REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

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VARGA,S.A. Operating Reactors Branch 1

SUBJECT: Submits results of NUS survey of toxic chemical shipments in facility vicinity,per TMI Action Item III.D.3.4 re control room habitablity.Chemicals shipped near facility do not present toxic hazard to control room.

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Director of Nuclear Reactor Regulation
Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
CONTROL ROOM HABITABILITY, NUREG-0737, ITEM III.D.3.4

Dear Mr. Varga:

SUMMARY

Earlier correspondence (June 2, 1983 and February 7, 1984) discussed Carolina Power & Light Company (CP&L) plans for a survey of toxic chemical shipments in the vicinity of H. B. Robinson Steam Electric Plant, Unit No. 2 (HBR2). This survey was performed to assess the need to provide gas detectors and associated Technical Specifications for the Control Room.

DETAILS

The survey was performed by NUS Corporation. The methodology employed consisted of a roadside survey to identify chemical shipments along South Carolina Highway 151, the only major commercial artery within five miles of HBR2, and contacts with state and local officials and representatives of local industries and chemical companies. Identified bulk chemical shipments were evaluated per Regulatory Guide 1.78 to determine whether toxicity limits were reached at the air intake plenum for the Control Room.

Chemicals identified as passing the plant in bulk shipments were gasoline, sodium hydroxide solution, #6 crude oil, cutting oils, isopropyl alcohol, acetone, liquid nitrogen, LNG, LPG, sulfuric acid, and petroleum naphtha. The cutting oils and #6 crude oil are not volatile under the postulated release conditions and liquid nitrogen, LNG, and LPG are classified as simple asphyxiants and need not be evaluated per Regulatory Guide 1.78. Also, sulfuric acid and sodium hydroxide do not reach a vapor pressure of 1 torr until they reach a temperature of 295°F and 1362°F, respectively, and were therefore excluded from further evaluation. Various other chemicals were identified as being shipped locally in small quantities; a 150 lb. chlorine gas bottle rupture was analyzed as representative of these small-quantity shipments. The results of the evaluation are summarized below.

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Chemical	Amount Released	Intake Concentration (mg/m^3)	Control Room Concentration (mg/m^3)	Toxicity Limit (mg/m^3)
Gasoline	10,000 gal.	695.4	--	3,200
Acetone	10,000 gal.	11,210	3,577	4,800
Isopropyl Alcohol	10,000 gal.	1,569	708.3	980
Petroleum Naphtha	10,000 gal.	752.4	--	2,000
Chlorine	150 lb.	f(t)*	11.94	45

* This is a function of time for an instantaneous or puff type release.

CONCLUSION

Chemicals identified as being shipped near HBR2 are found not to present a toxic hazard to the Control Room. Therefore, toxic gas instrumentation and associated Technical Specifications discussed in NUREG-0737, Item III.D.3.4 are not necessary at HBR2.

Any questions your staff may have regarding this subject should be referred to Mr. Stephen D. Floyd at (919) 836-6901.

Yours very truly,

S. D. Floyd for

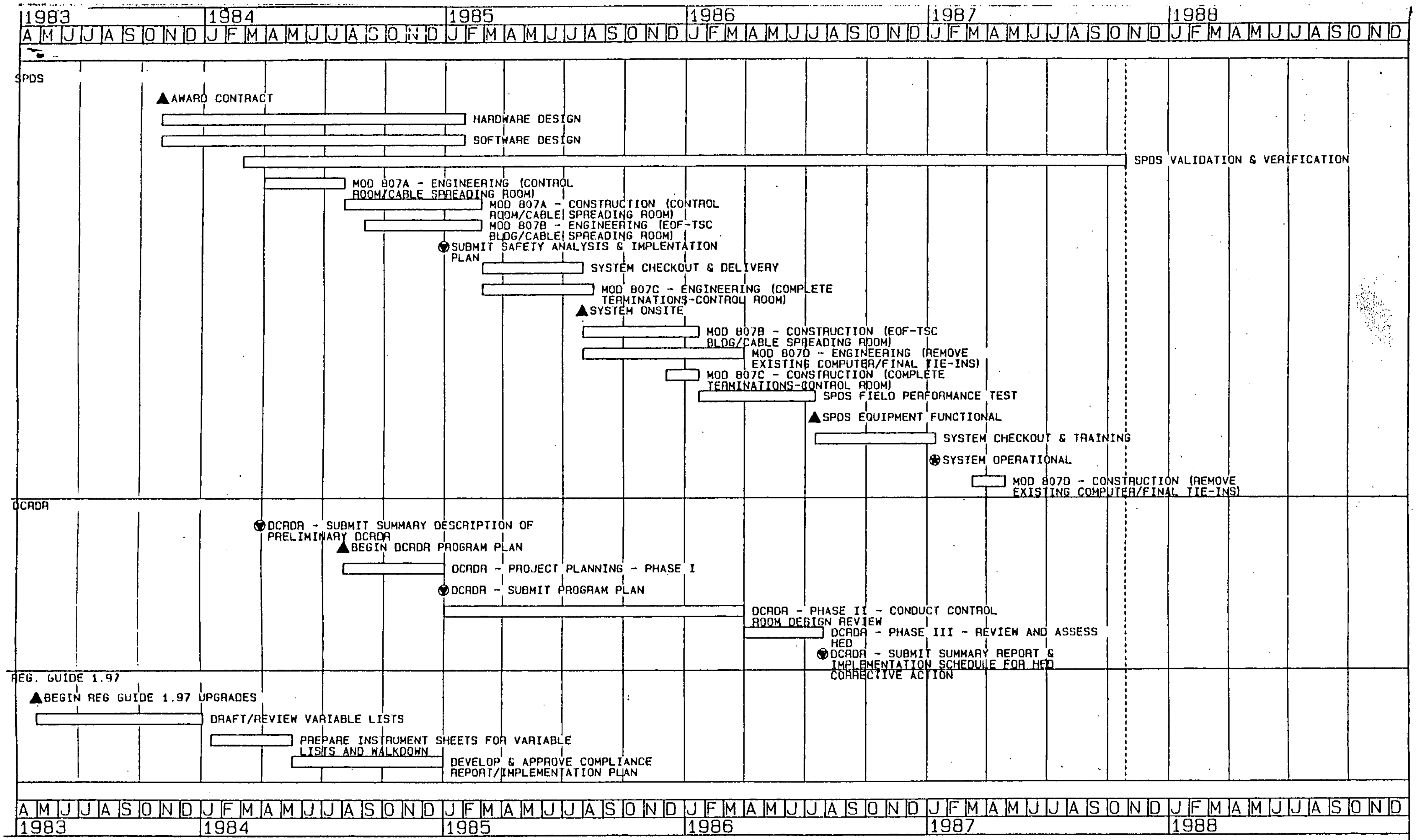
S. R. Zimmerman
Manager
Nuclear Licensing Section

JSK/ccc (895JSK)

cc: Mr. J. P. O'Reilly (NRC-RII)
Mr. G. Requa (NRC)
Mr. H. Krug (NRC Resident Inspector - RNP)

NUREG-0737 SUPPLEMENT 1

LEVEL 1 COMPLIANCE SCHEDULE

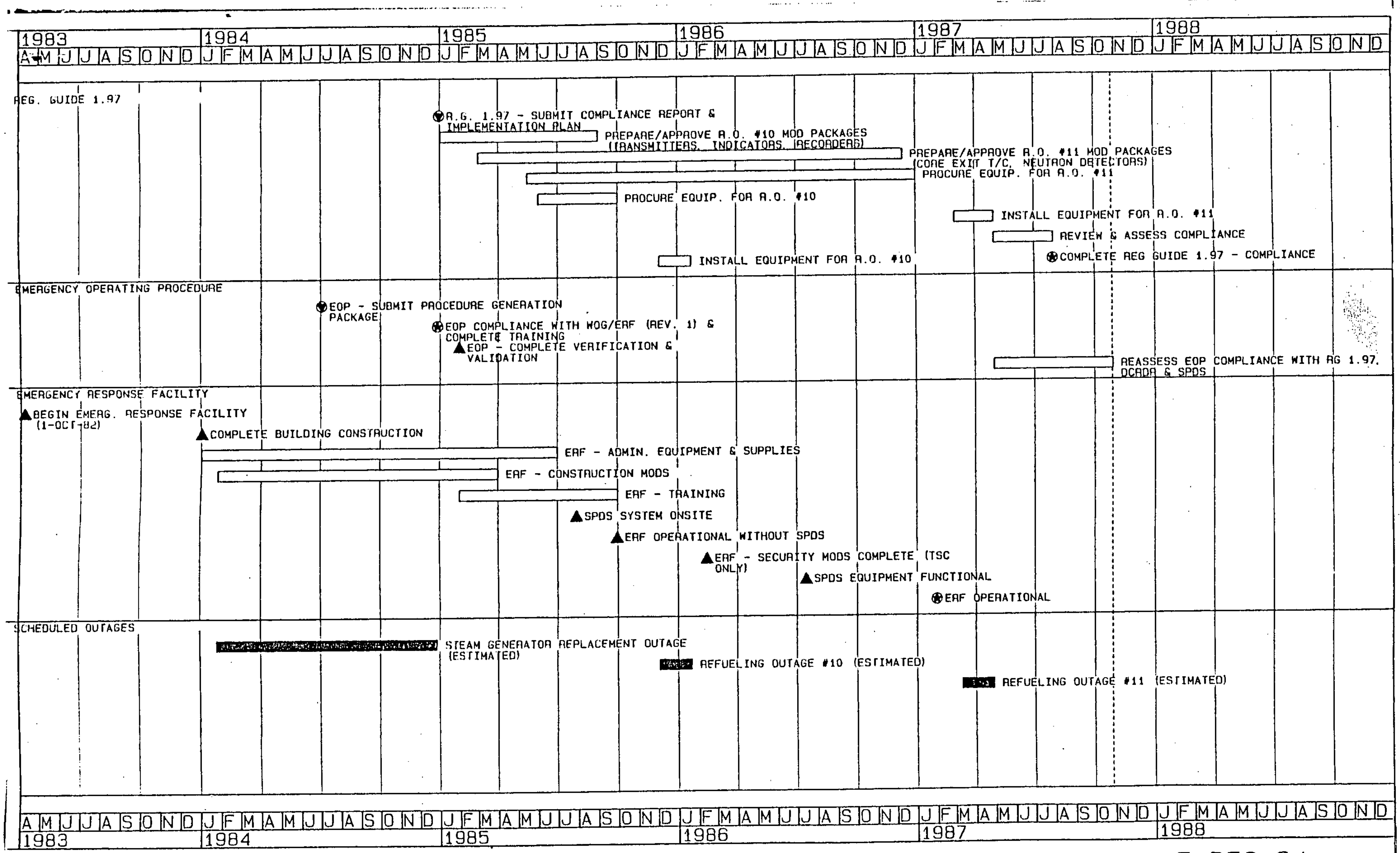


EMERGENCY RESPONSE CAPABILITIES LEVEL I SCHEDULE - REV. 0 AS OF 17-DEC-84

CAROLINA POWER & LIGHT COMPANY
H.B. ROBINSON DEPARTMENT

PROJECTED SCHEDULE

NOTE: REFUELING OUTAGES HAVE 7 WEEKS DURATION FOR PHYSICAL WORK. CONTINGENCY TIME MAY BE APPLIED FOR GRID OPERATIONS PURPOSES ONLY.



EMERGENCY RESPONSE CAPABILITIES LEVEL I SCHEDULE - REV. 0 AS OF 17-DEC-84

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H.B. ROBINSON DEPARTMENT

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IMPLEMENTATION PLAN FOR HBR-2

SPDS/ERFIS

I. INTRODUCTION

This document describes the salient features of the system and the plan for implementation as it is known at the time of this writing. In the context used here, implementation refers to the SPDS/ERFIS system as a "stand-alone" system and does not encompass the broader aspects of control room design reviews, EOPs, etc., involved in an "integrated" implementation plan. It should be understood that for a project of this complexity, many changes in system features and in implementation details are sure to occur as work progresses. It is expected that these changes will not alter the important characteristics of the system nor cause major changes in the implementation process, but this cannot be guaranteed.

The system is to be a near duplicate of a system bought from the same vendor, Science Applications International Corporation (SAIC), for our Shearon Harris Plant. It is to be a computer based system that integrates the SPDS, ERFIS and plant process computer functions into a single system. The inclusion of the plant process computer function (replacement of the existing Westinghouse PRODAC-250 (P-250) System) will have a minimal effect on the schedule for implementation of the other two functions. The existing inputs to the P-250 will be paralleled (through use of special connectors) to new temporary multiplexers in a manner which will minimize, if not eliminate, any associated schedule delays.

Work is to be accomplished through four separate plant modifications, three of which require a plant outage and one of those comes after the system is fully operational.

The remainder of this submittal consists of a general description of the system and a presentation of the implementation schedule.

II. GENERAL SYSTEM DESCRIPTION

The Emergency Response Facility Information System (ERFIS) is an information gathering, analysis and display system. It acquires analog and digital inputs from field sensors and other plant systems. It monitors systems throughout the plant and processes, displays, and logs these with the intent of improving the decision-making process in the event of an incident, as well as supporting routine plant operation.

The ERFIS displays its information in the Control Room, Technical Support Center, and Emergency Operations Facility.

Data processed by the ERFIS originates from the field sensors and is pre-processed through the Computer Products Data Concentrator prior to its transfer into the host computer. In addition, the ERFIS may be required to receive and transmit data to/from other computer systems outside the ERFIS. For example, when a Meteorological Computer (MET) interface is desired, a data link is provided between the computers.

The Safety Parameter Display System is a subset of ERFIS, providing operational and emergency stations with the overall status of critical safety functions. The ERFIS performs additional functions relative to long-term monitoring of potential post-accident parameters. When initially operable for SPDS support, all of the ERFIS parameters beyond SPDS may not be functional.

The ERFIS computer system consists of two mainframe CPUs. One CPU is referred to as the primary computer and the other as the backup computer. The primary computer is responsible for data acquisition and processing for the ERFIS. The backup computer serves as a "backup" to achieve the high availability

required. In the event of a failure of the primary computer, a switchover occurs automatically to the backup computer and the latter becomes the new Primary computer.

A more complete description is provided in the attached Systems Overview Document.

II.A. ERFIS Hardware

The ERFIS consists of three major hardware sections:

1. Data Acquisition System Hardware.

2. Computer System Hardware.

3. Display System Hardware.

The Data Acquisition Hardware includes the remote multiplexer cabinets (1E and non-1E), fiber optic communication links and Data Concentrators. This hardware is provided by Computer Products, Inc. The computer system hardware is configured around two Gould SEL Model 32/6780 computers. The display hardware is based around Model 2312 color graphics display terminals supplied by Industrial Data Terminals (IDT).

II.A.1 Data Acquisition System Hardware

The Data Acquisition Hardware (Phase I) will initially consist of five remote multiplexers in the Cable Spreading Room of the Robinson plant. Up to two additional remote multiplexers may be installed during Phase IV of the upgrade. In addition, redundant Data Concentrators are located in the Computer Room.

Each remote multiplexer consists of a multiplexer cabinet containing:

1. The termination interface for the analog/digital field wiring inputs or cable inputs from the existing Westinghouse P-250 I/O cabinets.

2. The electronics for signal conditioning, scanning, and digitizing of the input signals.

3. The communications and control equipment for each location.

The Data Concentrator is a high performance microprocessor system which receives, decodes, and buffers the data collected from up to 10 data links to remote multiplexers and makes it available to host computers. Two Data Concentrators are provided for redundancy and each Data Concentrator communicates with each remote multiplexer via a high speed fiber optic link.

Where required, by reliability, to maintain separation between Train "A" and Train "B" signals at a location, two dual data links are provided.

II.A.2 Computer System Hardware

The Computer System consists of two Gould SEL 32/6780 computers which are configured with an interprocessor link, dual-ported 675-MB data disk units, two 160-MB system disks (one dedicated to each CPU), a peripheral switch and a variety of peripherals. The system is configured to support failover to backup units for all critical hardware to provide maximum availability for the ERFIS.

The SEL 32/6780 Computer is a high-speed general purpose, digital computer specifically designed for data acquisition and real-time applications. The SEL 32/6780 consists of a standard CPU and also contains an additional Internal Processing Unit (IPU). The IPU has the capability to perform CPU functions in parallel with the CPU except that it does not perform I/O operations, system services and interrupt instructions.

The SEL 32/6780 has a large instruction set that includes fixed and floating-point arithmetic instructions. A special look-ahead feature enables the CPU to overlap instruction execution with memory accessing. This feature reduces program execution time. The SEL 32/6780 can be configured with up to 16 MB of physical memory.

Communication between the major elements of the SEL 32/6780 is via the SELBUS. This bus is a 184-line bidirectional bus that sends and receives data between the CPU, the memory subsystem, the disc, I/O subsystem, etc., on 32 data lines at a continuous data rate of 26.67 million bytes per second. Twenty-four lines are used for addressing purposes for the subsystem to perform, read, or write operations. Both data and address lines operate concurrently with the transfers occurring every 150 nanoseconds.

This equipment is to be located in the Computer Room in the TSC/EOF Building.

II.A.3 Display System Hardware

The Display Subsystem consists of 12 color graphic display units, Model 2312, manufactured by Industrial Data Terminal (IDT), mounted in various consoles located in the Control Room, Computer Room, Technical Support Center (TSC), and the Emergency Operations Facility (EOF) at the H. B. Robinson plant. Also

included with the display subsystem is the communication equipment required for the data communications from the various locations to the computers in the Computer Room.

Three display units will be located in the Control Room, one wall mounted, two in the operator's consoles. The wall-mounted and one-operator console display units will share a single switchable keyboard. Also, a hard copy unit and a character printer will be located in the Control Room and a 600 lpm printer will be located in the Cable Spread Room below the Control Room. The TSC contains four display units, two of which share a single switchable keyboard, two character printers, two color hardcopy units and a video image store and copy system (VISCS). The EOF contains four display units, two of which share a single switchable keyboard, two character printers and a VISC.

II.B ERFIS Software

The ERFIS software is segregated into functional subsystems. The subsystems are:

1. Applications Executive Subsystem.

2. Data Base Management Subsystem.

3. Data Acquisition Subsystem.

4. Man-Machine Interface Subsystem.

5. Log Generation/Report Subsystem.

6. Software Support Services Subsystem.

7. Data Archival/Retrieval Subsystem.

8. Applications Software Utilities Subsystem.

9. SPDS Subsystem.

10. NSSS Subsystem including Secondary (Balance of Plant) Calculations Subsystem.

11. Special Software Subsystem.

Brief descriptions of these subsystems are contained in the attached Systems Overview Document.

II.C Physical Arrangement

The CPUs and associated disc drives, tape drives, etc., will be located in the Computer Room in the TSC/EOF Building. The Computer Room is in the TSC portion of this building. The building is located at the security fence some 1,400 feet from the Control Room - Cable Spreading Room area. During any site event, the TSC including the Computer Room is inside the security fence.

The data acquisition equipment will be in the Unit 2 Cable Spreading Room and the CRTs, printers, video copiers, etc., will be located in the Control Room, Cable Spread Room, TSC, EOF and Computer Room as described in the attached document.

