function of the size of the input file. Point IDs whose quality is neither GOOD nor INSERTED will automatically be deleted from consideration at the time of this operation.

The calculation being performed to determine maximum can be summarized as:

C266nn .GE. (ptid-1, or ptid-2, or ptid-3, ..., or ptid-N)

"N" is a function of the size of the input file. Point IDs whose quality is neither GOOD nor INSERTED will automatically be deleted from consideration at the time of this operation.

3.3.5.2 Rate of Change

The calculation being performed to determine the time rate of change of a data base value can be summarized as:

$$C266nn = \frac{\text{ptid-1 (at t(1)) minus ptid-1 (at t(0))}}{\text{t(1) minus t(0)}}$$

The difference "t(1) - t(0)" is nominally 1 minute for these calculations. Point IDs whose quality is neither GOOD nor INSERTED will automatically be deleted from consideration at the time of this operation.

3.3.5.2.1 Interpretation of Rate-of-Change Value in Conjunction with the Bar Graphs

The value provided for rate-of-change is intended to be used in conjunction with the bar graphs provided on the trending displays of the SPDS display group. The bar graph will indicate the value of the parameter with respect to the measurement range provided by the PMC. The rate-of-change value will give a numerical indication on whether the bar is growing or shrinking and how fast this growth is happening. This arrangement makes maximum use of the PMC hardware provided for SPDS displays.

3.3.5.3 DIF

The preprocessor calculation performed to determine the difference between two point ID values can be illustrated as:

C266nn = XSSSnn(1) minus XSSSnn(2)

If either one of the "XSSSnn" point IDs are not GOOD or INSERTED then the calculation of the related "C266nn" will be skipped.

3.3.5.4 AVG

The preprocessor calculation performed to determine the average of a group of point ID values can be illustrated as:

$$C266nn = \frac{(XSSSnn(1) + XSSSnn(2) + XSSSnn(3) + \ldots + XSSSnn(N))}{N}$$

"N" is a function of the size of the input file. Point IDs whose quality is neither GOOD, nor INSERTED will automatically be deleted from consideration at the time of this operation.

3.3.5.5 Action Limit Checking

An input list of "N" point IDs will each have a value setpoint to be tested against. If any of the tests are true for the input list, the related C266nn will be set so that CGS will be able to make a logical decision to display a conditional message. "N" is a function of the size of the input file. Point IDs whose quality is neither GOOD nor INSERTED will automatically be deleted from consideration at the time of this operation.

Section 4

SPDS PARAMETER SELECTION

The purpose of the SPDS is to display information to the operator that will enable him to quickly determine the critical safety function status of the plant during an accident or off-normal event. This is done by choosing key plant parameters to display which relate to the performance of the safety functions. These key parameters were chosen based on information requirements from the Emergency Procedure Guidelines (CEN-152) and a broad range of anticipated operational occurrences and Design Basis Accidents.

The following sections describe and justify the selection of the major parameters displayed on the SPDS. There are many parameters that are included on the SPDS but that are not discussed here. These additional parameters provide the operator with supplemental information and are not strictly required to assess the safety function status. The safety functions monitored by the SPDS are Containment Conditions, Radioactivity Control, Reactivity Control, Core Cooling and RCS Heat Removal, and RCS Integrity. All instrument signals used in the SPDS are screened by a validation algorithm.

4.1 CONTAINMENT CONDITIONS

Containment Conditions assures that the temperature and pressure inside the containment building does not increase to the point that its integrity is threatened. Loss of containment integrity could result in the uncontrolled release of radioactivity to the environment.

4.1.1 Containment Pressure

Containment pressure is a primary indicator of the potential or actual loss of containment integrity. It can also indicate the existence of an RCS leak into the containment building. If primary coolant is lost from the RCS into the containment, the pressure in containment will increase. The pressure must be controlled below design limits to ensure that containment integrity is maintained.

Three containment pressure values are displayed, two narrow range and one wide range. The numerical average of three signals with a 0-30 psia range is shown under the Narrow Range 1 heading. The average of four signals with a 0-40 psia range is shown under Narrow Range 2. The Wide Range value is the average of two signals with a range of 0-70 psia.

4.1.2 Containment Temperature

Containment temperature is monitored to indicate the ability of the containment cooling systems to remove heat that is deposited in the containment. It is also used to detect extreme temperatures that may affect the integrity or functionability of equipment inside the containment building.

Eight signals which measure the air temperature entering the containment fan coolers are monitored. These have been divided into two channels, both of which are displayed. The value shown for each channel is the numerical average of the four fan cooler air inlet temperatures with a range of 0-450°F.

4.1.3 Containment Spray Flow

The containment spray flow rate is displayed to allow the operator to verify that this system is functioning. Containment Spray plays a major role in heat removal and pressure reduction.

Spray flow rate values for both trains are shown on the SPDS. These signals have a range of 0-2500 gpm.

4.1.4 Containment Fan Cooler Differential Pressure

The differential pressure across each containment cooling fan is displayed to provide an indication that the fans are working. The fans function to reduce the containment atmosphere temperature.

One differential pressure signal with a range of 0-10 inches of water is shown for each of the four fans.

4.1.5 Containment Hydrogen Concentration

The concentration of hydrogen within the containment is an indicator of the potential for a hydrogen burn or explosion.

The hydrogen concentration displayed by the SPDS is the same value determined by the Qualified Safety Parameter Display System (QSPDS).

4.2 RADIOACTIVITY CONTROL

Radioactivity Control assures that minimal radioactive material escapes from the plant to the environment. Monitoring the activity of both gas and liquid discharges to the environment allows an assessment of how well this safety function is being performed. Plant area activities are also monitored to indicate if high radiation levels exist at those locations. This information could indicate that a normally safe operation would not be safe if high radiation levels exist inside containment.

4.2.1 Containment Atmosphere Radiation

The radiation level in the containment atmosphere is displayed on the SPDS. During an accident, it can be used to determine the activity released due to possible containment leakage. This information can also be helpful in determining the type of accident that may have occurred, and possibly even determine the location of a pipe break.

There are many containment area radiation monitors located on all floor elevations that are displayed on the SPDS. A list and approximate locations of these monitors is provided in Section 4. An indication in mR/hr or R/hr is given. Signals from both safety grade and non-safety grade sensors are displayed.

4.2.2 Main Steam Line Radiation

An indication of radioactivity in the main steam line can alert the operators to a primary to secondary leak or steam generator tube rupture.

The activity of each main steam line is displayed on the SPDS. The monitor is located just outside containment prior to the secondary safety valves. The signal is displayed in mR/hr under this safety function.

4.2.3 Condenser Air Ejector Radiation

High radiation levels in the condenser air ejector exhaust is an additional indication of a primary to secondary leak or steam generator tube rupture.

Two signals are displayed which show the non-condensable gas activity in the condenser air ejector exhaust. The indication is given in micro Ci/cc.

4.2.4 Plant Stack Radiation

The activity level in the plant stack is displayed to provide an indication of any significant gaseous release of radioactivity to the environment.

The plant stack monitor measures particulates, iodine, and noble gases at the point of release to the atmosphere. Signals for two channels are shown in micro Ci/cc.

4.2.5 Liquid Waste Management Discharge Radiation

The activity in the effluent leaving the Liquid Waste Management System is displayed to provide an indication of any significant release of radioactivity to the environment via the plant liquid discharge.

The liquid waste discharge radiation monitors measure the gross gamma activity in the effluent from the Liquid Waste Management System. A non-safety grade signal is displayed in micro Ci/cc.

4.3 REACTIVITY CONTROL

Reactivity control assures that excessive core power that could threaten the integrity of the fuel cladding or RCS is not produced. Failure to control power level is characterized by a level of power production that exceeds the capability of the system to remove the heat generated. A power excursion is characterized by an increase in neutron flux which raises the heat generation rate. The operator can use the control rods and coolant boron concentration to control reactivity.

4.3.1 Neutron Flux

The neutron flux is displayed to provide a direct indication of the core power level, and therefore, a determination of the success of reactivity control. Upon receiving a reactor trip signal, the operator can verify that core power is (or is not) decreasing as would be expected following a reactor trip.

The signal for the neutron flux is taken from the safety channel excore detectors through the QSPDS. The display is in percent power and ranges from 10^{-7} to 200% power.

4.3.2 Control Element Assembly Position

A signal that control rods have dropped and are fully inserted is a strong indication that subcritical conditions exist and that reactivity is being controlled. If more than a certain number of control rods are not fully inserted, the operator may have to rely on soluble boron to achieve and maintain subcriticality.

This information is based on the control rod bottom indicators and is displayed on the SPDS in message format. If the rod bottom indicators show that the control element assemblies (CEAs) are fully inserted, then the message "CEAs Dropped" is displayed. If some CEAs are not fully inserted, that number is displayed as "CEAs WITHDRAWN".

4.3.3 RCS Boron Concentration

The soluble boron concentration in the RCS is displayed on the SPDS since it can be used to control reactivity and core power.

The RCS boron concentration is determined from the boronometer located in the letdown line. It has a range of 0-2500 ppm.

4.3.4 Charging Pump Flow Rate

The flow rate from the charging pump is displayed since this is a primary path for adding boron to the RCS. The operator can verify that, with the proper pump suction alignment, a high boron concentration is being delivered to the RCS.

The charging pump flow rate is taken from the QSPDS and has a range of 0-150 gpm.

4.3.5 Safety Injection Flow Rate

The flow rate from the High Pressure and Low Pressure Safety Injection pumps is displayed since this is an additional source of borated water (from the Refueling Water Storage Pool) that can be delivered to the RCS if pressure is below the pump shutoff head.

The high pressure pump flow rate is displayed with a range of 0-500 gpm and the low pressure pump flow rate is displayed with a range of 0-5000 gpm.

4.4 CORE COOLING AND RCS HEAT REMOVAL

This safety function is first related to assuring that heat is removed from the core so that fuel cladding temperatures do not increase to the point where gross cladding failure occurs. If the core is covered with water, adequate core cooling is assured. This heat is removed by the steam generators or shutdown cooling heat exchangers. These displays alert the operator to the approach of an inadequate core cooling condition and provide information on systems designed to maintain proper heat removal.

4.4.1 Pressurizer Level

Pressurizer level is displayed as an indication of coolant inventory in the primary system. As long as there is water in the pressurizer, there is (under most conditions) sufficient inventory to cool the core and allow RCS heat removal. Control of pressurizer level indicates successful recovery from many accidents.

The average of four pressurizer level signals is displayed on the SPDS. One of these comes directly from the QSPDS. The display range is 0-100%.

4.4.2 Pressurizer Pressure

Pressurizer pressure is displayed since it is often an early indicator that an event has occurred that might threaten core cooling or RCS heat removal. A rapid decrease in pressure is characteristic of a loss of coolant accident which could result in inadequate core cooling. An increase in pressure is characteristic of a failure to remove heat from the RCS.

The minimum value of two pressurizer pressure signals from the QSPDS is displayed. The signal range is 0-3000 psia.

4.4.3 Saturation Margin

The margin to saturation conditions (subcooled or superheated) in the RCS is displayed on the SPDS to alert the operator to the approach or existence of inadequate core cooling. Loss of subcooling is characteristic of RCS depressurization and heat-up transients. A certain amount of subcooling must be maintained to assure that this safety function is being accomplished.

The saturation margin displayed on the SPDS is the minimum (or most negative) of six separate values, two from the Process Analog Circuitry (PAC) and four from the QSPDS. The PAC uses the temperature from the hot and cold leg RTDs. The QSPDS uses the hot and cold leg RTDs, the unheated junction thermocouples in the upper head, and the core exit thermocouples. Pressure input to the calculation by QSPDS is from the wide range safety grade pressurizer pressure channels. The display range is 200°F subcooled to about 2100°F superheated.

4.4.4 Reactor Vessel Water Level

The reactor vessel water level is displayed to extend the RCS water level measurement down to approximately the top of the core. As long as the core is entirely covered by water or a two-phase mixture, successful core cooling is accomplished. Measurement of the water inventory above the core that is available for cooling can provide a direct indication of the approach to inadequate core cooling if the reactor vessel level were to decrease.

The reactor vessel level displayed is a collapsed level (i.e. shows water inventory) taken from the QSPDS and is measured by heated junction thermocouple instrument assemblies.

The signal from both instruments is displayed. The reactor vessel level is measured and displayed as two separate and independent levels, one in the upper head region (above the upper guide structure support plate) and one in the upper plenum region (between the upper guide structure support plate and the fuel alignment plate). The display range is 0-100% height for each region.

4.4.5 Core Exit Temperature

The core exit temperature is displayed to provide an indication of core uncovery and fuel cladding heatup. As the core uncovers, steam at the core exit increases its temperature and becomes superheated. This provides trending information on the fuel cladding heatup.

The temperature displayed is taken from the QSPDS which processes the signals from all core exit thermocouples (CETs). A representative CET temperature, which is close to the maximum temperature, is determined from a statistical analysis of the thermocouple signals. The maximum representative CET temperature from the two QSPDS channels is displayed on the SPDS. The range is 32-2300°F.

4.4.6 Hot and Cold Leg Temperatures

The primary coolant temperature in all hot and cold legs is shown on the SPDS. The temperature difference between the hot and cold legs is also displayed. The coolant temperatures inform the operator of the effectiveness of heat transfer from the core to the coolant and from the coolant to the steam generators or shutdown cooling heat exchangers. The loop differential temperatures are used to verify natural circulation if the RCPs are not running.

4.4.7 Reactor Coolant Pump (RCP) Current

The RCP motor current is displayed on the SPDS to inform the operator which pumps are running and that forced circulation through the RCS exists. Forced circulation with the RCPs greatly improves the heat removal capability, as well as pressure control with the normal pressurizer spray. RCP current is also shown because of the effect that pump operation has on the reactor vessel level measurement response during an accident. If the RCPs are running, the level in the upper plenum is biased in the low direction. The RCP current display allows the operator to quickly and correctly interpret the level signal.

The current applied to each RCP motor is displayed with a range of 0-1200 amps. This is an indication that the RCPs are running and providing forced circulation.

4.4.8 Safety Injection Flow

The flow rate delivered to the RCS by the High Pressure and Low Pressure Safety Injection (HPSI and LPSI) pumps is displayed to allow the operator to verify that primary coolant inventory is being replenished after an RCS pipe break or leak. For some accidents, safety injection is required to assure that adequate core cooling is maintained.

The flow rate from the HPSI and LPSI pumps delivered to each leg, including the hot legs during simultaneous hot and cold leg injection, is displayed in gallons per minute. The range for HPSI flow is 0-500 gpm and the range for LPSI flow is 0-5000 gpm.

4.4.9 Steam Generator Water Level

The steam generators are the primary heat sinks for heat transfer from the RCS coolant. To provide this heat sink there must be sufficient water on the secondary side. The steam generator water level displays the inventory on the secondary side to inform the operator that the steam generator is capable of removing heat from the RCS.

The steam generator level displayed on the SPDS is the average of four wide range control channel signals and one wide range signal from the QSPDS. The level in each steam generator is shown. The range is 0-100%.

4.4.10 Steam Generator Pressure

The steam generator secondary side pressure is displayed to assist the operator in determining the type of event that may have occurred. The pressure is also related to the heat removal capability and assists the operator to perform a controlled cooldown of the RCS to shutdown cooling conditions.

The steam generator pressure displayed is the average of four control channel signals and one signal from the QSPDS. Pressure in each steam generator is shown with a range of 0-1200 psia.

4.4.11 Steam Flow Rate

The steam flow rate leaving each steam generator is an indication that steam is being produced and heat is being removed from the steam generator and RCS.

The steam flow rate is measured on each main steam pipe before it exists the containment building. The average of two signals, one from the QSPDS, is displayed for each main steam line. The range is 0 to 8.0×10^6 lbs/hr.

4.4.12 Main and Emergency Feedwater Flow Rate

The main and emergency feedwater flow rates are displayed to inform the operator that the steam generator secondary side inventory is being replenished so that RCS heat removal is maintained. If the feedwater flow were to stop, the steam generators would boil dry and RCS heat removal would be lost.

The feedwater flow rates are taken from the QSPDS and displayed for each steam generator. The measurement is made just upstream of the flow control valves. The range for the main feedwater is 0 to 8.0×10^6 lbs/hr. The emergency feedwater range is 0-800 gpm.

4.4.13 Shutdown Cooling Heat Exchanger Flow Rate

The flow rate of primary coolant through the shutdown cooling heat exchangers is displayed so the operator can verify that forced flow to the core does exist during the shutdown and refueling modes of operation. Forced flow through the core and shutdown cooling heat exchangers is required during these modes to maintain RCS heat removal.

The flow rate is taken from the QSPDS and displayed for each heat exchanger loop. The measurement is made upstream of the LPSI injection header. The range is 0-5000 gpm.

4.4.14 Shutdown Cooling Heat Exchanger Temperatures

The primary coolant temperature at the inlet and outlet of the shutdown cooling heat exchangers is displayed on the SPDS. This allows the operator to assess the effectiveness of the shutdown cooling heat exchanger in removing heat from the RCS. A small or zero temperature difference between inlet and outlet indicates that cooling is not taking place.

The temperatures are measured at the inlet and outlet of the shutdown cooling heat exchangers with safety grade instruments. The values for each heat exchanger are displayed. The inlet temperature has a range of 32-350°F and the outlet temperature has a range of 0-400°F. The range need not extend to higher temperatures since the shutdown cooling system is not used above 350°F.

4.5 REACTOR COOLANT SYSTEM INTEGRITY

RCS Integrity relates to assuring that RCS coolant inventory is not lost in an uncontrollable manner. Coolant loss from a leak or pipe break could threaten the ability to cool the core if enough inventory is lost to uncover the core. A leak also means that the possibility of radioactive material escaping from the RCS boundary exists. This may present a radiation hazard of which the operator should be aware. A leak can be detected by monitoring RCS conditions as well as possible leak paths or collection areas.

4.5.1 Pressurizer Level

Pressurizer level is displayed to give the operator a direct indication of the amount of coolant inventory in the RCS. A decreasing level indicates a loss of inventory at a rate that is too high for the Pressurizer Level Control System (charging pumps) to replenish. The rate of change in pressurizer level can provide information on the leak rate. The level can also inform the operator if and when a leak has been isolated or brought under control.

The same value as described in Section 4.4.1 is displayed here.

4.5.2 Pressurizer Pressure

Pressurizer pressure is displayed since a decreasing value is characteristic of a loss of inventory by a pipe break or large leak. The controlled reduction of RCS pressure is an important operator action to reduce the leak rate during, for example a steam generator tube rupture.

The same value as described in Section 4.4.2 is displayed here.

4.5.3 Containment Sump Level

The containment sump level is displayed to inform the operator if water is collecting in the sump. An increasing sump level is an indication that a leak, possibly from the RCS, into containment exists. All floor drains within the containment are routed to the sump so that water does not accumulate in other areas.

The maximum of two safety grade containment sump level signals is displayed on the SPDS. The two values have a range of 0-30 ft.

4.5.4 Pressurizer to Quench Tank Line Temperature

Any leakage past the pressurizer safety relief valves will cause an increase in the temperature of the discharge line to the quench tank. This temperature is displayed to indicate leakage past the safety relief valves.

The discharge line temperature is displayed for both lines with a range of 0-300°F.

4.5.5 Quench Tank Level

The pressurizer safety relief valves discharge directly to the quench tank which is located inside containment. This tank is partially filled with water to condense steam from the pressurizer. An increase in the quench tank water level indicates that the safety relief valves are open or leaking. The level display can also be used by the operator to confirm that water exists in the tank to condense steam. The quench tank level is displayed with a range of 0-100%.

4.5.6 Quench Tank Pressure

The pressure in the quench tank is displayed to inform the operator of the potential for, or occurrence of, rupture disk blowout. If the pressure in the quench tank exceeds a certain value, the rupture disc on the tank will burst. This provides a direct path for loss of RCS inventory to the containment via the pressurizer safety valves.

4.5.7 Secondary Side Radiation

A leak of primary coolant to the secondary side, as in a steam generator tube rupture, can be detected by increasing radiation levels on the secondary side. Thus, radiation levels from both steam lines and the condenser air ejectors are displayed to alert the operator to this type of RCS inventory loss.

The same values as described in Section 4.2 are displayed here.

Section 5

SPDS DISPLAY HIERARCHY

5.1 SAFETY FUNCTIONS TO BE MONITORED

Each of the five principle safety functions to be maintained are defined separately beginning with Section 5.3. The five safety functions are:

Containment Conditions
Radiation Releases
Reactivity Control
Core Cooling and RCS Heat Removal
RCS Integrity

5.2 NAMING, COLORING AND ORGANIZATION OF THE DISPLAYS

5.2.1 Display Naming and Recalling

When the ERF start-up procedure is run, the man-machine interface is activated. A main menu is displayed on each of the CPU 3 related HERCO consoles. This menu is used to select the general class of ERF commands to be entered. A menu selection is made by moving the cursor to the line describing the function that the user needs and depressing the XMIT key. The menu options appear as below:

MAIN MENU

SAFETY PARAMETER DISPLAY
REPORT GENERATION
HISTORICAL DATA COLLECTION
CEPADAS

The SPDS functions on CPU 3 will be accessed by the user (Control Room, TSC, or EOF personnel) through the HERCO Console. The HERCO interaction will produce Historical Logs on the CPU 3 associated printers, or display predefined mimics on the CPU 3 related CRTs. The SPDS mimics will be displayed on the CPU 3 CRTs, with the SPDS menu being displayed on the HERCO's plasma display. To make the SPDS displays available, the user places the cursor on the line with the first option of the ERF Main Menu. A "transmit" should then be keyed into the desired CPU 3 HERCO. Initially, this request will display the SPDS mimic selection menu on the HERCO's plasma display.

The actual recalling of display on CPU 3 will be similar to that used for CPU 2. Each display is assigned up to an eight alpha-numeric character name. The SPDS display selection menu appears as follows:

SAFETY PARAMETER DISPLAY MENU

DISPLAY MIMIC, MIMINAME, CRT #
RESET MIMIC, CRT #
DIRECTORY, LOGGER #

To bring a display to a CRT the (up to) eight character display name is to be followed by a comma and then the CRT number corresponding to what is available at the HERCO station and where the user wishes to place the display. The number of available CRTs is dependent on which HERCO is being used. There are five CRTs in the TSC for two ERF HERCOs. In the control room, there are two ERF CRTs. In the primary Emergency Operating Facility (EOF), there are three ERF CRTs; and in the backup EOF, there is one CRT.

If the user selects the RESET MIMIC option, the top-level (A) SPDS Summary Display is activated on the CRT specified by CRT #.

If the user enters the directory command, the directory of display titles is generated at the printer specified by LOGGER #. This list shows the displays that have been generated.

The legal values for CRT # and LOGGER # on this menu are restricted according to the following table:

ERF Location	Legal CRT #	Legal Logger #
Main Control Room	1,2	NONE
TSC Conference Room	1,2,3	1,2
TSC Emergency Control Center	1,2	3
EOF Conference Room	1,2	4
EOF Dose Assessment	1	5
Backup EOF	1	6

For any of the HERCO menus, if the user places the cursor on a blank line and depresses XMIT, the main ERF Menu will return to the HERCO.

The Color Graphics System (CGS) permits names for displays up to eight characters long. A display can only be called by one name unless the same display is compiled under several names. These names, once selected must be entered exactly for the computer to recall the desired display. SPDS users will be trained to understand that the displays are entitled by letters of the alphabet, assigned to follow the listing order of monitored safety functions. Each SPDS location will have a User's Manual available for ready reference to the display names. The SPDS Displays will have one- or two-character alpha names so that calling them to the CRT will be simplified. The display titles are assigned as follows:

A Parameter Summary Display
AA Summary Display Trending
B Containment Conditions
BB Containment Conditions Parameter Trending
C Containment Support Systems
CC Containment Support Systems Trending
D Dedicated Spare
E Radiation Releases - Containment +46
F Radiation Releases - Containment +21
G Radiation Releases - Containment - 4
H Radiation Releases - RAB +46

I Radiation Releases - RAB +21
J Radiation Releases - RAB - 4
K Radiation Releases - RAB -35
L Radiation Releases - FHB +46
M Radiation Releases - FHB + 1
N Radiation Releases - RAB Ventilation
NN Radiation Releases - RAB Ventilation Parameter Trending
P Radiation Releases - BOP/FHB Process Monitors
PP Radiation Releases - BOP/FHB Process Monitors Parameter Trending
Q Radiation Releases - RAB Effluent
QQ Radiation Releases - RAB Effluent Parameter Trending
R Reactivity Control Display
RR Reactivity Control Parameter Trending Display
S Boric Acid Supply to Charging
T Core Cooling Display
TT Core Cooling Parameter Trending
U RCS Heat Removal Display
UU RCS Heat Removal Display Parameter Trending
V RCS Heat Removal SIS/PZR Spray Flow
VV RCS Heat Removal SIS/PZR Spray Flow Parameter Trending
W RCS Integrity - Overview Display
WW RCS Integrity - Overview Parameter Trending
X RCS Integrity - Safety Injection Tanks
XX RCS Integrity - Safety Injection Tanks - Parameter Trending
Y RCS Integrity - SIS Piping
YY RCS Integrity - SIS Piping Parameter Trending
Z RCS Integrity - Reactor Coolant Pump Seals
ZZ RCS Integrity - Reactor Coolant Pump Seals Parameter Trending

5.2.2 Display Coloring

The draft EPRI Guidelines - Integrating Human Factors Engineering Into Nuclear Power Plant Design will be used to establish the display conventions to be used during the installation of SPDS displays under the CGS system of CPU 3. The specific rules to be used are described below.

All of the SPDS displays are composed of a small set of symbols for piping, valves, tanks, pumps, vessels, walls, alphanumeric labels, and bar graphs.

Solid dark blue lines will outline portions of the screen in a silhouette resembling the mimicked pipe, duct, tank or wall.

Green will be used to color a closed valve, or inoperative pump.

Red will be used to color an open valve, operating pump, and alarm range (high and low) on a bar graph.

Orange will be the color of special messages (e.g. SIS LEAK DET).

Cyan will be used for text column headings and labels. While cyan and white will be alternated on solid text portions of the screen (e.g. point ID valve descriptions).

Yellow will be used for indeterminate conditions (e.g. valve positions).

The blinking feature will not be employed.

5.2.3 Display Organization

The ERF software package is designed to contain only one directory of SPDS Displays. This means that all the displays compiled under SPDS are equally accessible. The SPDS user, therefore, will be allowed to call any legitimate display title in any order which seems appropriate.

The Parameter Summary is intended to be the primary, or top level display present on CRT 1 of any given SPDS station. The Parameter Summary should be present on all SPDS stations when those stations are not otherwise in use. Each station has at least two CRTs available (save the Backup EOF) as the chart in Section 5.2.1 indicates. This means there is room for the corresponding Parameter Summary Trending Display to be placed on the adjacent screen (CRT 2) when it is not otherwise in use. This display details values relative to available ranges and the rate change of each dynamic value on the Parameter Summary Display.

Problems are detected via the Parameter Summary through conditional messages or color changes which can appear in several areas of the screen. As problems are detected via the Parameter Summary, the adjacent screen (CRT 2) could be used to bring up the principle displays of Containment Conditions, Radiation Releases, etc. (titled B through Z), for further and more detailed information. Once a principle display of interest is found on CRT 2, its corresponding trending display (titled BB through ZZ) could be brought to CRT 1.

As the problem is mitigated, the SPDS user can alternate the content of CRT 2 between the principle display and the Parameter Summary Display, to confirm that all five safety parameters have returned to normal.

5.3 CONTAINMENT CONDITIONS

Section 4.1 describes the major parameters selected to display the status of the Containment Conditions Safety Function. Two displays (B and C) are provided to monitor Containment Conditions. Display B allows the user to assess the temperature, differential pressure from ambient, humidity, etc. inside containment. Based on the values displayed, the user may determine that one of the containment systems is malfunctioning. Display C gives an overview of the systems in direct support of containment, particularly the systems which remove heat from inside containment.

5.3.1
Description of the Data Base Values Used on Containment Conditions

Two displays have been generated to convey to the user of SPDS the status of the environment inside the steel containment vessel and the operation of equipment removing heat from containment. Display B is intended as the main display for this safety function, incorporating the Containment environmental data (pressure, temperature, etc.). Display C provides data on water flow temperatures interfacing containment. Both figures have a common layout showing a cross section of containment and the Plant Protection information in the same locations. Static illustrations of these displays and listings of the parameters displayed are included in Section 5.3.2.

5.3.1.1 Display "B" - Containment Conditions

The point IDs for pressure inside of containment have several ranges. Each point ID with the same range will be numerically averaged and displayed under the heading of "NARROW RNG - 1," NARROW RNG - 2" and "WIDE RNG." "NARROW RNG -1" will be the numerical average for three point IDs. These point IDs have a range of 0-30 psia. "NARROW RNG - 2" will be the numerical average of four point IDs with a range of 0-40 psia. "WIDE RNG" will be the numerical average of two point IDs with a a range of 0-70 psia.

The PMC has access to eight point IDs which measure the air temperature entering the containment fan coolers. One set of four has been dedicated to the QSPDS, and the other remain attached to the normal PMC multiplexing system. Technical Specifications require that containment temperature be determined by using the numerical average of the four fan cooler inlet temperatures. The field instruments which supply signals to the computers were divided into two channels. This division will be retained on Display B. Channel 1 point IDs come into the PMC data base via the QSPDS data link. Channel 2 comes directly through the PMC System. The values will be located in the center of the display under the headlines "TEMPERATURE, CHNL - 1" and "CHNL - 2".

The Plant Protection System (PPS) signals important to maintaining containment are SIAS, MSIS, CSAS, and CIAS. Each have an associated output message from the PMC data base (detected or cleared). These point IDs are the generic sources of information in the SPDS user's assessment of a potential problem with containment integrity. Since a "detected" state is, under all circumstances, an indication of a problem, this message will appear in red.

"CNTMT TO AMB D/P" will be a single value indicative of the radioactive gas flow path direction (into or out of) with respect to containment. The value is shown between two "openings" in the illustrated walls of the Annulus and Shield Building to indicate the instrument installation supplying this value.

"ANUL TO AMB D/P" will be a single value determined from a numerical average of two point IDs. This value is an indication of the general direction of flow between the ambient atmosphere, and the annulus between the Shield Building and the steel containment vessel. The value is shown in one opening of the illustrated Shield Building wall, again showing the installed nature of the sensor for this point ID value.

The level of humidity inside containment as shown in the average of two point IDs. Unusually high humidity would be indicative of a steam leak somewhere in containment.

The concentration of hydrogen in containment is shown from the QSPDS measurement. This value will be consulted in determining the activation of the Containment Atmosphere Relief System and the Hydrogen Recombiners.

Safety Injection Sump level is measured by two channels, both of which are illustrated on the display.

The PMC is able to monitor several containment isolation valves which are required to be leak tight when closed and do not receive CIAS. Containment isolation valves which are required to be leak tight are those identified by noting which valves are Type C Leak Rate Tested. The PMC, by this definition, is able to monitor the closure of eight valves. The operating system valve number and the penetration number is included on the display for identification. A valve symbol is provided for each valve.

Valve Number	State Message
PMU-151	Not Closed/Closed
CVR-101	Not Closed/Closed
CVR-201	Not Closed/Closed
CAR-101B	Not Closed/Closed
CAR-101A	Not Closed/Closed
CAR-202A	Not Closed/Closed
CAR-202B	Not Closed/Closed
CMU-244	Not Open/Open

5.3.1.2 Display "C" - Containment Support Systems

Display C illustrates the supporting Containment Conditions display with the various flows and a repeat of the PPS signals.

The discharge temperatures of the two hydrogen recombiners are monitored to assess this source of heat input to containment atmosphere. These temperatures are also indicative of the recombiners' operating state. The averages of three point IDs measuring the temperature of the exhaust to containment for each recombiner are displayed.

The temperature of the Refueling Water Storage Pool (RWSP) water is measured in the Safety Injection suction piping in trains A and B. Containment Spray is designed to pump water from the RWSP at a temperature of no more than 100 DEGF. The two temperatures shown on the display are for the A and B suction lines.