The entire system will be powered from off-site power introduced at the TSC/EOF area. This power will be supplied through an uninterruptible power supply (UPS) (designed to carry the system for 30 minutes on batteries) and backed up by a diesel generator. A static transfer switch will also be provided as part of the UPS system.

II.D Other System Features

Several specific system features that are of possible interest because of their relationship to system implementation are discussed below.

II.D.1 SPDS Displays

The displays are arranged in a three-level hierarchy, with each display containing the same critical safety function indicators along the bottom of the display. Display examples are contained in the Safety Analysis Report.

II.D.1.a SPDS Level-One Display (Primary Display)

The SPDS Primary Display is dedicated to overall plant safety. It displays overall status of each critical safety function. The following requirements apply to the SPDS Level-One Display function:

1. A top-level display in the SPDS clearly indicates normal operation or existence of an abnormal, unsafe, or potentially unsafe condition.

2. This high-level display reflects the operational mode of the plant by changes in format and alarm criteria.

3. Any of the SPDS displays can be shown on any in the system.

4. The SPDS Level-One Display is defined as the series of six critical safety function indicator boxes. These boxes provide rapid detection of abnormal conditions in any safety function. The indicator

boxes are arranged in hierarchical fashion, with the most important function appearing on the left and the least important function on the right. The hierarchy in decreasing order of importance is as follows:

a. Subcriticality.

b. Core Cooling.

c. Heat Sink.

d. RCS Integrity.

e. Containment.

f. RCS Inventory.

Implementation of the Level-One Display requires use of both the safety function hierarchy and the status color hierarchy. RED functions must be responded to first, using the safety function hierarchy, followed by ORANGE and YELLOW. The color hierarchy takes precedence over the function hierarchy. For example, a RED Heat Sink condition must be responded to before a ORANGE Subcriticality condition.

5. The indicator box for the highest priority function with a RED status will blink.

6. Once the primary display has been brought up on a display console, the more detailed SPDS displays (secondary displays) may be brought up and organized in a structured set that lends itself to two-dimensional paging.

II.D.1.b SPDS Level-Two Displays (Secondary Displays)

The SPDS Secondary Displays are dedicated to each of the critical safety functions and display the overall status of each safety function. The following requirements apply to the SPDS Level-Two Display function:

1. The SPDS CRT displays any one of a set of formats that provide more detailed information about the six critical safety functions.

2. A corresponding second-level display containing the appropriate variables is supplied for each critical safety function.

3. The secondary display for each critical safety function is a status tree, with each path through the tree corresponding to a unique combination of conditions that define the status of the function. The trees show success or degree of failure of the critical safety function, the proper action for the operator to take, and the priority of the response.

4. The secondary display for each critical safety function will show the current value or status of each parameter which defines the status tree.

5. The six critical safety function indicator boxes will appear on all SPDS Level-Two displays.

These displays are based on the Westinghouse Owner's Group status trees.

II.D.1.c SPDS Level-Three Displays

Level-three displays provide detailed information about individual parameters which comprise the secondary displays.

In this system, level-three displays will consist of trend plots and x-y plots of key plant parameters tied to specific critical safety functions. These displays are currently being developed.

The six critical safety function boxes will appear on all level-three displays.

II.D.2 Inputs

Inputs required for the SPDS displays are those required for the critical safety function status information and are discussed in the Safety Analysis Report that accompanies this submittal. Additional inputs for the ERFIS were determined by starting with all the currently available and planned Regulatory Guide 1.97 parameters as the base set. Minor additions and deletions were made to this set. Meteorological data for support of dose-assessment activity will be input to the system.

The Data Acquisition Subsystem provides all of the equipment necessary to convert the specified process I/O signals to digital words at the rates specified. Each cabinet connects over fiber-optic cables to each of the two data concentrators. Each data concentrator is cross-connected to the two host computers through high-speed parallel interfaces. This provides redundant data acquisition capability from the conversion point to the host computer system.

The initial (Phase I) installation will include five multiplexer cabinets of which two (MUX-1, MUX-2) will be classified as 1E-qualified and will contain 1E-qualified electronics housed in a seismically qualified cabinet. One of the three cabinets (MUX-3) will contain non-1E electronics housed in a seismically qualified cabinet. MUX-4 and MUX-5 cabinets will contain non-1E equipment housed in standard electronics cabinets and special cables will be provided to connect the input points currently connected to the Westinghouse P-250 system to the inputs of MUX-4 and 5. During Phase IV of the installation, the electronics in MUX-4 and MUX-5 will be moved to the vacated P-250 cabinets.

Isolation for 1E signals is provided by using optical isolation on all digital signal inputs, transformer isolation on all analog signal inputs, with the isolation between cabinets provided by the optical link between remotes and the associated data concentrators.

The power supply contained in each cabinet connects to the DALCAL card and is monitored for out-of-tolerance voltage levels. In addition, cabinet integrity is checked with a temperature sensor mounted in the cabinet.

II.D.3 Data Handling Features

The entire system is designed to provide reliable data and high availability. Computer system availability (not accounting for supporting systems) should exceed 0.99.

System features provided to assure reliable data include:

II.D.3.a Error Monitoring

Each major system employs on-line error monitoring. Error monitoring is also provided for the backup components to ensure their availability if a failure occurs in the on-line system.

On-line error monitoring for the data acquisition subsystem is provided by checking each communication between the high-speed data concentrators (HSDC) for error (parity) and retransmitting, if required. The host is also notified of errors or inactive links, if requested. Protocol checking is performed by the HSDC for each host/HSDC interchange. A negative acknowledgment is returned for a failed protocol test.

The Gould/SEL 8055 disk processors provide multiple bit error detection and correction for the disk units. Uncorrectable errors are reported to the ERFIS.

For the magnetic tape units, both lateral and longitudinal parity are checked by the tape processor during NRZI operations. Errors are reported to the requestor. During phase-encoded operations (1600 bpi), multiple bit error detection is provided and correction is attempted. The error is reported to requestor with an indication if the correction was successful.

For those serial I/O devices which require it, parity generation and detection are provided by the eight-line async communication multiplexer. As hardware errors are detected by the CPU or device handlers, they are passed back to the highest level program capable of interpreting and possibly recovering the error. This procedure allows the user a facility to determine the criticality of the facility. Once the nature and seriousness of an error has been determined, an error message, either

warning or fatal, is issued via the an error logging facility. The error message is printed (hardcopy) and logged onto a disk file. Watch-dog timers are used in each CPU to support failover.

On-line diagnostics involving processor function tests and ALU tests cause very little degradation of system performance. On-line diagnostics involving device exercise and analysis tests, however, could seriously interfere with normal system activities and such tests should be executed on the backup CPU whenever possible.

There will be little or no degradation of the Primary (on-line) system due to execution of on-line diagnostics. On-line diagnostics are of two types:

1. Processor function tests.

2. Device exercise and analysis tests.

Processor function tests are designed to determine the ability of the CPU to accurately execute its installation repertoire. This is accomplished via the system "health monitor" on both CPUs by performing a series of predefined calculations to check the arithmetic logic units. This periodic task, running at low priority, produces no significant effect on system performance.

II.D.3.b Data Quality

The DAS assigns a "Data Quality Code" to each field-input and calculated point at the time the point is processed. These quality codes are assigned based on a series of checks/tests performed during both input-data validation and point processing. The assigned Data Quality Code is then stored, along with the

Point value, in the system's Current Values Table (CVT) for access by other applications tasks (e.g., MMIS, Data Archival/ Retrieval, Logs/Reports, etc.).

II.D.3.c Programmer/Engineer's Console Functions

The Programmer/Engineer's Console in the Computer Room can be used for addition or modification of point attributes, generating new displays, modifications to the log programs, or for normal system programming. Any changes which are made to the data base from this terminal will be written to the printer.

II.D.3.d Security and Access Restrictions

Three levels of security are provided on the ERFIS system:

1. "Read Only" access

2. Data base changes

3. Program logic and system changes

To implement these security levels, a key lock, keys, and passwords are utilized. Each console has a key lock whose locked/unlocked state can be sensed by the system allowing controlled access. Monitoring of system functions is allowed from a console in the locked state, but alterations of system functions are not allowed. Data base changes are permitted only when a console is unlocked and only for those point attributes that are allowed for that particular console. The ability to alter the system logic data tables and the data base is only allowed through the Programmer/Engineer console after the appropriate key and password have been entered.

The TSC, EOF, and Control Room consoles have lockable keyboards and a set of function keys. The TSC and EOF terminals cannot be used to alter any system data. The TSC and EOF requests run at a lower priority than Control Room requests so as not to affect the overall operation of the system. The Programmer/Engineer, through the Programmer/Engineer's console, can establish for each console in the system those functions permitted in the locked state and those allowed in the unlocked state.

II.D.3.e Historical Data Storage and Retrieval

The Data Archival/Retrieval Sybsystem supports the archival and retrieval of both field-input points and calculated points. The latter includes transforms, pseudo-analog and logical points such as Boolean, AND, and OR.

Three types of data archival are supported by SAIPMS:

1. Short-Term Data Storage (Short-Term Archival).

2. Mid-Term Data Storage (Mid-Term Archival).

3. Long-Term Data Storage (Long-Term Archival).

The Point I/O Summary List file record for each point defined to the system contains a collection of processing control logical bits (flags). The operator may independently specify any point in the system to be archived on short-term or mid-term or both. Interaction of enabling and disabling points from archive is handled via the data based template displays supported under the Man-Machine Interface Subsystem.

Short-term and mid-term archive data is stored on line and accessible to the system at any time. Short-term and mid-term archive data is stored on two dual-ported disks concurrently. In this fashion, the second disk is used as the backup media for the primary computer and as the primary media for the backup computer.

1. Short-Term Data Storage

The short-term archived data resides on disk and is on-line accessible. Only points designated as "Short-Term Archival" on the point I/O Summary List file will be archived. The most recent 14-hour period is always maintained in a circular file fashion. In this fashion, the design and implementation is simplified as this file will always contain the period defined as two hours pre-event and 12-hours post-event. In addition to providing the most current 14 hours of short-term data, the complexities of expanding and contracting the file have been eliminated.

Short-term data is to be archived at its scan or computational frequency. Real points (analog, pseudo-analog and real calculated) are archived at their scan or computational frequency. Logical points (digital inputs, Booleans and SOEs) are not truly archived at their scan or computational frequency, but the data retrieval returns data values for each sample.

All logical points flagged for short-term archival are archived every five minutes. Only changes in state from the last archived value are tagged and written to the file. This is the simple compression algorithm utilized on logical type points. The

reason for the "archive all" associated with logical variables is to establish a base reference point to enable the recreation of data values during data retrieval.

This archive data is extracted from a buffer built by the Data Acquisition Subsystem. Once a second, archival accesses the buffer, extracts the data tag, data value, and data quality. The archive entries are time tagged and stored on the short-term archival file. Data Acquisition also buffers the SOE points (at 100-millisecond intervals, time tagged to within 1 millisecond) for the Archival/Retrieval Subsystem so that preservation of their changes-in-state is ensured to be archived to the short-term archival file.

It is important to note that the data quality codes reflect the condition of the point data value that was archived. That is, it denotes whether the point data value is in alarm, in warning, return-to-normal or normal. In this fashion, the need for alarm transaction records on the short-term archival file is eliminated as this requirement is inherently supported by the design for the Archival/Retrieval Subsystem.

Asynchronous activities are written to a separate data file called the Archival Transaction file. It contains the following types of transactions:

1. Man-Machine activities.

2. CPU failover activities.

3. Device failover activities.

4. Hardware errors.

5. Software errors.

Entries in this file are tagged with the operator input, workstation origin, and time tag. Failover transactions are time tagged and contain a reason for the failover. Similar data retrieval routines are also supplied for this file.

2. Mid-Term Storage

The mid-term archived data resides on disk and is on line accessible. Only points designated as "Mid-Term Archival" on the Point I/O Summary List file will be archived. The system maintains the most recent two weeks plus 48-hour period in a circular file fashion. In this fashion the system always supports on-line retrieval of this data.

Mid-term data is not stored at its scan or computational frequency. This data is reduced (compressed) by averaging the real and calculated points over particular time integrals. Data storage to this file is usually at the rate of six samples/hour/point (i.e., 10-minute averages).

All status variables flagged for mid-term archival are archived every 10 minutes. Changes-in-state from the last archived value are tagged to a one-second resolution. The reason for the "archive all" associated

with status variables is so that a base point recreation of data values can be established for the data retrieval routines.

In computing the averages, the worst quality of any point data value that was used in the average is propogated as the quality of the averaged value that will be archived on the mid-term archival file.

3. Long-Term (Archival) Storage

Long-term archival data is identical to mid-term archival data in format and archive entry contents. The only difference is the storage media and the time span covered. Long-term archival data is stored on magnetic tape.

When the mid-term archival disk file is 35 percent full or at the computer operator's discretion, the mid-term disk file may be spooled to magnetic tape to create a long-term archival file.

Each time a magnetic tape file is written, the Archival Tape Management file is updated. The file maintains a directory of the latest 50 tapes worth of long-term data.

Long-term archival, just as short-term and mid-term, contains point data values. There is no provision to store any of the man-machine displays on magnetic tape.

II.D.4 Human Factors/Validation and Verification

Human-factor considerations have been applied in design of the consoles and in the displays.

SAIC will perform validation and verification on the system hardware and software design. The SAIC organization responsible for this activity is independent of the system design organization.

III. IMPLEMENTATION SCHEDULE

The schedule for completing system installation is predicated on performing four plant modifications. The attached bar chart schedule illustrates the proposed approach. Outage dates shown on the bar chart represent the best estimates we have at this time, but as with any plant outage, are subject to change.

Phase 1 for Plant Modification Package 807A (PMP807A) activities are preparatory to installation of equipment in the Control Room and Unit 2 Cable Spreading Room. Major tasks are listed on the bar chart. This work requires a plant outage and was scheduled to be done during the steam generator replacement outage. This work is underway at the time of this writing.

Phase 2 (PMP807B) involves installation of equipment in the TSC/EOF Building and Cable Spreading Room and performing electrical terminations on the, at this time, unenergized side of the circuits. This work can be done while the plant is operating.

Phase 3 (PMP807C) requires an outage, and is planned for Refueling Outage No. 10 currently scheduled for the December 1985 - February 1986 time frame. The work planned for this outage is installation of Control Room equipment required for the SPDS functions and completion of all terminations. The SPDS portion of the system would be checked out, tested and is intended to be completely functional six months after completion of this outage, and fully operational six months after that.

Phase 4 (PMP807D) requires an outage, and is planned for Refueling Outage No. 11 currently scheduled for March - June, 1987 time frame. The work planned for this is not required for SPDS system operation but includes the removal of all P-250 equipment, except the existing Westinghouse I/O cabinets. These cabinets will be emptied of existing gear and used as a permanent location for the electronics that were installed in temporary Multiplexer Cabinets Nos. 4 and 5 to allow for parallel operation with the P-250. The remaining Control Room equipment will be installed during this outage. Phase 4 completes the integration of the plant operational computer function with the ERFIS/SPDS.

SAFETY ANALYSIS OF THE H. B. ROBINSON UNIT 2

SAFETY PARAMETER DISPLAY SYSTEM

Prepared by

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TABLE OF CONTENTS

1. INTRODUCTION

The SPDS is part of CP&L's response to NUREG-0737 Supplement 1; CP&L's commitments with regard to this NRC document were submitted to the NRC in April 1983. The SPDS is a subunit of the H. B. Robinson Unit 2 Emergency Response Facility Information System (ERFIS). Processing of plant parameters by ERFIS is presented on two SPDS terminals within the main control room. The logic and typical displays by the SPDS are presented within this report.

The purpose of the Safety Parameter Display System (SPDS) is to assist operating personnel in evaluating the safety status of the plant. The SPDS provides a continuous indication of plant parameters or derived variables which are representative of the safety status of the plant during both normal and emergency use. The primary function of the SPDS is to aid in the rapid detection of abnormal operating conditions. Secondary functions include analyzing and diagnosing the abnormality and providing an informational basis for corrective action execution.

This report analyzes the SPDS for the H. B. Robinson Steam Electric Plant (HBR-2) with regard to its capabilities for assessing the safety status of the plant. The basis for selection of the parameters used by the SPDS will be discussed and will be shown to be sufficient for assessing the status of each critical safety function for a wide range of events.

Reference should be made to H. B. Robinson Steam Electric Plant Updated Final Safety Analysis Report for complete design and transient parameter conditions/setpoints/assumptions.

HBR-2 Emergency Operating Procedures will be based on Revision 1 of the Westinghouse Owners' Group Emergency Response Guidelines. These emergency operating procedures provide a manual, independent means of monitoring the critical safety function status trees which are incorporated into the SPDS. The final issue of the above guidelines (dated September 1, 1983) contains refinements in three status trees (Core Cooling, Heat Sink, RCS Integrity). The Core Cooling and RCS Inventory Status Trees assume the NRC will approve the Reactor Vessel Level Instrumentation System (RVLIS) prior to SPDS becoming operational. Also, the appearance of the status trees at HBR-2 may be changed to resemble other flow chart type emergency procedures. These changes will not alter any conclusions or analyses contained in this document.

2. CRITICAL SAFETY FUNCTIONS

In order to maintain a nuclear power plant in a safe condition, there is a set of functions that must be performed. The full set of functions that must be performed in order to fully safeguard the general public from possible consequences of nuclear power plant operation is commonly referred to as the set of critical safety functions (CSFs). For a PWR, the set of critical safety functions consists of the following:

1. Subcriticality
2. Core Cooling
3. Heat Sink
4. RCS Integrity
5. Containment Integrity
6. RCS Inventory

2.1 BARRIERS TO THE RELEASE OF RADIOACTIVITY

The functions listed above were chosen because they relate directly to one or more plant barriers to the release of radioactivity. Satisfying these functions will keep the barriers intact. The barriers that are provided in every nuclear power plant installation consist, at the minimum, of

- the fuel matrix and fuel clad
- the reactor coolant system pressure boundary
- containment
- distance

For the purposes of the SPDS, only the first three barriers are considered. The "distance" barrier and portions of the general containment barrier other than the main containment vessel are considered to be included within the scope of the Site Emergency Plan.

These first three are direct physical barriers to the transport of radioactive materials and together provide the required "defense in depth". The reactor coolant system pressure boundary blocks the transport of radionuclides that escape through the fuel rod barriers and those that are

produced outside of the fuel rods themselves. Containment blocks the release of radionuclides that pass through the reactor coolant system pressure boundary and those few radionuclides that form outside the reactor coolant system. In its most general form, "containment" includes the main containment vessel, the boundaries of those systems that penetrate the main containment vessel (the steam and feedwater systems and various auxiliary systems) and the boundaries of the separate waste storage facilities (waste gas storage tanks, spent fuel storage, etc.).

As long as the fuel rod, reactor coolant system pressure boundary and containment barriers are intact in a nuclear power plant, that plant poses no threat to the health and safety of the general public. Should one or more of the barriers be faulted, the threat to the general public increases. If all barriers are lost, the threat becomes significant and external emergency actions may be called for. Therefore, the goal of nuclear power plant operation, in terms of nuclear safety, is the assuring that as many as possible of the three primary barriers remain intact at all times and under all conditions and/or circumstances that may exist.