The next set of temperatures and flows relate to each of the Shutdown Cooling Heat Exchangers (SDCHx) and Containment Spray. These parameters are important in assessing the containment spray's ability to remove heat from the containment atmosphere via the SDCHx. The temperature of the containment spray water at the inlet and outlet of the SDCHx is shown. The flow rate and outlet temperature of the Component Cooling Water (CCW) on the secondary side of the SDCHx is also displayed.

"CS SPRAY FLOW" displays values for train A and B flow to verify that the main containment emergency heat removal mechanism is functioning.

Containment fan cooler flow is most closely seen by the PMC data base in differential pressure measurements across each fan. The point IDs for each fan differential pressure are displayed.

Component Cooling Water flow to each of the containment fan coolers is displayed. This is used to verify that the fans can remove heat from the containment air.

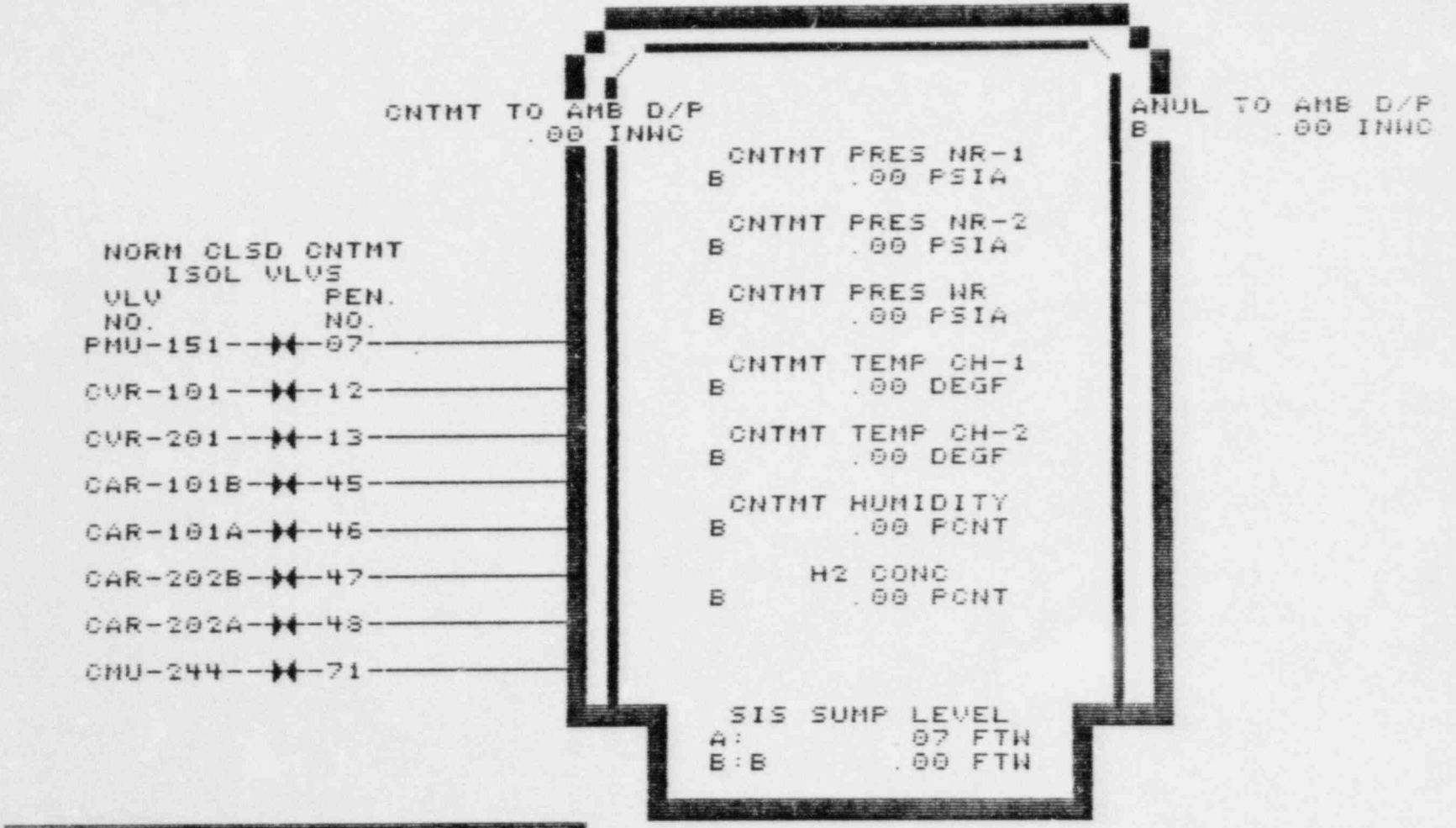
5.3.2 Static Illustration of the Containment Conditions Displays and Associated Parameter Listings

NOTE:

The copies of the displays included in this report are an indication of the type of copies which can be obtained from the SPDS dedicated hard copy device.

DATA BASE FOR DISPLAY B - CONTAINMENT CONDITIONS

DESCRIPTION	SET POINT LO	SET POINT HI
SIS SUMP LVL A:	N/A	N/A
CNTMT TO AMB D/P	N/A	0 INWG
SIAS CHNL-B	ACTIVATED	NOT ACTIV
MSIS CHNL-B	ACTIVATED	NOT ACTIV
SIS SUMP LVL B:	N/A	N/A
H2 CONC	N/A	4 PCNT
CNTMT PRES NR-1	N/A	18.2 PSIA
CNTMT PRES NR-2	N/A	18.2 PSIA
CNTMT PRES WR	N/A	18.2 PSIA
CNTMT TEMP CH-2	N/A	120 DEGF
CNTMT HUMIDITY	N/A	N/A
ANUL TO AMB D/P	N/A	-5.0 INWG
CNTMT TEMP CH-1	N/A	120 DEGF
CSAS CHNL-A	DETECTED	CLEARED
MSIS CHNL-A	DETECTED	CLEARED
CIAS CHNL-A	DETECTED	CLEARED
CSAS CHNL-B	DETECTED	CLEARED
CIAS CHNL-B	DETECTED	CLEARED
SIAS CHNL-A	DETECTED	CLEARED
PENET. 13 CVR-201	NOT CLOSED	CLOSED
PENET. 12 CVR-101	NOT CLOSED	CLOSED
PENET. 45 CAR-101B	NOT CLOSED	CLOSED
PENET. 46 CAR-101A	NOT CLOSED	CLOSED
PENET. 48 CAR-202A	NOT CLOSED	CLOSED
PENET. 47 CAR-202B	NOT CLOSED	CLOSED
PENET. 71 CMU-244	NOT OPEN	OPEN
PENET. 7 PMU-151	NOT CLOSED	CLOSED



PPS	CHNL-A	CHNL-B
SIAS	@ XXXXXXXX	@ XXXXXXXX
CSAS	@ XXXXXXXX	@ XXXXXXXX
MSIS	@ XXXXXXXX	@ XXXXXXXX
CIAS	@ XXXXXXXX	@ XXXXXXXX

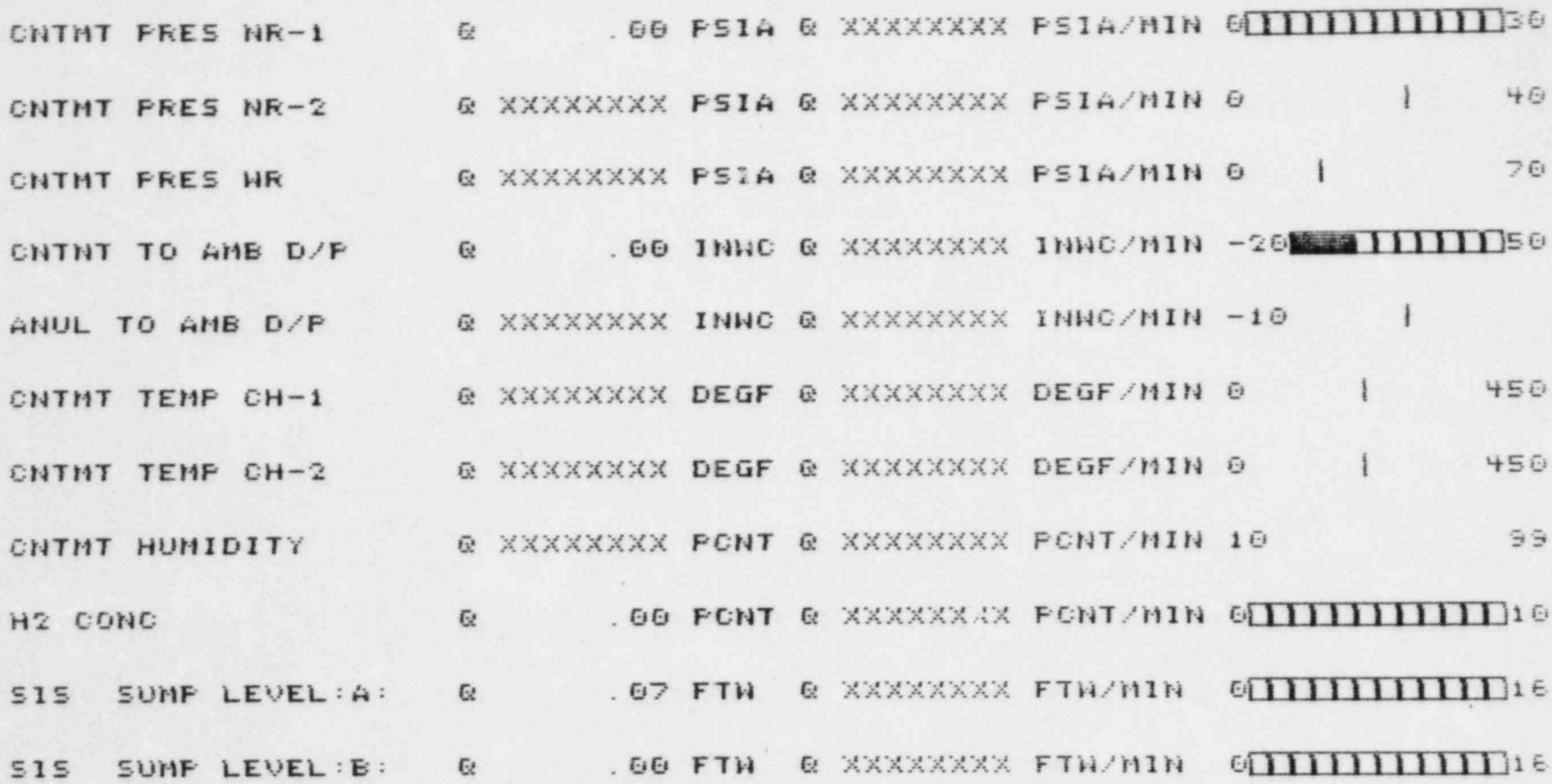
B

CONTAINMENT CONDITIONS - ENVIRONMENT

13:52:50 30MAR84

DATA BASE FOR DISPLAY BB - CONTAINMENT CONDITIONS PARAMETER TRENDING

DESCRIPTION	SET POINT LO	SET POINT HI
SIS SUMP LVL A	N/A	N/A
CNTMT TO AMB D/P	N/A	0 INWG
SIS SUMP LVL B:	N/A	N/A
H2 CONC	N/A	4 PCNT
CNTMT PRES NR-1	N/A	18.2 PSIA
CNTMT PRES NR-2	N/A	18.2 PSIA
CNTMT PRES WR	N/A	18.2 PSIA
CNTMT TEMP CH-2	N/A	120 DEGF
CNTMT HUMIDITY	N/A	N/A
ANUL TO AMB D/P	N/A	-5.0 INWG
CNTMT TEMP CH-1	N/A	120 DEGF



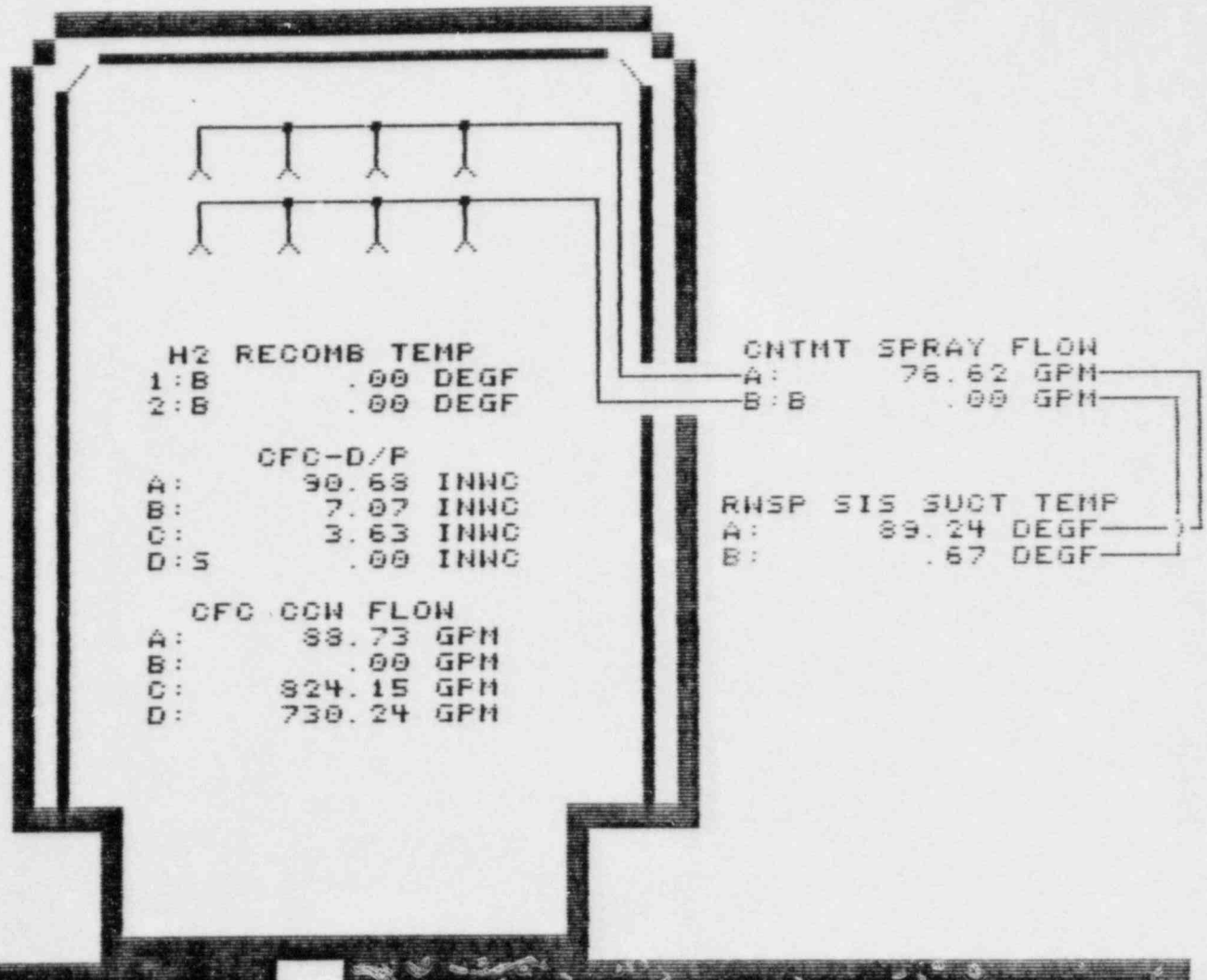
88

CONTAINMENT ENVIRONMENT TRENDING

13:53:12 30MAR84

DATA BASE FOR DISPLAY C - CONTAINMENT SUPPORT SYSTEMS

DESCRIPTION	SET POINT LO	SET POINT HI
SIS INLT DEGF A: (SD HX)	N/A	N/A
SIS INLT DEGF B: (SD HX)	N/A	N/A
CCW OUTL DEGF A: (SD HX)	N/A	N/A
CCW OUTL DEGF B: (SD HX)	N/A	N/A
RWSP SIS SUCT TEMP B:	35 DEGF	100 DEGF
RWSP SIS SUCT TEMP A:	35 DEGF	100 DEGF
CFC D/P A:	N/A	N/A
CFC D/P B:	N/A	N/A
CFC D/P C:	N/A	N/A
CFC D/P D:	N/A	N/A
SIAS CHNL-B	ACTIVATED	NOT ACTIV
MSIS CHNL-B	ACTIVATED	NOT ACTIV
SIS OUTL DEGF A: (SD HX)	N/A	N/A
SIS OUTL DEGF B: (SD HX)	N/A	N/A
H2 RECOMB TEMP: 1	N/A	N/A
H2 RECOMB TEMP: 2	N/A	N/A
CSAS CHNL-A	DETECTED	CLEARED
MSIS CHNL-A	DETECTED	CLEARED
CIAS CHNL-A	DETECTED	CLEARED
CSAS CHNL-B	DETECTED	CLEARED
CIAS CHNL-B	DETECTED	CLEARED
SIAS CHNL-A	DETECTED	CLEARED
CNTMT SPRAY FLOW A:	1810 GPM	N/A
CNTMT SPRAY FLOW B:	1810 GPM	N/A
CCW OUTL GPM A: (SD HX)	N/A	N/A
CCW OUTL GPM B: (SD HX)	N/A	N/A
CFC CCW FLOW A:	N/A	N/A
CFC CCW FLOW D:	N/A	N/A
CFC CCW FLOW C:	N/A	N/A
CFC CCW FLOW B:	N/A	N/A
SIS OUTL GPM (A)	N/A	N/A
SIS OUTL GPM (B)	N/A	N/A



PPS	CHNL-A	CHNL-B
SIAS @	XXXXXXXX	@ XXXXXXXX
CSAS @	XXXXXXXX	@ XXXXXXXX
MSIS @	XXXXXXXX	@ XXXXXXXX
CIAS @	XXXXXXXX	@ XXXXXXXX

PARAMETER	SHDN HX A	SHDN HX B
SIS OUTL GPM B	.00 B	.00
SIS INLT DEGF	21.53	75.63
SIS OUTL DEGF B	.00 B	.00
CCW OUTL DEGF	.00	74.55
CCW OUTL GPM S	.00 S	.00

CONTAINMENT CONDITIONS - SUPPORT SYSTEMS

14:10:06 30MAR84

DATA BASE FOR DISPLAY CC - CONTAINMENT SUPPORT SYSTEMS TRENDING

DESCRIPTION	SET POINT LO	SET POINT HI
SHDN HX A SIS IN TEMP	N/A	N/A
SHDN HX B SIS IN TEMP	N/A	N/A
SHDN HX A CCW OUT TEMP	N/A	N/A
SHDN HX B CCW OUT TEMP	N/A	N/A
RWSP SIS SUCT TEMP B:	35 DEGF	100 DEGF
RWSP SIS SUCT TEMP A:	35 DEGF	100 DEGF
CFC D/P A:	N/A	N/A
CFC D/P B:	N/A	N/A
CFC D/P C:	N/A	N/A
CFC D/P D:	N/A	N/A
SHDN HX A SIS OUT TEMP	N/A	N/A
SHDN HX B SIS OUT TEMP	N/A	N/A
H2 RECOMB TEMP: 1	N/A	N/A
H2 RECOMB TEMP: 2	N/A	N/A
CNTMT SPRAY FLOW A:	1810 GPM	N/A
CNTMT SPRAY FLOW B:	1810 GPM	N/A
SHDN HX A CCW OUT FLOW	N/A	N/A
SHDN HX B CCW OUT FLOW	N/A	N/A
CFC CCW FLOW A:	N/A	N/A
CFC CCW FLOW D:	N/A	N/A
CFC CCW FLOW C:	N/A	N/A
CFC CCW FLOW B:	N/A	N/A
SIS OUTL GPM (A)	N/A	N/A
SIS OUTL GPM (B)	N/A	N/A

H2 RECOMB TEMP 1	@	XXXXXXXX	DEGF	@	XXXXXXXX	DEGF/MIN	0	2000
H2 RECOMB TEMP 2	@	XXXXXXXX	DEGF	@	XXXXXXXX	DEGF/MIN	0	2000
CFC D/P A:	@	7.10	PSID	@	XXXXXXXX	PSID/MIN	0	10
CFC D/P B:	@	3.54	PSID	@	XXXXXXXX	PSID/MIN	0	10
CFC D/P C:	@	.00	PSID	@	XXXXXXXX	PSID/MIN	0	10
CFC D/P D:	@	5.62	PSID	@	XXXXXXXX	PSID/MIN	0	10
CFC CCW FLOW A:	@	735.42	GPM	@	XXXXXXXX	GPM/MIN	0	150
CFC CCW FLOW B:	@	910.25	GPM	@	XXXXXXXX	GPM/MIN	0	150
CFC CCW FLOW C:	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	150
CFC CCW FLOW D:	@	823.46	GPM	@	XXXXXXXX	GPM/MIN	0	150
CNTMT SPRAY FLOW A:	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	2500
CNTMT SPRAY FLOW B:	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	2500
RNSP SIS SUCT TEMP A:	@	89.00	DEGF	@	XXXXXXXX	DEGF/MIN	32	240
RNSP SIS SUCT TEMP B:	@	89.25	DEGF	@	XXXXXXXX	DEGF/MIN	32	240

SHDN HX A SIS OU FLOW	@	XXXXXXXX	GPM	@	XXXXXXXX	GPM/MIN	0	5000
SIS IN TEMP	@	75.62	DEGF	@	XXXXXXXX	DEGF/MIN	32	350
SIS OUT TEMP	@	.00	DEGF	@	XXXXXXXX	DEGF/MIN	32	350
CCW OUT TEMP	@	74.46	DEGF	@	XXXXXXXX	DEGF/MIN	32	175
CCW OUT FLOW	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	7000
SHDN HX B SIS OU FLOW	@	XXXXXXXX	GPM	@	XXXXXXXX	GPM/MIN	0	5000
SIS IN TEMP	@	76.61	DEGF	@	XXXXXXXX	DEGF/MIN	32	350
CCW OUT TEMP	@	.00	DEGF	@	XXXXXXXX	DEGF/MIN	32	350
CCW OUT TEMP	@	74.77	DEGF	@	XXXXXXXX	DEGF/MIN	32	175
CCW OUT FLOW	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	7000

CC

CONTAINMENT SUPPORT SYSTEMS TRENDING

13:53:36 30MAR84

5.4 RADIATION RELEASES

During the analysis of the "Radiation Releases" function, it became apparent that this function may overlap the design of CEPADAS[1]. A division was artificially established so that the SPDS design would only monitor radioactive flows or airborne radiation levels inside the plant. The external environmental monitoring of radiation exposure was left to CEPADAS.

The SPDS and CEPADAS functions of the PMC can be performed on adjacent CRTs at the same HERCO station. The SPDS CRT displays present the user with information on radioactive process flows and, pictorially, of airborne radiation levels. Based on the conditional message which appears in the Radiation Releases section of the Parameter Summary Display (see Section 5.8), the corresponding map should be called to CRT 2. The airborne radiation maps (displays E through M) include trend displays on them. The message "PROCESSES" on the Parameter Summary Display will require the SPDS user to page through the three radiation process flow illustrations on displays N, P, and Q.

1. The Computerized Emergency Planning and Data Acquisition System (CEPADAS) provides for post-accident offsite impact assessment through monitoring gaseous and liquid releases along with meteorological data.

5.4.1 Description of the Data Base Values Used on Radiation Release Maps

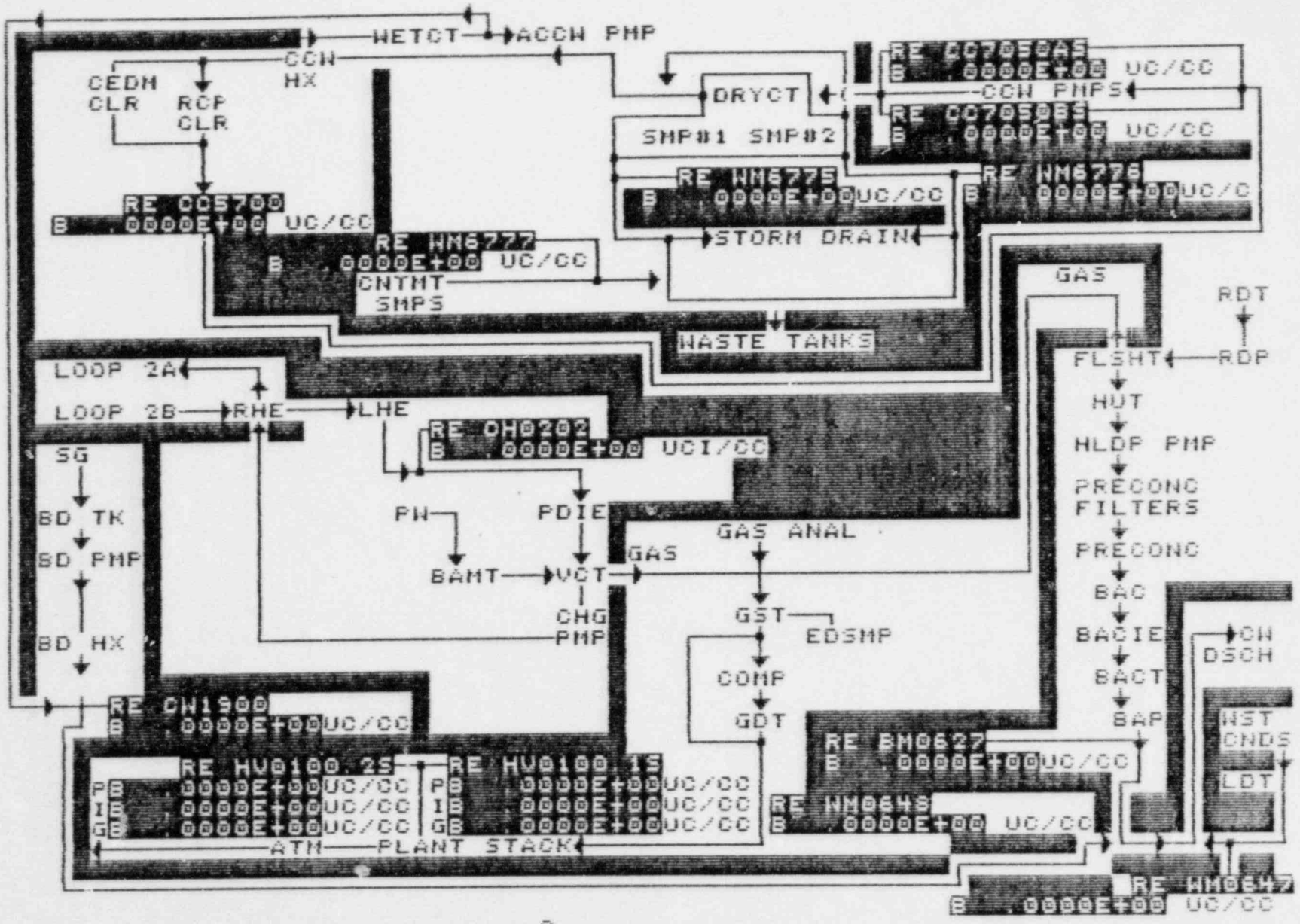
The subtier displays associated with the Radiation Release safety function monitoring of SPDS illustrate the location of the various radiation detectors with respect to the physical component (mechanical and civil) locations in the plant. The radiation monitor skid number is referenced on the display; however, it is the location of the actual radiation detector that is depicted. Each floor of the plant which has an area radiation monitor is illustrated. The point ID information provided on the floor elevation displays includes trending information normally provided on a companion display for other safety functions. The design of the displays with respect to the room available on the CRT made this compression possible. The process flow monitors are shown with respect to the beginning of the flow path and the end destination of the effluent, noting major plant equipment in that path. The process flow displays have the conventional companion trend display. No special conversions or averaging of point ID information is necessary for these displays, beyond the trend processing.

The process flow display is generally arranged so that the sources of radiation (processes, tanks, etc.) inside of containment are shown in the upper left or top of the display. The final effluent is shown leaving the bottom or the right side of the display. The area radiation displays have the detector locations numbered left to right, top to bottom across the floor plan area. The accompanying figures describe the displays for this safety function.