2.2 RELATIONSHIP OF CRITICAL SAFETY FUNCTIONS TO BARRIER

The six critical safety functions can be associated with the barriers in the following manner:

Barrier	Critical Safety Function
	Maintenance of SUBCRITICALITY (minimize energy production in the fuel)
Fuel Matrix and Fuel Clad	Maintenance of CORE COOLING (provide adequate heat removal from the fuel)
	Maintenance of a HEAT SINK (provide adequate secondary coolant for heat removal from the fuel)

Barrier	Critical Safety Function
	Control of RCS INVENTORY (maintain enough reactor coolant for effective heat removal and pressure control
Reactor Coolant System Pressure Boundary	Maintenance of a HEAT SINK (provide adequate heat removal from the RCS)
	Maintenance of RCS INTEGRITY (prevent overpressurization of the RCS)
	Control of RCS INVENTORY (prevent flooding and loss of pressure control)
Containment Vessel	Maintenance of CONTAINMENT Integrity (prevent failure of containment vessel)

If the critical safety functions are maintained, the barriers will remain intact. The SPDS provides a means of monitoring the critical safety functions and provides guidance for restoring any function which may be challenged. In this way, the SPDS provides an additional line of defense for the plant, independent of the Reactor Protection System and Engineered Safeguards System. The manner by which the SPDS monitors the critical safety functions is described in the following section.

2.3 MODES OF APPLICABILITY OF THE CRITICAL SAFETY FUNCTIONS

Critical Safety Function monitoring using the Status Trees assumes a Power Operation or Startup initial condition, followed by some Reactor Protection system actuation, to result in a subcritical reactor. Use of the trees can be extended beyond this original intent, but with an understanding of the intent of each tree. For example, the Heat Sink tree assumes the steam generators are required for heat removal by steaming. If all reactor decay heat is being removed by the RHR System, the steam generators are not required in their

normal capacity. So steam generator availability is really not required to be satisfied. Yet the tree would indicate a steam generator in either wet layup or in dry layup to be abnormal.

3. CRITICAL SAFETY FUNCTION STATUS TREES

In order to determine whether a critical safety function is satisfied, it is necessary to check only a few parameters. However, these parameters cannot be considered individually, since their significance is often affected by some other parameter. For example, for H. B. Robinson Unit 2, the Heat Sink critical safety function is challenged if the total feedwater flow to all steam generators falls below 300 gallons per minute. However, this low feedwater flow is not of concern if the water volume in at least one steam generator is at least 25 percent of narrow range indication. Therefore, the important parameters for each function have been combined in a logical array called a "status tree." The combination of parameters existing at any time defines a unique path through the tree, and also a unique "status" of the critical safety function.

The branch points of each tree are based on a comparison of the parameters with a reference value indicating a safe condition. In the previous example, the Heat Sink tree contains a branch for total feedwater flow relative to 300 gpm. If the total feedwater flow to all steam generators is less than 300 gpm with level less than 25 percent in all steam generators, the path through the tree will indicate that the Heat Sink function is challenged. If feedwater flow is greater than 300 gpm, the path through the tree will progress towards other branches where other parameters will be checked. When each of these branches is resolved, the final path will indicate success in maintaining the Heat Sink function or the mode of impairment of this function. A more detailed description of the trees is presented later.

3.1 PRIORITIZATION OF TREE BRANCHES

Since there are a number of parameters of importance to each function, the trees contain several branches and paths. The end point of each path defines a unique set of plant conditions, expressed as a combination of current values of the parameters. Each set of conditions reflects how nearly adequate the critical safety function is satisfied, and thus the priority of the required response. In order to quickly inform the operator of the nature

of the current conditions, each path is color coded. The color tells the operator immediately if the critical safety function is challenged and tells him the relative severity of the challenge.

The SPDS presents this color-coded status in two ways. First, all SPDS displays contain status blocks for each of the six critical safety functions. Each block will appear on the screen in the appropriate color indicating the current status of that function. Thus, the operator can see at a glance the status of all six functions. Second, on the display of each critical safety function status tree, the path defining the current conditions will be drawn through the tree in the appropriate color. Because each path defines a unique set of conditions only one path is colored at any time.

The scheme of color coding used to identify the priority of the current conditions is as follows:

GREEN - the critical safety function is satisfied; no operator action is called for.

YELLOW - the critical safety function is not fully satisfied; operator action may eventually be needed.

ORANGE - the critical safety function is under severe challenge; prompt operator action is necessary.

RED - the critical safety function is challenged; immediate operator action is required.

3.2. FUNCTION RESTORATION GUIDELINES

In addition to providing information on the current set of conditions and their importance, the critical safety function trees provide information which can be used as a basis for execution of corrective action. The end point of each path in the status trees directs the operator to a particular "function restoration procedure". These procedures differ depending upon the seriousness of the threat to the critical safety function. The procedures direct the operator to perform various actions designed to restore the threatened function to a satisfactory status.

4. BASIS FOR CRITICAL SAFETY FUNCTION TREES PARAMETER SELECTION

The six critical safety function trees are shown and described in this section. The basis for the selection of each of the parameters in the trees will be discussed. In addition, the state (of the critical status function) which results from following each tree path will be established. In this analysis, the following letters are used in place of color coding: "R" for RED, "O" for ORANGE, "Y" for YELLOW, and "G" for GREEN.

4.1 SUBCRITICALITY TREE

The Subcriticality Tree is shown in Figure 4.1-1. Since this tree is gauging the reactivity state of the core, the parameters selected are those characterizing neutron flux behavior as measured by the nuclear instrumentation system. The basis of this tree is that the Subcriticality Function is satisfied whenever the indicated core neutron level is in the source range and core neutron level is steady or decreasing (as indicated by a zero or negative startup rate).

Immediately after a reactor trip, a few minutes will elapse before the source range instruments become energized. During this time, it is still possible to satisfy the Subcriticality Function by having a sufficiently negative startup rate in the intermediate range. For the purposes of this tree, the Subcriticality Function is considered satisfied if the neutron flux has dropped into the intermediate range with a startup rate more negative than - 0.2 decades per minute (dpm).

The tree is arranged in a logical downward progression through the ranges of neutron flux instrumentation, starting with power range and proceeding through intermediate range to source range. For power range, the tree branches at a power level of five percent. This level is well above the power level following reactor trip, and is considered easily readable on power range instruments. Confirmation of a power level in excess of five percent is a RED path status since it represents a serious challenge to the integrity of the fuel matrix/cladding barrier.

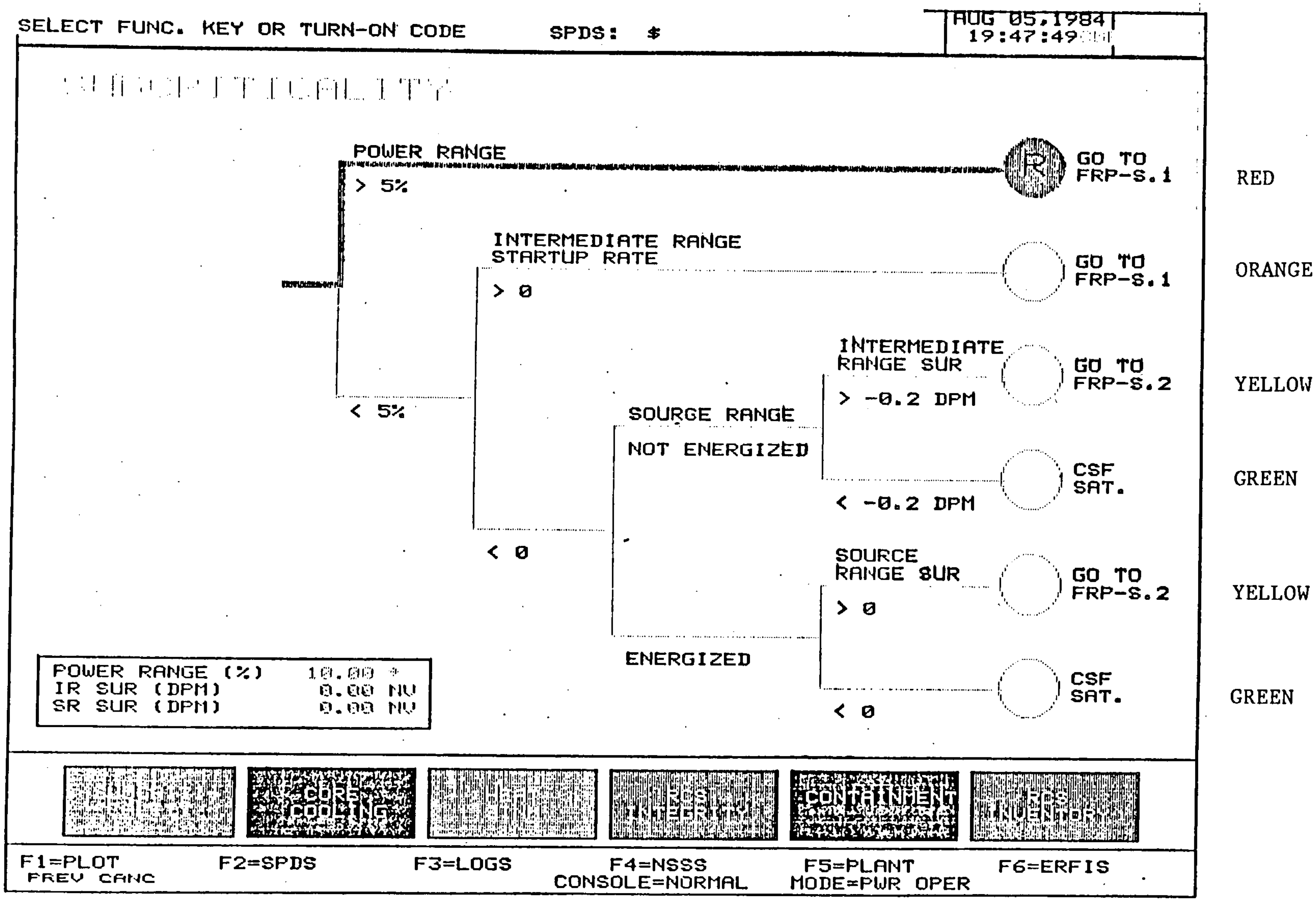


FIGURE 4.1-1

Subcriticality Critical Safety Function Tree

If power is below five percent, the flux may be at a level where the intermediate range instruments provide the best means of tracking it. Here we are not concerned with the level of flux, but whether it is decreasing. If the neutron flux in the intermediate range is increasing (positive startup rate), then it is only a matter of time before the flux level becomes sufficiently high to re-enter the power range. This condition is not as serious as the RED path described above, so it is coded ORANGE, indicating that operator action is required promptly. Notice that both the RED and ORANGE paths direct the operator to function restoration guideline FRP-S.1. The required actions are the same, but the degree of urgency is different.

If neutron level is in the intermediate range and the source range instruments are not yet energized, the Subcriticality Function is considered satisfied if the startup rate (SUR) is sufficiently negative (< -0.2 dpm). The existence of this set of conditions implies that the core is, in fact, subcritical. This branch is designed to allow the Subcriticality Function block to remain GREEN following a trip, but before long-lived delayed neutron precursors have decayed. If neutron level is in the intermediate range and SUR is not sufficiently negative, the path is colored YELLOW. If the source range is energized, the reactor still may not be subcritical. If the flux is in the source range, but increasing (positive SUR), the reactor is not subcritical and the function is not satisfied. However, this does not represent an immediate threat since the flux level is far below power production levels, so this path is also coded YELLOW. If the flux is in the source range and stable or decreasing (zero or negative SUR), the Subcriticality Function is satisfied and the path is coded GREEN.

It should be noted that since this tree is designed to measure the extent to which the core is shutdown, the Subcriticality Function cannot be satisfied during power operation. Therefore, the SPDS software will consider the Subcriticality Function to be GREEN when the plant is in the power operation mode, until a reactor trip signal is generated by the Reactor Protection System. At this time, it becomes necessary to satisfy the Subcriticality Function, and the SPDS will begin to monitor the tree.

In summary, the parameters chosen for the Subcriticality tree are those which give an indication of the reactivity state of the core. The function is considered satisfied if neutron flux is in the source range with a zero or negative startup rate, or if power is below five percent with a startup rate less than -0.2 dpm.

4.2 CORE COOLING TREE

The Core Cooling tree is shown in Figure 4.2-1. The tree gauges the plant's capability for removing decay heat from the core. Failure to remove decay heat could result in failure of the fuel matrix/cladding barrier due to fuel melting or zirconium-water reactions. Therefore, the parameters used in this tree were selected on the basis of their ability to indicate either the temperature or level of the water in the core. The definition of an adequately cooled core is one in which the average of the five highest operable core exit thermocouple temperatures is less than 1200°F and the RCS water is subcooled.

A temperature of 1200°F indicates that most liquid inventory has been removed from the RCS and the remaining steam is being superheated by core decay heat. This represents a severe challenge to the fuel matrix/cladding barrier, and this branch of the Core Cooling tree is color-coded RED. If the temperature is less than 1200°F and RCS water is subcooled, the path is coded GREEN since the Core Cooling Function is satisfied. If the RCS is not subcooled, but the core exit thermocouples are below 1200°F, there is some inventory left in the RCS so questions about reactor vessel level and reactor coolant pump status must be answered to determine how effective this coolant inventory will be in maintaining core cooling.

If at least one RCP is running and sufficient coolant inventory is present, the core can be effectively cooled, even by a two-phase mixture, because of the forced flow. Coolant inventory is indicated by the Reactor Vessel Level Indicating System (RVLIS). The satisfactory level of inventory depends upon how many of the three RCPs are running. The level chosen for the tree is the plant-specific value which corresponds to a system void fraction of 50 percent with the current number of pumps running. If core exit

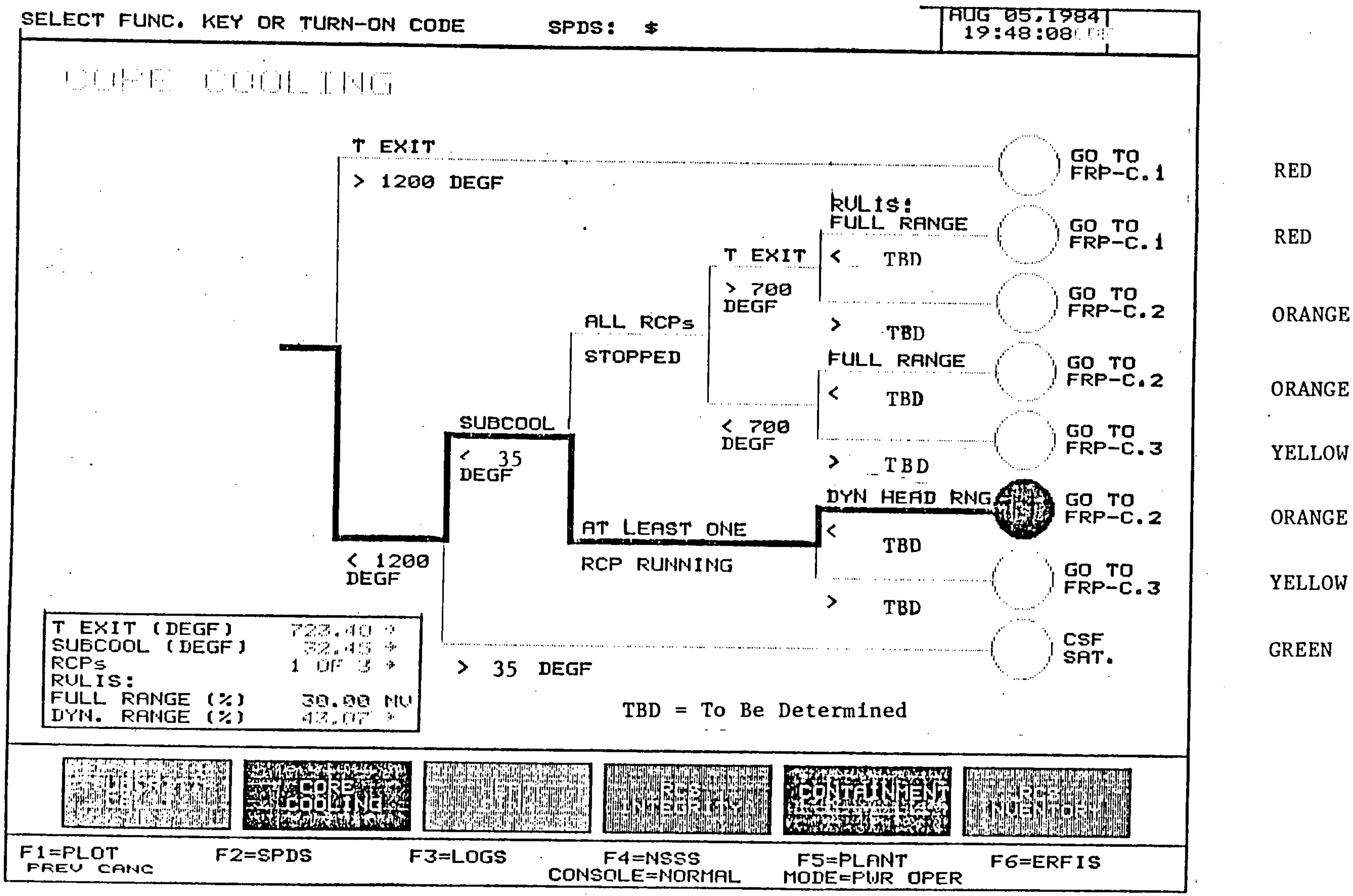


FIGURE 4.2-1

Core Cooling Critical Safety Function Tree

thermocouple temperature is less than 1200°F and RCS water is not subcooled and at least one RCP is running and sufficient coolant inventory is available, then the core cooling function status is considered YELLOW since adequate core cooling can be maintained. However, heat removal is being accomplished using a two-phase mixture which is an abnormal mode of operation for a pressurized water reactor. If the RVLIS criterion is not met, the function status is considered ORANGE because the RCS inventory is seriously depleted.

If no RCPs are running, then the amount of available inventory becomes much more important because of the absence of forced flow. Also, the current core exit thermocouple temperatures are important as a measure of core dryout by their indication of superheated steam temperatures. A core exit temperature of 700°F indicates that the fuel has heated up enough to superheat the cooling steam flow. The presence of the minimum coolant inventory which is sufficient to ensure core cooling for an extended period of time is indicated by a water level (with no void fraction) of at least 3-1/2 feet above the bottom of the active fuel. Figure 4.2-1 shows how the various combinations of temperature and level are color-coded for status, ranging from RED for temperature greater than 700°F and level less than 3-1/2 feet to YELLOW for the reverse situation.

In summary, the parameters chosen for the Core Cooling tree are those which give an indication of the temperature of the water in the core or the amount of inventory in the reactor vessel. The function is considered satisfied if the core exit thermocouples read less than 1200°F and the RCS is subcooled.

4.3 HEAT SINK TREE

The Heat Sink tree is shown in Figure 4.3-1. This tree gauges the plant's ability to remove heat from the RCS, thus protecting the barrier to release provided by the reactor coolant system pressure boundary. The parameters used in this tree are those which indicate the ability of the steam generators to remove heat from the RCS. The residual heat removal system (RHR) is not considered in this tree because it must be manually aligned and the operator would readily know if it is functioning. Prior to RHR actuation, if all three steam generators have sufficient inventory, are receiving

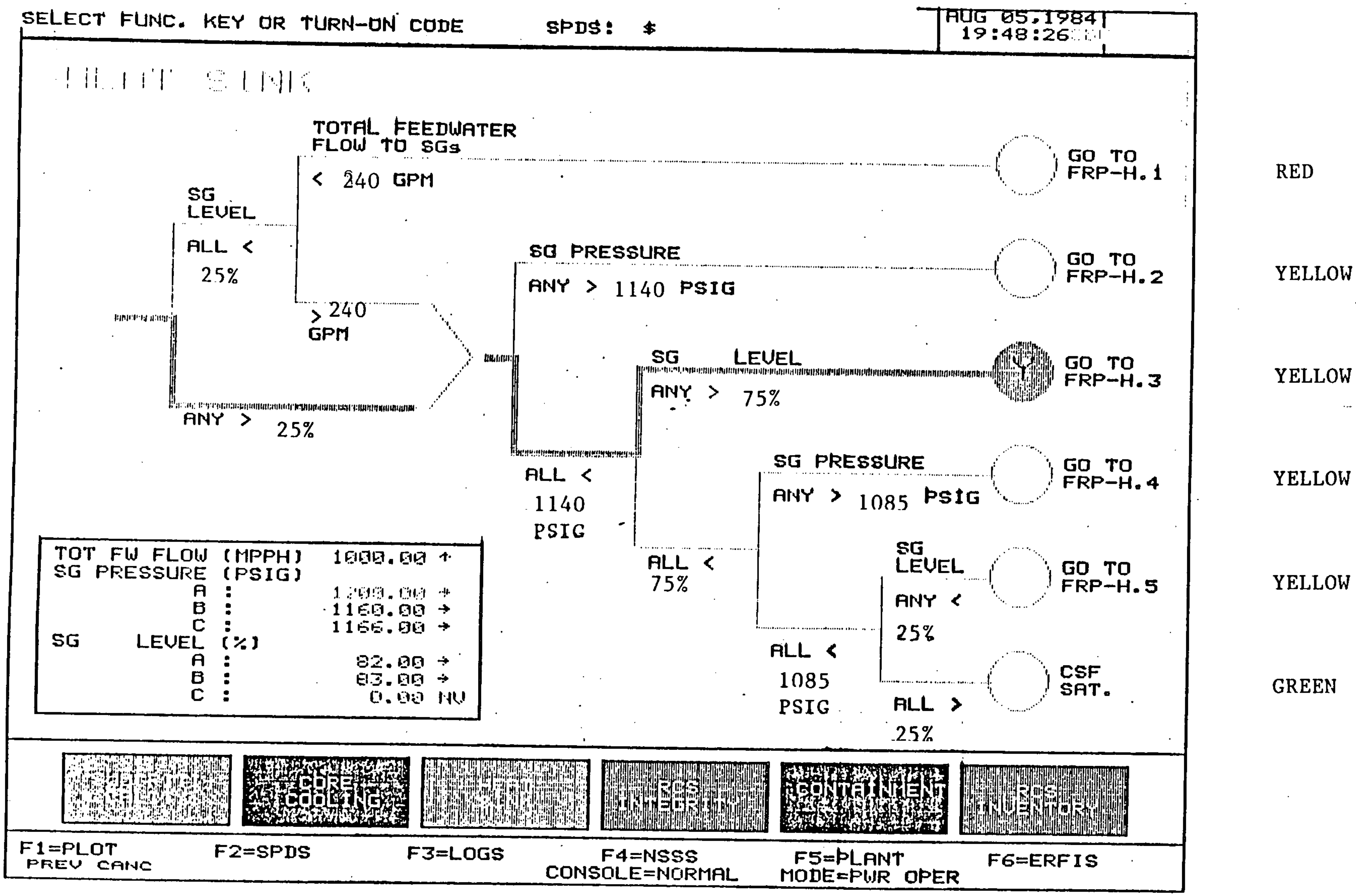


FIGURE 4.3-1

Heat Sink Critical Safety Function Tree

adequate feedwater flow, and are not overpressurized, then an adequate heat sink exists.

One steam generator is sufficient to remove decay heat from the RCS. The tree begins by determining whether at least one steam generator has sufficient water level. The reference water level corresponds to a level just inside the narrow range (including allowances), and implies that the operator has a reliable level indication. In this case, the Heat Sink function status can be no worse than YELLOW. If none of the steam generator levels is high enough to be in the narrow range, the Heat Sink can still be maintained if there is adequate feedwater flow. The flow from one motor driven auxiliary feedwater pump is adequate for decay heat removal. If this flow is not available and none of the steam generator levels is in the narrow range, the steam generator heat sink is severely challenged. This path through the tree is color-coded RED.

If either the level requirement or the feedwater flow requirements is met, the Heat Sink function is not severely threatened. However, in order for the function to be satisfied, all three steam generators must be able to serve as useful heat sinks. The remaining branches of the tree determine the pressure and level status of all steam generators.

If any steam generator pressure is greater than the highest setpoint of any steamline safety valve, that steam generator is unable to relieve pressure. This is a threat to the Heat Sink function and the branch of the tree is coded YELLOW. If any steam generator pressure is greater than the lowest safety valve setpoint, the threat is not as serious but this path is also coded YELLOW.

Given adequate steam generator pressures, the adequacy of water levels must also be investigated. Adequate water level in the steam generators is determined as follows. A level above the steam generator hi-hi setpoint (level at which turbine trips and feedwater isolation occurs) is considered undesirable because of excessive moisture carry-over. Also, the possibility exists for filling the steam lines with water and relieving water through the safety valves. If the level is too low to be in the narrow range, there may be insufficient water to provide adequate heat removal, and the operator will not have a reliable level indication. In either case, the status is coded YELLOW. If all steam generator levels are between the low

value and the hi-hi setpoint, the Heat Sink function is satisfied and the status is coded GREEN.

None of the YELLOW status paths on this tree result in any extreme or severe challenges to a barrier to radioactivity release since they only indicate steam generator levels out of the normal range in some steam generators or potential challenges to secondary integrity.

In summary, the parameters selected for the Heat Sink tree are those which indicate the ability of the steam generators to serve as effective heat sinks. The function is satisfied if all steam generators pressures are below the safety valve setpoints and all steam generator levels are in the narrow range but lower than the hi-hi level setpoint.

4.4 RCS INTEGRITY TREE

The RCS Integrity tree is shown in Figure 4.4-1. This tree gauges the thermal stresses on the reactor coolant system with the reactor vessel as the limiting component. The RCS Integrity tree is unique among all the critical safety function status trees in that the reference values against which current plant parameters are compared do not appear explicitly at the branch points. Rather, the reference values are lines separating entire operating regions in pressure-temperature space, and are shown in Figure 4.4-2. The main concern of the Integrity tree is the reactor vessel wall and its degraded material properties due to radiation embrittlement. As the thick-walled vessel ages, it tends to lose its ductility, and its nil-ductility temperature (that temperature at which it begins to exhibit brittle behavior) increases. Operators are normally aware of the brittle fracture concern, and are required by Technical Specifications to limit heatup and cooldown rates precisely to avoid a stackup of stresses, especially the thermal stresses, which might exceed a critical yield stress, and cause a postulated internal flaw to grow. This flaw growth could eventually lead to vessel failure. The concern of this status tree is for those serious transients which produce extremely large cooldown rates, and thus extremely large thermal stresses. Cooldown at the vessel wall could be caused by a

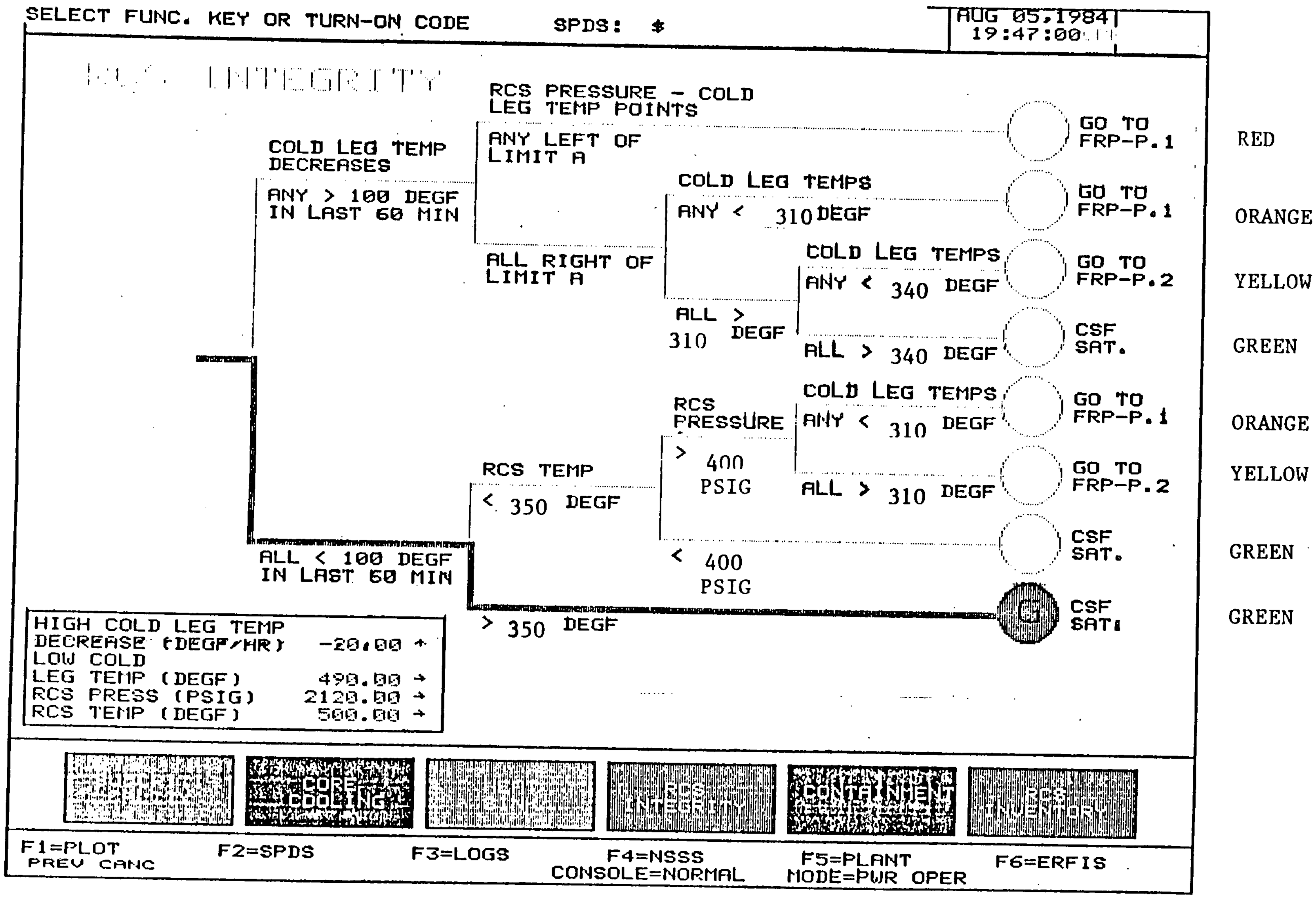


FIGURE 4.4-1

RCS Integrity Critical Safety Function Tree

secondary break cooling down the entire RCS, and/or the addition of cold injection water into the cold legs and downcomer region of the vessel. The final temperature reached and the cooldown rate determine the severity of the challenge to the vessel wall. Technical specifications require that cooldown be limited to 100°F/hour.

If the cooldown is greater than 100°F/hour, the RCS Integrity function may be challenged. Figure 4.4-2 is a plot of the operational limits for the reactor which applies when cooldown is greater than 100°F/hour. It is representative of the plant-specific plot, which was developed based on the reactor vessel material properties and weld composition, and on the power history of the plant. The three lines on the plot divide the pressure-temperature space into four regions, in which there are varying threats to vessel due to crack initiation and growth. These lines exhibit very little pressure dependence. The lack of significant pressure dependence implies that the primary cause of crack initiation or growth is thermally induced stress resulting from rapid cooldown. In the region to the left of Limit A, a crack can initiate at constant pressure. Such a condition is a severe challenge to the reactor vessel wall, so this region on the plot and the corresponding branch of the tree are given a RED status. Between Limit A and temperature T_1 a crack could initiate with some increase in pressure. This condition represents a serious threat to the Integrity function, or an ORANGE status. Between temperatures T_1 and T_2 it is unlikely that a crack would initiate, but the condition is sufficiently off-normal to warrant operator vigilance. Therefore, this region and the corresponding branch of the tree are given a YELLOW status. If the temperature is above T_2 there is no threat to the Integrity function, despite the rapid cooldown, hence the GREEN status.

The Integrity limits for cold overpressure are based on the temperature at which the Cold Overpressure Protection System is placed in service. If RCS pressure is less than the cold overpressure limit then the function is satisfied, hence a GREEN status. If RCS pressure is above the cold overpressure limit and cold leg temperature is above temperature T1 (i.e., the ORANGE priority boundary) then vessel integrity will not be challenged, even with full repressurization, since the "Isothermal Wall Crack Initiation Limit" will not be exceeded. The function is considered not satisfied and a YELLOW priority is warranted.

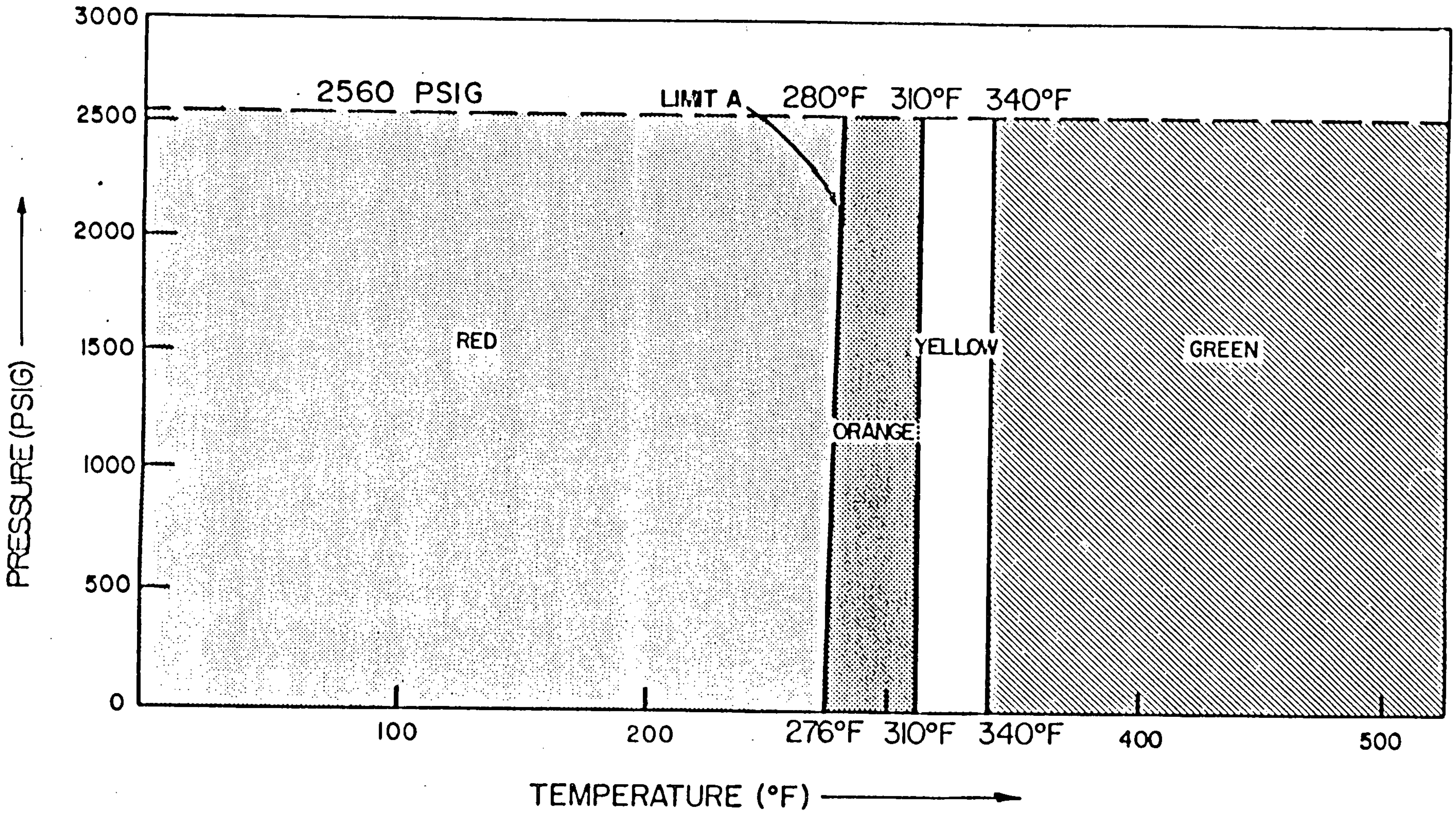


FIGURE 4.4-2

Operational Limits Curve for RCS Integrity Status Tree

If the RCS pressure is greater than the cold overpressure limit, and cold leg temperature is less than T1, then continued pressure increase could violate the "Isothermal Wall Crack Initiation Limit" and a flaw may initiate. Therefore prompt operator action is required to address a severe challenge to the function and an ORANGE priority is warranted.

In summary, the parameters selected for the RCS Integrity tree are those which reflect the degree of thermal stress on the reactor vessel. Cooldown rate and the combination of RCS pressure and temperature provide this indication. The function can be satisfied in several ways, but it is desirable to have a cooldown rate lower than 100°F/hour.

4.5 CONTAINMENT TREE

The Containment tree is shown in Figure 4.5-1. The parameters used in this tree serve to evaluate several possible threats to containment integrity. The function is satisfied if none of these threats are present.

The most serious threat to the containment results if pressure inside the containment exceeds the design pressure, which is 42 psig at H. B. Robinson Unit 2. In this case, the threat comes not from the existing pressure but from the possible burning of hydrogen. Typically, containment buildings can withstand up to twice the design pressure. However, if at design pressure there were sufficient hydrogen present to cause a burn, the sudden increase in pressure could exceed the design pressure of the containment. Since the Containment function is severely threatened, this branch of the tree is color-coded RED. The function restoration guideline associated with this path directs the operator to check the containment hydrogen concentration.

If containment pressure is below design pressure, then it is unlikely that even with a hydrogen burn, the containment would fail from overpressure, although significant equipment damage could result. There is still danger if the containment pressure is above the Hi-Hi setpoint, which at H. B. Robinson is 20 psig. A pressure this high indicates a significant energy release into containment and requires some operator action to evaluate the containment atmosphere composition and pressure suppression equipment. This branch of the tree is coded ORANGE.