5.4.2 Static Illustration of the Radiation Releases Displays and Associated Parameter Listings

DATA BASE FOR DISPLAY Q - RADIATION RELEASES, RAB EFFLUENT

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV0100.1S PART	N/A	8.76E-06 uCi/cc
RE-HV0100.1S IOD	N/A	3.15E-07 uCi/cc
RE-HV0100.1S GAS	N/A	5.76E-03 uCi/cc
RE-HV0100.2S PART	N/A	8.76E-06 uCi/cc
RE-HV0100.2S IOD	N/A	3.15E-07 uCi/cc
RE-HV0100.2S GAS	N/A	5.76E-03 uCi/cc
RE-WM6775	N/A	1E-08 uCi/cc
RE-WM6776	N/A	1E-08 uCi/cc
RE-CW1900	N/A	5E-08 uCi/cc
RE-WM0647	N/A	1E-04 uCi/cc
RE-WM0648	N/A	1E-04 uCi/cc
RE-WM6777	N/A	N/A
RE-CC7050AS	N/A	1E-04 uCi/cc
RE-CC7050BS	N/A	1E-04 uCi/cc
RE-CC5700	N/A	N/A
RE-CH0202	N/A	N/A
RE-BM0627	N/A	5E-07 uCi/cc



RADIATION RELEASES @ - RAB EFFLUENT

14:33:13 30MAR84

DISPLAY QQ - RADIATION RELEASES, RAB EFFLUENT PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
RE-HV0100.1S PARTIC	N/A	8.76E-06 uCi/cc
RE-HV0100.1S IOD	N/A	3.15E-07 uCi/cc
RE-HV0100.1S GAS	N/A	5.76E-03 uCi/cc
RE-HV0100.2S PARTIC	N/A	8.76E-06 uCi/cc
RE-HV0100.2S IOD	N/A	3.15E-07 uCi/cc
RE-HV0100.2S GAS	N/A	5.76E-03 uCi/cc
RE-WM6775"DRY"SUMP #1	N/A	1E-08 uCi/cc
RE-Wm6776"DRY"SUMP #2	N/A	1E-08 uCi/cc
RE-CW1900 WET TWR/BLD	N/A	5E-08 uCi/cc
RE-WM0647 LDT/WST TNK	N/A	1E-04 uCi/cc
RE-WM0648 GAS TNK EFF	N/A	N/A
RE-WM6777 CNTNT SUMP	N/A	N/A
RE-CC7050AS CCW TRN A	N/A	1E-04 uCi/cc
RE-CC7050BS CCW TRN B	N/A	1E-04 uCi/cc
RE-CC5700 CEDM/RCP RTN	N/A	N/A
RE-CH0202 FRM LTDN HX	N/A	N/A
RE-BM0627 FROM BA PMP	N/A	5E-07 uCi/cc

RE-CC7050AS	CCW TRN A	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-CC7050BS	CCW TRN B	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-CC5700	CEDM/RCP RTN	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-WM6777	CNTMT SUMP	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-WM6775	"DRY" SUMP #1	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-WM6776	"DRY" SUMP #2	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-CH0202	FRM LTDN HX	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-CW1900	WET TWR/BLD	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-BM0627	FROM BA PMP	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M

PLANT STACK:

RE-HV0100.1S	PARTIC	@ XXX.XXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-HV0100.1S	IOD	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-HV0100.1S	GAS	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-HV0100.2S	PARTIC	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-HV0100.2S	IOD	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M
RE-HV0100.2S	GAS	@ XXXXXXXX	UCI/CC	@ XXXXXXXX UCI/CC/M

RE-WM0648	GAS TNK EFF	@ XXXXXXXX	UCI/ML	@ XXXXXXXX UCI/ML/M
RE-WM0647	LDT/WST TNK	@ XXXXXXXX	UCI/ML	@ XXXXXXXX UCI/CC/M

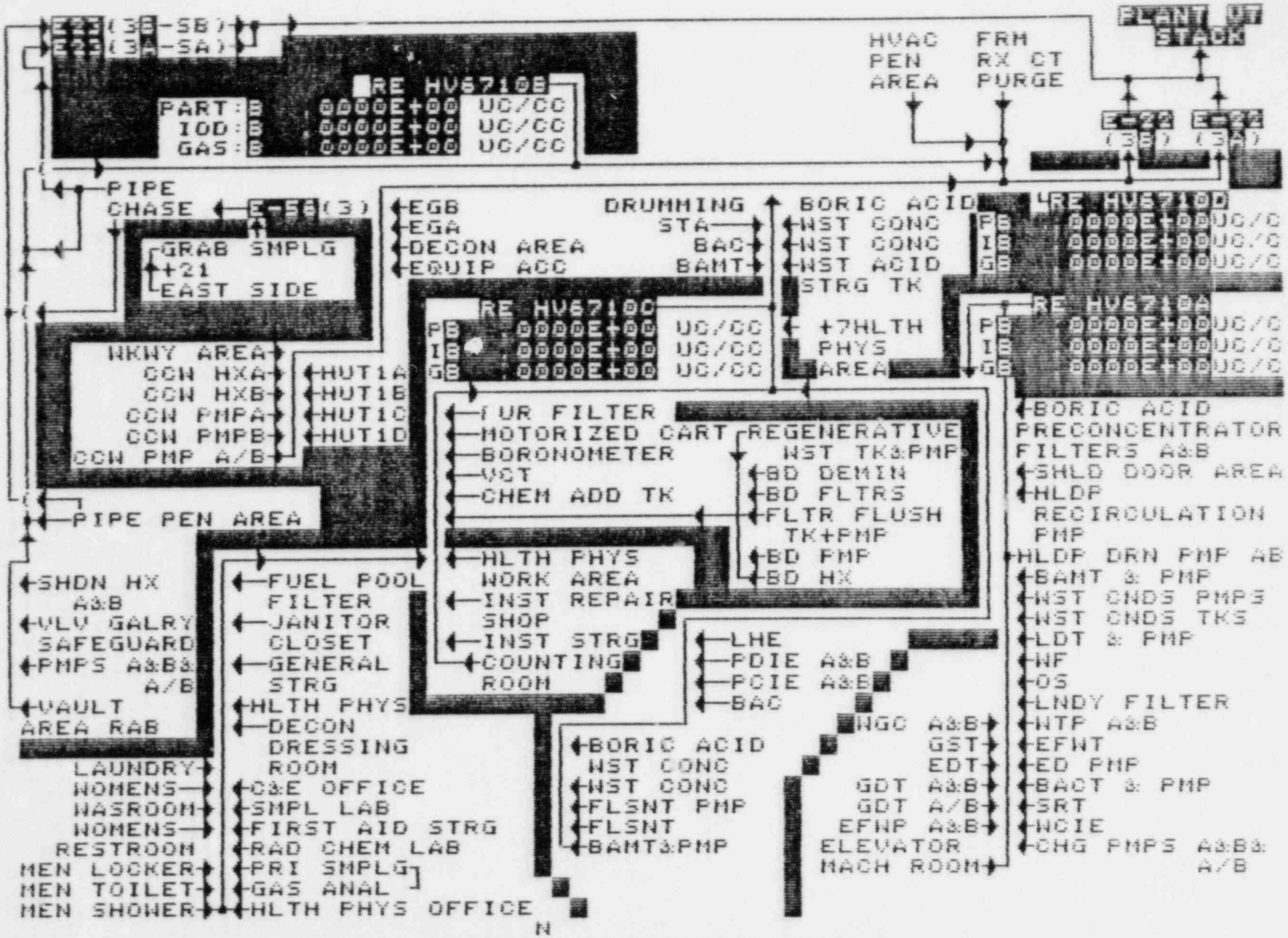
@@

RAB EFFLUENT PARAMETER TRENDING

14:06:56 30MARS4

DATA BASE FOR DISPLAY N - RADIATION RELEASES, RAB VENTILATION

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV6710A PART	N/A	N/A
RE-HV6710A IOD	N/A	N/A
RE-HV6710A GAS	N/A	N/A
RE-HV6710C PART	N/A	N/A
RE-HV6710C IOD	N/A	N/A
RE-HV6710C GAS	N/A	N/A
RE-HV6710B PART	N/A	N/A
RE-HV6710B IOD	N/A	N/A
RE-HV6710B GAS	N/A	N/A
RE-HV6710D PART	N/A	N/A
RE-HV6710D IOD	N/A	N/A
RE-HV6710D GAS	N/A	N/A


PLANT VT STACK
HVAC PEN AREA
FRM RX CT PURGE
RE HV6710B
PART: B .0000E+00 UC/CC
IOD: B .0000E+00 UC/CC
GAS: B .0000E+00 UC/CC
RE HV6710D
RE HV6710A
RE HV6710C
PIPE CHASE
GRAB SMPLG +21 EAST SIDE
EAST SIDE
EGB
EGA
DECON AREA
EQUIP ACC
DRUMMING STA
BAC
BAMT
BORIC ACID
NST CONC
NST CONC
NST ACID
STRG TK
+7HLTH PHYS AREA
NKWY AREA
CCW HXA
CCW HXB
CCW PMPA
CCW PMPB
CCW PMP A/B
HUT1A
HUT1B
HUT1C
HUT1D
PIPE PEN AREA
FUR FILTER
MOTORIZED CART
BORONOMETER
VCT
CHEM ADD TK
REGENERATIVE NST TK&PMP
BD DEMIN
BD FLTRS
FLTR FLUSH TK+PMP
BD PMP
BD HX
HLTH PHYS WORK AREA
INST REPAIR SHOP
INST STRG
COUNTING ROOM
BORIC ACID PRECONCENTRATOR FILTERS A&B
SHLD DOOR AREA
HLDP RECIRCULATION PMP
HLDP DRN PMP AB
BAMT & PMP
NST CNDS PMPS
NST CNDS TKS
LDT & PMP
NF
OS
LNDY FILTER
NTP A&B
EFNT
ED PMP
BACT & PMP
SRT
NCIE
CHG PMPS A&B&A/B
SHDN HX A&B
VLV GALRY SAFEGUARD
PMPS A&B&A/B
VAULT AREA RAB
FUEL POOL FILTER
JANITOR CLOSET
GENERAL STRG
HLTH PHYS
DECON DRESSING ROOM
C&E OFFICE
SMPL LAB
FIRST AID STRG
RAD CHEM LAB
PRI SMPLG
GAS ANAL
HLTH PHYS OFFICE
LAUNDRY
NOMENS
NASROOM
NOMENS
RESTROOM
MEN LOCKER
MEN TOILET
MEN SHOWER
LHE
PDIE A&B
PCIE A&B
BAC
BORIC ACID NST CONC
NST CONC
FLSNT PMP
FLSNT
BAMT&PMP
NGC A&B
GST
EDT
GDT A&B
GDT A/B
EFNP A&B
ELEVATOR MACH ROOM
N
RADIATION RELEASES - RAB VENTILATION
14:33:31 30MAR84

DATA BASE FOR DISPLAY NN - RADIATION RELEASES,
RAB VENTILATION PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
CVAS AIRBORNE PART (A)	N/A	N/A
CVAS AIRBORNE IOD (A)	N/A	N/A
CVAS AIRBORNE GAS (A)	N/A	N/A
CVAS AIRBORNE PART (C)	N/A	N/A
CVAS AIRBORNE IOD (C)	N/A	N/A
CVAS AIRBORNE GAS (C)	N/A	N/A
CVAS AIRBORNE PART (B)	N/A	N/A
CVAS AIRBORNE IOD (B)	N/A	N/A
CVAS AIRBORNE GAS (B)	N/A	N/A
CVAS AIRBORNE PART (D)	N/A	N/A
CVAS AIRBORNE IOD (D)	N/A	N/A
CVAS AIRBORNE GAS (D)	N/A	N/A

RE-HV6710A EQUIP HATCH RAB -4

CVAS AIRBORNE PARTIC @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE IOD @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV6710B EQUIP AREA RAB +21

CVAS AIRBORNE PARTIC @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE IOD @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV6710C CHEM/HP/BORON MGT AIR

CVAS AIRBORNE PARTIC @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE IOD @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV6710D SHLD BLDG VENT AIR

CVAS AIRBORNE PARTIC @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE IOP @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

CVAS AIRBORNE GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

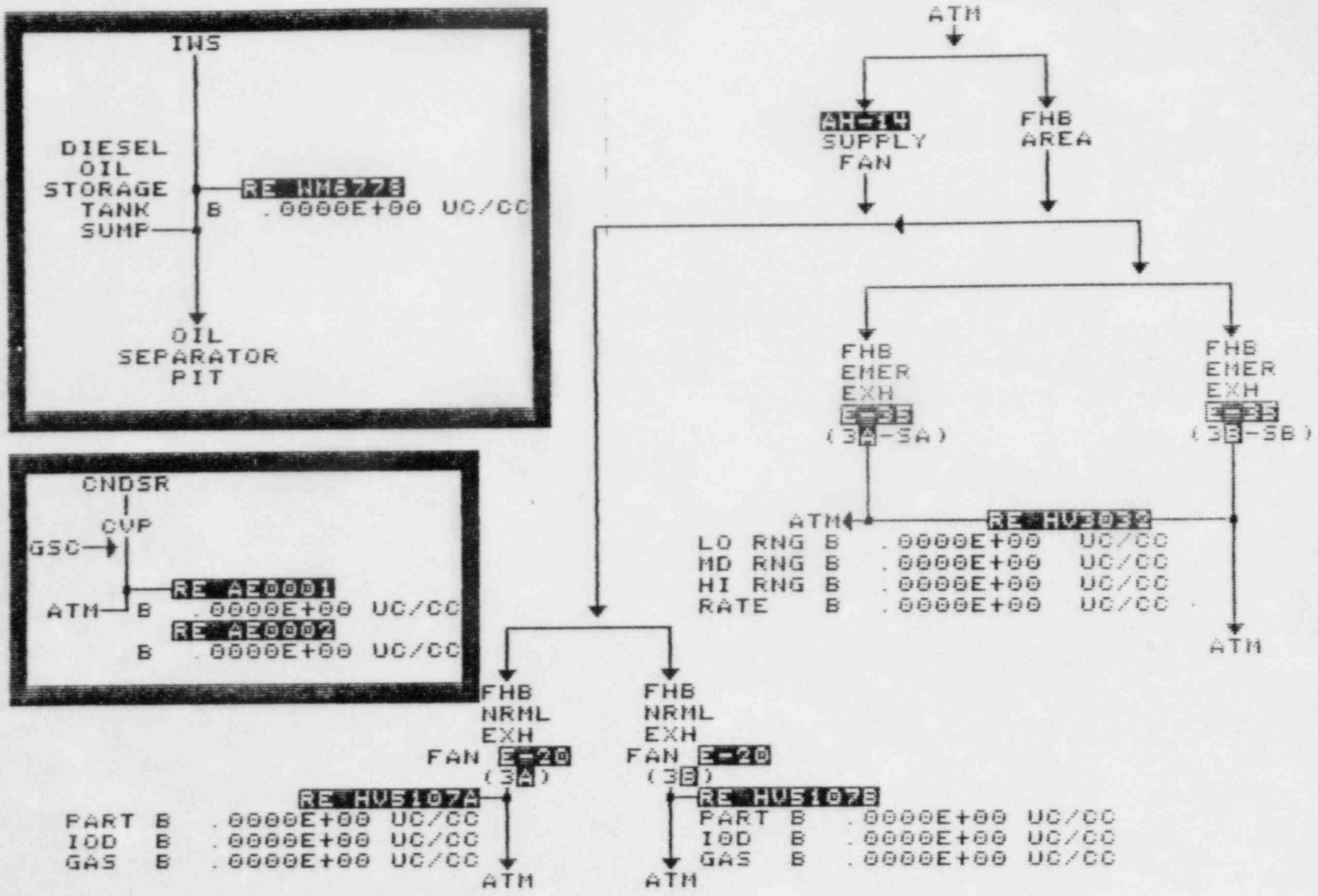
NN

RAB VENTILATION PARAMETER TRENDING

13:54:24 30MAR84

DATA BASE FOR DISPLAY P - RADIATION RELEASES, BOP/FHB PROCESS MONITORS

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV5107A PART	N/A	1.04E-04 uCi/cc
RE-HV5107A IOD	N/A	1.18E-06 uCi/cc
RE-HV5107A GAS	N/A	2.35E-02 uCi/cc
RE-HV5107B PART	N/A	1.04E-04 uCi/cc
RE-HV5107B IOD	N/A	1.18E-06 uCi/cc
RE-HV5107B GAS	N/A	2.35E-02 uCi/cc
RE-AE0001	N/A	0.254 uCi/cc
RE-WM6778	N/A	1E-08 uCi/cc
RE-HV3032 LO RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 MD RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 HI RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 RATE	N/A	N/A
RE-AE0002	N/A	1E-11 uCi/ml



P

RADIATION RELEASES - BOP/FHB PROCESS MONITORS

14:13:55 30MAR84

DATA BASE FOR DISPLAY PP - RADIATION RELEASES, BOP/FHB PROCESS MONITORS
PARAMETER TRENDING

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV5107A PART	N/A	1.04E-04 uCi/cc
RE-HV5107A IOD	N/A	1.18E-06 uCi/cc
RE-HV5107A GAS	N/A	2.35E-02 uCi/cc
RE-HV5107B PARTIC	N/A	1.04E-04 uCi/cc
RE-HV5107B IOD	N/A	1.18E-06 uCi/cc
RE-HV5107B GAS	N/A	2.35E-02 uCi/cc
RE-AE0001 CND OFF GAS	N/A	0.254 uCi/cc
RE-WM6778 INDST WST	N/A	1E-08 uCi/cc
RE-HV3032 LO RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 MD RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 HI RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 RELEASE	N/A	N/A
RE-AE0002 CND OFF GAS	N/A	1E-11 uCi/ml

BOP PROCESSES:

RE-WM6778 INDST WST @ XXXXXXXX UCD/CC @ XXXXXXXX UCI/CC/M

RE-AE0001 CND OFF GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-AE0002 CND OFF GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

FHB EMER EXHAUST:

RE-HV3032 LO RNG @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV3032 MD RNG @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV3032 HI RNG @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV3032 RELEASE RATE @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

FHB NORMAL EXHAUST:

RE-HV5107A PARTIC @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV5107A IOP @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV5107A GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV5107B PARTIC @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV5107B IOD @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

RE-HV5107B GAS @ XXXXXXXX UCI/CC @ XXXXXXXX UCI/CC/M

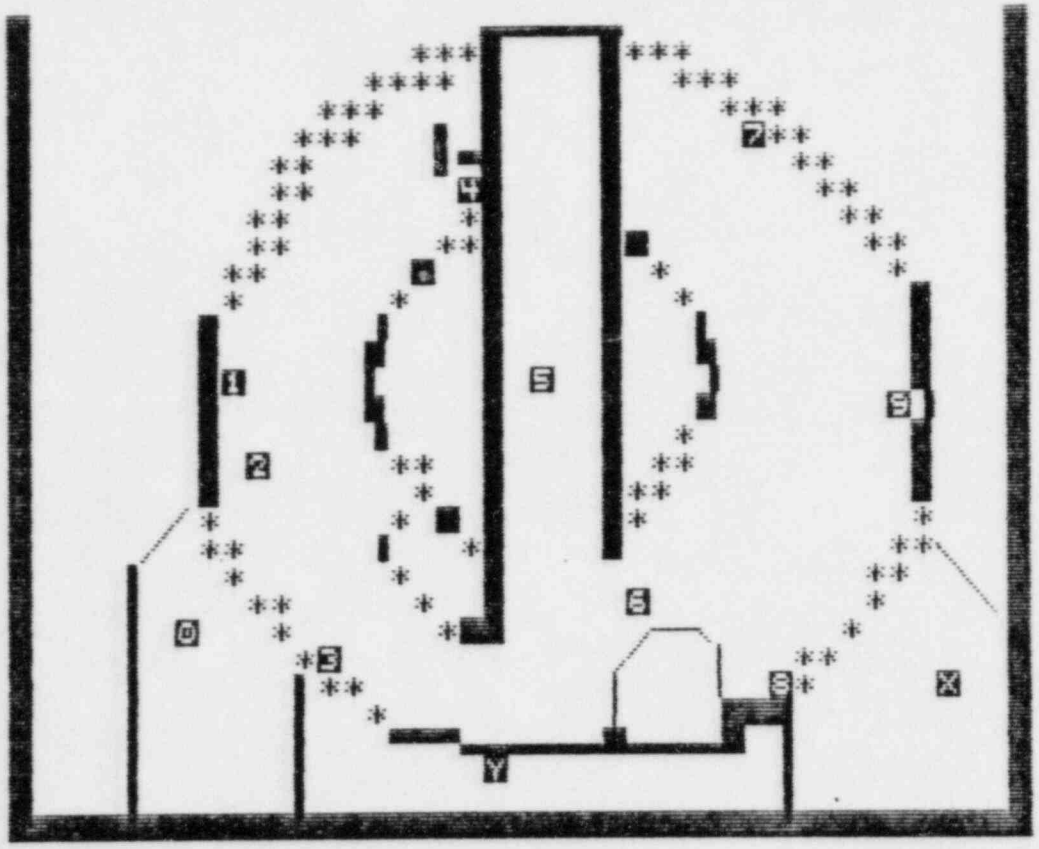
PP

BOP/FHB PROCESS MONITORS PARAMETER TRENDING

14:05:52 30MAR34

DATA BASE FOR DISPLAY E - RADIATION RELEASES, CONTAINMENT +46

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV5015 CNTMT NE STR	N/A	100 mrem/HR
RE-HV5013 UNDR MSL SHD	N/A	100 mrem/HR
RE-HV5024S PURGE ISO B	N/A	100 mrem/HR
RE-HV5014 CNTMT SW STR	N/A	100 mrem/HR
RE-HV5025S PURGE ISO A	N/A	100 mrem/HR
RE-HV5028S RB46 225DEG	N/A	100 mR/HR
RE-HV5031S RB46 110DEG	N/A	100 mR/HR
RE-HV5200 PLT STK +46	N/A	5E04 mR/HR
RE-MS5500A MN STM LN#1	N/A	0.19 mR/HR
RE-MS5500B MN STM LN#2	N/A	0.19 mR/HR
RE-CA5400AS CNTMT AREA	N/A	5E+03 R/HR
RE-CA5400BS CNTMT AREA	N/A	5E+03 R/HR



0	RE-MS5500A MN STM LN#1	:B	.00	MR/HR	B	.00 MR/H/MIN
1	RE-CA5400BS CNTMT AREA	:B	.00	R/HR	B	.00 MR/H/MIN
2	RE-HV5014 CNTMT SW STR	:B	.00	MR/HR	B	.00 MR/H/MIN
3	RE-HV5031S RB46 110DEG	:B	.00	MR/HR	B	.00 MR/H/MIN
4	RE-HV5024S PURGE ISO B	:B	.00	MR/HR	B	.00 MR/H/MIN
5	RE-HV5013 UNDR MSL SHD	:B	.00	MR/HR	B	.00 MR/H/MIN
6	RE-HV5025S PURGE ISO A	:B	.00	MR/HR	B	.00 MR/H/MIN
7	RE-HV5015 CNTMT NE STR	:B	.00	MR/HR	B	.00 MR/H/MIN
8	RE-HV5028S RB46 225DEG	:B	.00	MR/HR	B	.00 MR/H/MIN
9	RE-CA5400AS CNTMT AREA	:B	.00	R/HR	B	.00 MR/H/MIN
X	RE-MS5500B MN STM LN#2	:B	.00	MR/HR	B	.00 MR/H/MIN
Y	RE-HV5200 PLT STK RB46	:B	.00	MR/HR	B	.00 MR/H/MIN

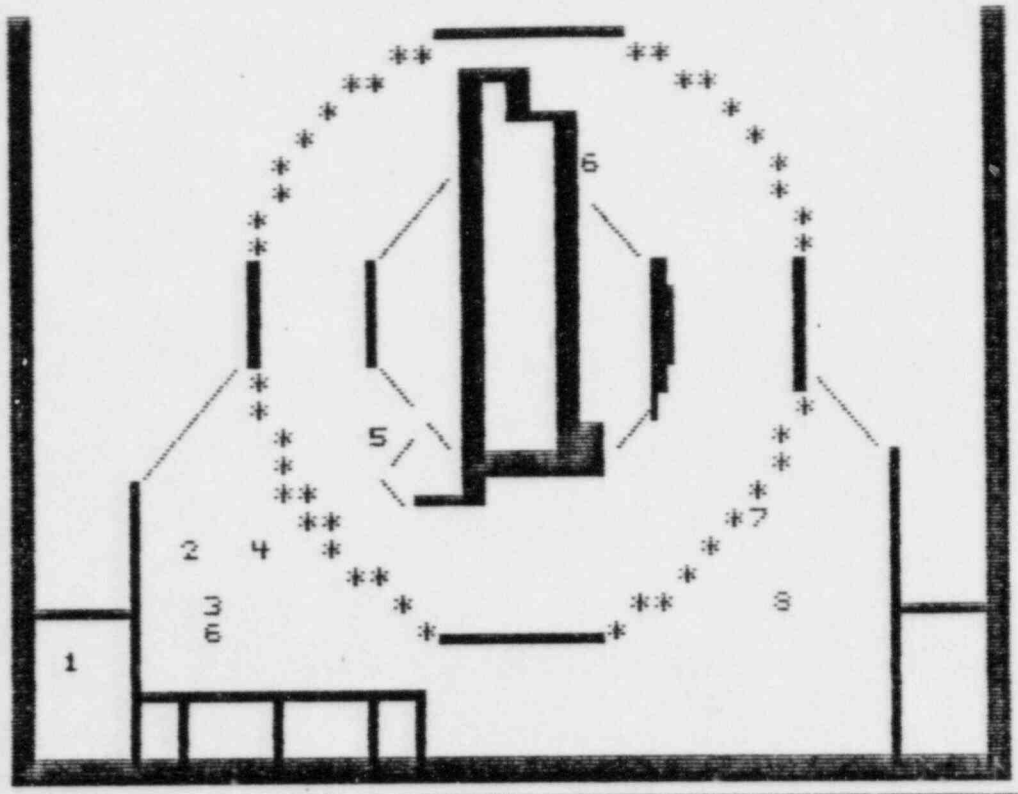
E

RADIATION RELEASES - CONTAINMENT +46

14:15:02 30MAR84

DATA BASE FOR DISPLAY F - RADIATION RELEASES, CONTAINMENT +21

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV5027S CPI B	N/A	Later
RE-HV5026S CPI A	N/A	Later
RE-HV5030S PAMI A	N/A	100 mR/HR
RE-HV5029S PAMI B	N/A	100 mR/HR
RE-HV5023A DECON ROOM	N/A	15 mR/HR
RE-HV5144 DECON PARTIC	N/A	N/A
RE-HV5144 DECON IODINE	N/A	N/A
RE-HV5144 DECON GAS	N/A	N/A
RE-HV5132 HMS PARTIC	N/A	N/A
RE-HV5132 HMS IODINE	N/A	N/A
RE-HV5132 HMS GAS	N/A	N/A
RE-HV5204 PASS PNL	N/A	5E+04 mR/HR



1	RE-HV5132	HMS PART	B	.0000E+00	UC/CC	B	.00	UCI/CC/M	
		HMS IOD	B	.0000E+00	UC/CC	B	.00	UCI/CC/M	
		HMS GAS	B	.0000E+00	UC/CC	B	.00	UCI/CC/M	
2	RE-HV5144	DECON PART	B	.0000E+00	UC/CC	B	.00	UCI/CC/M	
		DECON IOD	B	.0000E+00	UC/CC	B	.00	UCI/CC/M	
		DECON GAS	B	.0000E+00	UC/CC	B	.00	UCI/CC/M	
3	RE-HV5023A	DECON ROOM	B	.0000E+00	MR/HR	B	.00	MR/H/MIN	
4	RE-HV5029S	PAMI B	B	.0000E+00	MR/HR	B	.00	MR/H/MIN	
5	RE-HV5026S	CPI A	B	.0000E+00	MR/HR	B	.00	MR/H/MIN	
6	RE-HV5027S	CPI B	B	.0000E+00	MR/HR	B	.00	MR/H/MIN	
7	RE-HV5030S	PAMI A	B	.0000E+00	MR/HR	B	.00	MR/H/MIN	
8	RE-HV5204	PASS PNL	B	.0000E+00	MR/HR	B	.00	MR/H/MIN	

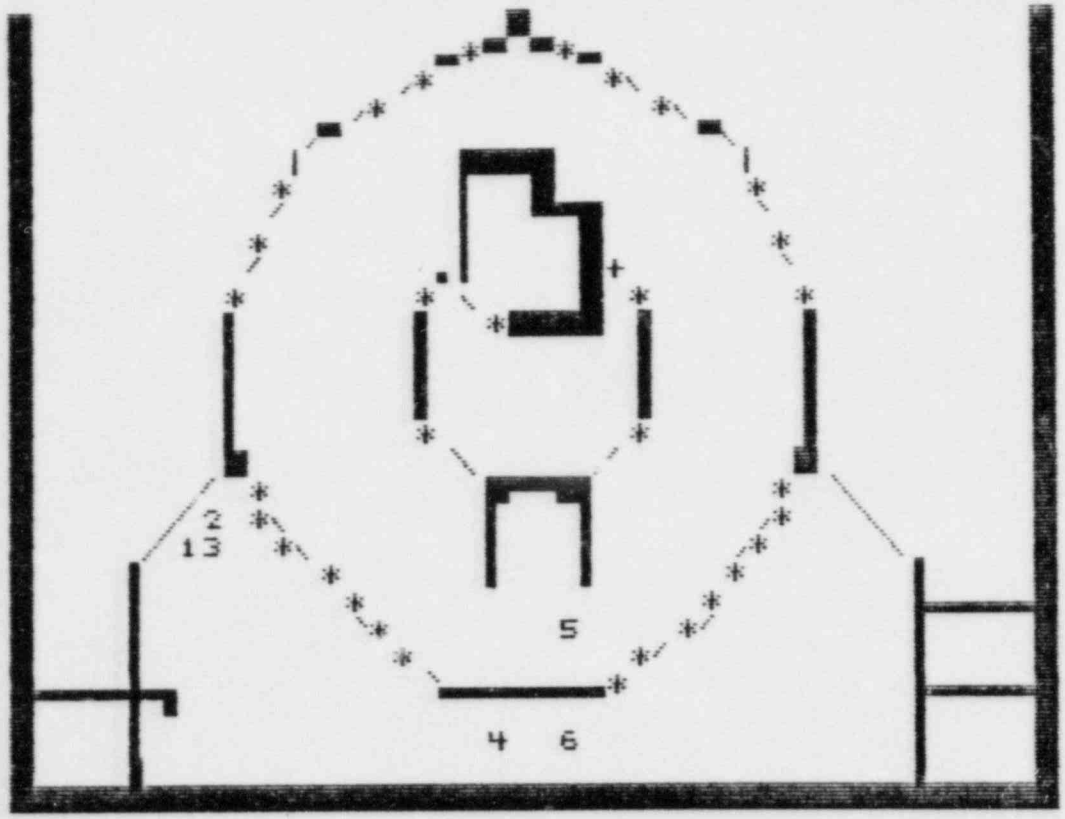
F

RADIATION RELEASES - CONTAINMENT +21

14:15:23 30MAR84

DATA BASE DISPLAY G - RADIATION RELEASES, CONTAINMENT -4

DESCRIPTION	SET POINT - LO	SET POINT - HI
RE-HV5018 PRSNL AIR LK	N/A	Later
RE-CA0100S PART	N/A	N/A
RE-CA0100S IOD	N/A	N/A
RE-CA0100S GAS	N/A	N/A
RE-HV5202 SIS SMP AREA	N/A	5E+04 mR/HR
RE-HV5201 PRSNL AIR LK	N/A	5E+04 mR/HR



1	RE-CA0100S CTMT ATM PARTB	.0000E+00UC/CC	B	.00	UC/CC/M
2	RE-CA0100S CTMT ATM IOD B	.0000E+00UC/CC	B	.00	UC/CC/M
3	RE-CA0100S CTMT ATM GAS B	.0000E+00UC/CC	B	.00	UC/CC/M
4	RE-HV5202 SIS SUMP AREA B	.0000E+00MR/HR	B	.00	MR/HR/M
5	RE-HV501S PRSNL AIR LK B	.0000E+00MR/HR	B	.00	MR/HR/M
6	RE-HV5201 PRSNL AIR LK B	.0000E+00MR/HR	B	.00	MR/HR/M

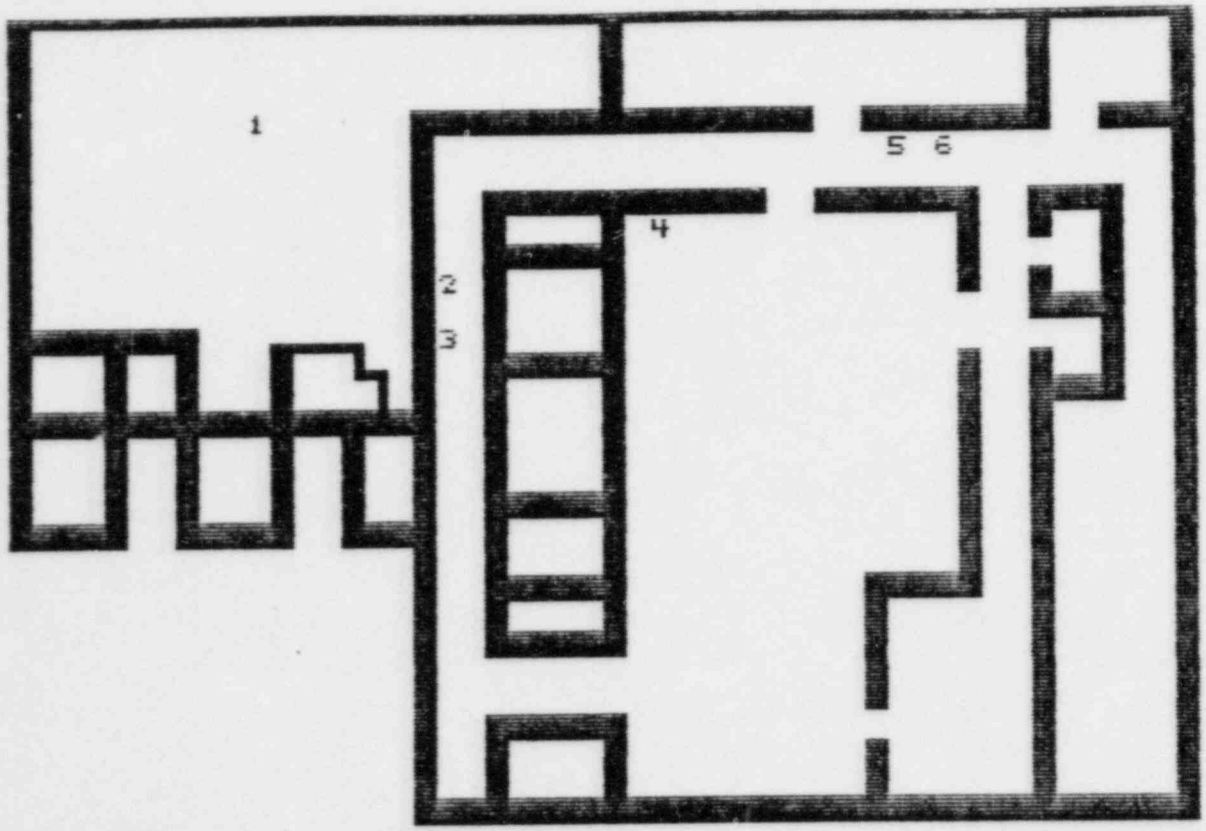
G

RADIATION RELEASES - CONTAINMENT -4

14:15:51 30MAR84

DATA BASE FOR DISPLAY H - RADIATION RELEASES, RAB +46

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV0200.1S RAD TSC	N/A	2.5E-06 uCi/cc
RE-HV0200.2S RAD TSC	N/A	2.5E-06 uCi/cc
RE-HV0200.5S RAD TSC	N/A	2.5E-06 uCi/cc
RE-HV0200.6S RAD TSC	N/A	2.5E-06 uCi/cc
RE-HV5001 CR NRTH WALL	N/A	2.5 mR/HR
RE-HV5002 E-22 AHS	N/A	15 mR/HR



1	RE HV5002 E-22 AHS	B	.0000E+00	MR/HR	B	.00	MR/H/MIN
2	RE HV0200.5S RLVL TSC	B	.0000E+00	UC/CC	B	.00	UC/CC/M
3	RE HV0200.6S RLVL TSC	B	.0000E+00	UC/CC	B	.00	UC/CC/M
4	RE HV5001 CR NRTH WALL	B	.0000E+00	MR/HR	B	.00	MR/H/MIN
5	RE HV0200.1S RLVL TSC	B	.0000E+00	UC/CC	B	.00	UC/CC/M
6	RE HV0200.2S TLVL TSC	B	.0000E+00	UC/CC	B	.00	UC/CC/M