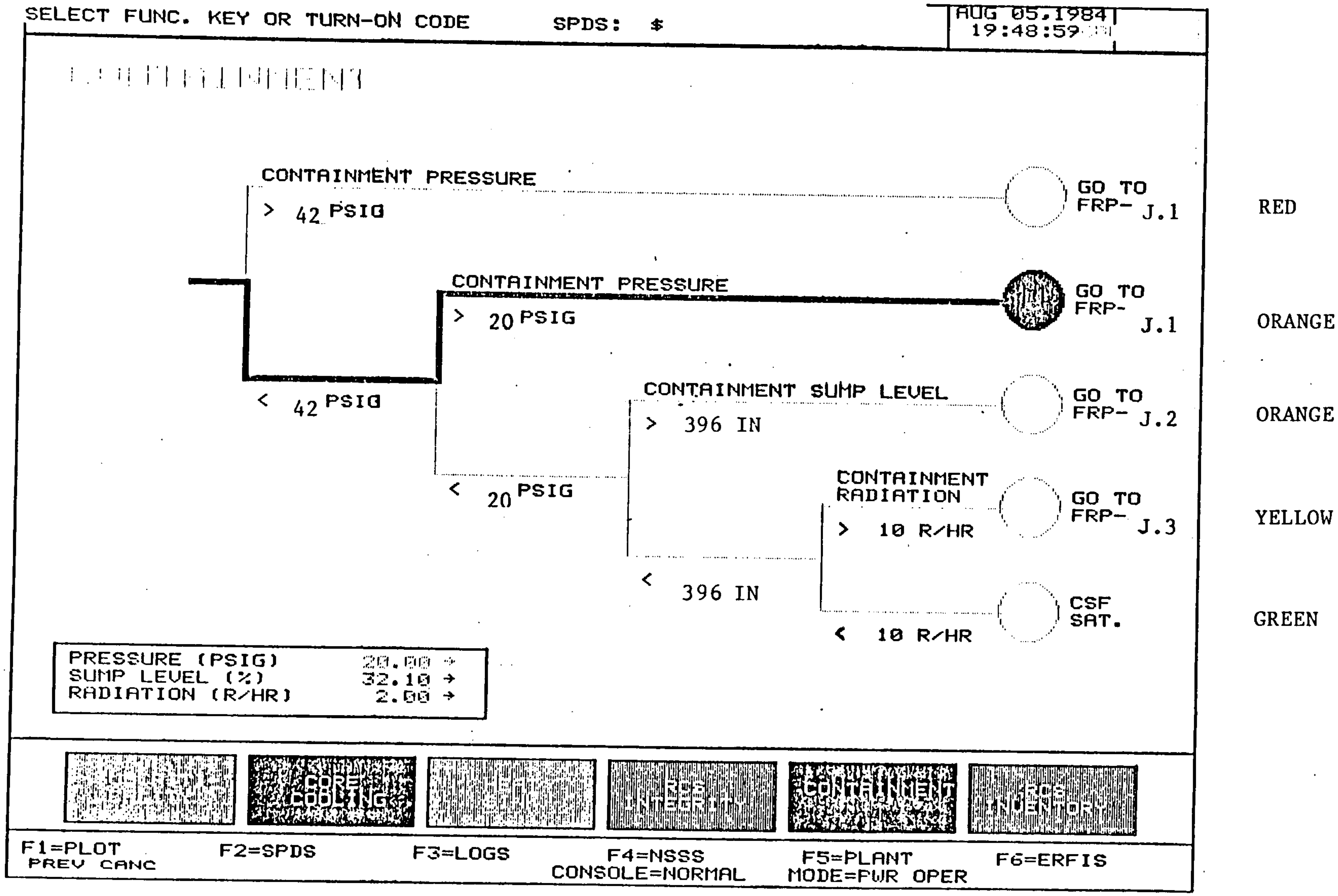


FIGURE 4.5-1

Containment Critical Safety Function Tree

If containment pressure is below the Hi-Hi setpoint, the tree then considers the water level in the sump. Equipment necessary for extended containment cooling (or for other long-term functions) located in the containment should not be threatened by water in the containment. A plant-specific reference value of water level, corresponding to the total volume of the RCS, the RWST, all the accumulators, and one-half of the condensate storage tank, is used. This volume of water is close to the maximum which could ever be pumped into the containment, and therefore, represents a close approach to the design flooding level. A water level above this reference value represents a serious threat to the Containment function because of possible equipment damage, and this branch is coded ORANGE.

If containment sump level is below the reference value, the tree then considers radiation in containment. While the presence of radiation does not directly threaten containment integrity, it makes proper isolation all the more important. A reference value of radiation level corresponding to the plant-specific alert setpoint for the Containment High Range Area Monitors is used in the tree. If radiation is above this reference value, the condition is considered off-normal and the path is coded YELLOW. If radiation is below the reference value, and there are no threats to the containment due to excessive pressure or sump level, the status of the Containment function is GREEN.

In summary, the parameters selected for the Containment tree are those which indicate possible threats to containment integrity. The threats considered are excessive pressure and sump level, with consideration also given to high radiation. The function is satisfied if none of these threats exist.

4.6 RCS INVENTORY TREE

The RCS Inventory tree is shown in Figure 4.6-1. RCS Inventory represents a critical safety function which supports Core Cooling and RCS Integrity. Inadequate inventory is a consideration in Core Cooling and excessive inventory is a consideration in RCS integrity. Therefore, the RCS Inventory tree contains no branch coded more urgent than YELLOW. The

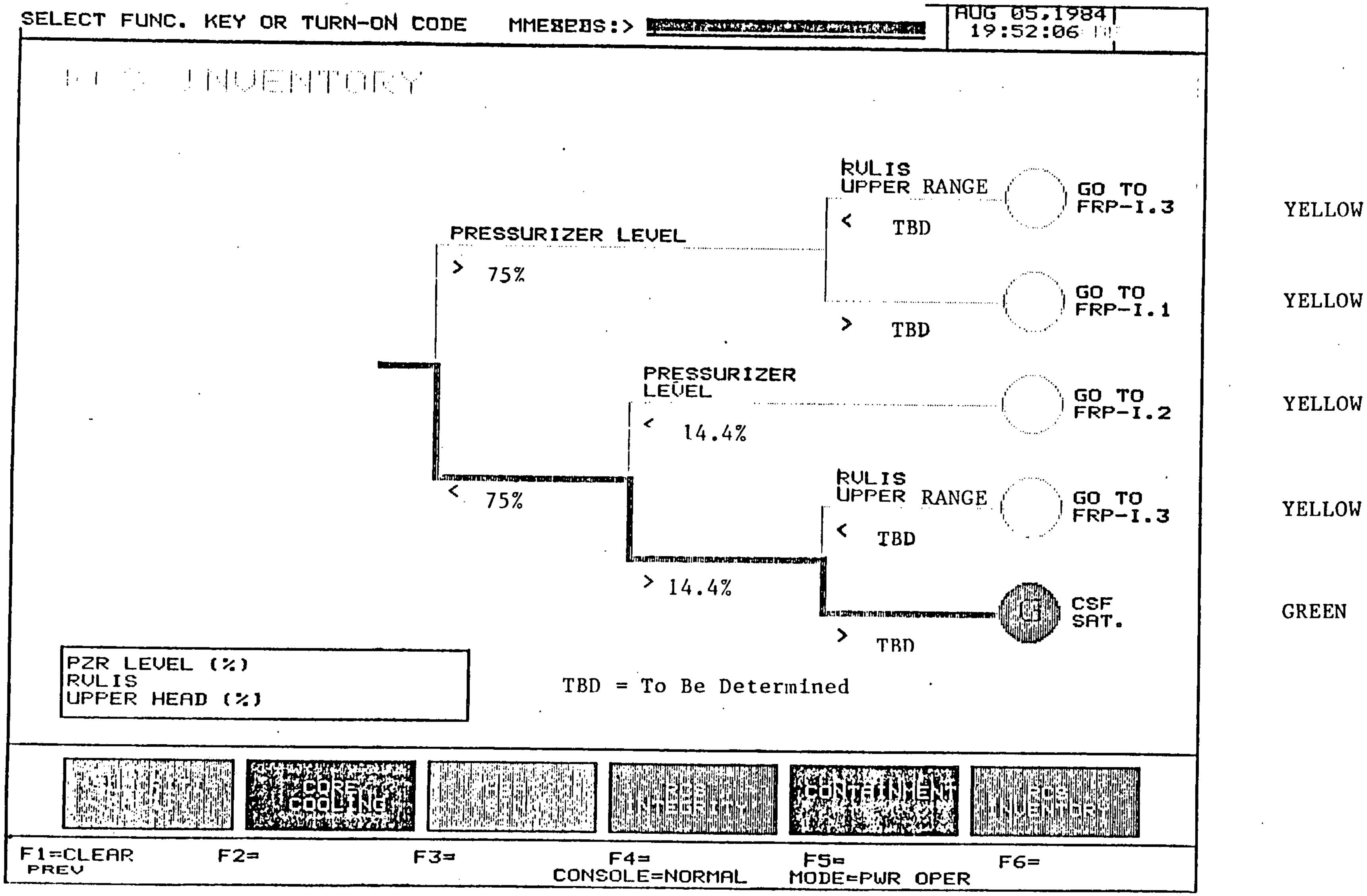


FIGURE 4.6-1

RCS Inventory Critical Safety Function Tree

parameters used in the tree are pressurizer level and RVLIS reading. The function is defined as satisfied if pressurizer level is between the high level reactor trip setpoint and the low level letdown isolation setpoint, and if the RVLIS indicates the upper head is full (i.e., no steam bubble is present in the vessel).

As indicated in the tree, there are four paths which result in a YELLOW condition. If the pressurizer level is high and RVLIS indicates the upper head is full, then there is a problem of excessive inventory in the RCS. If the pressurizer level is high and the RVLIS indicates the presence of a bubble in the upper vessel head region, then the problem is one of having two separate bubbles controlling pressure in the system. If, on the other hand, pressurizer level is low, there is a problem with inadequate inventory in the RCS. If pressurizer level is between the high and low setpoints, but there is RVLIS indication of a bubble, the problem again is one of having two steam bubbles controlling pressure. Each of these four conditions is considered off-normal and coded YELLOW.

In summary, the parameters selected for the RCS Inventory tree are pressurizer level and RVLIS. They give an indication of either excessive inventory, inadequate inventory, or a problem with pressure control. The function is satisfied when pressurizer level is between the high and low setpoints and the RVLIS indicates that the upper vessel head is full.

4.7 TREND AND X-Y PLOTS

The third level displays will provide detailed information about individual parameters which comprise the status trees. These displays will consist of trend plots and X-Y plots of the following key plant parameters.

A. Subcriticality

- Power Range NIS
- Intermediate Range NIS
- Source Range NIS

B. Core Cooling (two 3rd level screens)

- Core Exit Thermocouples
- Subcooling — First Screen
- RCP Status (not trended)

- RVLIS Full Range Level
- RVLIS Dynamic Head Range Level — Second Screen
- RVLIS Upper Range Level

C. Heat Sink (1 screen for each steam generator)

- Narrow Range Level
- Steam Generator Pressure
- Feedwater Flow (display total feedwater flow numerically)

D. RCS Integrity
- Integrity Curve with current low cold leg RTD plotted on the curve
- Display A, B, and C wide range cold leg RTD numerically

E. Containment

- Containment Pressure
- Containment Sump Level
- Containment Radiation (R-32A, R-32B)

F. RCS Inventory

- Pressurizer Level
- RVLIS Upper Range Level

The six critical safety function indicator boxes will appear on all SPDS Trend and X-Y plots.

5. SPDS CRITICAL SAFETY FUNCTION STATUS BLOCKS

Each SPDS display contains along the bottom a row of six boxes, each bearing the name of a critical safety function. These boxes are known as the critical safety function status blocks. The blocks change color to reflect the color-coded status of each critical safety function, either RED, ORANGE, YELLOW, or GREEN.

The logic for changing the color of the status blocks is based on the critical safety function trees and validation of parameters. The SPDS checks the current values for each parameter in the trees, compares these values with the tree setpoints based upon the parameter validation scheme described below, and determines the appropriate path through the tree. As described in the previous section, each path through the trees represents a unique set of plant conditions with a specified priority of response. Based upon this priority, each path is color-coded for status. The SPDS status block for each critical safety function will appear in the same color as the color-coding for the current path through its tree. That is, the status color of the tree is used in the function status block.

5.1 PARAMETER VALIDATION

In order to determine the status of each of the six critical safety functions, the current values of the relevant parameters are checked against the various setpoints in the critical safety function trees. In many cases, there is more than one analog signal for a given parameter. When this is the case, normally the most conservative value is used. In some cases, an averaged value is appropriate. If the parameter is one which is used by the reactor protection system (RPS) or engineered safety features actuation system (ESFAS), the values are combined in a different manner, using the RPS or ESFAS logic. This method is described below.

In the RPS or ESFAS logic, signals are combined in an M out of N coincidence. For example, there are four signals for power range flux, and if two of these signals are above the RPS power range high flux setpoint, the reactor will trip. This is an example of two out of four coincidence. In the

SPDS Subcriticality tree, there is a branch at power range greater than five percent. The SPDS software compares each of the four analog signals for power range flux with the five percent power value. If two or more values are greater than five percent power, the SPDS will consider power range to be greater than five percent, which is a RED condition. If less than two of four are greater than five percent, the criteria for the "power range > 5 percent" path are not met, so the status block will have the color of the path whose selection criteria are completely met.

The SPDS also checks for signals of bad quality. Any signals of bad quality are discarded, and a reduced logic used. For example, if a parameter normally has two of four logic, but one signal is of bad quality, the logic will be reduced to two of three. Listed below is the order in which the SPDS logic will reduce when there are bad quality signals.

2 of 4
2 of 3
1 of 2
1 of 1
0

If there are no signals of good quality, a value for the parameter cannot be determined. In this case, the critical safety function will be given a status color of WHITE, and the tree will be filled in up to the point where the bad quality data occurs.

If a particular SPDS parameter is not included in the RPS or ESFAS, then either the most conservative value or a straight arithmetic average of all available signals will be used to calculate the current value. Instead of comparing each individual signal with the tree setpoint, the most conservative value or the average value will be used to determine the status of the critical safety function.

5.2 ARRANGEMENT OF STATUS BLOCKS AND PRIORITIZATION OF RESPONSE

The six critical safety function status blocks are arranged on the SPDS displays in a hierarchical order, based directly on the barrier

concept. The importance of the function blocks decreases from left to right on the display.

The first barrier to fission product release is the fuel matrix/cladding, the Critical Safety Functions related to this barrier are given the highest priority. Challenges to this barrier can come from inside and outside the barrier. The internal challenge comes from excessive core heat production resulting from fission power production (normal decay heat production is considered in safeguards systems design). Core heat production in excess of safeguard systems core heat removal capability is the most severe challenge to the fuel matrix/cladding barrier. If the core is at power, the energy production represents a potential additional significant challenge to the other barriers which may also be challenged for failed. Consequently, SUBCRITICALITY is the highest priority Critical Safety Function. The external challenges to the fuel matrix/cladding barrier come from inadequate decay heat removal due to either inadequate reactor coolant or secondary coolant. Even though the reactor core is shutdown, failure to remove the thermal energy from decay heat production can rapidly lead to sufficiently high core temperatures to fail the first barrier. CORE COOLING and HEAT SINK are the second and third priority, respectively, Critical Safety Functions.

The second barrier to fission product release is the reactor coolant system pressure boundary. Although challenges can again come from inside and outside, only the internal threats are considered in prioritizing Critical Safety Functions since only they can be addressed by the operator. Potential internal threats due to excessive core heat production and inadequate core heat removal are addressed through the SUBCRITICALITY, CORE COOLING and HEAT SINK Critical Safety Functions. The remaining internal threat to reactor coolant system pressure boundary results from a reactor vessel pressurized thermal shock condition. Such a challenge can result from thermal stresses acting the reactor vessel in a low temperature reactor coolant condition. Reactor Coolant System INTEGRITY is, therefore, the fourth priority Critical Safety Function.

The third barrier, Containment, is analogous to the second barrier in that only internal threats are considered in prioritizing Critical Safety functions. CONTAINMENT is the fifth priority Critical Safety Function.

The sixth priority Critical Safety Function is Reactor Coolant INVENTORY. This Critical Safety Function is actually a subset of the CORE COOLING Critical Safety function but is considered separately to facilitate Status Tree construction and prioritization of challenges. This Critical Safety Function addresses situations wherein reactor coolant inventory is adequate to satisfy the CORE COOLING Critical Safety Function but not within nominal operational limits. The challenges associated with the Reactor Coolant INVENTORY Critical Safety Function are the lowest priority of all Critical Safety Function challenges.

The priority of operator action during an event is determined by the hierarchy of the critical safety functions and by the color-coded status of each function. Functions whose status blocks have been coded RED have the highest priority, followed by ORANGE and YELLOW. The rules for operator response are as follows:

1. If any RED terminus is encountered, the operator is required to immediately stop any procedure in progress, and perform the procedure required by the terminus.

2. If during the performance of any RED-condition procedure, a RED-condition of higher priority arises, then the higher priority condition should be addressed first, and the lower priority RED-condition procedure suspended.

3. If any ORANGE terminus is encountered, the operator is expected to monitor all of the remaining trees, and then, if no RED condition is encountered, suspend any procedure in progress and perform the procedure required by the ORANGE terminus.

4. If during the performance of an ORANGE-condition procedure, any RED-condition or higher priority ORANGE-condition arises, then the RED or higher priority ORANGE-condition is to be addressed first, and the original ORANGE-condition procedure suspended.

5. Once a procedure is entered due to a RED or ORANGE condition, that procedure is performed to completion, unless pre-empted by some higher priority condition.

6. A YELLOW terminus does not require immediate operator attention. Frequently, it is indicative of an off-normal and/or temporary condition which will be restored to normal status by actions already in progress. In other cases, the YELLOW status might provide an early indication of a developing RED or ORANGE condition. A YELLOW might also indicate a residual off-normal condition following completion of actions required by a procedure for a RED or ORANGE condition. The operator is allowed to decide whether or not to implement any YELLOW condition procedure.

7. Status tree monitoring should be continuous if any ORANGE or RED condition is found to exist. If no condition more serious than YELLOW is encountered monitoring frequency may be reduced to 10-20 minutes unless some significant change in plant status occurs.

For example, a RED in Core Cooling is more important that a RED in Heat Sink, due to the hierarchy of the critical safety functions. However, a RED in Heat Sink is more important than any ORANGE, due to the hierarchy of the color codes. As an example of item 4, if the operator is performing the function restoration guideline for a RED Heat Sink when the Subcriticality block turns RED, he must leave the Heat Sink guideline and respond immediately to the threat to Subcriticality. If Core Cooling is ORANGE when RCS Integrity turns RED, the operator must leave Core Cooling and respond to RCS Integrity because any RED condition is more serious than any ORANGE condition.

5.3 STATUS BLOCKS AND PLANT SAFETY

To maintain H. B. Robinson Unit 2 plant in a safe state, it is necessary to keep the barriers to the release of radioactive material intact. It has been shown how the set of critical safety functions relate to the barriers, and that satisfying the functions will maintain the integrity of the barriers. The SPDS critical safety function status blocks provide a quick

and easy way to determine if any of the critical safety functions are threatened. The operator can then examine the trees for the threatened functions, determine the nature of the threat, and be directed to the appropriate function restoration procedure. Since the trees provide accurate information on the status of each function, and satisfying the functions results in a safe plant, the SPDS provides an accurate and timely determination of the safety status of the plant.

6. EXAMPLES OF SPDS RESPONSE TO TRANSIENTS

It has been shown that the SPDS is designed to provide the operator with accurate information concerning the safety status of the plant. The function of the SPDS during six major classes of events is discussed in this section. Emphasis is on the color of the CSF status blocks at points during the postulated events. Operator response to threatened functions should be accomplished based on the rules discussed in Section 5.2. Information for this section is taken from the H. B. Robinson Unit 2 Updated FSAR, Chapter 15 (Accident Analysis).

In Chapter 15 of the Updated FSAR, six major classes of events are discussed:

1. Increases in heat removal by the secondary system

2. Decreases in heat removal by the secondary system

3. Decreases in RCS flow rate

4. Reactivity and power distribution anomalies

5. Increase in reactor coolant inventory

6. Decrease in reactor coolant inventory

One event of each type is examined in this section.

6.1 STEAM SYSTEM PIPING FAILURE

The steam release arising from a rupture of a main steam line would result in an initial increase in steam flow which decreases during the accident as the steam pressure falls. The energy removal from the Reactor Coolant System (RCS) causes a reduction of reactor coolant temperature and pressure. In the presence of a negative moderator temperature coefficient, the cooldown results in an insertion of positive reactivity. If the most

reactive rod cluster control assembly (RCCA) is assumed stuck in its fully withdrawn position after reactor trip, there is an increased possibility that the core will become critical and return to power. A return to power following a steam line rupture is a potential problem mainly because of the high power peaking factors which exist assuming the most reactive RCCA to be stuck in its fully withdrawn position. The core is ultimately shut down by the boric acid injection delivered by the Safety Injection System.

Figures 6.1-1 through 6.1-4 provide data for this event. During the first 140 seconds, the critical safety function status codes are expected to be:

Subcriticality	- RED
Core Cooling	- GREEN
Heat Sink	- YELLOW
RCS Integrity	- GREEN
Containment	- GREEN, YELLOW or ORANGE
RCS Inventory	- YELLOW

Subcriticality will initially be RED. Following the steam line rupture, the reactor will be tripped and power will initially drop below five percent. However, the cooldown will result in a positive reactivity insertion and thus a positive intermediate range startup rate. About 15 seconds into the event reactor power enters the power range and exceeds 5 percent power. The operator will be directed to function restoration guideline FRP-S.1 which calls for initiation of boration and isolation of the faulted steam line. Boration will begin automatically due to actuation of the Safety Injection System. As boron enters the core, the status of Subcriticality will shift back to GREEN.

The Core Cooling function is satisfied because of the low RCS temperature and adequate subcooling. Although the initial cooldown rate will be greater than 100°F per hour, RCS Integrity will also be satisfied because RCS temperature will remain above T_2 on the Operational Limits Plot (Figure 4.4-2).

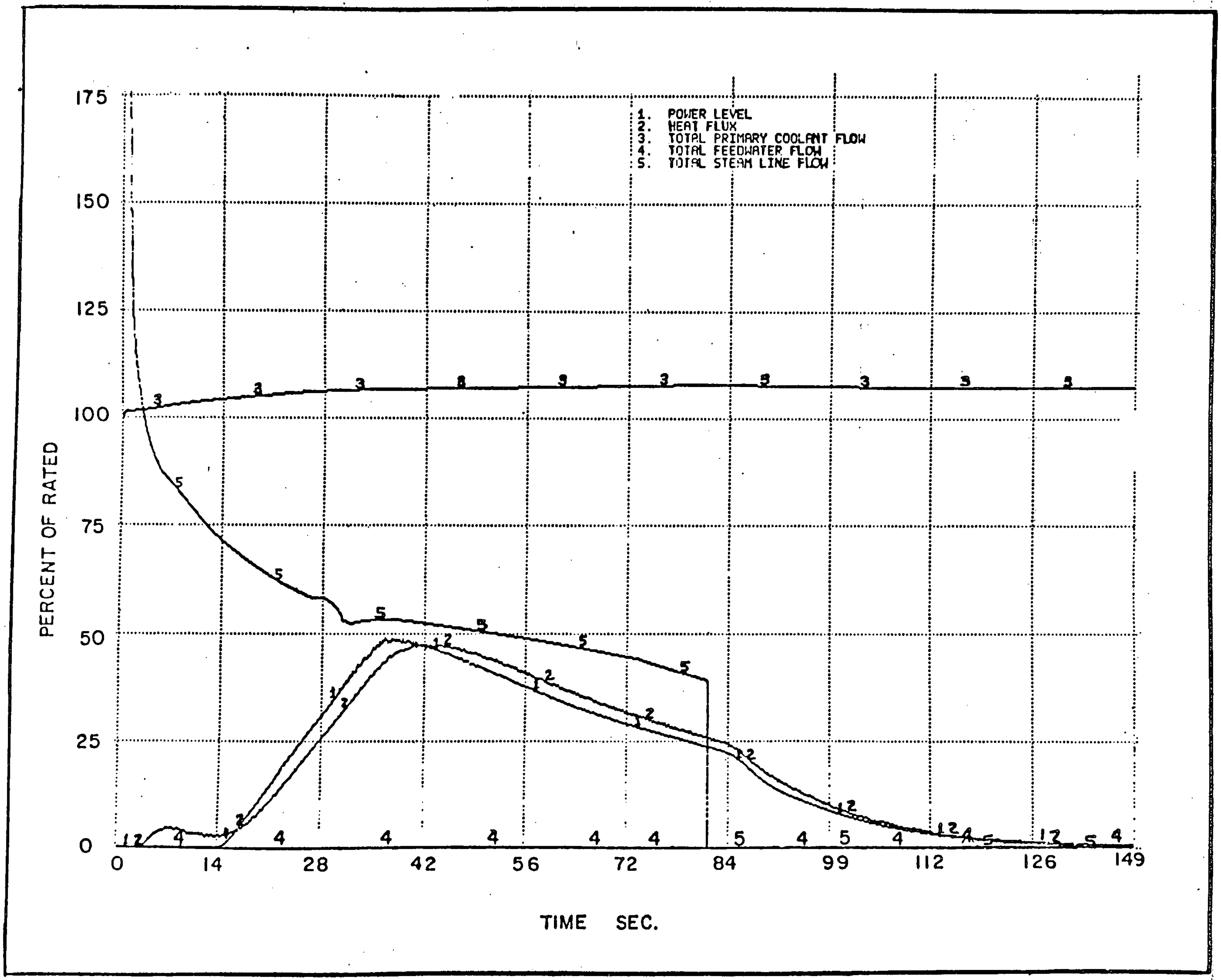


Figure 6.1-1

STEAM LINE BREAK

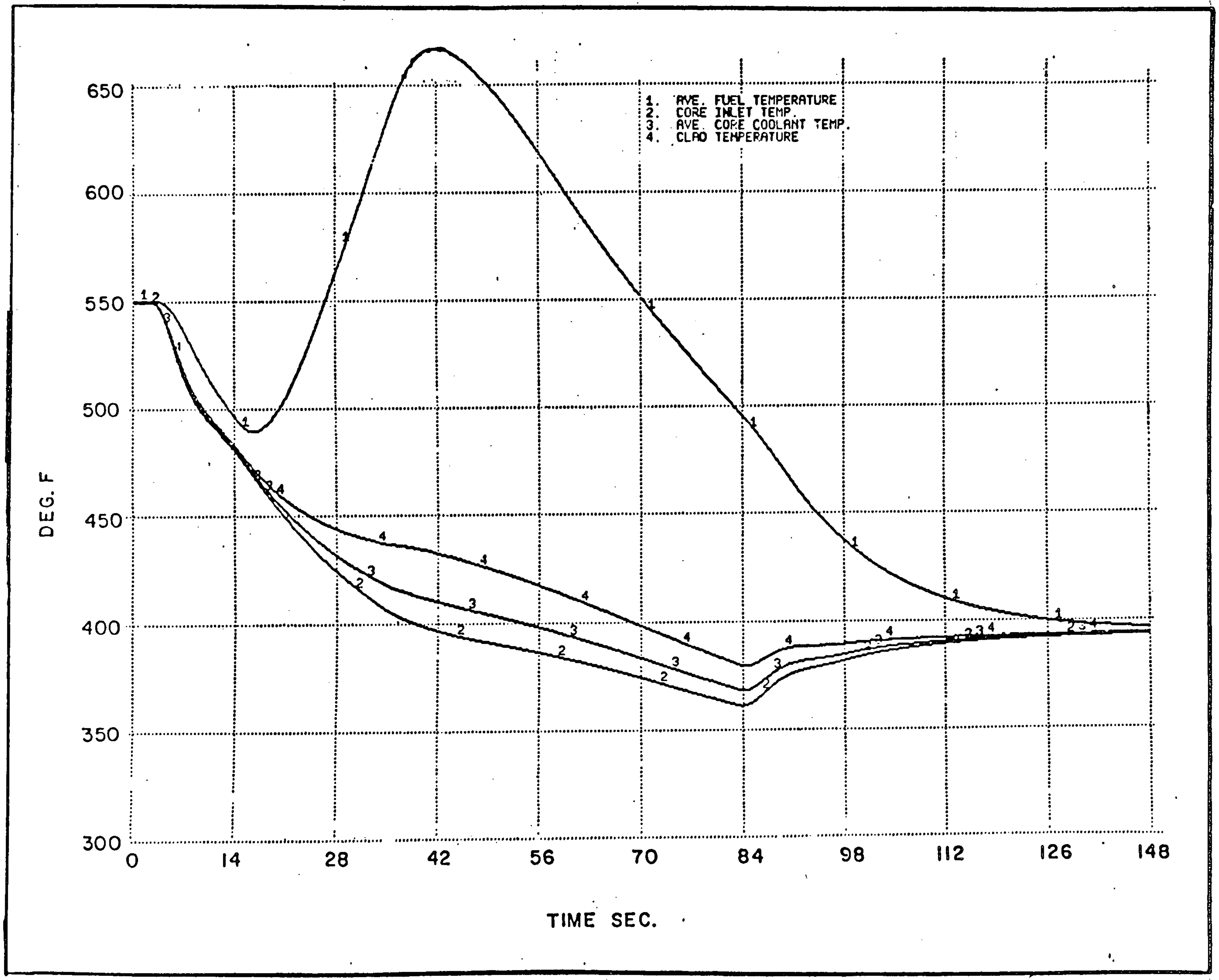


Figure 6.1-2

STEAM LINE BREAK

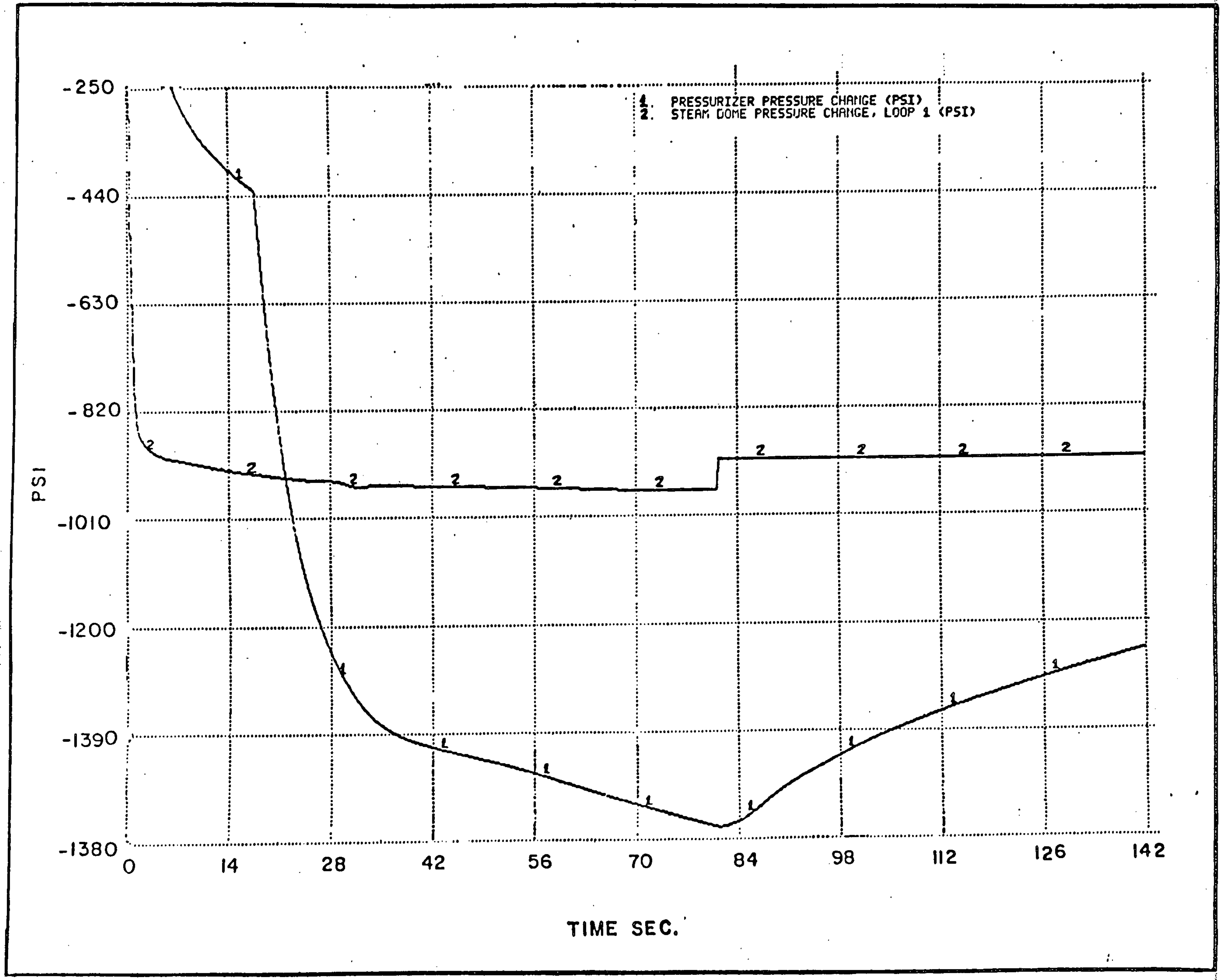


Figure 6.1-3
STEAM LINE BREAK

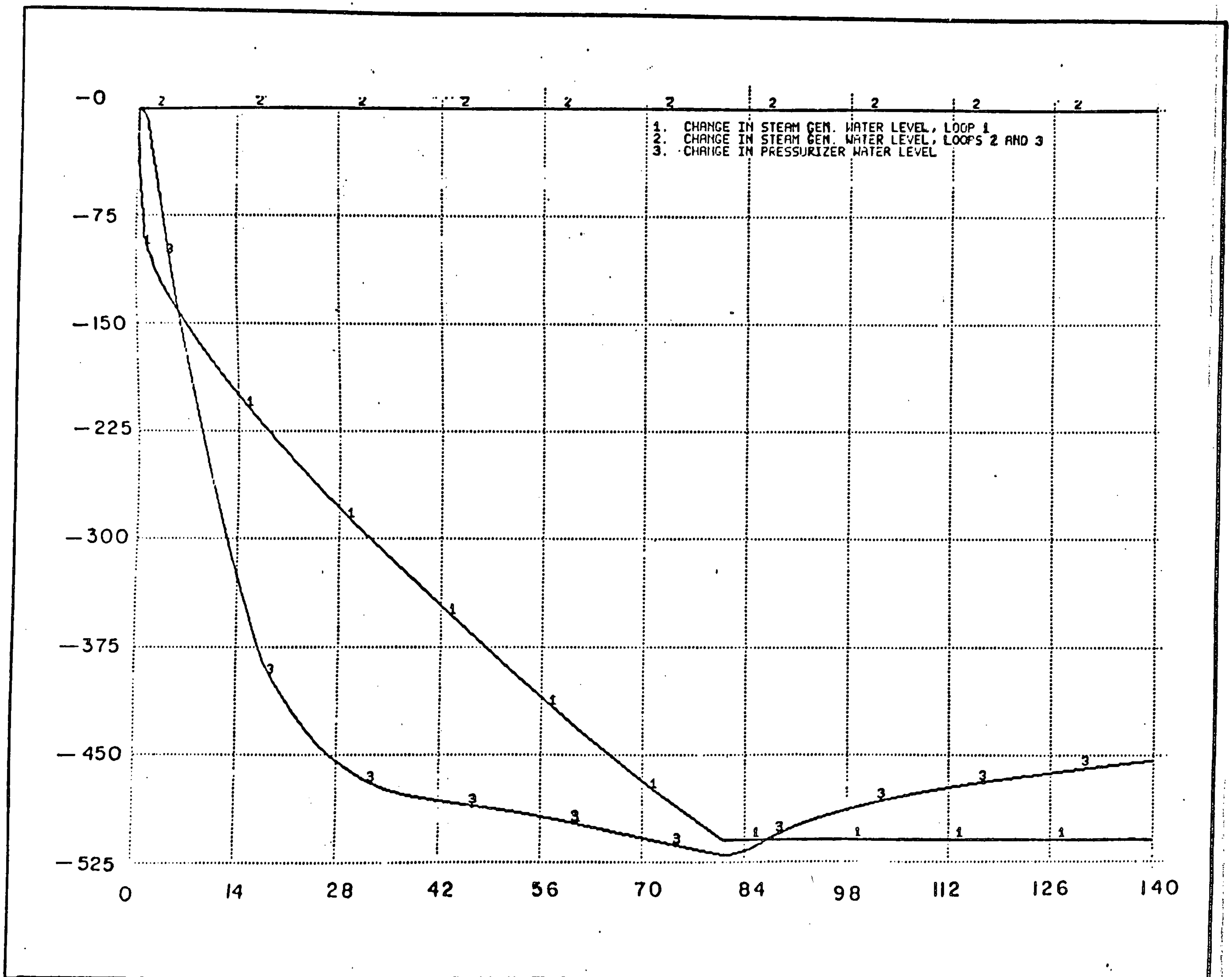


Figure 6.1-4

STEAM LINE BREAK

Heat Sink will be YELLOW because of low level in the faulted steam generator. FRP-H.5 directs the operator to determine the cause of the low level, which is an uncontrolled steam release. He is then directed to the Loss of Secondary Coolant guideline. Containment pressure may exceed the Hi-Hi setpoint, resulting in a ORANGE status. FRP-J.1 directs the operator to check containment isolation, containment spray system, emergency fan coolers, and hydrogen concentration. If pressure does not exceed Hi-Hi, Containment status may still be YELLOW due to high radiation. If the steam break is outside the containment, containment status should be GREEN. RCS Inventory will be YELLOW because of low pressurizer level. Automatic injection by the Safety Injection System will restore this function.

6.2 LOSS OF NORMAL FEEDWATER

A loss of normal feedwater (from a pipe break, pump failures, valve malfunctions, or loss of offsite AC power) results in a reduction in capability of the secondary system to remove the heat generated in the reactor core. If an alternative supply of feedwater were not supplied to the plant, core residual heat following reactor trip would heat the Reactor Coolant System water to the point where water relief from the pressurizer would occur, resulting in a substantial loss of water from the RCS. Since the plant is tripped well before the steam generator heat transfer capability is reduced, the reactor coolant system variables never approach a departure from nucleate boiling (DNB) condition.