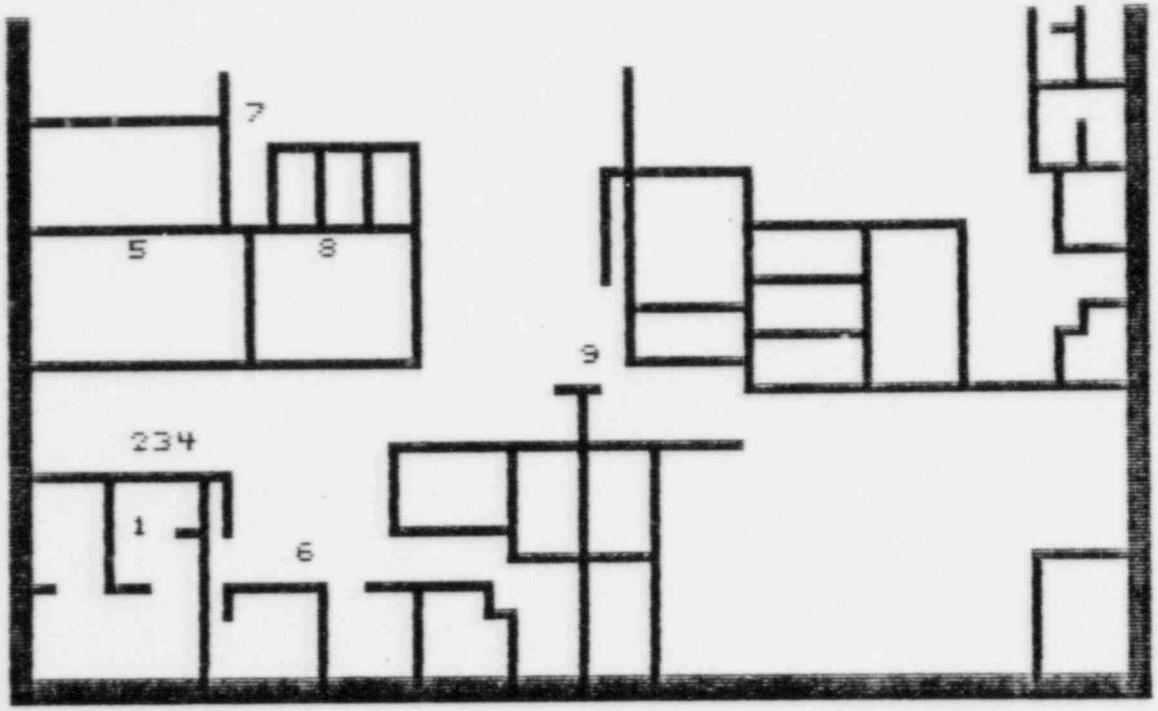
H

RADIATION RELEASES - RAB +46

14:16:23 30MAR84

DATA BASE FOR DISPLAY I - RADIATION RELEASES, RAB +21

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV5019 HUT AREA	N/A	2.5 mR/HR
RE-HV5003 BAC AREA	N/A	15 mR/HR
RE-HV5016 DRM CNTRL ST	N/A	15 mR/HR
RE-HV5146 DRM STA PART	N/A	N/A
RE-HV5146 DRM STA IOD	N/A	N/A
RE-HV5146 DRM STA GAS	N/A	N/A
RE-HV5207 SWGR AREA	N/A	5E+04 mR/HR
RE-HV5208 CCW PMP AREA	N/A	5E+04 mR/HR
RE-HV5206 DSL GEN 3BS	N/A	5E+04 mR/HR
RE-HV5205 DSL GEN 3AS	N/A	5E+04 mR/HR



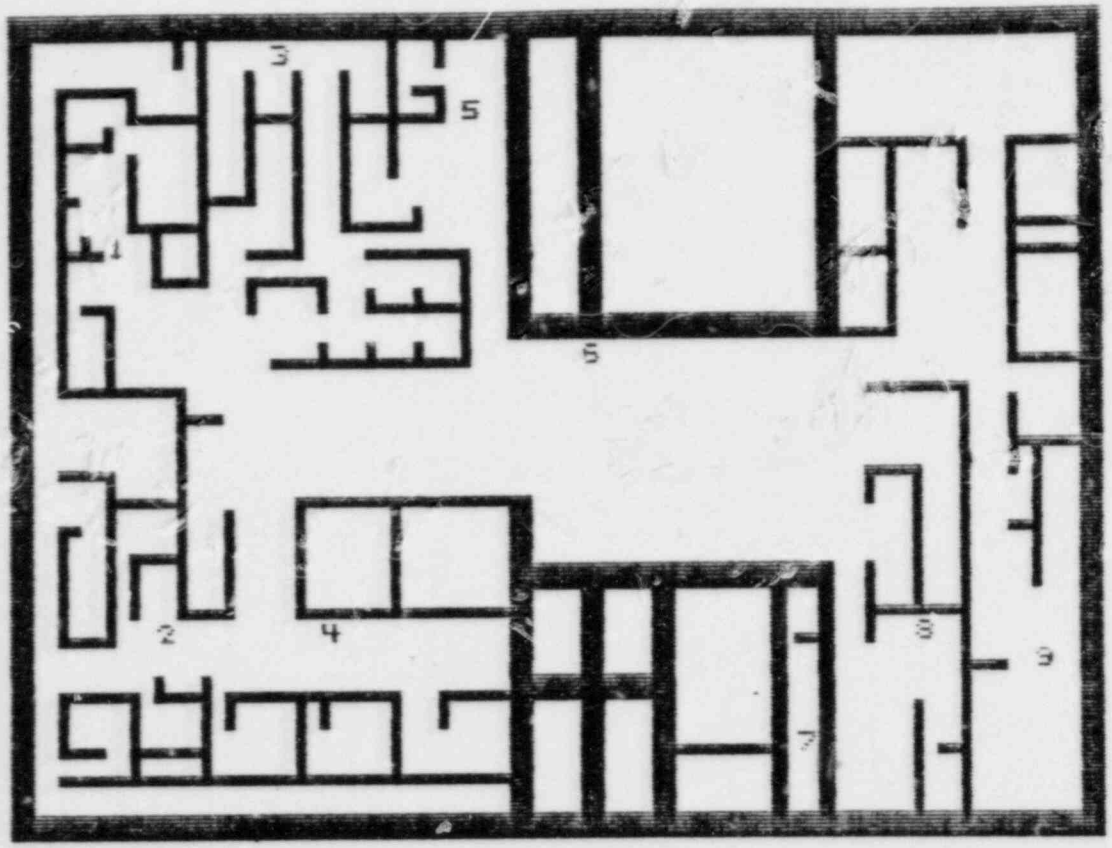
1	RE HV5016 DRM CTRL STAB	.0000E+00	MR/HR B	.00	MR/H/MIN
2	RE HV5146 DRM STA PARTB	.0000E+00	UC/CC B	.00	UCI/CC/M
3	RE HV5146 DRM STA IOD B	.0000E+00	UC/CC B	.00	UCI/CC/M
4	RE HV5146 DRM STA GAS B	.0000E+00	UC/CC B	.00	UCI/CC/M
5	RE HV5205 DSL GEN 3AS B	.0000E+00	MR/HR B	.00	MR/H/MIN
6	RE HV5003 BAC AREA B	.0000E+00	MR/HR B	.00	MR/H/MIN
7	RE HV5208 CCW PMP AREAB	.0000E+00	MR/HR B	.00	MR/H/MIN
8	RE HV5206 DSL GEN 3BS B	.0000E+00	MR/HR B	.00	MR/H/MIN
9	RE HV5019 HUT AREA B	.0000E+00	MR/HR B	.00	MR/H/MIN
0	RE HV5207 SWGR AREA B	.0000E+00	MR/HR B	.00	MR/H/MIN

RADIATION RELEASES - RAB +21

14:16:45 30MAR84

DATA BASE FOR DISPLAY J - RADIATION RELEASES, RAB -4

DESCRIPTION	SET POINT - LO	SET POINT HI
RE-HV5007 SECD SMPL RM	N/A	2.5 mR/HR
RE-HV5020 PRI SMPL RM	N/A	100 mR/HR
RE-HV5006 COUNTING RM	N/A	2.5 mR/HR
RE-HV5022 CORDR TO CB	N/A	15 mR/HR
RE-HV5005 BAC AREA	N/A	100 mR/HR
RE-HV5021 VLV GALLERY	N/A	100 mR/HR
RE-HV5004 VCT AREA	N/A	15 mR/HR
RE-HV5022C BACT AREA	N/A	100 mR/HR
RE-HV5209 BM & WM PNL	N/A	5E+04 mR/HR



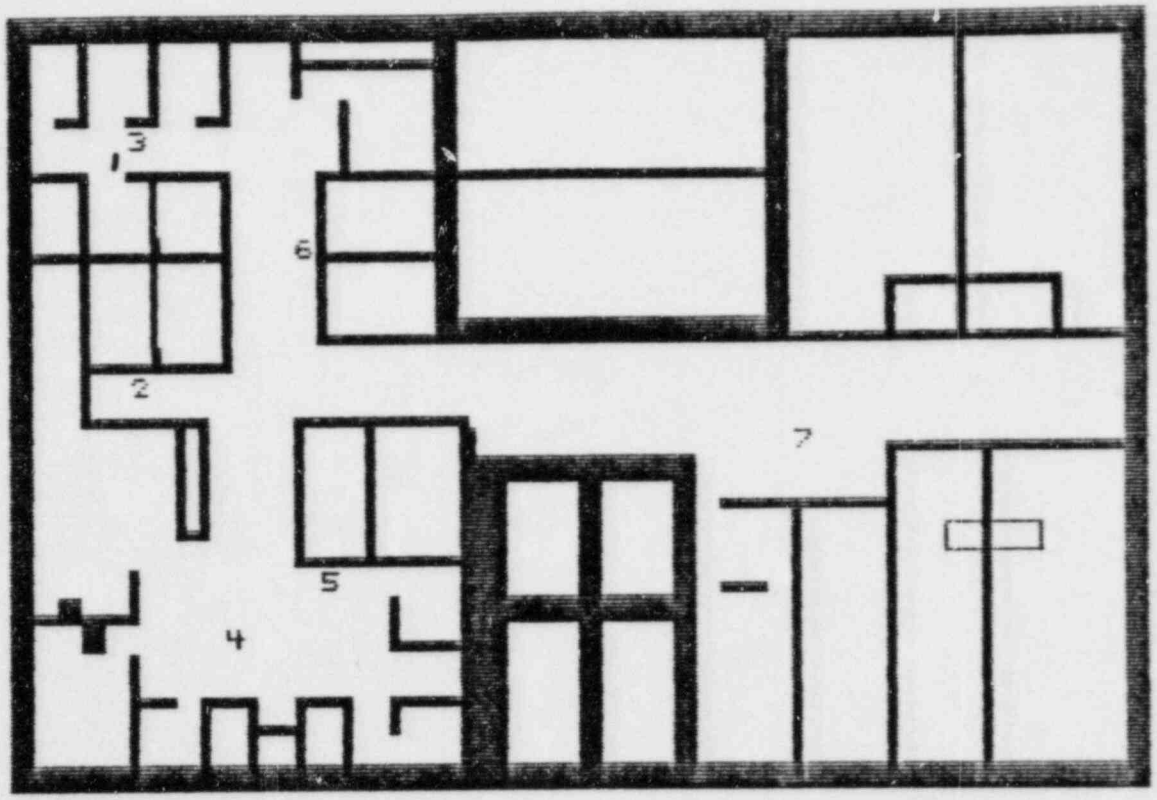
1	RE	HV5004	VCT AREA	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
2	RE	HV5022C	BACT AREA	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
3	RE	HV5021	VLV GALLERY	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
4	RE	HV5005	BAC AREA	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
5	RE	HV5022	CORR TO CB	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
6	RE	HV5209	BM & NM PNL	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
7	RE	HV5006	COUNTING RM	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
8	RE	HV5020	PRI SMPL RM	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
9	RE	HV5007	SCD SMPL RM	B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN

RADIATION RELEASES- RAB -4

14:17:09 30MAR84

DATA BASE FOR DISPLAY K - RADIATION RELEASES, RAB -35

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV5009 WF WALL AREA	N/A	15 mR/HR
RE-HV5008 BAC FLTR	N/A	15 mR/HR
RE-HV5022B BMS AREA	N/A	15 mR/HR
RE-HV5017A CHG PMP	N/A	100 mR/HR
RE-HV5023 GDT AREA	N/A	100 mR/HR
RE-HV5022A WGC AREA	N/A	100 mR/HR
RE-HV5210 EFW PMP AREA	N/A	5E+04 mR/HR



1	RE HV5023 GDT AREA	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	
2	RE HV5017A CHG PMP	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	
3	RE HV5022A WGC AREA	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	
4	RE HV5008 BAC FLT AREA	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	
5	RE HV5022B BMS AREA	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	
6	RE HV5210 EFN PMP AREA	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	
7	RE HV5009 NF WALL AREA	B	.0000E+00 MR/HR	B	.0000E+00 MR/H/MIN	

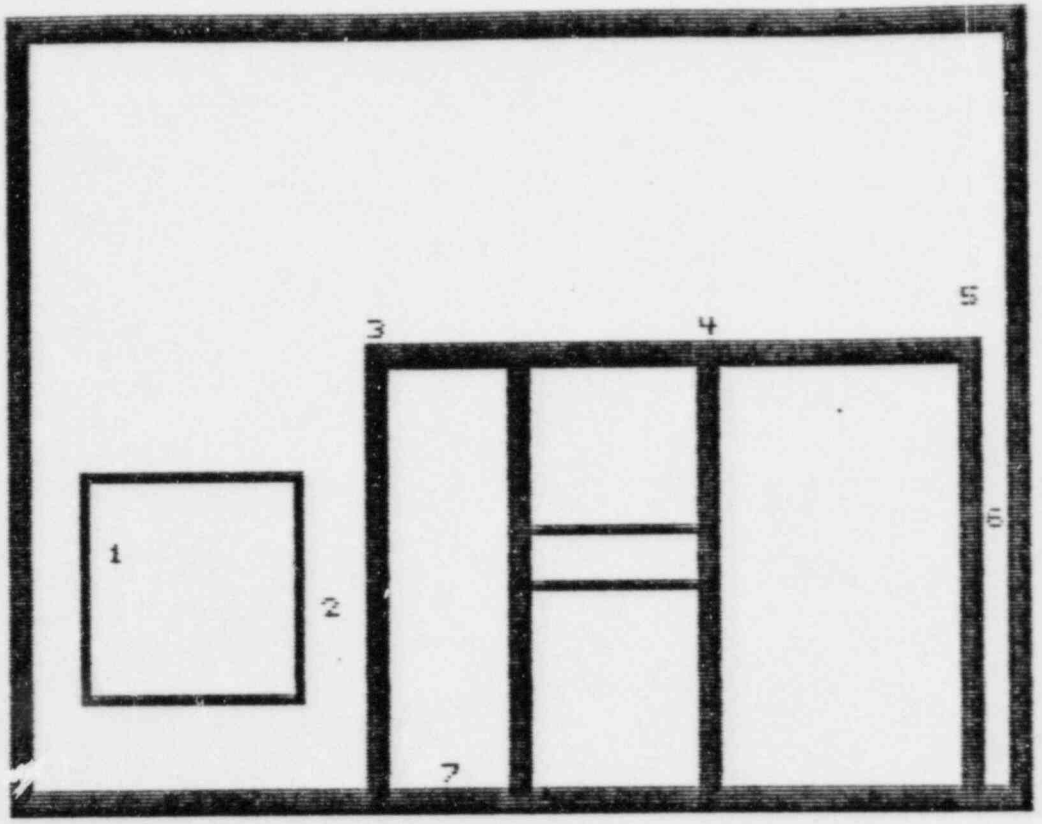
K

RADIATION RELEASES - RAB -35

14:17:43 30MAR84

DATA BASE FOR DISPLAY L - RADIATION RELEASES, FHB +46

DESCRIPTION	SET POINT - SET POINT LO	HI
RE-HV0300.1S LYDN ISO	N/A	N/A
RE-HV0300.2S LYDN ISO	N/A	100 mR/HR
RE-HV0300.3S LYDN ISO	N/A	100 mR/HR
RE-HV0300.4S LYDN ISO	N/A	100 mR/HR
RE-HV5010 SFP STRG	N/A	100 mR/HR
RE-HV5011 NEW FLPL	N/A	15 mR/HR
RE-HV5203 FHB RFC	N/A	5E+04 mR/HR



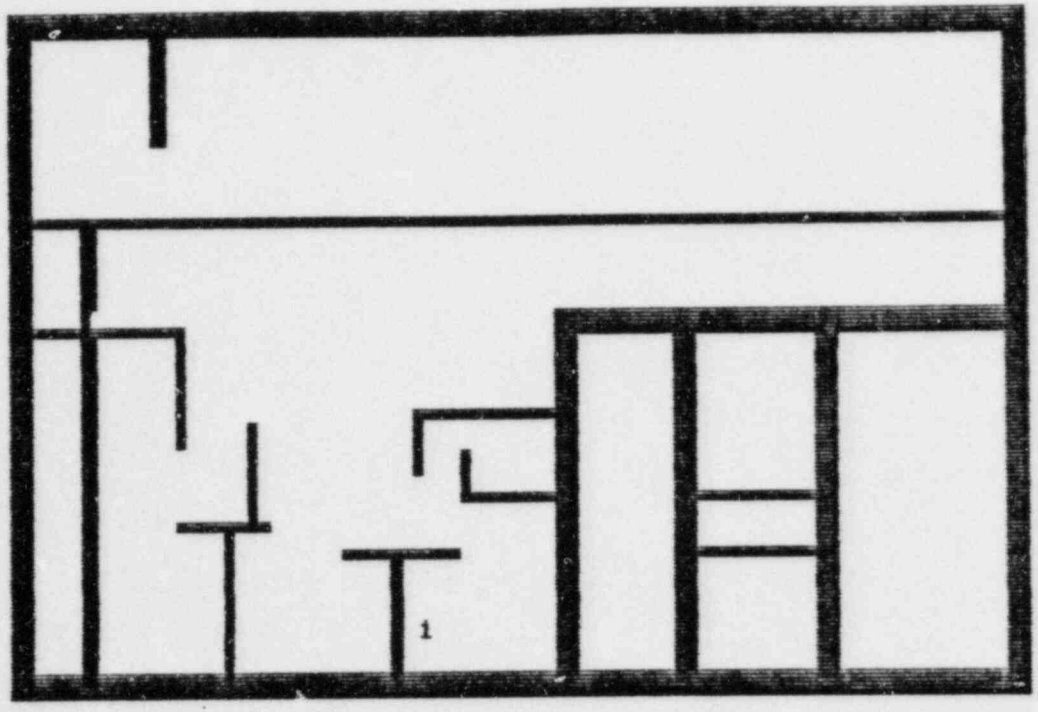
1	RE	HV5011	NEW FLPL AREA	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
2	RE	HV0300.4S	LYDN ISO A	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
3	RE	HV0300.3S	LYDN ISO B	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
4	RE	HV0300.2S	LYDN ISO A	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
5	RE	HV0300.1S	LYDN ISO B	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
6	RE	HV5010	SFP STRG AREA	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN
7	RE	HV5203	FHB RFC	:B	.0000E+00	MR/HR	B	.0000E+00 MR/H/MIN

RADIATION RELEASES - FHB +46

14:14:18 30MAR84

DATA BASE FOR DISPLAY M - RADIATION RELEASES, THB +1

DESCRIPTION	SET POINT - LO	SET POINT HI
RE-HV5012 FPPP AREA	N/A	15 mR/HR



1 RE HV5012 FPPP AREA B .0000E+00 MR/HR B .0000E+00 MR/H/MIN

M

RADIATION RELEASES - FHB +1

14:18:14 30MAR84

5.5 REACTIVITY CONTROL

The design for the Reactivity Control safety function CRT display highlights parameters discussed in the Generic Emergency Operating Procedure Guidelines (CEN-152, Revision 1). Reactivity Control parameters monitored by SPDS covers power supplies to the CEDMs; coolant temperatures and pressures; CEA position; and boron supply and concentration. The information is presented on two displays.

Display R contains most of the information related to Reactivity Control. All but boric acid supplies are shown on it. Display S is important when attempts are being made to shutdown the chain reaction by other than the CEDMCS trip mechanism. Display R has a corresponding RR trend display, while trend data is included on display S.

5.5.1 Description of the Data Base Values Used on Reactivity Control

Reactivity Control will be monitored by two displays, one overall and one display devoted to the boric acid supply to the charging system. Display R will be arranged into four parts. The Reactor Trip Switchgear (RTSG) is shown in the top left corner along with CEA position information. RCS information dominates the right side of the display with overall parameters at the top and an RCS mimic in the lower right portion of the display. The RCS mimic shows the loop temperature, pressurizer level and pressure data. The lower left is dedicated to showing the SIS flows, Charging flow, and RWSP level. Display S details the Boric Acid Make-up Tanks and valving going to the charging pumps.

One of the "manual" methods of achieving CEA insertion is the disabling of the CEDMCS power supply. The RTSG is shown from the supply breakers to the MG sets to the CEDMCS cabinets. The condition of the two power supply breakers is shown by displaying the digital point message for the A and B trains. Each of the nine trip circuit breakers are illustrated with respect to their physical connection in the field. The point ID identifying whether a trip circuit breaker is "closed" or "not closed" provides the messages underneath each "TCB-" label.

The results of the CEA dropped software routine are highlighted by a rectangle. The routine takes a count of how many control rod bottom indicators have a current message value of "Reset" i.e. the rod has not completely dropped. This result is placed in a new data base C-type point defined for SPDS. If the count is 0, then the "All CEAs Dropped" message will be lit on the screen. The count is shown as "CEA Withdrawn".

"Maximum Neutron Flux" is determined by taking the maximum of two QSPDS signals from the excore neutron detectors. The flux in this case is represented in percentages of full reactor power.

The boron concentration in the upper right of the display is the value retrieved from the QSPDS.

The next items directly above are the bulk coolant temperatures. The average temperature is shown for the individual channel measurements for loops 1 and 2, respectively, from the RRS.

The minimum of six saturation margin signals is displayed in the upper right corner. These signals are based on temperature measurements from the hot and cold leg RTDs, unheated junction thermocouples in the upper head, and core exit thermocouples.

The RCS loop temperatures are derived by taking the QSPDS/Regulatory Guide 1.97 value of the point ID associated with that loop.

Pressurizer level will be determined by taking the numerical average of three signals.

Pressurizer pressure will be the QSPDS average value between two QSPDS signals.

The ability of the SIS pumps to provide boration will be checked by monitoring the SIS flows. The flow of the HPSI and LPSI pumps to each cold leg (and hot leg) is shown.

The value displayed for charging flow will be the same as reported by the QSPDS.

The RWSP level shown will be a point ID composed by taking the minimum good quality value of seven signals and displaying the percentage value. This will indicate how much borated water has been pumped into the RCS by the SIS pumps.

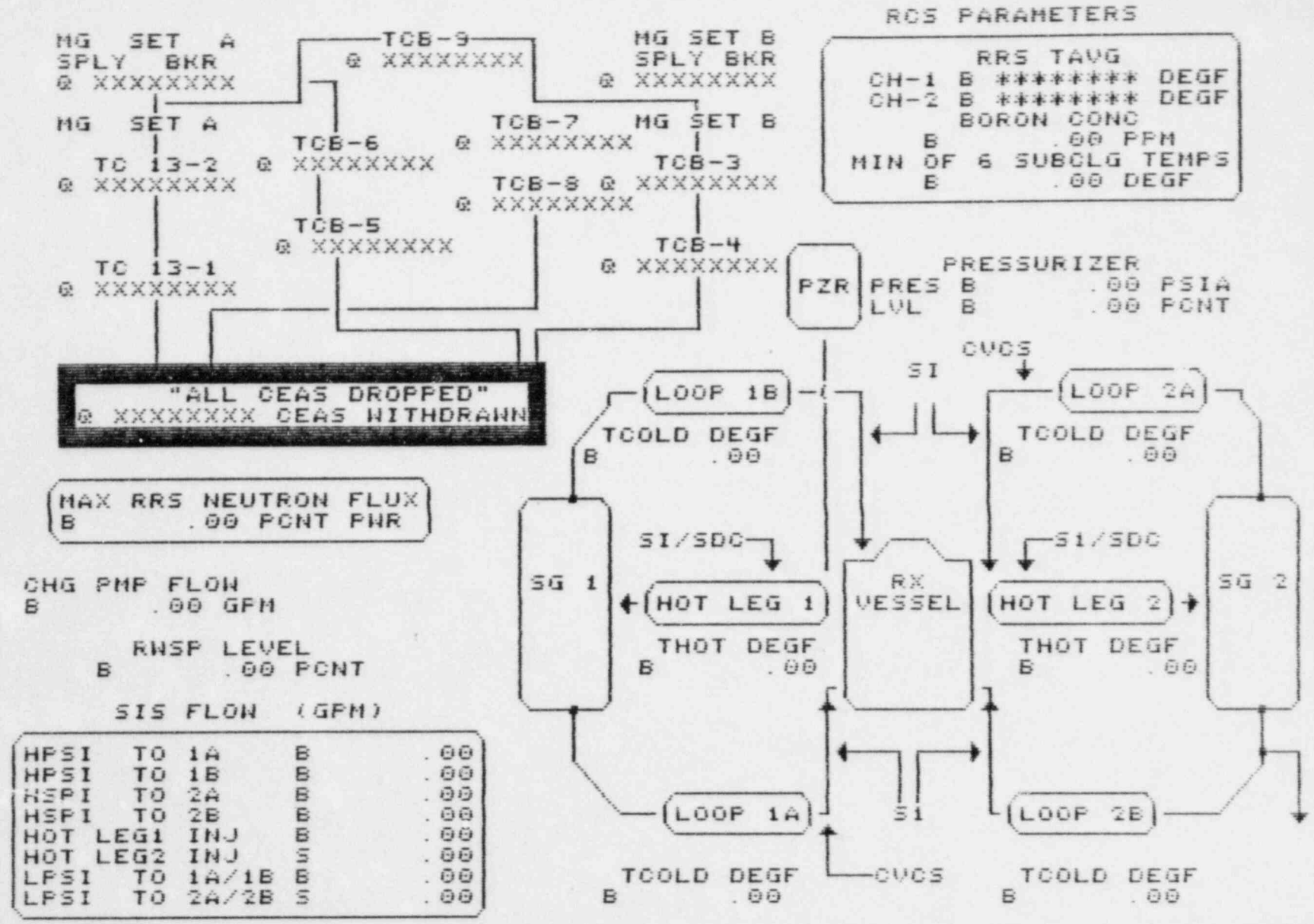
5.5.2 Static Illustration of the Reactivity Control Displays and Associated Parameter Listings

DATA BASE FOR DISPLAY R - REACTIVITY CONTROL

DESCRIPTION	SET POINT - SET POINT LO	HI
RRS TAVG CH-1	N/A	N/A
RRS TAVG Ch-2	N/A	N/A
BORON CONC	N/A	N/A
THOT DEGF (HOT LEG 1)	N/A	Later
TCOLD DEGF (RCL 1A)	544 DEGF	588 DEGF
TCOLD DEGF (RCL 2A)	544 DEGF	588 DEGF
CHG PUMP FLOW	N/A	N/A
HPSI TO 1A	N/A	N/A
HPSI TO 1B	N/A	N/A
HPSI TO 2A	N/A	N/A
HPSI TO 2B	N/A	N/A
TCOLD DEGF (RCL 2B)	544 DEGF	588 DEGF
TCOLD DEGF (RCL 1B)	544 DEGF	588 DEGF
PRESSURIZER LEVEL:	26 PCNT	62.5 PCNT
PRESSURIZER PRES:	1889 PSIA	2365 PSIA
THOT DEGF (HOT LEG 2)	N/A	Later
MAX. NEUTRON FLUX	N/A	N/A
MIN OF 6 SUBCOOL. TEMP	N/A	20 DEGF
RWSP LEVEL	77 PCNT (EQUIVALENT TO 447,100 GAL)	

DATA BASE FOR DISPLAY R - REACTIVITY CONTROL

DESCRIPTION	SET POINT - SET POINT LO	HI
NMBR OF CEAs WITHDRAWN	N/A	N/A
MG SET A SPLY BKR	NOT CLOSED	CLOSED
MG SET B SPLY BKR	NOT CLOSED	CLOSED
TCB-1	NOT CLOSED	CLOSED
TCB-2	NOT CLOSED	CLOSED
TCB-3	NOT CLOSED	CLOSED
TCB-4	NOT CLOSED	CLOSED
TCB-5	NOT CLOSED	CLOSED
TCB-6	NOT CLOSED	CLOSED
TCB-7	NOT CLOSED	CLOSED
TCB-8	NOT CLOSED	CLOSED
TCB-9	NOT CLOSED	CLOSED
HOT LEG 1 INJ	N/A	N/A
HOT LEG 2 INJ	N/A	N/A
LPSI TO 2A/2B	N/A	N/A
LPSI TO 1A/1B	N/A	N/A



R

REACTIVITY CONTROL DISPLAY

14:13:52 30MAR84

DATA BASE FOR DISPLAY RR - REACTIVITY CONTROL PARAMETER TRENDING

DESCRIPTION	SET POINT - SET POINT LO	HI
SLIDING T-AVG 1:	N/A	N/A
SLIDING T-AVG 2:	N/A	N/A
BORON CONCENTRATION	N/A	N/A
THOT (1)	N/A	Later
TCOLD (1A)	544 DEGF	588 DEGF
TCOLD (2A)	544 DEGF	588 DEGF
CHARGING PUMP FLOW	N/A	N/A
HPSI TO 1A	N/A	N/A
HPSI TO 1B	N/A	N/A
HPSI TO 2A	N/A	N/A
HPSI TO 2B	N/A	N/A
TCOLD (2B)	544 DEGF	588 DEGF
TCOLD (1B)	544 DEGF	588 DEGF
PZR LVL (AVG)	26 PCNT	62.5 PCNT
PZR PRESSURE	1889 PSIA	2365 PSIA
THOT (2)	N/A	Later
MAX NEUTRON FLUX	N/A	N/A
MIN 6 SUBCOOL TEMPS	N/A	20 DEGF
RWSP LEVEL	77 PCNT (EQUIVALENT TO 447,100 GAL)	
HOT LEG 1 INJ	N/A	N/A

DATA BASE FOR DISPLAY RR - REACTIVITY CONTROL PARAMETER TRENDING

DESCRIPTION	SET POINT - SET POINT LO	HI
HOT LEG 2 INJ	N/A	N/A
LPSI TO 2A/2B FLOW	N/A	N/A
LPSI TO 1A/1B FLOW	N/A	N/A

RRS NEUTRON FLUX	@	XXXXXXXX	PCNT	@	XXXXXXXX PCNT/MIN
BORON CONC	@	XXXXXXXX	PPM	@	XXXXXXXX PPM/MIN
RRS TAVG CH-1	@	.00	DEGF	@	XXXXXXXX DEGF/MIN
RRS TAVG CH-2	@	.00	DEGF	@	XXXXXXXX DEGF/MIN
MIN 6 SUBCOOL TEMPS	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
PZR PRESSURE	@	XXXXXXXX	PSIA	@	XXXXXXXX PSIA/MIN
PZR LEVEL	@	XXXXXXXX	PCNT	@	XXXXXXXX PCNT/MIN
LPSI TO 1A/1B FLOW	@	.00	GPM	@	XXXXXXXX GPM/MIN
LPSI TO 2A/2B FLOW	@	.00	GPM	@	XXXXXXXX GPM/MIN
HPSI TO 1A	@	XXXXXXXX	GPM	@	XXXXXXXX GPM/MIN
HPSI TO 1B	@	XXXXXXXX	GPM	@	XXXXXXXX GPM/MIN
HPSI TO 2A	@	XXXXXXXX	GPM	@	XXXXXXXX GPM/MIN
HPSI TO 2B	@	XXXXXXXX	GPM	@	XXXXXXXX GPM/MIN
HOT LEG 1 INJ	@	.00	GPM	@	XXXXXXXX GPM/MIN
HOT LEG 2 INJ	@	.00	GPM	@	XXXXXXXX GPM/MIN
RWSP LEVEL	@	XXXXXXXX	PCNT	@	XXXXXXXX PCNT/MIN
THOT(1)	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
TCOLD(1A)	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
TCOLD(2A)	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
THOT(2)	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
TCOLD(2A)	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
TCOLD(2B)	@	XXXXXXXX	DEGF	@	XXXXXXXX DEGF/MIN
CHARGING PUMP FLOW	@	XXXXXXXX	GPM	@	XXXXXXXX GPM/MIN

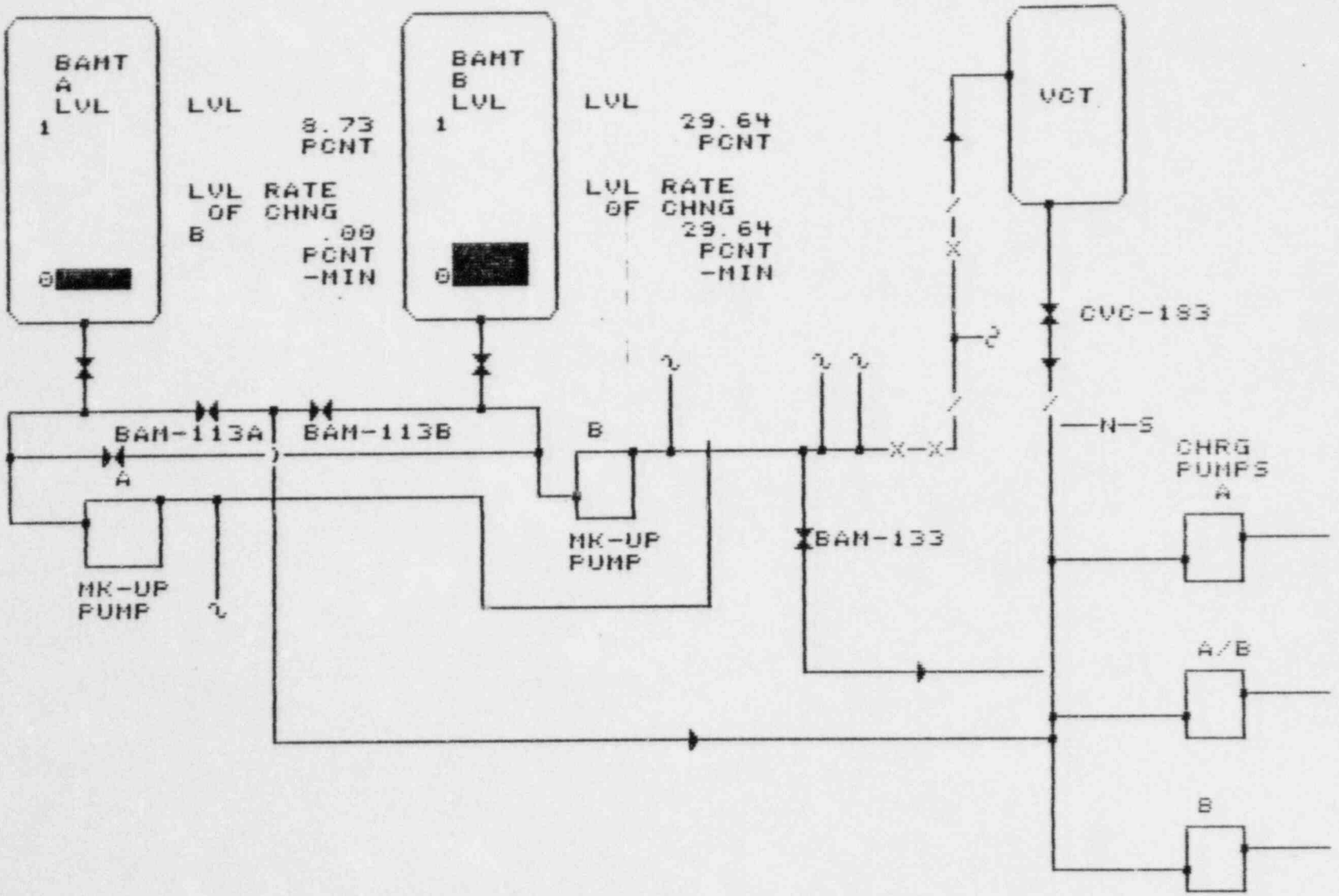
RR

REACTIVITY CONTROL PARAMETER TRENDING

14:07:29 30MAR84

DATA BASE FOR DISPLAY S - BORIC ACID SUPPLY TO CHARGING

DESCRIPTION	SET POINT - SET POINT LO	HI
BAMT A LVL	74.1 PCNT	95.0 PCNT
BAMT B LVL	74.1 PCNT	95.0 PCNT
CVC-183	NOT CLOSED	CLOSED
BAM-113B	NOT CLOSED	CLOSED
BAM-113A	NOT CLOSED	CLOSED
BAM-133	NOT CLOSED	CLOSED
MAKEUP PMP A&B (COLOR)	NOT AVAIL	AVAIL



REACTIVITY CONTROL S - BORIC ACID MAKE-UP

14:19:27 30MAR84

5.6 CORE COOLING AND RCS HEAT REMOVAL

Core Cooling and RCS Heat Removal displays make extensive use of data supplied by the Class 1E QSPDS System. Display T focuses on the ability to remove heat from the core. Data on subcooling and coolant level is illustrated inside of the vessel. Vessel and Pressurizer level is dynamically illustrated via a vertical bar graph. Display U concentrates on the ability to remove heat from the primary coolant. Steam generator level (dynamically illustrated by a vertical bar graph), secondary flow rates, and primary coolant temperatures are displayed. Display V presents Safety Injection flow data. Each of these three displays has a trend display defined, TT, UU, and VV, respectively.

5.6.1 Description of the Data Base Values Used on Core Cooling

The multiple page displays shown in Displays T, U, and V summarize the points IDs for core cooling and RCS Heat Removal. The displays show inventory in the pressurizer and reactor pressure vessel, heat removal via the steam generators and safety injection, and pressurizer spray flows.

5.6.1.1 Display T

Display T is dedicated to the illustration of reactor vessel temperatures, saturation margins, vessel level and RCS pressure. The vessel, both hot legs and the pressurizer are mimicked.

Pressurizer level data is provided in bar graph form inside of the Pressurizer mimic. Since the high or low value of pressurizer level will not be consistently conservative, an average of several point IDs is displayed to the operators.

Minimum Pressurizer pressure is displayed since the worst case for this parameter is always its low value. This is especially true in the area of maintaining subcooled conditions in the RCS. The QSPDS point IDs have a range in conformance to Regulatory Guide 1.97, while the control channel PMC point IDs have a much narrower range. The minimum between two QSPDS signals will be displayed to the operator.

Reactor pressure vessel level data is taken from the QSPDS Heated Junction Thermocouple (HJTC)[1] System. Level is measured in two parts above the fuel alignment plate. The display is consistent with this in that it shows the level in the upper head separately from the level in the upper plenum. The levels from both measurement channels are displayed. If the RCPs are operating, the level in the upper plenum may be unreliable. Operators will be trained in the interpretation of HJTC information while RCPs are running. RCP motor amperage data is provided on the display to allow the SPDS user to evaluate the legitimacy of the level data

QSPDS determines two representative core exit temperatures through a screening algorithm of all core exit thermocouple signals. The maximum of the two values is displayed under "REPRES. CET TEMP" on the display.

[1] It should be noted that the HJTC will not be used at Waterford 3 prior to the second cycle of operation.

Two separate calculations are made of the subcooling temperature margin. Two values are determined from the Process Analog Control (PAC) circuitry, and four values are derived from QSPDS inputs. The most conservative (smallest) value is displayed underneath "TEMPERATURE AWAY FROM SATUR."

The minimum pressure margin to saturation as calculated by the QSPDS is displayed to the operator.

Hot leg temperatures are included on Display T. THOT1 is a single value and THOT2 is from an average of two QSPDS signals. QSPDS inputs are selected since their ranges match the requirements of Regulatory Guide 1.97, Revision 2.

A calculation is included on the display for the difference between each hot leg temperature and the representative core exit temperature discussed earlier. This is used in the verification of natural circulation.

5.6.1.2 Display U

Display U is dedicated to RCS Heat removal via the two steam generators. The display has both steam generators mimicked with RCS temperature data, steam generator pressure and level, main steam, and both main and emergency feedwater flows.

Steam generator pressure will be determined from an average of four plant protection instruments as well as one QSPDS signal for each steam generator.

Since the amount of steam flow leaving the steam generators by means of the atmospheric dumps or the turbine bypass valves is not directly instrumented, the steam flow leaving each steam generator is provided. The numerical average of two signals (one from QSPDS) is displayed to the operator for each steam generator.

Steam generator level is mimicked with a bar graph inside of the steam generator figure. The point IDs used originate in the Plant Protection System and the QSPDS. The average of five signals is displayed for each generator.

The remaining data for the steam generator secondary sides cover feedwater flows. Indication of the state of the EFAS signals in the Plant Protection System is provided. When any of the four EFAS signal point IDs has a state message of "DETECTED," the "EFAS" and the respective "1A, 1B, 2A," or "2B" will appear on the display immediately below the EFW flow measurements.

Main Feedwater flow is provided to indicate the normal supply of water to the steam generators. Main feedwater flow to both steam generators will be labeled "MN FEED WTR (MPPH)" and will show values whose units are in 1E 06 lbm/hr. Emergency Feedwater Flow is shown directly under the main feedwater flow.

5.6.1.3 Display V

Display V is designed to show the safety injection flow to the RCS. Also included is data on main and auxiliary pressurizer spray valve position, and RCP operation.

Display V is arranged as an NSSS mimic with the reactor in the center, two steam generators (#1 to the left, #2 to the right), and the pressurizer in the upper center. Thicker lines represent the main coolant lines, while thinner lines represent the SIS lines.

Four squares labeled 1A, 1B, 2A, and 2B represent the RCPs. These boxes will be red if the pumps are active, and green if they are not. RCP amperage will drive the color indications. Using a setpoint of 1200 amps x 90 percent (i.e., 1080 amps), the boxes will be green if the amperage is 1080 or less.

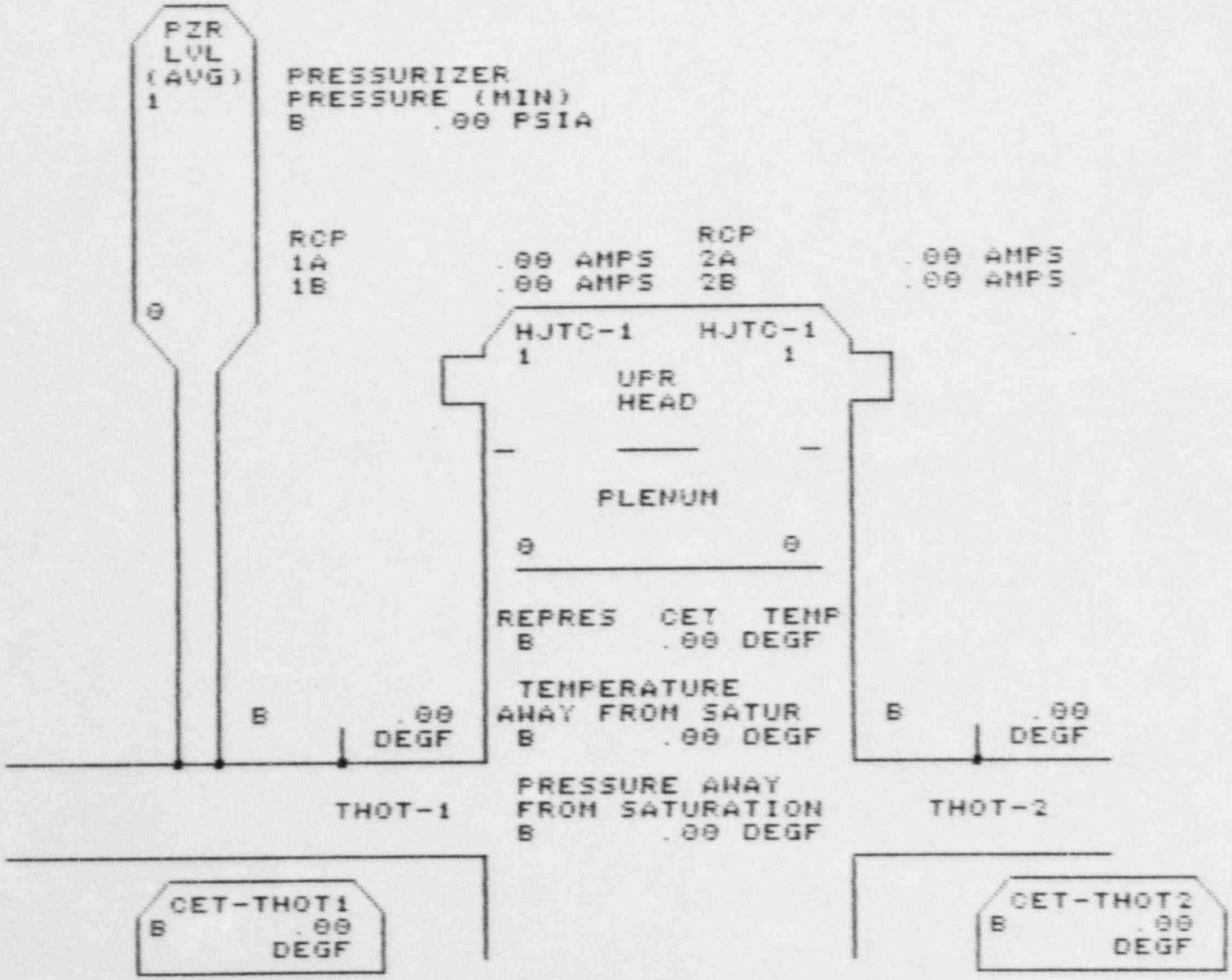
SIS flows are illustrated with respect to their injection location. HPSI injection to 1A, 1B, and the #1 hot leg appear on the left with the LPSI flow to 1A/1B. QSPDS processed signals and the PMC signal for hot leg injection are used for safety injection flow information.

Spray valve alignment and spray line temperature data is provided. The valve symbols will change colors based on the status of the associated point IDs. The valve symbols are red if the respective valve position indicator signals have a status of "open" and "not closed". The valve symbols are green if the respective valve position indicator signals have a status of "not open" and "closed". The valve symbol is yellow for any other condition. The spray line temperatures from loops 1A and 1B are also displayed.

5.6.2 Static Illustration of the Displays for Core Cooling and RCS Heat Removal and Associated Parameter Listings

DATA BASE FOR DISPLAY T - CORE COOLING

DESCRIPTION	SET POINT - SET POINT LO	HI
RCP 1A AMPS	N/A	N/A
RCP 2A AMPS	N/A	N/A
RCP 1B AMPS	N/A	N/A
RCP 2B AMPS	N/A	N/A
THOT-1	N/A	Later
UPR HEAD LEVEL HJTC-2	N/A	N/A
UPR PLENUM LVL HJTC-2	N/A	N/A
UPPER HEAD LVL HJTC-1	N/A	N/A
UPR PLENUM LVL HJTC-1	N/A	N/A
PZR LVL (AVG	26 PCNT	62.5 PCNT
THOT-2	N/A	Later
CET-THOT2	N/A	10 DEGF
CET-THOT1	N/A	10 DEGF
REPRES. CET TEMP	N/A	N/A
TEMP. AWAY FROM SAT	N/A	20 DEGF(SUB)
PRESSURIZER PRES. (MIN)	1889 PSIA	2365 PSIA
PRESSURE AWAY FROM SAT	N/A	0 PSIA


PZR
LVL
(AVG)
1
0
PRESSURIZER
PRESSURE (MIN)
B .00 PSIA
RCP
1A .00 AMPS
1B .00 AMPS
RCP
2A .00 AMPS
2B .00 AMPS
HJTC-1
1
HJTC-1
1
UPR
HEAD
PLENUM
0
0
REPRES CET TEMP
B .00 DEGF
TEMPERATURE
AWAY FROM SATUR
B .00 DEGF
PRESSURE AWAY
FROM SATURATION
B .00 DEGF
B .00
DEGF
B .00
DEGF
THOT-1
THOT-2
CET-THOT1
B .00
DEGF
CET-THOT2
B .00
DEGF
T
CORE COOLING
12:28:05 11APR94

DATA BASE FOR DSPLAY TT - CORE COOLING PARAMETER TRENDING

DESCRIPTION	SET POINT - SET POINT LO	HI
RCP 1A AMPS	N/A	N/A
RCP 2A AMPS	N/A	N/A
RCP 1B AMPS	N/A	N/A
RCP 2B AMPS	N/A	N/A
THOT-1	N/A	Later
VESSEL UPR HD LVL-2	N/A	N/A
VESSEL PLENUM LVL-2	N/A	N/A
VESSEL UPR HD LVL-1	N/A	N/A
VESSEL PLENUM LVL-1	N/A	N/A
PZR LVL (AVG)	26 PCNT	62.5 PCNT
THOT-2	N/A	Later
CET MINUS THOT-2	N/A	10 DEGF
CET MINUS THOT-1	N/A	10 DEGF
REPRES.CET TEMP	N/A	N/A
TEMP FRM SAT. (>0=ok)	N/A	20 DEGF(SUB)
PRESSURIZER MIN PRES	1889 PSIA	2365 PSIA
PRES FRM SAT (>0=ok)	N/A	0 PSIA

PRZ LVL (AVR)	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
PRESSURIZR MIN PRES	@ XXXXXXXX PSIA	@ XXXXXXXX PSIA/MIN
RCP 1A AMPS	@ XXXXXXXX AMPS	@ XXXXXXXX AMPS/MIN
RCP 1B AMPS	@ XXXXXXXX AMPS	@ XXXXXXXX AMPS/MIN
RCP 2A AMPS	@ XXXXXXXX AMPS	@ XXXXXXXX AMPS/MIN
RCP 2B AMPS	@ XXXXXXXX AMPS	@ XXXXXXXX AMPS/MIN
VESSEL UPR HD LVL-1	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
UPR HD LVL-2	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
VESSEL PLENUM LVL-1	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
PLENUM LVL-2	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
REPRES CET TEMP	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
TEMP FRM SAT (>0=K)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
PRES FRM SAT (>0=K)	@ XXXXXXXX PSIA	@ XXXXXXXX PSIA/MIN
THOT-1	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
CET MINUS THOT1 TEMP	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
THOT-2	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
CET MINUS THOT2 TEMP	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN

TT

CORE COOLING PARAMETER TRENDING

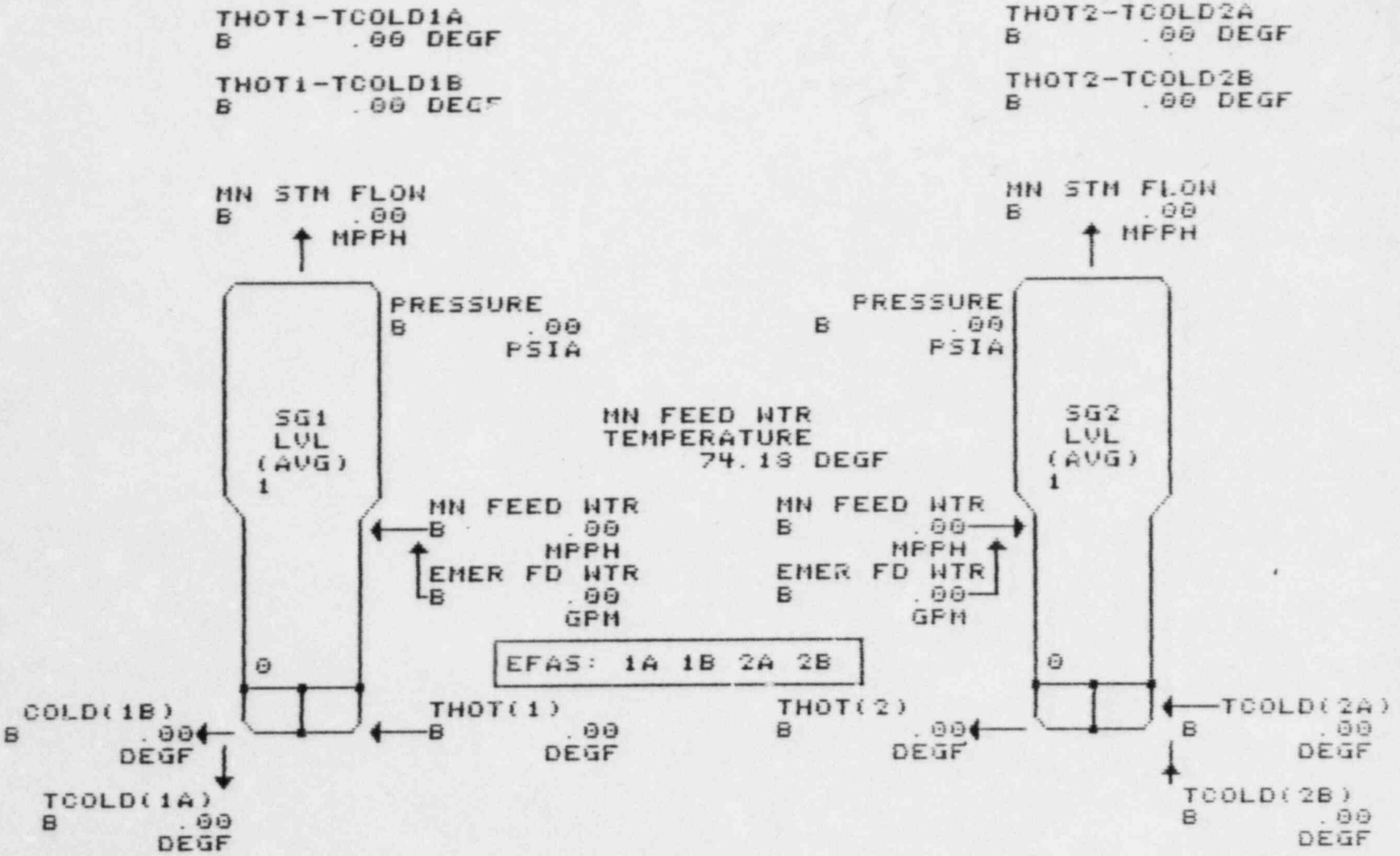
14:07:52 30MAR84

DATA BASE FOR DISPLAY U - RCS HEAT REMOVAL

DESCRIPTION	SET POINT - LO	SET POINT HI
MN FEED WTR TEMPERATURE	N/A	N/A
EMER FD WTR (SG 1)	N/A	N/A
EMER FD WTR (SG 2)	N/A	N/A
THOT (1)	N/A	N/A
TCOLD(1A)	544 DEGF	588 DEGF
TCOLD(2A)	544 DEGF	588 DEGF
MN FEED WTR (SG 1)	N/A	N/A
MN FEED WTR (SG 2)	N/A	N/A
TCOLD(2B)	544 DEGF	588 DEGF
TCOLD(1B)	544 DEGF	588 DEGF
SG1 LVL (AVG)	27 PCNT	87.7 PCNT
SG1 PRESSURE	813 PSIA	1020 PSIA
SG2 LVL (AVG)	27 PSIA	87.7 PSIA
SG2 PRESSURE	813 PSIA	1020 PSIA
THOT(2)	N/A	Later
THOT2-TCOLD2A	N/A	N/A
THOT2-TCOLD2B	N/A	N/A
MN STM FLOW (SG1)	N/A	N/A
MN STM FLOW (SG2)	N/A	N/A

DATA BASE FOR DISPLAY U - RCS HEAT REMOVAL

DESCRIPTION	SET POINT - LO	SET POINT - HI
THOT1-TCOLD1A	N/A	N/A
THOT1-TCOLD1B	N/A	N/A
EFAS 1B	DETECTED	CLEARED
EFAS 2B	DETECTED	CLEARED
EFAS 1A	DETECTED	CLEARED
EFAS 2A	DETECTED	CLEARED



U

RCS HEAT REMOVAL

14:19:52 30MAR84

DATA BASE FOR DISPLAY UU - RCS HEAT REMOVAL PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
MN FEEDWATER TEMP	N/A	N/A
EMER FD WTR (SG1 FLOW)	N/A	N/A
EMER FD WTR (SG2 FLOW)	N/A	N/A
THOT(1)	N/A	N/A
TCOLD(1A)	544 DEGF	588 DEGF
TCOLD(2A)	544 DEGF	588 DEGF
MN FEED WTR (SG1 FLOW)	N/A	N/A
MN FEED WTR (SG2 FLOW)	N/A	N/A
TCOLD(2B)	544 DEGF	588 DEGF
TCOLD(1B)	544 DEGF	588 DEGF
SG1 LEVEL (AVG)	27 PCNT	87.7 PCNT
SG1 PRESSURE (AVG)	813 PSIA	1020 PSIA
SG2 LEVEL (AVG)	27 PCNT	87.7 PCNT
SG2 PRESSURE (AVG)	813 PSIA	1020 PSIA
THOT(2)	N/A	Later
THOT2-TCOLD2A	N/A	N/A
THOT2-TCOLD2B	N/A	N/A
MN STM FLOW (SG1)	N/A	N/A

DATA BASE FOR DISPLAY UU - RCS HEAT REMOVAL PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
MN STM FLOW (SG2)	N/A	N/A
THOT1-TCOLD1A	N/A	N/A
THOT1-TCOLD1B	N/A	N/A

THOT1-TCOLD1A	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
THOT1-TCOLD1B	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
MN STM FLOW (1)	@ XXXXXXXX MPPH	@ XXXXXXXX MPPH/MIN
SG1 PRESSURE (AVG)	@ XXXXXXXX PSIA	@ XXXXXXXX PSIA/MIN
SG1 LEVEL (AVG)	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
MN FEED WTR (FLOW)	@ XXXXXXXX MPPH	@ XXXXXXXX MPPH/MIN
EMER FD WTR (FLOW)	@ XXXXXXXX GPM	@ XXXXXXXX GPM/MIN
THOT (1)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
TCOLD (1A)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
TCOLD (1B)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
MN FEEDWATER TEMP	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
THOT2-TCOLD2A	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
THOT2-TCOLD2B	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
MN STM FLOW (2)	@ XXXXXXXX MPPH	@ XXXXXXXX MPPH/MIN
SG2 PRESSURE (AVG)	@ XXXXXXXX PSIA	@ XXXXXXXX PSIA/MIN
SG2 LEVEL (AVG)	@ XXXXXXXX PCNT	@ XXXXXXXX PCNT/MIN
MN FEED WTR (FLOW)	@ XXXXXXXX MPPH	@ XXXXXXXX MPPH/MIN
EMER FD WTR (FLOW)	@ XXXXXXXX GPM	@ XXXXXXXX GPM/MIN
THOT (2)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
TCOLD (2A)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN
TCOLD (2B)	@ XXXXXXXX DEGF	@ XXXXXXXX DEGF/MIN

UU

RCS HEAT REMOVAL PARAMETER TRENDING

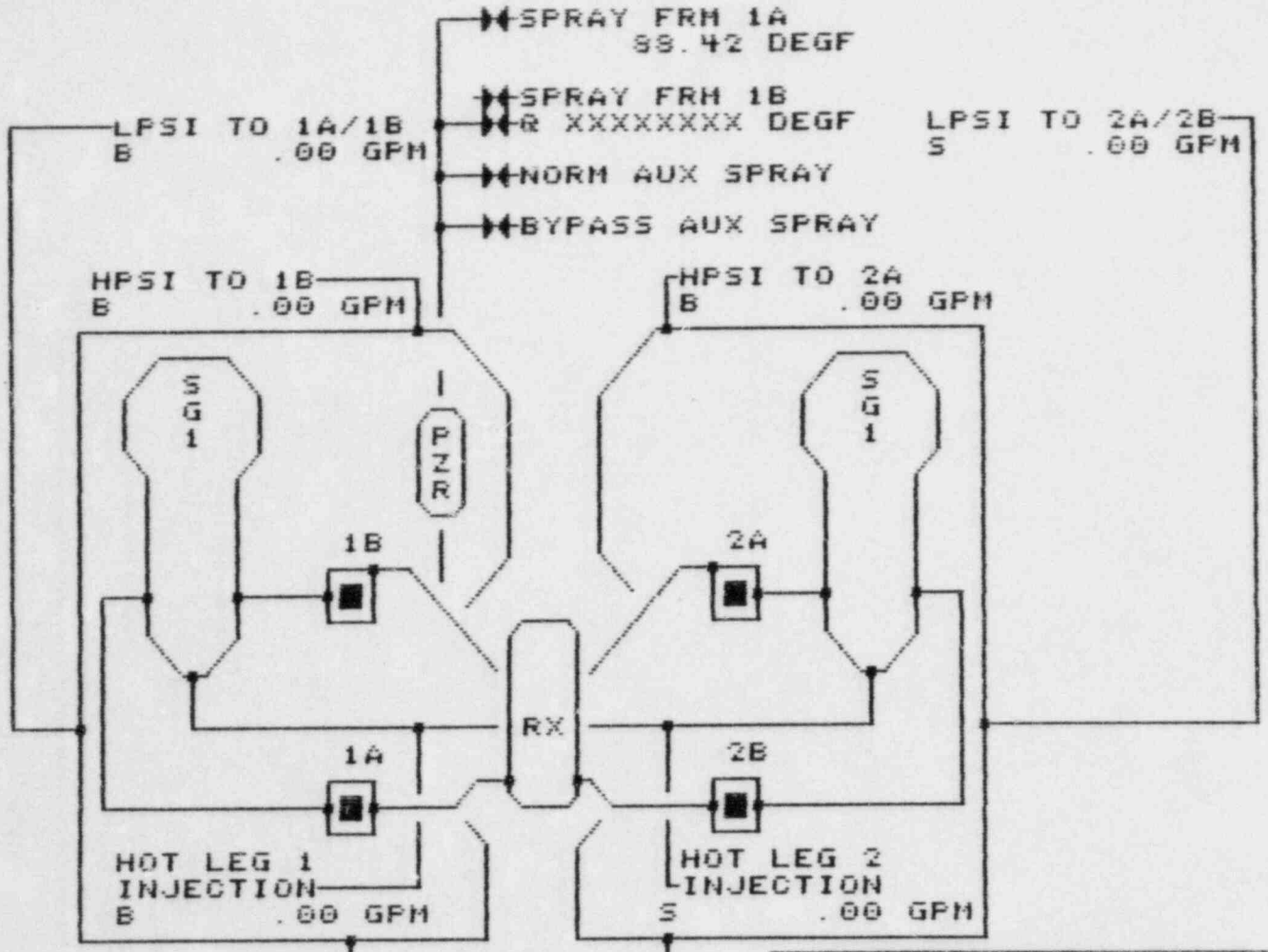
14:10:48 30MAR84

DATA BASE FOR DISPLAY V - RCS HEAT REMOVAL, SIS/PZR SPRAY FLOW

DESCRIPTION	SET POINT - SET POINT LO	HI
SPRAY FRM 1A DEGF	N/A	N/A
SPRAY FRM 1B DEGF	N/A	N/A
RCP 1A	1080 AMPS	N/A
RCP 2A	1080 AMPS	N/A
RCP 1B	1080 AMPS	N/A
RCP 2B	1080 AMPS	N/A
HPSI TO 1A	N/A	N/A
HPSI TO 1B	N/A	N/A
HPSI TO 2A	N/A	N/A
HPSI TO 2B	N/A	N/A
1A PZR SPRAY ISOLATION	N/A	N/A
1B PZR SPRAY ISOLATION	N/A	N/A
AUX SPRY ISOL	N/A	NOT CLOSED
BYPASS SPRY ISOLATION	N/A	N/A
HOT LEG INJECTION (1)	N/A	N/A
HOT LEG INJECTION (2)	N/A	N/A
LPSI TO 2A/2B	N/A	N/A
LPSI TO 1A/1B	N/A	N/A
CCW OUTL GPM A: (SD HX)	N/A	N/A
CCW OUTL GPM B: (SD HX)	N/A	N/A

DATA BASE FOR DISPLAY V - RCS HEAT REMOVAL, SIS/PZR SPRAY FLOW

DESCRIPTION	SET POINT - SET POINT LO	HI
SIS OUTL GPM A	N/A	N/A
SIS OUTL GPM B	N/A	N/A
SIS INLT DEGF A	N/A	N/A
SIS INLT DEGF B	N/A	N/A
SIS OUTL DEGF A	N/A	N/A
SIS OUTL DEGF B	N/A	N/A
CCW OUTL DEGF A	N/A	N/A
CCW OUTL DEGF B	N/A	N/A



PARAMETER	SHDN HX A	SHDN HX B
SIS OUTL GPM	B .00	B .00
SIS INTL DEGF	75.58	76.56
SIS OUTL DEGF	B .00	B .00
CCW OUTL GPM	S .00	3705.52
CCW OUTL DEGF	74.52	85.69

RCS HEAT REMOVAL - SIS/SPRAY FLOW

14:32:51 30MAR84

DATA BASE FOR DISPLAY VV - RCS HEAT REMOVAL, SIS/PZR SPRAY FLOW PARAMETER TRENDING

DESCRIPTION	SET POINT - SET POINT LO	HI
SPRAY FRM 1A (TEMP)	N/A	N/A
SPRAY FRM 1B (TEMP)	N/A	N/A
HPSI TO 1A	N/A	N/A
HPSI TO 1B	N/A	N/A
HPSI TO 2A	N/A	N/A
HPSI TO 2B	N/A	N/A
HOT LEG 1 INJ	N/A	N/A
HOT LEG 2 INJ	N/A	N/A
LPSI TO 2A/2B	N/A	N/A
LPSI TO 1A/1B	N/A	N/A
SHDN HX A SIS INL TEMP	N/A	N/A
SIS OUTL FLOW A	N/A	N/A
SIS OUTL TEMP A	N/A	N/A
CCW OUTL FLOW A	N/A	N/A
CCW OUTL TEMP A	N/A	N/A
SHDN HX B SIS INL TEMP	N/A	N/A
SIS OUTL FLOW B	N/A	N/A
SIS OUTL TEMP B	N/A	N/A
CCW OUTL FLOW B	N/A	N/A
CCW OUTL TEMP B	N/A	N/A

LPSI TO 1A/1B	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
HPSI TO 1A	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
HPSI TO 1B	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
HOT LEG 1 INJECTION	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
SPRAY FRM 1A (TEMP)	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN
SPRAY FRM 1B (TEMP)	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN
LPSI TO 2A/2B	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
HPSI TO 2A	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
HPSI TO 2B	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
HOT LEG 1 INJECTION	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN

SHDN HX A SIS OU FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
SIS IN TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN
SIS OUT TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN
CCW OUT FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
CCW OUT TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN

SHDN HX B SIS OU FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
SIS IN TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN
SIS OUT TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN
CCW OUT FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN
CCW OUT TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN

VV

RCS HEAT REMOVAL SIS/SPRAY FLOW PARAMETER TRENDING

14:11:03 30MAR84

5.7 RCS INTEGRITY

The complexity of the problem of monitoring RCS leakage led to employing four CRT displays to cover this safety function. Monitoring for leakage detection is done using a combination of data on the CRT displays.