The following events occur upon loss of normal feedwater (assuming main feedwater pump failures or valve malfunctions).

a. As the steam pressure rises following reactor and turbine trips, the steam generator power-operated relief valves are automatically opened to the atmosphere. Steam dump to the condenser is assumed not to be available. If the steam flow rate through the power-operated relief valves is not available, the steam generator self-actuated safety valves will lift to dissipate the sensible heat of the fuel and reactor coolant plus the residual decay heat produced in the reactor.

b. As the no-load temperature is approached, the steam generator power-operated relief valves (or the self-actuated safety valves, if the power-operated relief valves are not available) are used to dissipate the residual decay heat and to maintain the plant at the hot standby condition.

The reactor is protected by a trip on low-low water level in any steam generator. The Auxiliary Feedwater System is started automatically to provide makeup to the steam generator.

Figure 6.2-1 provides data for this event. After Reactor trip occurs, causing an initial decrease in most parameters, RCS temperature (and pressure) then increase until total heat generation (core decay heat plus pump heat) decreases to the auxiliary feedwater heat removal capacity.

During this time, all critical safety functions are expected to remain GREEN, except for Heat Sink which may initially be RED, if the loss of normal feedwater causes all steam generator levels to decrease out of the narrow range. FRP-H.1 directs the operator to initiate auxiliary feedwater flow, which should occur automatically. If at least one steam generator level stays in the narrow range, the status of the Heat Sink function will be no worse than YELLOW, due to high steam generator pressure. FRP-H.2 directs the operator to release steam from the affected steam generators.

Subcriticality remains GREEN because once a reactor trip is initiated neutron flux will drop at a normal rate into the source range. Core Cooling is satisfied because RCS subcooling stays within range. (Subcooling may briefly go out of range, resulting in a YELLOW status.) RCS Integrity is satisfied because there is no rapid cooldown and temperature stays above the T_2 setpoint. Release of steam from the steam generators is not expected to affect the Containment function, and RCS Inventory is satisfied because pressurizer level stays between the setpoints and no bubble is expected to form in the vessel head. (Towards the end of the time line, pressurizer level may increase above the high level setpoint, resulting in a YELLOW status.)

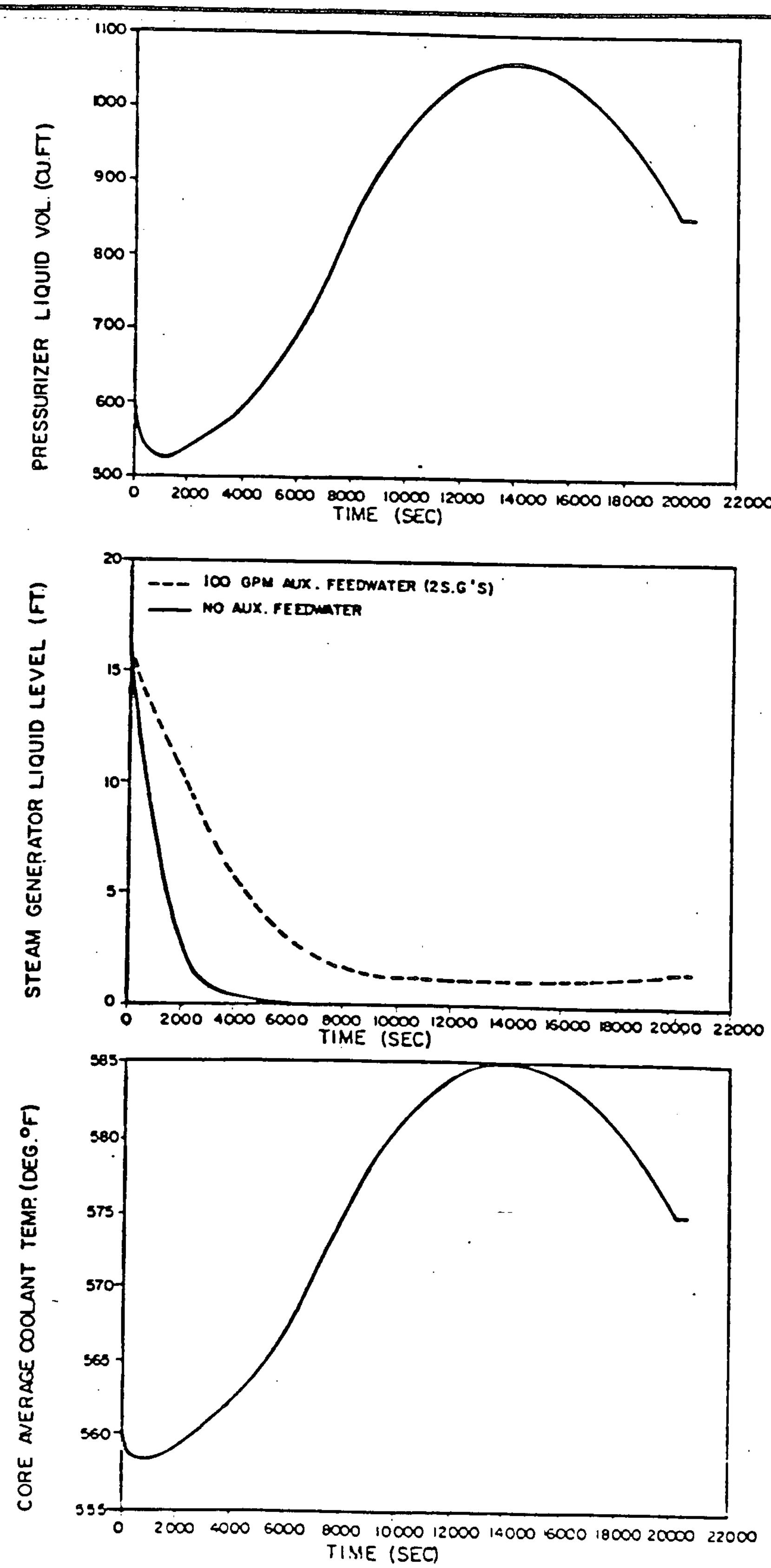


Figure 6.2-1

LOSS OF NORMAL FEEDWATER

6.3 COMPLETE LOSS OF FORCED REACTOR COOLANT FLOW

A complete loss of forced reactor coolant flow may result from a simultaneous loss of electrical supplies to all reactor coolant pumps. If the reactor is at power at the time of the accident, the immediate effect of loss of forced reactor coolant flow is a rapid increase in the reactor coolant temperature. This increase could result in DNB with subsequent fuel damage if the reactor were not tripped promptly.

Reactor trip will occur on either low voltage on reactor coolant pump power supply bus, or on pump circuit breaker opening, or on low reactor coolant loop flow. An underfrequency condition will trip the Reactor Coolant Pump circuit breakers which in turn trips the reactors.

It is assumed that the reactor is tripped sufficiently fast to ensure that the ability of the reactor coolant to remove heat from the fuel is not greatly reduced. Thus, the average fuel and clad temperatures do not increase significantly above their respective initial values.

Because a fast trip is assumed, Subcriticality should remain GREEN. Core Cooling may go to YELLOW, or ORANGE, depending on how high the RCS temperature goes and whether RCS subcooling decreases below the tree setpoint. The conditions for Core Cooling going RED (e.g., core exit TCs greater than 1200°F) are not expected to occur. Since this event does not involve a rapid cooldown, RCS Integrity will stay GREEN. The increase in RCS temperature will result in high steam generator pressures, so Heat Sink may go to YELLOW. Containment and RCS Inventory status should remain GREEN.

6.4 UNCONTROLLED ROD CLUSTER CONTROL ASSEMBLY BANK WITHDRAWAL AT POWER

Uncontrolled RCCA bank withdrawal at power results in an increase in the core heat flux. Since the heat extraction from the steam generator lags behind the core power generation until the steam generator pressure reaches the power-operated relief or safety valve setpoint, there is a net increase in the reactor coolant temperature. Unless terminated by manual or automatic action, the power mismatch and resultant reactor coolant temperature rise could eventually result in DNB. Therefore, in order to avert damage to the

fuel clad, the Reactor Protection System is designed to terminate any such transient before the DNBR falls below the analysis limit.

The automatic features of the Reactor Protection System which prevent core damage following the postulated accident include the following:

a. Power range neutron flux instrumentation actuates a reactor trip if two out of four channels exceed an overpower setpoint.

b. Reactor trip is actuated if any two out of three Δ T channels exceed an overtemperature Δ T setpoint. This setpoint is automatically varied with power distribution, reactor coolant temperature and pressure to protect against DNB.

c. Reactor trip is actuated if any two out of three Δ T channels exceed an overpower Δ T setpoint. This setpoint is automatically varied with power distribution to ensure that the allowable fuel power rating is not exceeded.

d. A high pressurizer pressure reactor trip activated from any two out of three pressure channels, which is set at a fixed point. This pressure is less than the set pressure for the pressurizer safety valves.

For this event, all critical safety functions are expected to remain GREEN. The high neutron flux and overtemperature Δ T trips occur before core heat flux and RCS temperature can increase significantly, for a wide range of possible reactivity insertion rates. The reactor is tripped sufficiently fast to ensure that the ability of the reactor coolant to remove heat from the fuel rods is not reduced.

6.5 DELETED

6.6 LARGE LOSS OF COOLANT ACCIDENT

A loss-of-coolant accident (LOCA) is the result of a pipe rupture of the Reactor Coolant System (RCS) pressure boundary. A major pipe break (large break) is defined as a rupture with a total cross sectional area equal to or greater than 1.0 ft^2. Should a major break occur, depressurization of the RCS results in a pressure decrease in the pressurizer. The reactor trip signal subsequently occurs when the pressurizer low pressure trip setpoint is reached. A safety injection actuation signal is generated when the appropriate setpoint (high containment pressure) is reached. These countermeasures limit the consequences of the accident in two ways:

a. Reactor trip and borated water injection complement void formation in causing rapid reduction of power to a residual level corresponding to fission product decay heat.

b. Injection of borated water provides for heat transfer from the core and prevents excessive clad temperatures.

Before the break occurs, the unit is in an equilibrium condition, i.e., the heat generated in the core is being removed via the secondary system. During blowdown, heat from fission product decay, hot internals and the vessel continues to be transferred to the reactor coolant. At the beginning of the blowdown phase, the entire RCS contains subcooled liquid which transfers heat from the core by forced convection with some fully developed nucleate boiling. Thereafter, the core heat transfer is unstable with both nucleate boiling and film boiling occurring. As the core becomes uncovered, both turbulent and laminar forced convection and radiation are considered as core heat transfer mechanisms.

The heat transfer between the Reactor Coolant System and the secondary system may be in either direction depending on the relative temperatures. In the case of continued heat addition to the secondary, secondary system pressure increases, and the main steam safety valves may actuate to limit the pressure. Make-up water to the secondary side is automatically provided by the Auxiliary Feedwater System. The safety injection actuation signal isolates the steam generators from normal feedwater

flow and initiates emergency flow from the Auxiliary Feedwater System. The secondary flow aids in the reduction of reactor coolant system pressure.

When the Reactor Coolant System depressurizes to 600 psia, the accumulators begin to inject borated water into the reactor coolant loops. Since the loss of off-site power is assumed, the reactor coolant pumps are assumed to trip at the inception of the accident. The effects of pump coastdown are included in the blowdown analysis.

The blowdown phase of the transient ends with the RCS pressure (initially assumed at 2250 psia) falls to a value approaching that of the containment atmosphere. Prior to or at the end of the blowdown, some amount of injection water begins to enter the reactor vessel lower plenum. At this time (called end of bypass) refill of the reactor vessel lower plenum begins. Refill is complete when emergency core cooling water has filled the lower plenum of the reactor vessel which is bounded by the bottom of the fuel rods (called bottom of core recovery time).

The reflood phase of the transient is defined as the time period lasting from the end of refill until the reactor vessel has been filled with water to the extent that the core temperature rise has been terminated. From the later stage of blowdown and the beginning of reflood, the safety injection accumulator tanks rapidly discharge borated cooling water into the RCS, contributing to the filling of the reactor vessel downcomer. The downcomer water elevation head provides the driving force required for the reflooding of the reactor core. The RHR (low head) and charging (high head) pumps aid the filling of the downcomer and subsequently supply water to maintain a full downcomer and complete the reflooding process.

Continued operation of the ECCS pumps supplies water during long-term cooling. Core temperatures have been reduced to long-term steady state levels associated with dissipation of residual heat generation. After the water level of the refueling water storage tank (RWST) reaches a minimum allowable value, coolant for long-term cooling of the core is obtained by switching from the injection mode to the cold leg recirculation mode of operation in which spilled borated water is drawn from the containment sumps by the pumps and returned to the RCS cold legs. The Containment Spray System continues to operate to further reduce containment pressure. Approximately 24

hours after initiation of the LOCA, the ECCS is realigned to supply water to the RCS hot legs in order to control the boric acid concentration in the reactor vessel.

Figures 6.6-1 through 6.6-4 provide data for a large LOCA. The expected critical safety function status codes are:

Subcriticality	- GREEN or YELLOW
Core Cooling	- RED or ORANGE
Heat Sink	- YELLOW
RCS Integrity	- Dependent on mixing.
Containment	- ORANGE
RCS Inventory	- YELLOW

Following the blowdown phase of LOCA, the reactor will be shutdown, with or without the control rods, due to the absence of moderating water. During the reflood phase as borated water is injected, the reactor will remain shutdown by the combination of control rods and boron. However, with the addition of a moderator (water) to the core, there may be periods of increase in subcritical neutron multiplication, resulting in a YELLOW status.

Core Cooling may be RED because core exit temperatures might exceed 1200^{o}F during the early stages of the LOCA. On Figure 4.2-1 this corresponds to the top path of the status tree. The status may also be RED if offsite power is assumed lost, with conditions corresponding to the second path of the tree. These conditions are low subcooling, no reactor coolant pumps operating, core exit temperature greater than 700^{o}F, and low reactor vessel level. Continued injection will lower temperature and increase level, resulting in ORANGE and eventually YELLOW status.

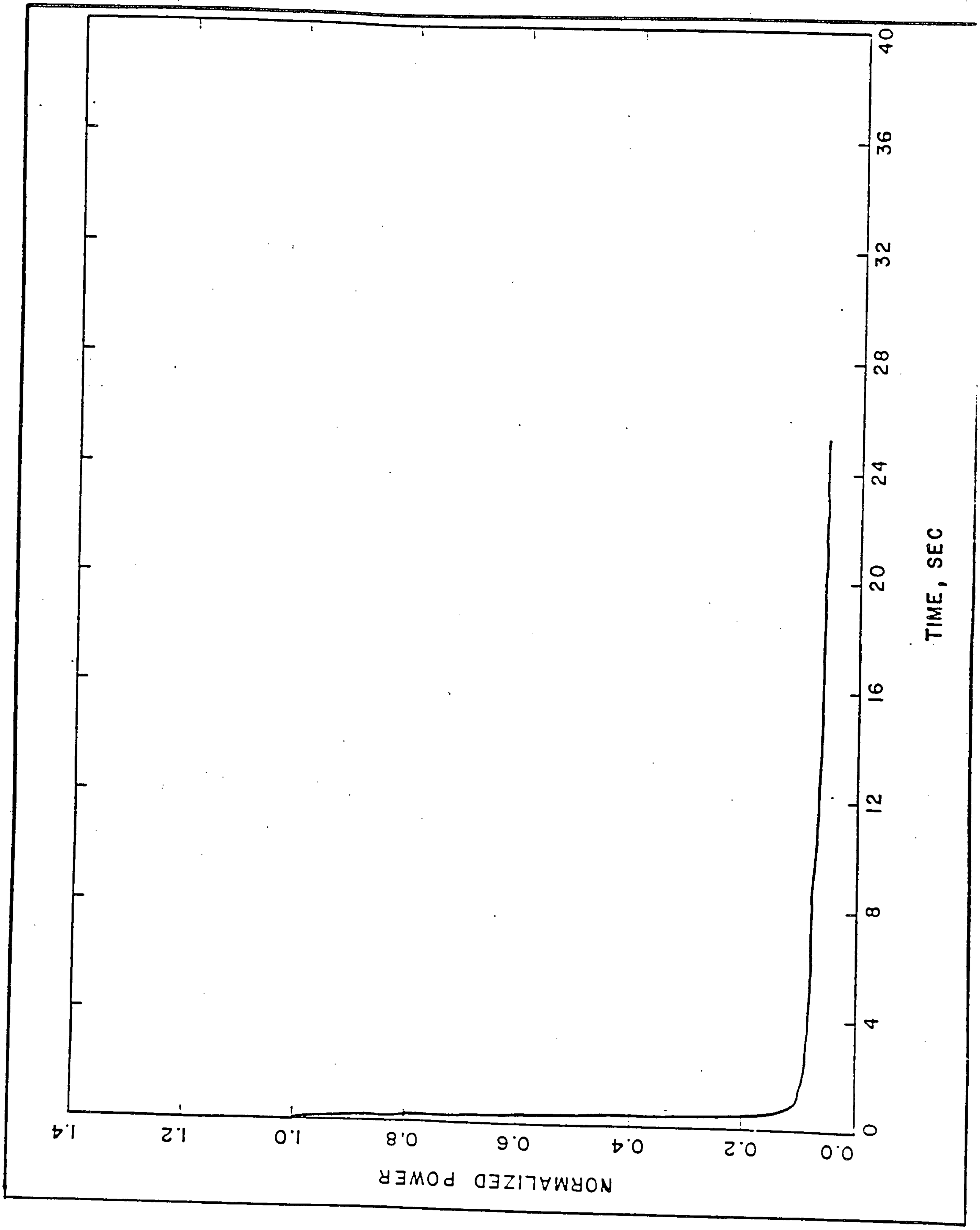
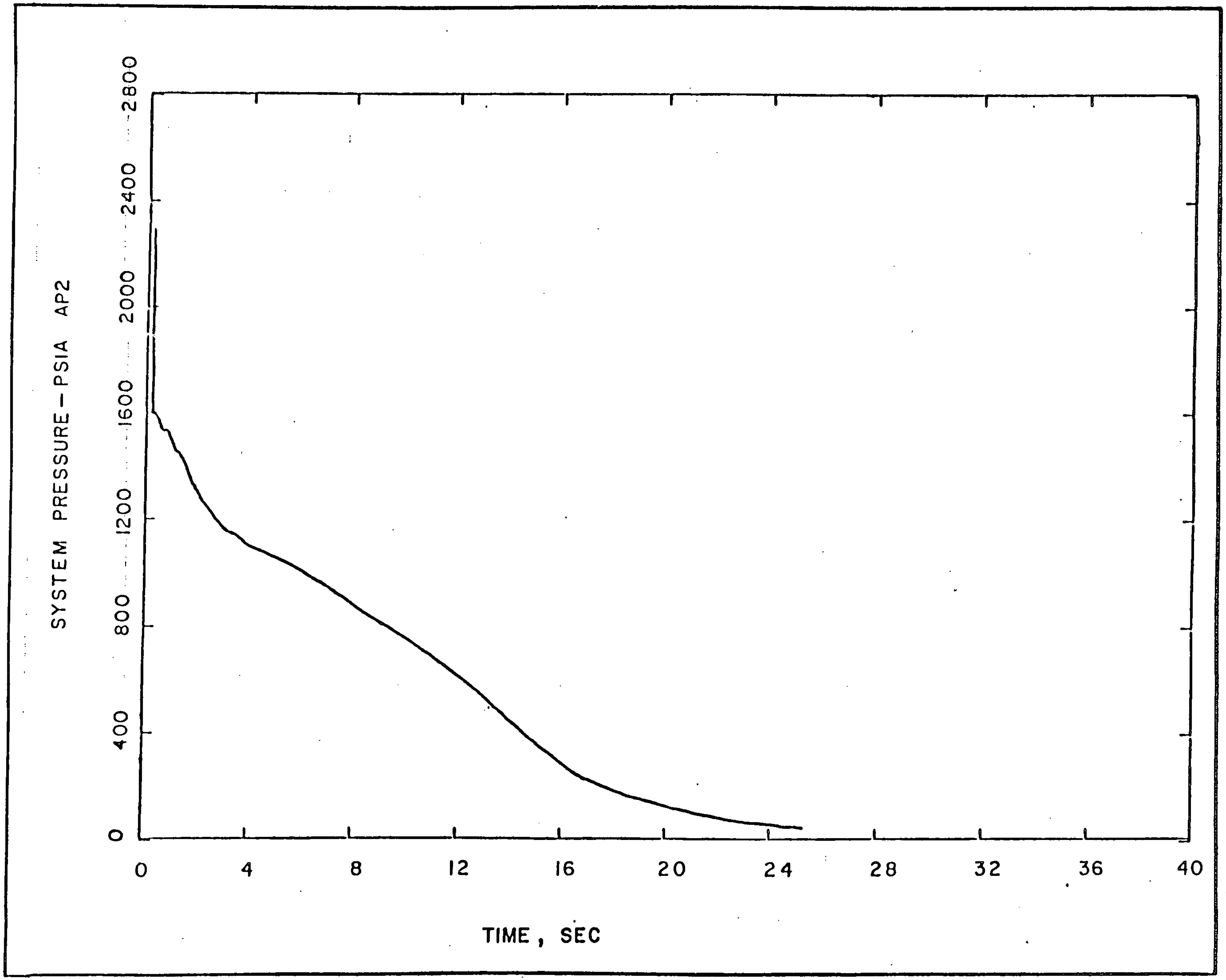