Display W is designed as an RCS Integrity Overview, to be used after a problem has been detected on the Parameter Summary Display. Display W will provide sufficient data for a gross leakage, or conditional messages for smaller leaks. Displays X, Y, and Z provide detailed information on small RCS leaks. The small leaks covered are reactor coolant pump seal leaks, safety injection isolation valve leakage, and safety injection tank leakage.

All four displays have corresponding trend displays WW, XX, YY, and ZZ.

5.7.1 Description of the Data Base Values Used on RCS Integrity

Displays W, X, Y, and Z for "RCS Integrity" present information to the control room operators in three parts: Reactor Coolant/Pressurizer System, Safety Injection System, and Reactor Coolant Pump Seal/Component Cooling Water.

The top display (W) for this SPDS Safety Function, Reactor Coolant/Pressurizer System, is designed with the Reactor Vessel in the center, surrounded by the four RCPs and two steam generators. The RCP and steam generator locations on the display are consistent with site general arrangement drawings and depict the actual physical configuration in the Reactor Containment Building. The Containment Sump information is at the bottom of the display (below the reactor vessel) and Containment Atmosphere radiation is in the upper left corner (above RCS). These placements were done with respect to their physical location. The Main Condenser Radiation Monitors are shown at the lower left corner of the display (visually depicted outside of the containment). The units for the point IDs (pressure, temperature, and flows) are displayed near the component area that they represent. Additional information will be conditionally written on the display to alert the control room operators of an abnormal condition in one of the four subsystems (SIS, CCW, RCPs, or the Reactor Vessel).

The Safety Injection Tank, Display X is designed to be consistent with the location of the four RCS cold loops shown on Display W. Four Safety Injection Tanks are depicted along with their nearby piping, pressure sensors and valves. The values which the SPDS user could use to determine the nature of an RCS leak into the SIS are provided on the display. Also abnormal valve positions will be indicated by the use of valve symbol color changes.

Display Y (Safety Injection Headers) focuses on the pressure instrumentation measuring the HPSI and LPSI hot and cold leg injection lines. This diagram fulfills part of the purpose of Display X, while it keeps Display X from being too dense with information. Pressure and valve position data is provided to the SPDS user.

The Reactor Coolant Pump/Component Cooling Water Display Z, shows four RCPs (the seal area), arranged to be consistent with the RCP location displayed on the Reactor Coolant display of the PMC. The values for the point IDs needed by the operators to determine the severity of the seal leakage will be provided on the display in close proximity to the related RCP.

Display W, for the RCS Integrity Safety Function, will show the value of containment airborne radiation levels determined by the Radiation Monitoring Computer. No additional processing will be performed. This measurement is an indication of a primary pressure boundary leak.

Leakage past the Pressurizer relief valves will be reliably detected by a rise in the temperature of the discharge to the Quench Tank. Additionally, leakage past the Pressurizer relief valves can be reliably detected by an increasing level, temperature, and pressure in the Quench Tank. This information is displayed in a box under Quench Tank in the upper right corner.

Pressurizer level and pressure data is summarized adjacent to its illustration. Pressurizer pressure is brought in by averaging the QSPDS supplied data. Pressurizer level is an average of four signals.

Display W includes certain messages, logically determined in CPU 3 from point ID values. If the pressure in the HPSI injection lines reaches 1000 psig or the LPSI injection line pressure reaches 300 psig the message "SIS Leak Detected" will appear on the display. The 1000 and 300 psig setpoints were chosen to be consistent with the annunciator setpoints associated with the instruments feeding the point IDs of interest.

The message "CCW Leak Detected" will appear if any of the component cooling water radiation monitor signals from the RMS, is beyond its setpoint.

The Liquid Waste Tank level is displayed to provide additional monitoring of leakage from the Safety Injection System.

Steam generator tube leakage could be sensed by relatively high radiation in the main steam lines. Main steam line radiation from QSPDS signals is displayed above the corresponding illustrated steam generator.

Main Condenser off-gas radiation monitors provide an additional indication of a significant steam generator tube leak. The values are labeled "RE-AE0001" and "RE-AE0002", respectively, on the lower left corner of the display.

The message 'Reactor Vessel Head Flange Leak Detected" will appear on the center of the display if the reactor vessel head gasket pressure is "High".

Each reactor coolant pump has two conditional messages associated with them on the display. Under the box labeled "RCP Flange Lk" the message RCP 1A, RCP 1B, RCP 2A, or RCP 2B will appear on the display if the corresponding RCP flange gasket pressure is "High" and has a "GOOD" quality tag.

The "RCP XX" message for each RCP will appear in the "SL LK" box if any of the seal pressures, bleed-off flow rates or temperatures exceed their setpoint values. The setpoints were chosen to correspond to 10 percent above the normal operating values. The seal water temperature setpoints will agree with those used for the corresponding annunciator window.

A relatively high condensate flow rate from the containment fan coolers may be indicative of a local steam-forming leak or a larger leak, if the condensate flow is high from several of the coolers. The "Cntmt Fan Cooler Drn Flow Detected" message will appear conditionally on the lower right corner of the display. A state message of "High" with an associated "GOOD" quality tag for any of the point IDs related to this conditional message will cause "Cntmt Fan Cooler Drn Flow Detected" to appear.

Data on the Containment Sump is located together in a rectangle at the bottom of the page. This will be a gross measurement of the degree to which some pressure boundary inside of containment has been breached. The label "CNTMT WTR LK RATE" will headline the sump inlet water flow rate. A relatively high radioactive leak inside of containment may be sensed by the containment sump radiation monitor. "Rad Level RE WM6777" will have below it the value from the radiation monitor. The sump water level will be determined by using the maximum value of two signals. The highest water level indication in the containment sump will be consistently conservative. This will provide indication of a slow/small leak inside containment.

The next level displays for "RCS Integrity" provide clarifying information based on conditional messages appearing on Display W. "RCS Coolant Pump Seal/Component Cooling Water" provides the numerical data which caused the message to appear on Display W. Additionally, CCW in-leakage data is displayed on the center of the display. The point ID identified as the conditional operators on Display W provide the values on Display Z without additional processing.

5.7.2 Static Illustration of the RCS Integrity Displays and Associated Parameter Listings

DATA BASE FOR DISPLAY W - RCS INTEGRITY, OVERVIEW

DESCRIPTION	SET POINT - LO	SET POINT HI
QUENCH TANK LEVEL	ANN.	ANN.
QUENCH TANK-PRES PSIA	N/A	10.0 PSIG
A: LINE FROM PZR TO QT	N/A	280 DEGF
B: LINE FROM PZR TO QT	N/A	280 DEGF
QUENCH TANK TEMP	N/A	200 DEGF
WASTE TANK LVL A:	N/A	N/A
WASTE TANK LVL B:	N/A	N/A
FW RATE OF WTR TO SUMP	N/A	N/A
RE-AE0002	N/A	0.254 uCi/cc
RE-MS5500AS	N/A	N/A
RE-MS5500BS	N/A	N/A
PZR LEVEL	26 PCNT	62.5 PCNT
PZR PRESS	1889 PSIA	2365 PSIA
SEAL LEAK (1A)	N/A	1.25 GPM
SEAL LEAK (1A)	N/A	1650 PSIG
SEAL LEAK (1A)	N/A	850 PSIG
SEAL LEAK (1A)	N/A	100 PSIG
SEAL LEAK (1A)	N/A	140 DEGF

DATA BASE FOR DISPLAY W - RCS INTEGRITY, OVERVIEW

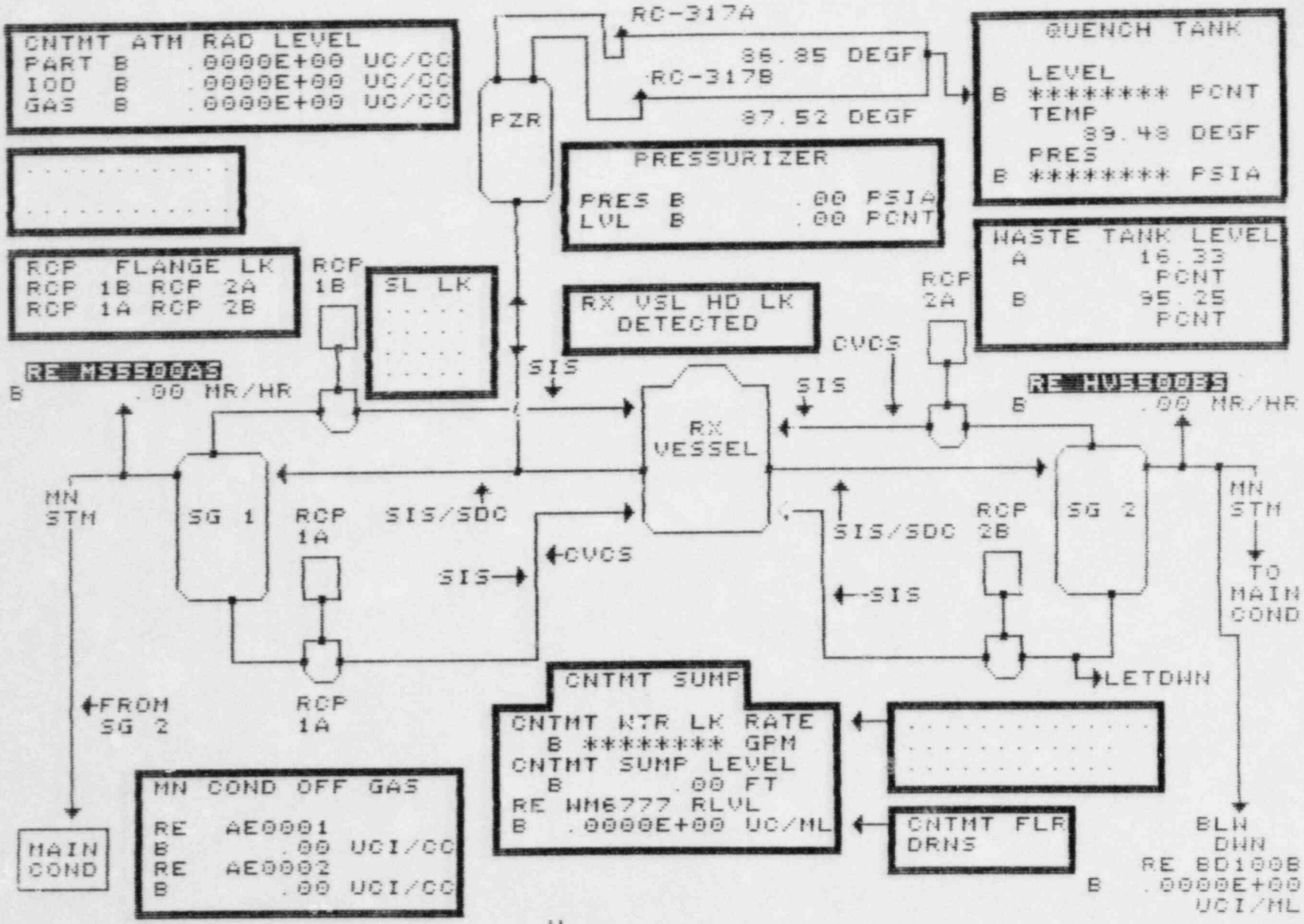
DESCRIPTION	SET POINT - SET POINT LO	HI
SEAL LEAK (1A)	N/A	180 DEGF
SEAL LEAK (2A)	N/A	1.25 GPM
SEAL LEAK (2A)	N/A	1650 PSIG
SEAL LEAK (2A)	N/A	850 PSIG
SEAL LEAK (2A)	N/A	100 PSIG
SEAL LEAK (2A)	N/A	140 DEGF
SEAL LEAK (2A)	N/A	180 DEGF
SEAL LEAK (1B)	N/A	1.25 GPM
SEAL LEAK (1B)	N/A	1650 PSIG
SEAL LEAK (1B)	N/A	850 PSIG
SEAL LEAK (1B)	N/A	100 PSIG
SEAL LEAK (1B)	N/A	140 DEGF
SEAL LEAK (1B)	N/A	180 DEGF
SEAL LEAK (2B)	N/A	1.25 GPM
SEAL LEAK (2B)	N/A	1650 PSIG
SEAL LEAK (2B)	N/A	850 PSIG
SEAL LEAK (2B)	N/A	100 PSIG
SEAL LEAK (2B)	N/A	140 DEGF
SEAL LEAK (2B)	N/A	180 DEGF
CNTMT FAN CLR DRN FLOW	HIGH	NOT HIGH
CNTMT FAN CLR DRN FLOW	HIGH	NOT HIGH
CNTMT FAN CLR DRN FLOW	HIGH	NOT HIGH

DATA BASE FOR DISPLAY W - RCS INTEGRITY, OVERVIEW

DESCRIPTION	SET POINT - SET POINT LO	HI
CNTMT FAN CLR DRN FLOW	HIGH	NOT HIGH
CNTMT FAN CLR DRN FLOW	HIGH	NOT HIGH
CNTMT FAN CLR DRN FLOW	HIGH	NOT HIGH
SIS LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	1000 PSIG
SI LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	300 PSIG
SIS LEAK DETECTED	N/A	300 PSIG
CCW LEAK DETECTED	N/A	1E-04 uCi/cc
CCW LEAK DETECTED	N/A	1E-04 uCi/cc
CCW LEAK DETECTED	N/A	N/A
CNTMT SUMP LVL	N/A	N/A
RE-AE0001	N/A	0.254 uCi/cc
CNTMT ATM RAD LVL.PART	N/A	N/A
CNTMT ATM RAD LVL. IOD	N/A	N/A
CNTMT ATM RAD LVL. GAS	N/A	N/A
RE-WM6777 SUMP RAD LVL	N/A	N/A
BLW DWN RF-BD0100B	N/A	N/A

DATA BASE FOR DISPLAY W - RCS INTEGRITY, OVERVIEW

DESCRIPTION	SET POINT - LO	SET POINT HI
1A: FLNG LEAK	NOT HIGH	HIGH
2A: FLNG LEAK	NOT HIGH	HIGH
1B: FLNG LEAK	NOT HIGH	HIGH
2B: FLNG LEAK	NOT HIGH	HIGH
RPV HEAD FLANGE LEAK	N/A	HIGH



RCS INTEGRITY - OVERVIEW

13:07:08 10APR84

DATA BASE FOR DISPLAY WW - RCS INTEGRITY, OVERVIEW PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
QUENCH TNK LVL	ANN.	ANN.
QUENCH TANK PRES	N/A	10.0 PSIG
PZR RLF A LINE TEMP	N/A	280 DEGF
PZR RLF B LINE TEMP	N/A	280 DEGF
QUENCH TNK TEMP	N/A	200 DEGF
WASTE TANK LVL A	N/A	N/A
WASTE TANK LVL B	N/A	N/A
FLW RATE OF WTR TO SMP	N/A	N/A
MN CNDNSR RE-AE0002	N/A	N/A
RE-MS5500AS (MN STM #1)	N/A	N/A
RE-MS5500BS (MN STM#2)	N/A	N/A
PZR LVL (AVG)	26 PCNT	62.5 PCNT
PZR PRESSURE	1889 PSIA	2365 PSIA
CNTMT SUMP LVL	N/A	N/A
MN CNDNSR RE-AE0001	N/A	0.254 uCi/cc
CNTMT ATM RAD LVL PRT	N/A	N/A
CNTMT ATM RAD LVL IOD	N/A	N/A
CNTMT ATM RAD LVL GAS	N/A	N/A
RE-WM6777 SMP RAD LVL	N/A	N/A
BLW DWN RE-BD0100B	N/A	N/A

```
CNTMT ATM RAD LVL PRT    @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M

CNTMT ATM RAD LVL IOD    @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M

CNTMT ATM RAD LVL GAS    @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M


WASTE TANK LVL A:        @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
WASTE TANK LVL B:        @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN


PZR RLF A LINE TEMP      @ XXXXXXXX DEGF  @ XXXXXXXX DEGF/MIN
PZR RLF B LINE TEMP      @ XXXXXXXX DEGF  @ XXXXXXXX DEGF/MIN


@UENCH TNK PRES          @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN

@UENCH TNK LVL           @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN

@UENCH TNK TEMP          @ XXXXXXXX DEGF  @ XXXXXXXX DEGF/MIN


RE-MS5500AS (MN STM #1) @ XXXXXXXX MR/HR @ XXXXXXXX MR/HR/MIN
RE-MS5500BS (MN STM #2) @ XXXXXXXX MR/HR @ XXXXXXXX MR/HR/MIN


RE-BD0100B BLW DWN       @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M


MN CNDNSR RE AE0001      @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M
MN CNDNSR RE AE0002      @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M


RE-MN6777(CNTMT SUMP)    @ XXXXXXXX UC/CC @ XXXXXXXX UC/CC/M
CNTMT SUMP LVL (MAX)     @ XXXXXXXX FTN   @ XXXXXXXX UC/CC/M


PZR LVL (AVG)            @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN

PZR PRES (AVG)           @ XXXXXXXX PSIA  @ XXXXXXXX PSIA/MIN

FLW RATE OF NTR TO SUMP  @ XXXXXXXX GPM   @ XXXXXXXX GPM/MIN
```

NN

RCS INTEGRITY - OVERVIEW PARAMETER TRENDING

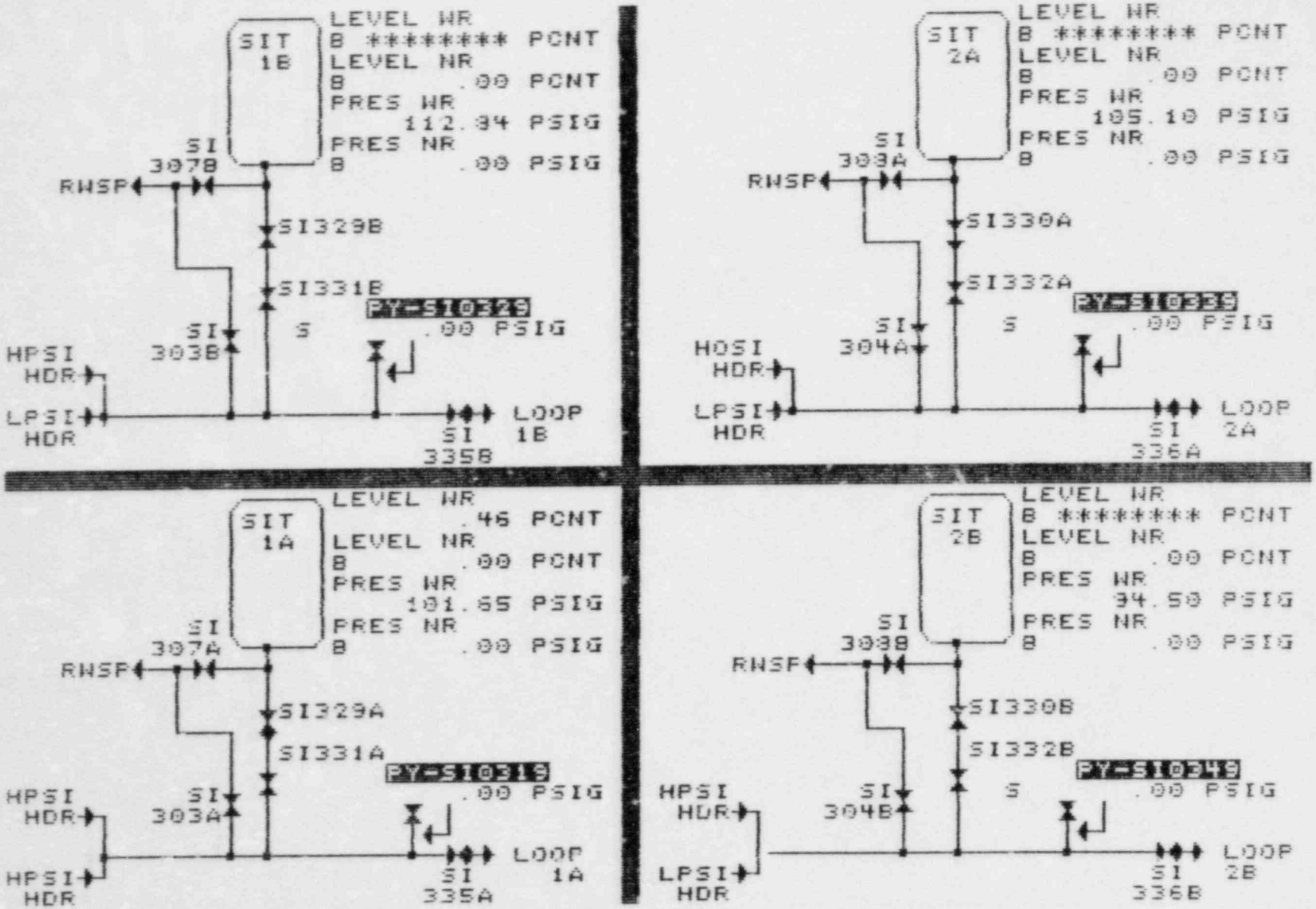
14:11:31 30MAR84

DATA BASE FOR DISPLAY X - RCS INTEGRITY, SAFETY INJECTION TANKS

DESCRIPTION	SET POINT - LO	SET POINT HI
PY-SI0319	N/A	N/A
PY-SI0329	N/A	N/A
PY-SI0339	N/A	N/A
PY-SI0349	N/A	N/A
LEVEL WR (SIT 1A)	78.8 PCNT	88 PCNT
PRES WR	600 PSIG	625 PSIG
LEVEL WR (SIT 2A)	78.8 PCNT	88 PCNT
PRES WR (SIT 2A)	600 PSIG	625 PSIG
LEVEL WR (SIT 1B)	78.8 PCNT	88 PCNT
PRES WR (SIT 1B)	600 PSIG	625 PSIG
LEVEL WR (SIT 2B)	78.8 PCNT	88 PCNT
PRES WR (SIT 2B)	600 PSIG	625 PSIG
LEVEL NR (SIT 1A)	78.8 PCNT	88 PCNT
PRES NR (SIT 1A)	600 PSIG	625 PSIG
LEVEL NR (SIT 2A)	78.8 PCNT	88PCNT
PRES NR (SIT 2A)	600 PSIG	625 PSIG
LEVEL NR (SIT 1B)	78.8 PCNT	88 PCNT
PRES NR (SIT 1B)	600 PSIG	625 PSIG
LEVEL NR (SIT 2B)	78.8 PCNT	88 PCNT
PRES NR (SIT 2B)	600 PSIG	625 PSIG
SI-307A	CLOSED	NOT CLOSED
SI-331A	OPEN	NOT OPEN
SI-303A	CLOSED	NOT CLOSED
SI-308A	CLOSED	NOT CLOSED
SI-332A	OPEN	NOT OPEN

DATA BASE FOR DISPLAY X - RCS INTEGRITY, SAFETY INJECTION TANKS

DESCRIPTION	SET POINT - LO	SET POINT HI
SI-304A	CLOSED	NOT CLOSED
SI-307B	CLOSED	NOT CLOSED
SI-331B	OPEN	NOT OPEN
SI-303B	CLOSED	NOT CLOSED
SI-308B	CLOSED	NOT CLOSED
SI-332B	OPEN	NOT OPEN
SI-304B	CLOSED	NOT CLOSED



RCS INTEGRITY - SAFETY INJECTION TANKS

13:07:51 10APR84

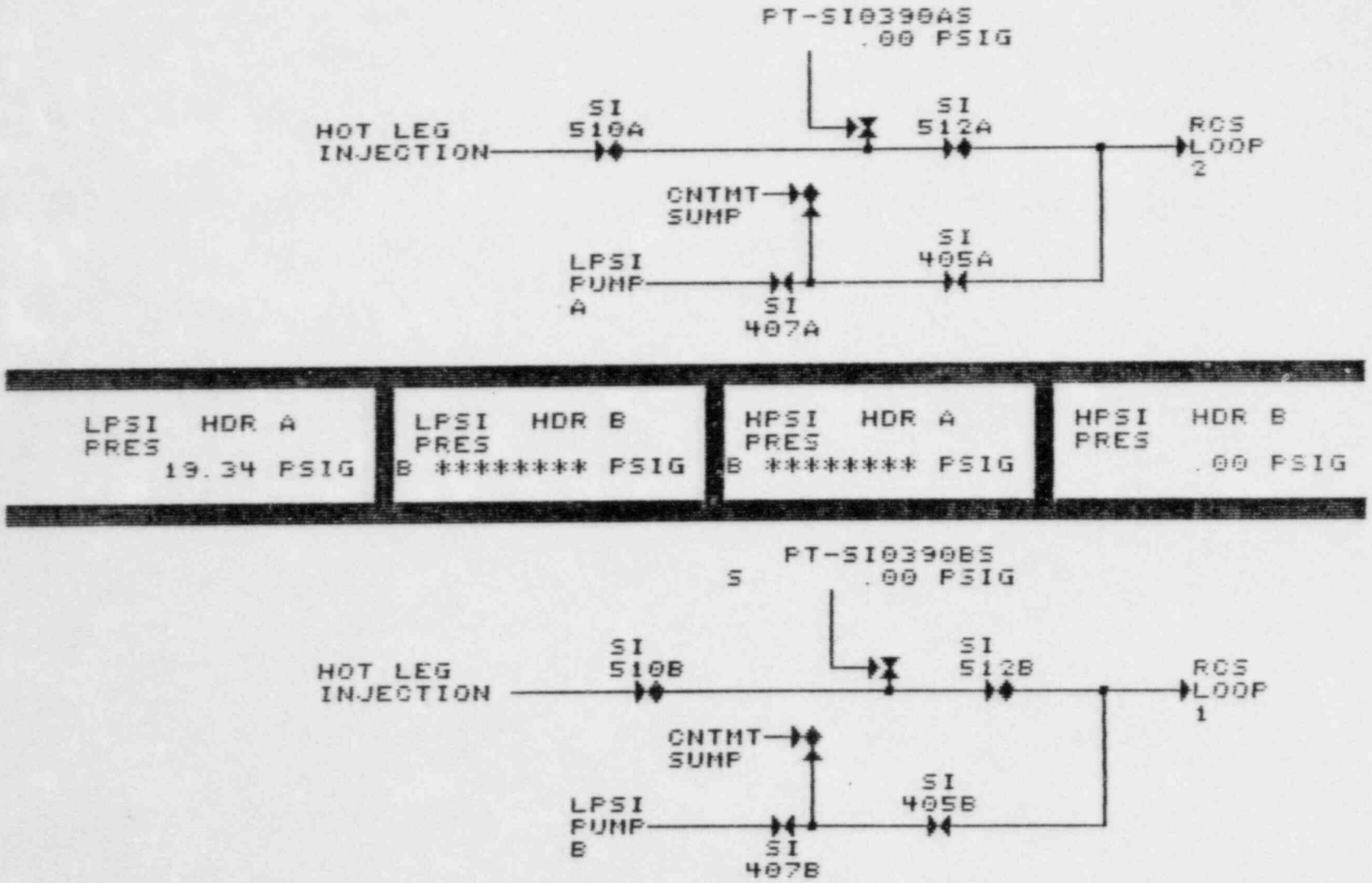
DATA BASE FOR DISPLAY XX - RCS INTEGRITY, SAFETY INJECTION TANKS PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
PY-SI0319 (SIT 1A)	N/A	N/A
PY-SI0329 (SIT 1B)	N/A	N/A
PY-SI0339 (SIT 2A)	N/A	N/A
PY-SI0349 (SIT 2B)	N/A	N/A
LEVEL WR (SIT 1A)	78.8 PCNT	88 PCNT
PRES WR (SIT 1A)	600 PSIG	625 PSIG
LEVEL WR (SIT 2A)	78.8 PCNT	88 PCNT
PRES WR (SIT 2A)	600 PSIG	625 PSIG
LEVEL WR (SIT 1B)	78.8 PCNT	88 PCNT
PRES WR (SIT 1B)	600 PSIG	625 PSIG
LEVEL WR (SIT 2B)	78.8 PCNT	88 PCNT
PRES WR (SIT 2B)	600 PSIG	625 PSIG
LEVEL NR (SIT 1A)	78.8 PCNT	88 PCNT
PRES NR (SIT 1A)	600 PSIG	625 PSIG
LEVEL NR (SIT 2A)	78.8 PCNT	88 PCNT
PRES NR (SIT 2A)	600 PSIG	625 PSIG
LEVEL NR (SIT 1B)	78.8 PCNT	88 PCNT
PRES NR (SIT 1B)	600 PSIG	625 PSIG
LEVEL NR (SIT 2B)	78.8 PCNT	88 PCNT
PRES NR (SIT 2B)	600 PSIG	625 PSIG
SI-30/A	CLOSED	NOT CLOSED
SI-331A	OPEN	NOT OPEN
SI-303A	CLOSED	NOT CLOSED
SI-308A	CLOSED	NOT CLOSED
SI-332A	OPEN	NOT OPEN

```
PY-SI0319 (SIS LOOP 1A) @ XXXXXXXX PSIG   @ XXXXXXXX PSIG/MIN

SI TNK 1A   LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN

PY-SI0329 (SIS LOOP 1B) @ XXXXXXXX PSIG   @ XXXXXXXX PSIG/MIN

SI TN  1B   LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN

PY-SI0339 (SIS LOOP 2A) @ XXXXXXXX PSIG   @ XXXXXXXX PSIG/MIN

SI TNK 2A   LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN

PY-SI0349 (SIS LOOP 2B) @ XXXXXXXX PSIG   @ XXXXXXXX PSIG/MIN

SI TNK 2B   LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            LEVEL  NR      @ XXXXXXXX PCNT  @ XXXXXXXX PCNT/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN
            PRES   NR      @ XXXXXXXX PSIG  @ XXXXXXXX PSIG/MIN

                    XX
 RCS INTEGRITY - SAFETY INJECTION TANKS - PARAMETER TRENDING

                  14:11:59  30MAR84
```

DATA BASE FOR DISPLAY Y - RCS INTEGRITY, SIS PIPING

DESCRIPTION	SET POINT - SET POINT LO	HI
PT-SI0390AS	N/A	300 PSIG
PT-SI0390BS	N/A	300 PSIG
LPSI HDR A PRES	N/A	N/A
LPSI HDR B PRES	N/A	N/A
HPSI HDR A PRES	N/A	1000 PSIG
HPSI HDR B PRES	N/A	1000 PSIG
SI-407A	CLOSED	NOT CLOSED
SI-407B	CLOSED	NOT CLOSED
SI-405A	CLOSED	NOT CLOSED
SI-405B	CLOSED	NOT CLOSED



Y

RCS INTEGRITY - SIS PIING

13:08:15 10APR84

DATA BASE FOR DISPLAY YY - RCS INTEGRITY, SIS PIPING PARAMETER TRENDING

DESCRIPTION	SET POINT - LO	SET POINT HI
PY-SI0390AS	N/A	300 PSIG
PY-SI0390BS	N/A	300 PSIG
LPSI HDR A PRES	N/A	N/A
LPSI HDR B PRES	N/A	N/A
HPSI HDR A PRES	N/A	1000 PSIG
HPSI HDR B PRES	N/A	1000 PSIG

LPSI HDR A PRES	@ XXXXXXXX PSIG	@ XXXXXXXX PSIG/MIN
HPSI HDR A PRES	@ XXXXXXXX PSIG	@ XXXXXXXX PSIG/MIN
LPSI HDR B PRES	@ XXXXXXXX PSIG	@ XXXXXXXX PSIG/MIN
HPSI HDR B PRES	@ XXXXXXXX PSIG	@ XXXXXXXX PSIG/MIN
PY-SI0390AS	@ XXXXXXXX PSIG	@ XXXXXXXX PSIG/MIN
PY-SI0390BS	@ XXXXXXXX PSIG	@ XXXXXXXX PSIG/MIN

YY

RCS INTEGRITY - SIS PIPING PARAMETER TRENDING

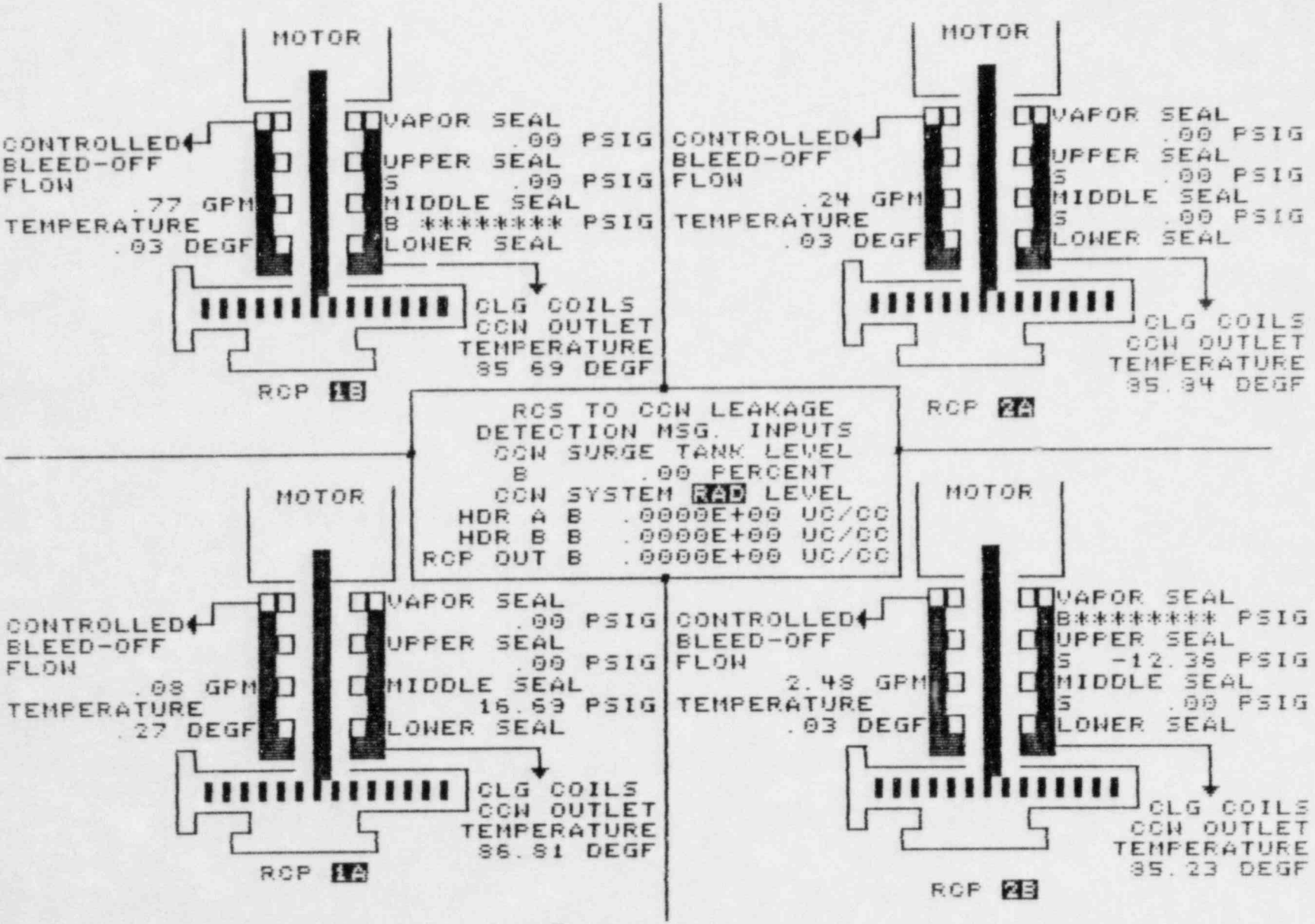
14:12:23 30MAR84

DATA BASE FOR DISPLAY Z - RCS INTEGRITY, REACTOR COOLANT SEALS PUMP

	DESCRIPTION	SET POINT - LO	SET POINT HI
(1A)	CONTROLLED BLD.OFF FW.	1 GPM	1.25 GPM
(1A)	MIDDLE/LOWER SEAL	N/A	100 PSIG
(1A)	UPPER/MIDDLE SEAL	N/A	850 PSIG
(1A)	VAPOR/UPPER SEAL	N/A	1650 PSIG
(1A)	CLG COIL CCW OUTLT TEM	N/A	140 DEGF
(1A)	CONTROLLLED BLD OFF TEMP	N/A	180 DEGF
(2A)	CONTROLLED BLD.OFF FLO	1 GPM	1.25 GPM
(2A)	MIDDLE/LOWER SEAL	N/A	100 PSIG
(2A)	UPPER/MIDDLE SEAL	N/A	850 PSIG
(2A)	VAPOR/UPPER SEAL	N/A	1650 PSIG
(2A)	CLG COIL CCW OUTLT TEM	N/A	140 DEGF
(2A)	CONTROLLED BLD.OFF TEMP	N/A	180 DEGF
(1B)	CONTROLD BLD. OFF FLOW	1 GPM	1.25 GPM
(1B)	MIDDLE/LOWER SEAL	N/A	100 PSIG
(1B)	UPPER/MIDDLE SEAL	N/A	850 PSIG
(1B)	VAPOR/UPPER SEAL	N/A	1650 PSIG
(1B)	CLG COIL CCW OULT TEMP	N/A	140 DEGF
(1B)	CONTROLD BLD. OFF TEMP.	N/A	180 DEGF
(2B)	CONTROLD.BLD.OFF FLOW	1 GPM	1.25 GPM
(2B)	MIDDLE/LOWER SEAL	N/A	100 PSIG

DATA BASE FOR DISPLAY Z - RCS INTEGRITY, REACTOR COOLANT SEALS PUMP

	DESCRIPTION	SET POINT - LO	SET POINT HI
(2B)	UPPER/MIDDLE SEAL	N/A	850 PSIG
(2B)	VAPOR/UPPER SEAL	N/A	1650 PSIG
(2B)	CLG COIL CCW OUTLT	N/A	140 DEGF
(2B)	CONTROLD.BLD.OFF TEMP	N/A	180 DEGF
	CCW SURGE TANK LEVEL	72.6 PCNT	92.5 PCNT
	CCW SYS.RAD LVL.HDR.A	N/A	1E-04 uCi/cc
	CCW SYS.RAD LVL.HDR.B	N/A	1E-04 uCi/cc
	CCW SYS.RAD LVL. RCP 0.	N/A	N/A



Z

RCS INTEGRITY - REACTOR COOLANT PUMP SEALS

13:08:42 10APR84

DATA BASE FOR DISPLAY ZZ - RCS INTEGRITY,REACTOR COOLANT PUMP SEALS PARAMETER TRENDING

	DESCRIPTION	SET POINT - LO	SET POINT HI
(1A)	CONTROLD BLD OFF FLOW	1 GPM	1.25 GPM
(1A)	MIDDLE/LOWER SEAL DP	N/A	100 PSIG
(1A)	UPPER/MIDDLE SEAL DP	N/A	850 PSIG
(1A)	VAPOR/UPPER SEAL DP	N/A	1650 PSIG
(1A)	CLG COIL CCW OUTLT	N/A	140 DEGF
(1A)	CONTROLD BLD OFF TEMP	N/A	180 DEGF
(2A)	CONTROLD BLD OFF FLOW	1 GPM	1.25 GPM
(2A)	MIDDLE/LOWER SEAL DP	N/A	100 PSIG
(2A)	UPPER/MIDDLE SEAL DP	N/A	850 PSIG
(2A)	VAPOR/UPPER SEAL DP	N/A	1650 PSIG
(2A)	CLG COIL CCW OUTLT	N/A	140 DEGF
(2A)	CONTROLD BLD OFF TEMP	N/A	180 DEGF
(1B)	CONTROLD BLD OFF FLOW	1 GPM	1.25 GPM
(1B)	MIDDLE/LOWER SEAL DP	N/A	100 PSIG
(1B)	UPPER/MIDDLE SEAL DP	N/A	850 PSIG
(1B)	VAPOR/UPPER SEAL DP	N/A	1650 PSIG
(1B)	CLG COIL CCW OUTLT	N/A	140 DEGF
(1B)	CONTROLD BLD OFF TEMP	N/A	180 DEGF
(2B)	CONTROLD BLD OFF FLOW	1 GPM	1.25 GPM

DATA BASE FOR DISPLAY ZZ - RCS INTEGRITY,REACTOR COOLANT PUMP SEALS PARAMETER TRENDING

	DESCRIPTION	SET POINT - SET POINT LO	HI
(2B)	MIDDLE/LOWER SEAL DP	N/A	100 PSIG
(2B)	UPPER/MIDDLE SEAL DP	N/A	850 PSIG
(2B)	VAPOR/UPPER SEAL DP	N/A	1650 PSIG
(2B)	CLG COIL CCW OUTLT	N/A	140 DEGF
(2B)	CONTROLD BLD OFF TEMP	N/A	180 DEGF
	CCW SURGE TNK LVL	72.6 PCNT	92.5 PCNT
	CCW HDR A RAD LVL	N/A	1E-04 uCi/cc
	CCW HDR B RAD LVL	N/A	1E-04 uCi/cc
	RCP CCW OUTL RAD LVL	N/A	N/A

RCP 1A					
CONTROLD BLD OFF FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN	
CONTROLD BLD OFF TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
VAPOR/UPPER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
UPPER/MIDDLE SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
MIDDLE/LOWER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
CLG COIL CCW OUTLT	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
RCP 1B					
CONTROLD BLD OFF FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN	
CONTROLD BLD OFF TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
VAPOR/UPPER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
UPPER/MIDDLE SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
MIDDLE/LOWER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
CLG COIL CCW OUTLT	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
RCP 2A					
CONTROLD BLD OFF FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN	
CONTROLD BLD OFF TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
VAPOR/UPPER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
UPPER/MIDDLE SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
MIDDLE/LOWER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
CLG COIL CCW OUTLT	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
RCP 2B					
CONTROLD BLD OFF FLOW	@ XXXXXXXX	GPM	@ XXXXXXXX	GPM/MIN	
CONTROLD BLD OFF TEMP	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
VAPOR/UPPER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
UPPER/MIDDLE SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
MIDDLE/LOWER SEAL DP	@ XXXXXXXX	PSIG	@ XXXXXXXX	PSIG/MIN	
CLG COIL CCW OUTLT	@ XXXXXXXX	DEGF	@ XXXXXXXX	DEGF/MIN	
CCW SURGE TNK LVL	@ XXXXXXXX	PCNT	@ XXXXXXXX	PCNT/MIN	
CCW HDR A RAD LVL	@ XXXXXXXX	UC/CC	@ XXXXXXXX	UC/CC/M	
CCW HDR B RAD LVL	@ XXXXXXXX	UC/CC	@ XXXXXXXX	UC/CC/M	
RCP CCW OUTL RAD LVL	@ XXXXXXXX	UC/CC	@ XXXXXXXX	UC/CC/M	

ZZ

RCS INTEGRITY - REACTOR COOLANT PUMP SEALS PARAMETER TRENDING

14:12:53 30MAR84

5.8 PARAMETER SUMMARY DISPLAY

The summary CRT display brings the most important values from the five display groups just described. This will be the CRT display most frequently used because reactor operation normally does not challenge the safety parameter envelope and only an overview of these parameters is necessary. The summary CRT display will call attention to a problem with a particular parameter if one is detected by the SPDS software in the PMC. For the convenience of the SPDS users outside of the control room, additional non-safety related data is provided with respect to core power operating limits.

The Parameter Summary Display A will be the default display. The ERF software allows one display to be so designated and force it to the screen when no other is requested. Display AA is the corresponding trend display.

5.8.1 Description of the Data Base Values Used on the Parameter Summary

For clarity to the users of the SPDS, the overall Parameter Summary Display is an integral part of the SPDS scheme. This display will be used to determine, in an overview fashion, the operator's success at maintaining the safety functions of Core Cooling, Reactivity Control, RCS Integrity, Radiation Releases, and Containment Conditions. The display is part of the first-level function of SPDS. The values displayed on the Summary Display were chosen based on their importance in maintaining the safety functions. Values are displayed which uniquely identify problems with a particular safety function that should be investigated further. Detailed investigation is done by paging into the secondary levels of the SPDS scheme discussed in Sections 5.3-5.7.

Containment Conditions monitored on Display A will cover the plant protection signals (CSAS, MSIS, CIAS, SIAS), temperature, pressure, humidity, and hydrogen gas concentration inside of containment. These parameters for the Summary Display are the same values described in Section 5.3 and shown in the Containment Conditions Display B.

The Radiation Releases information to be brought into the Summary Display will be displayed in a message format to indicate unusually high radiation levels at the various floors and potentially radioactive system process flows in the plant covered by SPDS. A tabular list of floors and processes with normal or abnormal indications next to them will be shown on the Summary Display. If any of the radiation monitor signals used by SPDS and described in Section 5.4 reach their high setpoint, a message is displayed. The messages, listed below, identify the general location of the high radiation and direct the operator to the more detailed second level display.

Rx BLDG +46
Rx BLDG +21
Rx BLDG -4
RAB +46
RAB +21
RAB -4
RAB -35
FHB +46
FHB +1
PROCESSES

With respect to the Reactivity Control monitoring function of SPDS, several calculated values are brought into the Summary Display. These parameters are the same as those that appear in the display for Reactivity Control as described in Section 5.5. The parameters shown on the Summary Display are:

Number of CEAs withdrawn
Maximum Neutron Flux (% PWR)
Minimum Temperature Subcooling Margin (°F)
Average Coolant Temperature (°F)
Boron Concentration (PPM)

Under the Core Cooling and RCS Heat Removal Safety Function the parameters listed below are shown on the Summary Display. These are the same as those that appear on the Core Cooling and RCS Heat Removal second level display described in Section 5.6.

Main Steam Flow (1.0E6 LB/HR)
Pressurizer Level (%)
Minimum Pressurizer Pressure (PSIA)
Minimum Pressure Subcooling (PSIA)
Steam Generator Level (%)
Steam Generator Pressure (PSIA)
Main Feedwater Flow (1.0E6 LB/HR)
Emergency Feedwater Flow (GPM)
Safety Injection Flow Rates (GPM)
Presence of EFAS

The RCS Integrity parameters shown on the Summary Display are primarily the message type and some secondary side radiation level information which are described in Section 5.7. If a leak is detected, the corresponding leak message is shown on the Summary Display:

SIS Leak Detected
CCW Leak Detected
Rx Head Flange Leak
Seal Leak - RCP xx
Flange Leak - RCP xx
Containment Sump Level
Containment Sump Radiation (micro Ci/cc)
Main Steam Radiation (mR/Hr)
Condenser Gas Exhaust Radiation (micro Ci/cc)

The Summary Display is intended to be used primarily during normal operation to draw the operator's attention to a potential problem. With this in mind, the thermodynamic parameters calculated by the Core Operating Limits Supervisory Program (COLSS) are summarized. It should be noted that if COLSS is in other than the "scheduled mode" of operation on the PMC, these values will be meaningless. COLSS will be placed into the unscheduled mode following a reactor trip. However, as a result of going into either the unscheduled or test mode, COLSS will not tag these point IDs as "BAD." The SPDS software in the PMC will mask this part of the display if COLSS is in any mode other than the "scheduled mode." The COLSS information displayed includes:

DISPLAY	ABBR.	DESCRIPTION	UNITS
BDELT	The heat balance done on the reactor vessel		%PWR
BSCAL	The heat balance done on the BOP side		%PWR
BTFSP	The plant power extrapolated from Turbine first stage inlet steam pressure		%PWR
DNBRPLC	Power operating limit based on DNBR		%PWR
KWPFPLC	Power operating limit based on KW/FT		%PWR
AZTILT	The azmuthial flux tilt across the core		NONE

5.8.2 Static Illustration of the Parameter Summary Displays and Associated Parameter Listings

DATA BASE FOR DISPLAY A - PARAMETER SUMMARY DISPLAY

DESCRIPTION	SET POINT LO	SET POINT HI
SLIDING TAVG 1:	N/A	N/A
SLIDING TAVG 2	N/A	N/A
SIAS CHNL-B	ACTIVATED	NOT ACTIV
MSIS CHNL-B	ACTIVATED	NOT ACTIV.
KWPFPLC	N/A	N/A
BTFSP	N/A	N/A
BDELT	N/A	N/A
BSCAL	N/A	N/A
AZTILT	N/A	N/A
DNBRPLC	N/A	N/A
EFW FLOW 1:	N/A	N/A
EFW FLOW 2:	N/A	N/A
BORON CONC	N/A	N/A
HPSI TO 1A	N/A	N/A
HPSI TO 1B	N/A	N/A
HPSI TO 2B	N/A	N/A
HPSI TO 2B	N/A	N/A
MN FD WTR FLOW(3G1)	N/A	N/A
MN FD WTR FLOW(SG2)	N/A	N/A
CNTMT H2 CONC	N/A	4 PCNT
RE-AE0002	N/A	N/A
SG1 LEVEL (AVG)	27 PCNT	87.7 PCNT
SG1 PRES	813 PSIA	1020 PSIA
SG2 LEVEL	27 PCNT	87.7 PCNT
SG2 PRES	813 PSIA	1020 PSIA
PZR LEVEL	26 PCNT	62.5 PCNT
CNTMT PRES-1	N/A	18.2 PSIA
CNTMT PRES-2	N/A	18.2 PSIA
CNTMT PRES WR	N/A	18.2 PSIA
CNTMT TEMP -2	N/A	120 DEGF
CNTMT HUMIDITY	N/A	N/A
MN STM FLOW 1:	N/A	N/A
MN STM FLOW 2:	N/A	N/A
MAX. NEUTRON FLUX	N/A	N/A
CNTMT SUMP LVL	N/A	N/A
MIN TEMP SUBCOOL MARGIN	N/A	20 DEGF(SUB)
MINIMUM PZR PRES.	1869 PSIA	2365 PSIA
MIN PRES SUBCOOLING	N/A	N/A
CNTMT TEMP -1	N/A	120 DEGF
CEAS WITHDRAWN	N/A	N/A
1A: SEAL LEAK	N/A	1.25 GPM
1A: SEAL LEAK	N/A	1650 PSIG
1A: SEAL LEAK	N/A	850 PSIG
1A: SEAL LEAK	N/A	100 PSIG

DATA BASE FOR DISPLAY A - PARAMETER SUMMARY DISPLAY

DESCRIPTION	SET POINT LO	SET POINT HI
1A: SEAL LEAK	N/A	140 DEGF
1A: SEAL LEAK	N/A	180 DEGF
2A: SEAL LEAK	N/A	1.25 GPM
2A: SEAL LEAK	N/A	1650 PSIG
2A: SEAL LEAK	N/A	850 PSIG
2A: SEAL LEAK	N/A	100 PSIG
2A: SEAL LEAK	N/A	140 DEGF
2A: SEAL LEAK	N/A	180 DEGF
1B: SEAL LEAK	N/A	1.25 GPM
1B: SEAL LEAK	N/A	1650 PSIG
1B: SEAL LEAK	N/A	850 PSIG
1B: SEAL LEAK	N/A	100 PSIG
1B: SEAL LEAK	N/A	140 DEGF
1B: SEAL LEAK	N/A	180 DEGF
2B: SEAL LEAK	N/A	1.25 GPM
2B: SEAL LEAK	N/A	1650 PSIG
2B: SEAL LEAK	N/A	850 PSIG
2B: SEAL LEAK	N/A	100 PSIG
2B: SEAL LEAK	N/A	140 DEGF
2B: SEAL LEAK	N/A	180 DEGF
RE-HV0300.1S	N/A	100 mR/HR
RE-HV0300.2S	N/A	100 mR/HR
RE-HV0300.3S	N/A	100 mR/HR
RE-HV0300.4S	N/A	100 mR/HR
RE-HV5010	N/A	100 mR/HR
RE-HV5011 NEW FLPL	N/A	15 mR/HR
RE-HV5012	N/A	15 mR/HR
RE-HV5107A PART	N/A	1.04E-04 uCi/cc
RE-HV5107A IOD	N/A	1.18E-06 uCi/cc
RE-HV5107A GAS	N/A	2.35E-02 uCi/cc
RE-HV5107B PART	N/A	1.04E-04 uCi/cc
RE-HV5107B IOD	N/A	1.18E-06 uCi/cc
RE-HV5107B GAS	N/A	2.35E-02 uCi/cc
RE-HV0100.1S PART	N/A	8.76E-06 uCi/cc
RE-HV0100.1S IOD	N/A	3.15E-07 uCi/cc
RE-HV0100.1S GAS	N/A	5.76E-03 uCi/cc
RE-HV0100.2S PART	N/A	8.76E-06 uCi/cc
RE-HV0100.2S IOD	N/A	3.15E-07 uCi/cc
RE-HV0100.2S GAS	N/A	5.76E-03 uCi/cc
RE-AE0001	N/A	0.254 uCi/cc
RE-WM6775	N/A	N/A
RE-WM6776	N/A	N/A
RE-CW1900	N/A	N/A
RE-WM6778	N/A	N/A
RE-WM0647	N/A	N/A
RE-HV6710A	N/A	N/A

DATA BASE FOR DISPLAY A - PARAMETER SUMMARY DISPLAY

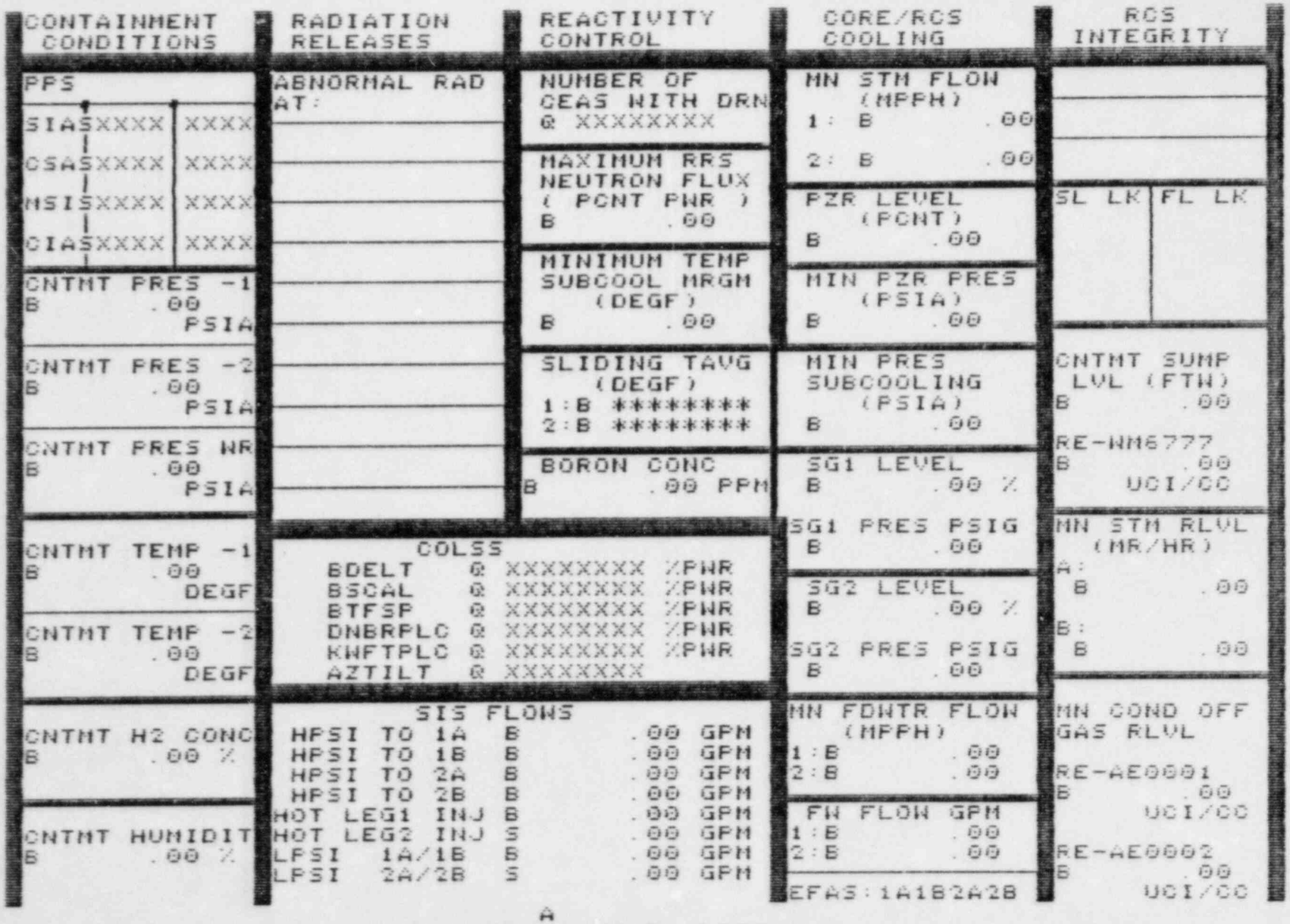
DESCRIPTION	SET POINT LO	SET POINT HI
RE-HV6710A IOD	N/A	N/A
RE-HV6710A GAS	N/A	N/A
RE-HV6710C PART	N/A	N/A
RE-HV6710C IOD	N/A	N/A
RE-HV6710C GAS	N/A	N/A
RE-HV6710B PART	N/A	N/A
RE-HV6710B IOD	N/A	N/A
RE-HV6710B GAS	N/A	N/A
RE-HV6710D IOD	N/A	N/A
RE-HV6710D	N/A	N/A
RE-WM0648	N/A	N/A
RE-WM6777	N/A	N/A
RE-CC7050AS	N/A	N/A
RE-CC7050BS	N/A	N/A
RE-CC5700	N/A	N/A
RE-CH0202	N/A	N/A
RE-BM0627	N/A	N/A
RE-HV3032 LO RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 MID RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 HI RNG	N/A	2.35E-02 uCi/cc
RE-HV3032 REL RATE	N/A	N/A
RE-AE0002 REL RATE	N/A	N/A
RE-HV5019	N/A	2.5 mR/HR
RE-HV5003	N/A	15 mR/HR
RE-HV5016	N/A	15 mR/HR
RE-HV5146 PART	N/A	N/A
RE-HV5146 IOD	N/A	N/A
RE-HV5146 GAS	N/A	N/A
AAA551 CCW PMP AREA	N/A	5E 04 mR/HR
AAA554 DSL GEN 3BS	N/A	5E 04 mR/HR
AAA556 DSL GEN 3AS	N/A	5E 04 mR/HR
RE-HV0200 1S RAD	N/A	2.5E-06 uCi/ml
RE-HV0200.2S RAD	N/A	2.5E-06 uCi/ml
RE-HV0200.5S RAD	N/A	2.5E-06 uC/ml
RE-HV0200.6S RAD	N/A	2.5E-06 uC/ml
RE-HV5001	N/A	2.5 mR/HR
RE-HV5002	N/A	15 mR/HR
RE-HV5009	N/A	15 mR/HR
AAA042 BORIC ACID	N/A	15 mR/HR
AAA043 PRE-CONC.	N/A	15 mR/HR
RE-HV5017A	N/A	100 mR/HR
RE-HV5023	N/A	100 mR/HR

DATA BASE FOR DISPLAY A - PARAMETER SUMMARY DISPLAY

DESCRIPTION	SET POINT LO	SET POINT HI
RE-HV5022A	N/A	100 mR/HR
AAA552 EFW PMP AREA	N/A	5E+04 mR/HR
RE-HV5007	N/A	2.5 mR/HR
RE-HV5020	N/A	100 mR/HR
AAA035 RAD CHEM LAB	N/A	2.5 mR/HR
RE-HV5022	N/A	15 mR/HR
RE-HV5005	N/A	100 mR/HR
AAA038 LTDN HX AREA	N/A	100 mR/HR
RE-HV5004	N/A	15 mR/HR
RE-HV5022C	N/A	100 mR/HR
AAA558 BM & WM CRL PNL	N/A	5E+04 mR/HR
RE-HV5027S	N/A	Later
RE-HV5026S	N/A	Later
RE-HV5030S	N/A	100 mR/HR
RE-HV5029S	N/A	100 mR/HR
RE-HV5023A	N/A	15 mR/HR
PII372 DECON RM IOD	N/A	Later
PIG373 DECON RM GAS	N/A	Later
PPP381 MACH SHOP PART	N/A	Later
PII382 MACH SHOP IOD	N/A	Later
PIG383 MACH SHOP GAS	N/A	Later
RE-HV5204	N/A	5E+04 mR/HR
PPP371 DECON RM PARTIC	N/A	Later
RE-HV5015	N/A	Later
RE-HV5013	N/A	Later
RE-HV5024S	N/A	Later
RE-HV5014	N/A	Later
RE-HV5025S	N/A	Later
RE-HV5028S	N/A	100 mR/HR
RE-HV5031S	N/A	100 mR/HR
RE-MS5500A	N/A	0.19 mR/HR
RE-MS5500B	N/A	0.19 mR/HR
RE-CA5400AS	N/A	5E+03 R/HR
RE-CA5400BS	N/A	5E+03 R/HR
RE-HV5018	N/A	Later
RE-CA0100S PART	N/A	Later
RE-CA0100S	N/A	Later
RE-CA0100 GAS	N/A	Later
AAA553 SIS SUMP PENET.	N/A	5E+04 mR/HR
AAA557 PRSNL AIR LOCK	N/A	5E+04 mR/HR

DATA BASE FOR DISPLAY A - PARAMETER SUMMARY DISPLAY

DESCRIPTION	SET POINT LO	SET POINT HI
SIS LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	1000 PSIG
SIS LEAK DETECTED	N/A	300 PSIG
SIS LEAK DETECTED	N/A	300 PSIG
CCW LEAK DETECTED	N/A	1E-04 uCi/cc
CCW LEAK DETECTED	N/A	1E-04 uCi/cc
CCW LEAK DETECTED	N/A	N/A
RE-AE0001	N/A	0.254 uCi/cc
RE-WM6777	N/A	N/A
1A: FLNG LEAK	NOT HIGH	HIGH
2A: FLNG LEAK	NOT HIGH	HIGH
1B: FLNG LEAK	NOT HIGH	HIGH
2B: FLNG LEAK	NOT HIGH	HIGH
CSAS CHNL-A	DETECTED	CLEARED
MSIS CHNL-A	DETECTED	CLEARED
CIAS CHNL-A	DETECTED	CLEARED
EFAS 1B	DETECTED	CLEARED
EFAS 2B	DETECTED	CLEARED
CSAS CHNL-B	DETECTED	CLEARED
CIAS CHNL-B	DETECTED	CLEARED
EFAS 1A	DETECTED	CLEARED
EFAS 2A	DETECTED	CLEARED
SIAS CHNL-A	DETECTED	CLEARED
RX HD FLNG LK	HIGH	NOT HIGH
HOT LEG 1 INJ	N/A	N/A
HOT LEG 2 INJ	N/A	N/A
LPSI -2A/2B	N/A	N/A
LPSI -1A/1B	N/A	N/A



A

PARAMETER SUMMARY DISPLAY

13:52:29 30MAR84

DATA BASE FOR DISPLAY AA - PARAMETER SUMMARY DISPLAY TRENDING

DESCRIPTION	SET POINT LO	SET POINT HI
SLIDING T-AVG CHNL #1	N/A	N/A
SLIDING T-AVG CHNL #2	N/A	N/A
KWPFPLC	N/A	N/A
BTFSP	N/A	N/A
BDELT	N/A	N/A
BSCAL	N/A	N/A
AZTILT (COLSS)	N/A	N/A
DNBRPLC	N/A	N/A
EFW FLOW RATE SG #1	N/A	N/A
EFW FLOW RATE SG#2	N/A	N/A
BORON CONCENTRATION	N/A	N/A
HPSI TO 1A	N/A	N/A
HPSI TO 1B	N/A	N/A
HPSI TO 2A	N/A	N/A
HPSI TO 2B	N/A	N/A
MN FD WTR FLOW (SG1)	N/A	N/A
MN FD WTR FLOW (SG2)	N/A	N/A
CNTMT H2 CONC	N/A	4 PCNT
MN CNDNSR RE-AE0002	N/A	N/A
AVG STM GEN #1 LVL	27 PCNT	87.7 PCNT
AVG SG#1 STM PRESS	813 PSIA	1020 PSIA
AVG STM GEN #2 LVL	27 PCNT	87.7 PCNT
AVG SG#2 STM PRESS	813 PSIA	1020 PSIA
PRESSURIZER LEVEL	26 PCNT	62.5 PCNT
CNTMT PRES -1	N/A	18.2 PSIA
CNTMT PRES -2	N/A	18.2 PSIA
CNTMT PRES WR	N/A	18.2 PSIA
CNTMT TEMP -2	N/A	120 DEGF
CNTMT HUMITIDY	N/A	N/A
SG#1 MN STM FLOW	N/A	N/A
MAX NEUTRON FLUX	N/A	N/A
CNTMT SUMP WATER LVL	N/A	N/A
MIN 6 SUBCOOL TEMPS	N/A	20 DEGF (SUB)
PRESSURIZER PRESS	1889 PSIA	2365 PSIA
MIN PRES MAR TO SAT	N/A	N/A
CNTMT TEMP -1	N/A	120 DEGF
MN CNDNSR RE-AE0001	N/A	0.254 uCi/cc
RE-WM6777 CNTMT SUMP	N/A	N/A
HOT LEG 1 INJ	N/A	N/A
HOT LEG 2 INJ	N/A	N/A
LPSI -2A/2B	N/A	N/A
LPSI -1A/1B	N/A	N/A
SG#2 MN STM FLOW	N/A	N/A

PRESSURE NARROW RNG-1	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	0	30
PRESSURE NARROW RNG-2	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	0	40
WIDE RNG	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	0	70
H2 CONC IN CNTMT	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	10
HUMIDITY	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	10	99
TEMPERATURE CHNL-1	@	XXXXXXXX	DEGF	@	XXXXXXXX	DEGF/MIN	0	450
TEMPERATURE CHNL-2	@	XXXXXXXX	DEGF	@	XXXXXXXX	DEGF/MIN	0	450
BDELT	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	200
BSCAL	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	200
BTFSP	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	200
DNBRPLC	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	200
KWPFPLC	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	200
AZTILT	@	XXXXXXXX	NONE	@	XXXXXXXX	NONE	-2	2
HPSI TO 1A	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	500
HPSI TO 1B	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	500
HPSI TO 2A	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	500
HPSI TO 2B	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	500
HOT LEG #1 INJ	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	500
HOT LEG #2 INJ	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	500
LPSI A TO 2A/2B	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	5000
LPSI B TO 1A/1B	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	5000
BORON CONCENTRATION	@	.00	PPM	@	XXXXXXXX	PPM/MIN	0	5000
MAX RRS NEUTRON FLUX	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	125
SLIDING T-AVG CHNL #1	@	.00	DEGF	@	XXXXXXXX	DEGF/MIN	525	625
SLIDING T-AVG CHNL #2	@	.00	DEGF	@	XXXXXXXX	DEGF/MIN	525	625
MIN 6 SUBCOOL TEMPS	@	XXXXXXXX	DEGF	@	XXXXXXXX	DEGF/MIN	200	-2100
SG #1 MN STM FLOW	@	XXXXXXXX	MPPH	@	XXXXXXXX	MPPH/MIN	0	8
SG #2 MN STM FLOW	@	XXXXXXXX	MPPH	@	XXXXXXXX	MPPH/MIN	0	8
PRESSURIZER LEVEL	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	100
PRESSURIZER PRESS	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	100	3000
MIN PRES MAR TO SATUR	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	500	-1200
AVG STM GEN #1 LVL	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	100
AVG SG#1 STEAM PRESS	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	0	1200
AVG STM GEN #2 LVL	@	XXXXXXXX	PCNT	@	XXXXXXXX	PCNT/MIN	0	100
AVG SG#2 STEAM PRESS	@	XXXXXXXX	PSIA	@	XXXXXXXX	PSIA/MIN	0	1200
MN FD WTR FLOW (SG1)	@	XXXXXXXX	MPPH	@	XXXXXXXX	MPPH/MIN	0	8
MN FD WTR FLOW (SG2)	@	XXXXXXXX	MPPH	@	XXXXXXXX	MPPH/MIN	0	8
EFW FLOW RATE SG#1	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	800
EFW FLOW RATE SG#2	@	.00	GPM	@	XXXXXXXX	GPM/MIN	0	800
CNTMT SUMP WATER LVL	@	XXXXXXXX	FTW	@	XXXXXXXX	FTW/MIN	0	30
RE-WM6777 CNTMT SUMP	@	.00	UC/CC	@	XXXXXXXX	UC/CC/M	1E-07	1E-01
MN CNDNSR RE-AE0001	@	.00	UC/CC	@	XXXXXXXX	UC/CC/M	1E-07	1E05
MN CNDNSR RE-AE0002	@	.00	UC/CC	@	XXXXXXXX	UC/CC/M	1E-11	1E05
RE-MS5500AS (MN STM 1)	@	.00	MR/HR	@	XXXXXXXX	MR/HR/M	1	1E05

AA

SUMMARY DISPLAY TRENDING

14:13:29 30MAR84

Section 6

RELIABILITY

6.1 PMC SYSTEM FAILOVER CAPABILITY

The hardware that constitutes the PMC make up two identical complexes, either of which are capable of being the "live" system. All external devices that interface to the "live" complex are in turn controlled by two peripheral switches that enable the external devices to be interfaced to either of the complexes.

Upon notification of a "live" system failure, all peripherals are switched to the "back-up" complex via the peripheral switch. The "back-up" complex software is then initialized. Once initialization is complete the "back-up" complex becomes the "live" complex. This allows maintenance technicians to isolate and correct the problem(s) with the failed complex. Upon correction of the problem the failed complex becomes the "back-up" complex which is then available to support the "live" complex.

6.2 AC & DC POWER DISTRIBUTION TO THE PMC

The AC&DC power distribution to the PMC is described in this section.

6.2.1 Waterford 3 480VAC Switchgear Bus Configuration

The PMC Power System is supplied by two redundant 480VAC switchgear busses by either normal station power, or the emergency diesel generators. The normal 480VAC bus feed supplies power to the Rectifier section of the solid state uninterruptible power supply (SUPS), while a bypass 480VAC bus feed is available to the Static Switch section of the SUPS.

6.2.2 Static Uninterruptible Power Supply (SUPS)

The SUPS is a solid state system that provides rectification of the AC power input to supply "float" or "recharge" voltage to the Battery Back-up and power for conversion back to AC by the Inverter section. The inverter changes the DC output of the rectifier or battery to AC power which meets load requirements. The inverter AC output is applied to the static switch as one of its two AC input sources. The SUPS Detector Assembly monitors various conditions within the SUPS system and generates certain control signals which affect the operation of the system. In addition, the detector assembly controls front panel alarm indicator operation and remote alarming indications. A SUPS remote indicator panel in the PMC computer room informs PMC Operators of the SUPS condition. The static switch selects either normal/battery or bypass power and applies the selected source to an adjacent power distribution panel. A manual bypass is also available in case of static switch maintenance or failure.

6.2.3 Battery Backup System

Under emergency conditions (loss of normal input power) the Battery Back-up System shall supply power for 30 minutes to maintain the load required. The Battery Back-up System consists of 180 lead calcium cells.

6.2.4 Power Distribution

The power distribution panel (PDP 387) supplies power circuits to the multiplexer computer cabinets, (-1) and (-3), throughout the plant and to PMC Computer Room distribution panels. AC strips in the multiplexer sensor cable termination cabinet, (-2), are connected to the (-1) and (-3) cabinet supplies. The dual triad (CPU-1, CPU-2, and CPU-3) receives SUPS power from the power distribution panels in the Computer Room. Each cabinet assembly of computer equipment distributes power by an AC distribution panel or AC strips, to the necessary units or power supplies.

6.2.5 Computer Equipment Power Supplies

A variety of power supplies are used throughout the computer equipment depending upon its application and load requirement. Most typical are three varieties that supply +/- 5VDC at 100 amps, +/- 5VDC at 7 amps, +/- 15VDC at 33 amps, and +/- 12 VDC at 4 amps. High frequency switching techniques are used in all three types of power supply to obtain small size and high efficiency. Composite assemblies feature reference and sense control rectification and filtering, high current switched transistor circuitry for Primary and Secondary output, current and voltage limit control, as well as over-temperature and over-voltage protection.

6.3 RELIABILITY OF COMPUTER COMPONENTS

Reliability studies of individual pieces of computer equipment power supplies are available from the vendor. Data provided here, of various configurations shows typical application and does not reflect total system implementation:

Model	Configuration	MTBF (HRS)	MTTR (HRS)
2190	Logic Power Supply	23,000	1.00
2191	Memory Power Supply	20,000	1.00
2195	AC Distribution Panel	71,426	0.50
9305	GPDC & Power Supplies	20,619	0.80
2332	Memory Carriage & Power Supplies	9,542	0.75
2395	MOS Memory Support Package	6,092	1.00

Where:

MTBF is Mean Time Between Failures

MTTR is Mean Time To Repair

GPDC is General Purpose Device Controller

Section 7

HUMAN FACTORS ENGINEERING

7.1 PMC HUMAN FACTORS REVIEW

LP&L has performed a human factors review of the PMC. The review results deemed appropriate, along with changes suggested through operational experience, are being incorporated into revisions to the SPDS.

7.1.1 Objectives

The objective of this human factors review was to determine to what degree the Waterford 3 PMC, including the SPDS function, conforms to good human factors practices.

7.1.2 Scope

The scope of this review includes the PMC, SPDS display formats, and power plant SPDS user stations.

7.1.3 Human Factors Criteria

The criteria that was used in this review includes the following:

7.1.3.1 Software Security

- Authorization for data base changes
- Secure storage of software
- Editing
- Acknowledgment of data base changes

7.1.3.2 User/Computer Dialogue

- Language characteristics
- Entry length
- Abbreviation usage
- Error avoidance

7.1.3.3 Prompting and Structuring

- Operator requests for additional information
- Prompts to assist in correction of data
- Display of mode and time
- Correction of specific errors
- Sequential entry file usage

7.1.3.4 Data Entry Keyboards

- o Alphanumeric keyboard arrangement
- o Numeric keyboard arrangement
- o Use of multiple keyboards
- o Key measurements
- o Key displacement and resistance
- o Positive indication
- o Keyboard slope
- o Visual feedback
- o Relevant keys

7.1.3.5 Computer Function Controls

- o Control design
- o Labeling and nomenclature
- o Master control
- o Function controls (grouping, consistency of layout, etc.)

7.1.3.6 Other Control Devices

- o Location
- o Speed of use
- o Accuracy
- o Displacement

7.1.3.7 Computer Response Time to Operator Queries

- o Maximum response times
- o Response delay messages

7.1.3.8 Access Aids

- o Computer system procedures
- o Data point indices

7.1.3.9 CRT Display Characteristics

- o Readability
- o Glare
- o Screen luminescence
- o Geometric distortion
- o Resolution
- o Regeneration rate
- o CRT display controls

7.1.3.10 Symbols and Characters

- o Size
- o Character width-to-height ratio
- o Stroke width-to-size ratio
- o Graphic lines
- o Character and symbol separation
- o Character style (font)

7.1.3.11 Operator-Display Relationships

- o Viewing distance
- o Viewing angle
- o Screen location
- o Mounting in consoles
- o Visibility of data

7.1.3.12 Data Presentation Format

- o Usability of data
- o Illustration usage
- o Character groupings
- o Maintenance of ordering of data
- o Presentation of Identical Data
- o Menu designator usage
- o List alignment, justification
- o Table and graph usage
- o Hyphenation usage
- o Alignment of data
- o Period usage
- o Standardized field design
- o Data group listing
- o Label placement
- o Label orientation
- o Option label content

7.1.3.13 Screen Layout and Structuring

- o Organization of data
- o Location of data groups
- o Demarcation of data subgroups
- o Frequency of use ranking
- o Alphanumeric ranking
- o Separation of paragraphs
- o Selection designators
- o Page designation
- o Continuous numbering
- o Placement of instructions
- o Urgent message location, highlighting
- o Use of cursor
- o Screen loading
- o Trend plot scale division

7.1.3.14 Messages

- Content
- Use of prompts
- Content of prompts
- Prompt information sequence
- Use of error messages
- Error correction guidance
- Error correction ease
- System status feedback
- Selection feedback
- Delay feedback
- Activity completion feedback

7.1.3.15 Graphic Coding and Highlighting

- Consistency
- Contrast enhancement
- Flicker or blinking
- Inverse video
- Geometric shape coding
- Number of symbols
- Use of color (meanings, consistency)

7.1.3.16 Multiple-page Considerations

- Operator memory requirements
- Location references
- Operator control
- Location consistency

7.1.3.17 Printer characteristics

- Usage
- Capability to copy display
- Form of printed information
- Printer speed
- Operation (paper type, recording instructions, etc.)
- Printer accessibility

7.1.3.18 Alarm Messages

- Records of alarms
- Alarm sequence
- Operator-requested printout capability
- Alarm identification
- Alarm discrimination
- Consistent terminology

7.2 PRINCIPLES EMPLOYED DURING THE DEVELOPMENT OF SPDS DISPLAYS

7.2.1 Basic Concept of SPDS Displays

The SPDS displays were developed at the conclusion of a study of the Waterford 3 FSAR, and Generic Emergency Operating Procedure Guidelines CEN-152, Revision 1. These two documents discussed in detail the parameters used to decide what type of systems and functions must be performed for the safety of the power plant. The PMC has many data values which provide for the monitoring of these FSAR, CEN-152 topics. In fact, the number of data base values available to describe the safety functions were so numerous that it was necessary to implement software to summarize them.

The displays were designed to provide the operator the information specified in the FSAR and CEN-152, Revision 1 in the simplest, most efficient manner. This normally resulted in several displays under the heading of one of the five safety parameter.

A single Parameter Summary display highlighted information provided specifically for each of the five safety parameters.

Companion displays were provided for each principle display to summarize alarm limit and data trend information.

During the development of the first draft of the displays, Plant Staff, Training, and Licensing were solicited to review individual safety parameter studies as they were completed. The first draft of the PMC SPDS Functions Engineering Report was a compilation of these comments received and the FSAR/CEN-152 studies.

7.2.2 Display Design Review

Following the first draft of the displays an independent review was performed on the adequacy of the data base values selected versus industry guidance (NUREG-0700, NUREG-0696, NUREG-0737 Supplement 1, NUREG-0835, et. al.)

Secondly, the power plant operators were invited to review and modify the proposed screens, with the only restriction that no parameter data be deleted in the final version of the display set. This resulted in the expansion of the number of displays to the present multiple-page per safety function format.

Comments received from these two reviews were incorporated in the second draft of the PMC SPDS Function Report. A third revision resulted from reviews done in conjunction with the development of test procedures and SPDS Calculation Software development. These comments were made with respect to inconsistencies between data base point information, data base value selection, data missing from the displays, and display descriptions omitted from the SPDS Functions Report. The corrections resulted in the present version of the PMC SPDS Functions Engineering Report used as input to this report. It should be noted that as SPDS testing and human factors reviews are completed, additional document revisions are expected.

Section 8

VALIDATION AND VERIFICATION

8.1 DESIGN, MANUFACTURING, AND INSTALLATION

The SPDS Functions were designed with extensive documentation with respect to parameter selection and display/report construction. Development of the design report was done with technical input from engineers, computer systems analysts, trainers, and power plant operators. SPDS Calculation software was documented in accordance with Waterford 3 Plant Staff procedures. The remaining software packages were documented by vendor procedures coordinated with LP&L.

8.1.1 Verification

The SPDS Function Design Report written for LP&L was reviewed and commented on throughout its development. Reviews were done by Plant Staff, Training, Licensing, Operations, and other Computer Group staffers not directly involved in the production of the report. All comments received from reviewers were analyzed by the design team for technical merit. Those comments incorporated were found to affect the accuracy and clarity of the final product.

8.1.2 Module Validation

8.1.2.1 SPDS Algorithms

RTM, MPX, PRXCOMM, CYCLIC, QSPDS Communications, RADMON Communications, CE NUCLEAR EXECUTIVE et. al., ERF, and CGS were accepted separately for operation by LP&L after the vendor performed stand alone Factory Acceptance Tests. Factory Acceptance Tests verify that the software performs the major functions specified for the individual software systems. Major functions include sending messages to the Alarm CRT, process branching, reading/writing to/from the PMC data base, and correctly resolving algorithms specified by vendor functional requirement specification.

SPDS Calculation Software is developed and tested internally according to established plant procedures.

An independent group was established to develop software test procedures, including those to exercise the SPDS Functions. The test engineer for the SPDS Functions independently reviewed and commented on the SPDS Functions documention. All issues were resolved to the test engineer's satisfaction. The test engineer independently established criteria to test, and processing paths to exercise. The SPDS Functions test is incorporated into a larger test of all of the PMC System's software.

Software exists for the test engineer to artificially provide input and record output of algorithms of interest via the PMC data base. Print-outs and xerographical copies of displays provide hardcopy documentation of PMC System output (displays and reports).

8.1.2.2 SPDS Displays

Three basic dynamic functions were incorporated in various combinations to create SPDS Displays. PMC data base values, in any form (bar graphs, numerical, or conditional messages) are updated from the PMC data base. Each value is shown with static labels and engineering units. Conditional messages appear on some displays which summarize several alert states/levels of PMC data base values. Lastly, bar graph type displays are presented to visually aid the SPDS user in relating the parameter value to its measurement range.

All three display dynamic functions are tested by artificially stimulating the PMC data base and observing the results on the SPDS Displays.

The reports printed on hardcopy have a single format with varying content. The content of reports can be artificially set by the same method used for the SPDS Display tests.

8.1.2.2.1 Verify that each Display has been Implemented as Designed

A major function of the SPDS Functions test is to verify that the displays shown by the CGS are those designated by the SPDS Functions Final Report being maintained by LP&L Nuclear Records.

8.1.2.3 SPDS Applications Software

All software is tested and verified independently of the SPDS Function definition project.

The test upon the SPDS Displays and Reports involves the integrated operation of PRXCOMM, CYCLIC, QSPDS Communications, RADMON Communications, ERF, CE NUCLEAR EXECUTIVE, SPDS Calculation Software, and CGS. This integration overlaps testing done on the individual software during Factory Acceptance Testing.

Test cases to simulate FSAR Chapter 15 studied accidents are under development. Parameters discussed in FSAR Chapter 15 have corresponding locations in the PMC data base. Therefore, these PMC data base entries can be artificially manipulated to simulate the course of accidents.

8.1.2.3.1 Verify that QSPDS data in the PMC is Being Updated by New Data from QSPDS

Several PMC data base values being updated by QSPDS Communications are displayed and reported directly by SPDS Functions. Value refreshment is verified during SPDS Functions testing.

8.1.2.3.2 Verify that RMS data in the PMC is Being Updated by New Data from RMS

Several PMC data base values being updated by RADMON Communications are displayed and reported directly by SPDS Functions. Value refreshment will be verified during SPDS Functions testing.

8.1.2.3.3 Retrieve Data Stored on Magnetic Tape

The ERF program function to retrieve data from magnetic tape and enter it into the historical data base being maintained by ERF was tested.

8.1.2.3.4 Store/Save Data onto Magnetic Tape

The ERF program function to archive data onto magnetic tape from the historical data base being maintained by ERF was tested.

8.1.2.4 SPDS Data Acquisition Software

Each external instrument feed to the remote data acquisition computers is calibrated via I&C plant procedures from the instrument to the read-out on the PMC displays (either CRTs or HERCO Displays) and control board meters. This includes instrument signal, analog to digital conversion, message retrieval from the remote data acquisition computers, and correct conversion by CYCLIC into Engineering Units.

8.1.3 System Validation

Each software package implemented on the PMC had a factory acceptance test performed by the vendor and witnessed by LP&L. These tests were augmented by the preoperational test series performed on the PMC to demonstrate the integrated functioning of the PMC. All test procedures were developed completely independent of the functional design phases and the software development phases.

Procedures are established which control the data base points. Each individual Data Base input was reviewed and verified for correctness. In addition, an independent group (made up of operators and engineers) reviewed each data base point.

8.1.3.1 Individual hardware Diagnostic Test

Preoperational Test SFG-15-100 embodies PMC hardware testing.

8.1.3.1.1 Verify that each HERCO/SPDS Station is Operable

Preoperational test SPO-15-102 demonstrates this capacity.

8.1.3.2 Program Development and Modification Test

Preoperational Test SPO-15-100 established the base line PMC System software on which all further system development is based.

8.1.3.3 Static End to End Data Test

Each field input to the PMC is separately and regularly calibrated to be functioning correctly in accordance with plant procedures.

8.1.3.4 Dynamic Performance Simulation Test

Test Cases are under development to simulate the changes that would occur in data base values with respect to various plant transients. Reactor operators will be involved during the exercise of these test cases to confirm the capability of the SPDS to provide the operator with information sufficient to meet the intent of NUREG 0737, Supplement 1.

8.1.3.4.1 Verify Calculations (AVG, Rate-of-Change, etc.) are Being Performed

SPO-15-102 demonstrates that SPDS Calculation Software is providing correct data to the PMC Data Base, via the SPDS Displays provided through the CGS System.

8.1.3.4.2 Add and Delete Point IDs During Normal and Post-Trip Conditions

The ERF is tested to be able to add and delete point ID information being retained in the Historical Data Base.

8.1.3.4.3 Change Quality and Verify that the New Quality is Displayed

A test program is used to insert various quality tags to verify that the CGS displays the current quality in the PMC data base.

8.1.3.4.4 Verify that RCS Conditional Messages Appear on the Proper Trigger

The point ID which triggers conditional messages to SPDS displays are set and noted to result in the correct message.

8.1.3.5 Man-Machine Interface Test

SPO-15-102 tests the functionality of the HERCO Console ERF menus, and the AYDIN keyboards.

8.1.3.5.1 Print Reports on Each SPDS Related Printer

ERF is tested to produce reports specified at PMC initiation time at each available printer. (NOTE: ERF was completely tested as part of the SPO-15-101 test.)

8.1.3.5.2 Print all Reports

Each report is printed during SPO-15-102 to verify that the data base values reported match the data base values specified for the report.

8.1.3.6 Fault Simulation and Recovery Test

The PMC hardware has been designed and used in a prime and backup configuration. PMC operating procedures are in place to enable the back-up CPU triad to become the primary in a timely manner.

8.1.3.7 Timing Study Demonstration

Preoperational testing demonstrates that the SPDS and other functions added since SPO-15-100 do not degrade the basic functions of the PMC. A timing study of the application software is performed in the SPO-15-101 and SPO-15-102 tests.

8.2 VALIDATION AND VERIFICATION - SYSTEM INTEGRATION

8.2.1 Objective

The PMC System will be tested to determine that all of the system components interface and work together to perform the intended functions of the PMC. The test involves using the displays and reports produced by the PMC in the Control Room, TSC, EOF, and BEOF.

8.2.2 System Definition

The system encompasses equipment and software used to perform remote data acquisition, data conversion, presentation, and analytical calculations.

8.2.3 Methodology

The PMC complex, operating on live plant data, will be interacted with to verify preoperational test procedure steps. Data base point IDs will be stimulated to verify correct system response.

Section 9

COMPARISON OF THE WATERFORD 3 SPDS WITH THE REQUIREMENTS OF NUREG 0737 SUPPLEMENT 1

NUREG 0737, Supplement 1 describes the regulatory requirements for implementation of an SPDS. This section addresses each of the SPDS requirements, summarizing LP&L's compliance.

9.1 Requirement

"The SPDS should provide a concise display ..."

Response

The SPDS parameters are grouped and displayed to present the status of the critical safety functions. Where appropriate, display patterns and enhancements are utilized to facilitate viewer integration and understanding of the information presented. All SPDS displays (i.e. "pages" or "mimics") are available for viewing at each SPDS terminal. The SPDS displays are described in detail in Section 5 of this report.

9.2 Requirement

"The SPDS should provide a concise display of critical plant variables ..."

Response

A minimum set of SPDS parameters is defined in Section 4. This minimum set of parameters, when organized by safety function, is sufficient to assess the plant safety status for a wide range of events, including severe accident symptoms. Supplementary parameters, grouped by safety function, are available to the operator in lower level displays.

9.3 Requirement

"The SPDS should provide a concise display of critical plant variables to control room operators to aid them in rapidly and reliably determining the safety status of the plant."

Response

Implicit in this requirement is that the SPDS reflect the current plant status with negligible delay from sensor input to display. As described in Section 2 the SPDS parameters are sampled periodically by the PMC. The parameters are converted to engineering units every 1-60 seconds. Upon operator request for a particular SPDS display, such display will normally be generated within 5 seconds. This arrangement ensures that the operator is dealing with current information.

Accuracy of displayed information is of prime importance to the operator in reliably determining plant safety status. Section 3.0 of this report explains the PMC software capability in evaluating accuracy of the sensor inputs. Briefly, all information in the PMC data base is tagged as to reliability. "Bad" data will be dropped from SPDS averaging routines and

will not be displayed to the operator. Should no reliable input be available for a particular parameter a series of asterisks (*) will be substituted in the SPDS display. In this manner, the operator will not be misled by incorrect data.

The breadth of data available to the operator is sufficiently large to encompass a wide range of events, including symptoms of severe accidents. The minimum SPDS parameter set was developed from a review of the CE Emergency Procedure Guidelines (CEN-152) and the Chapter 15 analyses in Waterford's FSAR.

An inoperable SPDS will be easily identified within a short period of time. Upon failure of the SPDS/PMC either the displayed time will stop updating (and parameter values remain constant) or the screen will go blank. At the same time, the control room annunciator will announce a PMC failure.

Finally, to verify the functional qualification of the SPDS, a series of test cases will be performed on the SPDS as described in Section 8. Operators will participate during this testing to ensure that the safety status of the plant may be rapidly and reliably assessed with the SPDS.

9.4 Requirement

"Although the SPDS will be operated during normal operations as well as during abnormal conditions, the principal purpose and function of the SPDS is to aid the control room personnel during abnormal and emergency conditions in determining the safety status of the plant in assessing whether abnormal conditions warrant corrective actions by operators to avoid a degraded core."

Response

To aid control room personnel in evaluating plant safety status the Waterford SPDS will present the magnitude and trend of displayed parameters. For each SPDS display there exists a related display, as described in Section 5, containing:

1. a parameter's value in engineering units,
2. the rate of change of that value, and
3. a bar graph illustrating the value's magnitude or deviation from normal.

The time derivative is intended for operator use in conjunction with the bar graph. While the time derivative alone could provide ambiguous information for oscillating variables, the bar graph, as its length changes, will provide the sense of the overall trend with the time derivative supplying the magnitude of the rate of change.

To aid the operator in the detection of abnormal conditions visual cues are provided. These consist of color changes to the parameter values and bar charts as described in Section 3.

9.5 Requirement

"Each operating reactor shall be provided with a Safety Parameter Display System that is located convenient to the control room operators."

Response

As described in Section 2 of this report, the SPDS displays are located at the operators consoles, separate from the main control panels. This central location affords convenient access to all control room personnel including the operators, shift supervisor and STA.

9.6 Requirement

"This system will continuously display information ..."

Response

The SPDS displays consist of a summary display and lower level displays as described in Section 5. Movement from display to display is under operator control at all times. Because two SPDS displays are provided in the control room the operator has the flexibility of maintaining the summary display on one screen while accessing the supplementary displays on the other screen for more detailed information.

9.7 Requirement

"The SPDS shall be suitably isolated from electrical or electronic interference with equipment and sensors that are in use for safety systems."

Response

The SPDS receives all its input from the Plant Monitoring Computer (PMC), a non-safety related system. The PMC, as described in Section 2 is suitably isolated from safety-related equipment and sensors.

9.8 Requirement

"Procedures which describe the timely and correct safety status assessment when the SPDS is and is not available, will be developed by the licensee in parallel with the SPDS. Furthermore, operators should be trained to respond to accident conditions both with and without the SPDS available."

Response

The Waterford 3 emergency operating procedures do not specifically address the use of the SPDS anymore than they would designate which of several instrumentation readings should be consulted to obtain a particular piece of information. The operators are trained in all information resources available to them, including the SPDS. Specifically, the operator training program contains instructions and training in the use of the SPDS within the framework of normal, off-normal and emergency operating conditions. As additional assistance an SPDS User's Manual will be available for reference in the control room.

9.9 Requirement

"The SPDS shall be designed to incorporate accepted human factors principles ..."

Response

During design of the SPDS, the displays and parameters selected for display were reviewed by a wide range of Waterford 3 personnel including Operations, Training, and Plant Staff. This continuous review resulted in a number of changes to the display format to accommodate operational considerations. The integrated human factors review will be conducted as described in Section 7 of this report.

9.10 Requirement

"The SPDS display shall be designed to incorporate accepted human factors principles so that the displayed information can be readily perceived and comprehended by SPDS users."

Response

Care has been taken to present SPDS information in a patterned manner so as to facilitate communication of data from the displays (see Section 5). Parameters, where appropriate, are displayed on representations of the physical plant layout. Bar charts and color coding, as mentioned previously, are used to indicate approach to unsafe operating conditions and provide visual alarming capabilities. The ability of the operator to readily perceive and assimilate the displayed information will be further confirmed during the verification and validation phase (Section 8) of SPDS development.

9.11 Requirement

"The minimum information to be provided shall be sufficient to provide information to plant operators about:

(i) Reactivity control

(ii) Reactor core cooling and heat removal from the primary system

(iii) Reactor coolant system integrity

(iv) Radioactivity control

(v) Containment conditions

The specific parameter to be displayed shall be determined by the licensee."

Response

The SPDS parameters are grouped into displays reflecting the five critical safety functions of NUREG 0737, Supplement 1. The individual displays, and the minimal set of SPDS parameters necessary to assess plant safety status are discussed in Sections 5 and 4, respectively.

The formats of SPDS displays are constant regardless of the mode of plant operation. Sufficient information is presented for each safety function to allow the operator to identify plant safety status. Additionally, the operators will be trained in the use and interpretation of the SPDS under normal, off-normal and emergency conditions.

NS20076