Figure 6.6-1

LOSS OF COOLANT ACCIDENT

Figure 6.6-2


SYSTEM PRESSURE – PSIA AP2
0
400
800
1200
1600
2000
2400
2800
TIME, SEC
0
4
8
12
16
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24
28
32
36
40

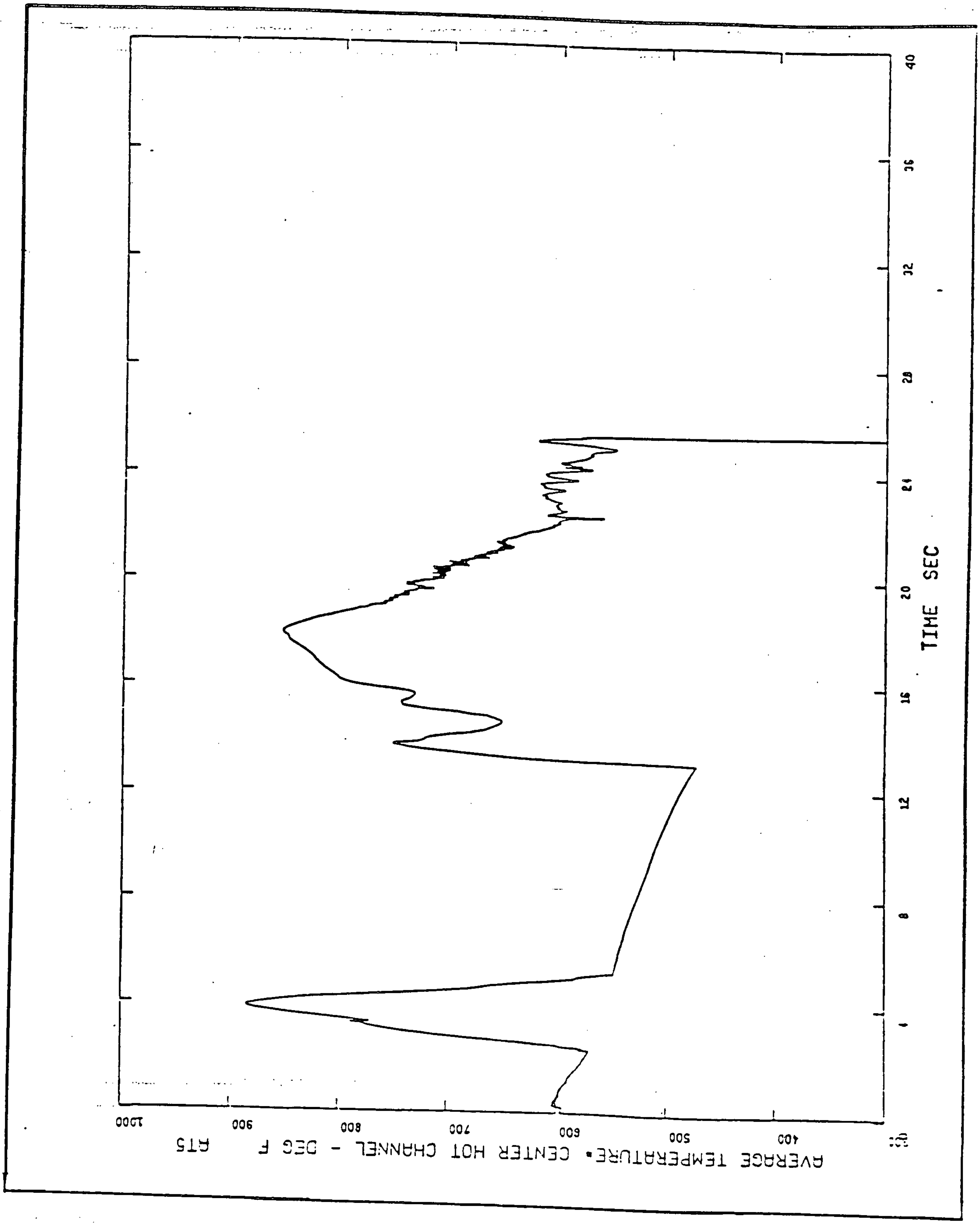

Figure 6.6-3

LOSS OF COOLANT ACCIDENT

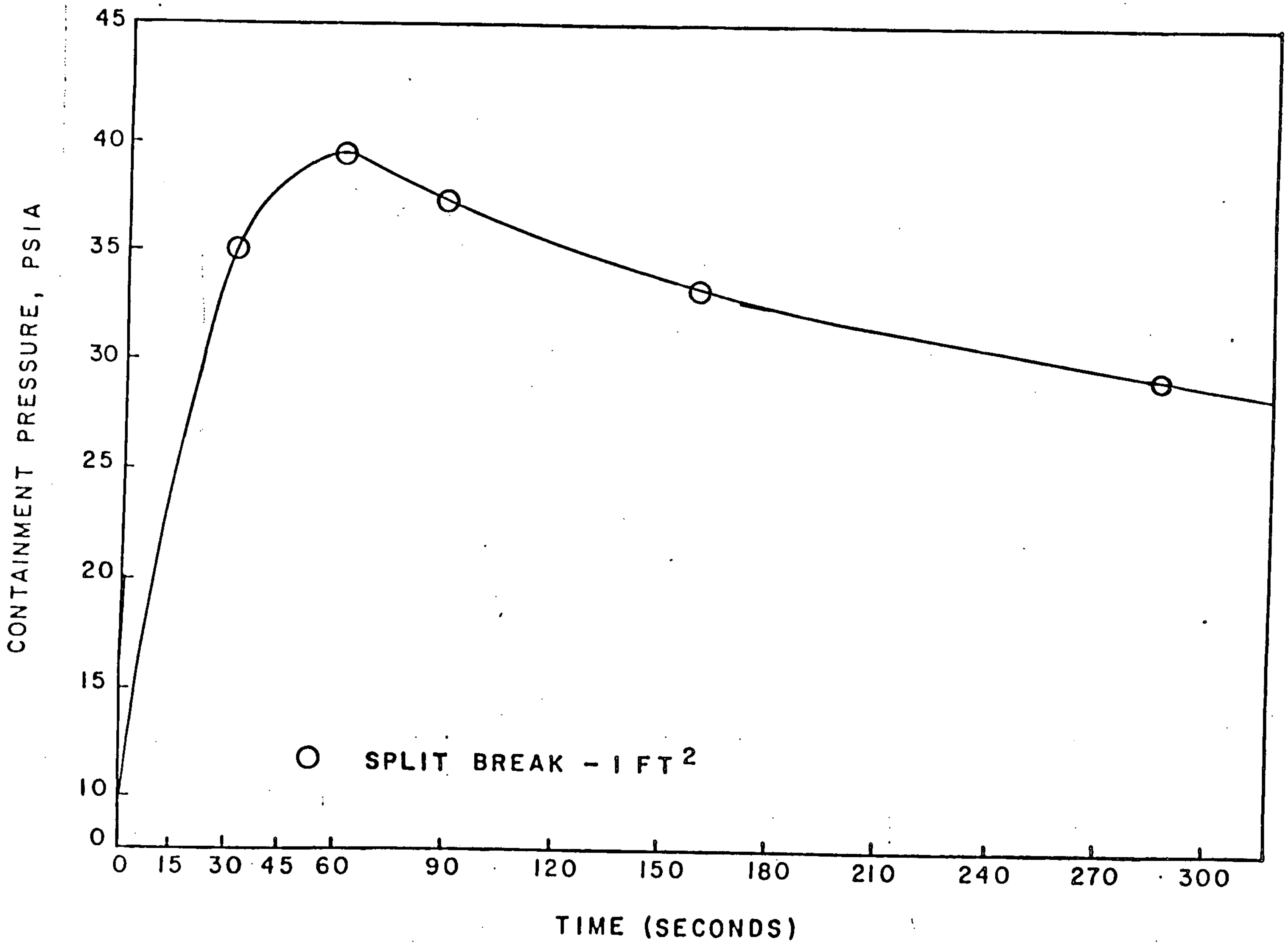

Figure 6.6-4

LOSS OF COOLANT ACCIDENT

The RCS Integrity status tree is concerned only with overpressurization or rapid cooldown of the RCS. Incomplete mixing of the cold injected water with the hot water in the RCS, particularly with no reactor coolant pumps running, may result in cold leg temperatures indicating a challenge to reactor vessel integrity. The priority system (core cooling higher than vessel integrity) will prevent the initiation of action to insure vessel integrity until adequate core cooling is assumed. Thus, the priority system prevents premature integrity actions such as securing Safety Injection.

Secondary system pressure may increase to the safety valve setpoints during blowdown. This would cause the Heat Sink status to become YELLOW. Containment status will be ORANGE due to pressure exceeding the Hi-Hi setpoint. From Figure 6.6-4, it can be seen that pressure will not exceed the H. B. Robinson Unit 2 design pressure of 42 psig, so the status will not become RED. RCS Inventory status will be YELLOW due to low pressurizer level.

The function restoration procedures to which the operator will be directed deal mainly with initiation of systems which should be automatically actuated by the Engineered Safety Features Actuation System, e.g., the Safety Injection System and Containment Spray. Other tasks include making sure the accumulator isolation valves are open, re-aligning the SIS to cold leg recirculation when the RWST water level becomes low, switching over to RHR heat removal, and checking containment hydrogen concentration.

Carolina Power & Light

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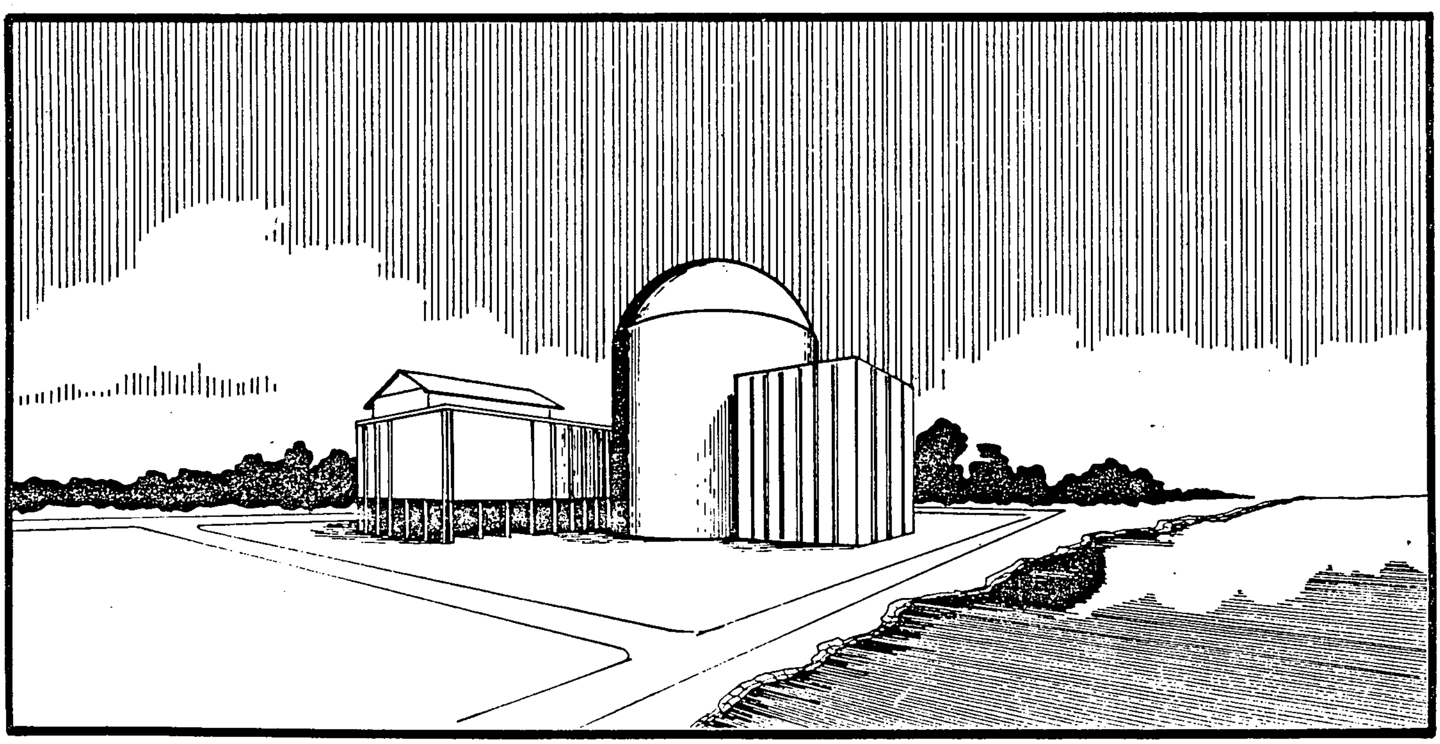
SPEC NO. L2-E-022
PROJECT NO. 1-319-25-892-XX

CAROLINA POWER & LIGHT
Emergency Response Facility Information System
H. B. Robinson Steam Electric Plant Unit 2

SYSTEMS OVERVIEW DOCUMENT – REVISION C

DOCUMENT NO. 501-8207500-25



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Emergency Response Facility Information System
H. B. Robinson Steam Electric Plant Unit 2

SYSTEMS OVERVIEW DOCUMENT – REVISION C

DOCUMENT NO. 501-8207500-25

OCTOBER 26, 1984

Technical Review

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CHAPTER 1

INTRODUCTION

This document provides a high-level description of the Emergency Response Facility Information System (ERFIS) to be developed/delivered by Science Applications International Corporation (SAIC) for the Carolina Power and Light Company's (CP&L) H. B. Robinson Steam Electric Plant - Unit 2. The system reflects the hardware/software specifications and requirements as described in CP&L's Functional Specification Document No. L2-E-022 and SAIC's Technical Proposal No. 1-314-71-840-01.

1.1 ERFIS SYSTEM OVERVIEW

The ERFIS is a realtime data collection, monitoring, and display system. The system acquires data inputs from various plant subsystems/instrumentation. These inputs are then processed and made available for interactive display and hardcopy logging/reporting.

Analog and digital inputs to the ERFIS originate from the existing Westinghouse P250 I/O cabinets and various field sensors located throughout the plant. The "raw-data" inputs are first scanned and pre-processed by the ERFIS Data Acquisition Subsystem (DAS) front-end hardware, and are then routed to the ERFIS host computer for processing. Data inputs from the Meteorological Data Tower are acquired by the ERFIS host computer via an inter-computer data communication link.

The ERFIS host computer system validates the point data inputs, and performs all processing associated with engineering-unit conversion, alarm monitoring, data quality tagging, historical

data archival retrieval, and "calculated" Point processing. The processed Point-data values are maintained in the system's data base for access, display, performance calculations, alarming, and/or hardcopy output upon operator request.

The ERFIS system is a fully-redundant hardware/software configuration. One system is designated as the "primary" system; the other as the "backup" system. During normal operation, the primary system performs all required ERFIS functions. In the event of a major failure of the primary hardware/software system components, failover occurs automatically to the backup system. Failover to the backup system may also be accomplished manually upon operator command.

1.2 REFERENCES

DOCUMENT NO.	TITLE	DATE
L2-E-022	Functional Specification for the H.B. Robinson Steam Electric Plant Unit 2 ERFIS	2 March 84
1-314-71-840-01	Technical Proposal for Emergency Response Facility Information System and Plant Upgrade for the Robinson Nuclear Power Plant	18 Aug 83

1.3 ORGANIZATION OF DOCUMENT

The remainder of this document is organized as follows:

- o Chapter 2 - ERFIS Hardware Overview
- o Chapter 3 - ERFIS Software Overview

- o Chapter 4 - ERFIS Hardware/Software Documentation
- o Chapter 5 - Implementation Concept

CHAPTER 2

ERFIS HARDWARE OVERVIEW

This chapter provides an overview of the ERFIS hardware to be delivered for the CP&L Robinson ERFIS system.

The ERFIS hardware consists of three (3) major subsystems:

- o Data Acquisition Subsystem Hardware
- o Computer Subsystem Hardware
- o Display Subsystem Hardware.

The Data Acquisition Hardware includes the remote multiplexer cabinets, fiber optic communication links, and Data Concentrators. All are provided by Computer Products Inc.. The Computer System Hardware is based around two model SEL 32/6780 computers provided by Gould SEL. The Display Hardware is based around Model 2312 color graphic display units supplied by Industrial Data Terminals (IDT).

Figure 2-1 shows a block diagram of the ERFIS hardware.

2.1 DATA ACQUISITION HARDWARE

The Data Acquisition Hardware consists of remote multiplexers in the cable spreading room of the Robinson plant. In addition, redundant Data Concentrators are located in the computer room in the TSC/EOF building.

Each remote multiplexer cabinet contains:

1. The termination interface for the analog/digital field wiring inputs or cable inputs from the existing Westinghouse P250 I/O cabinets.

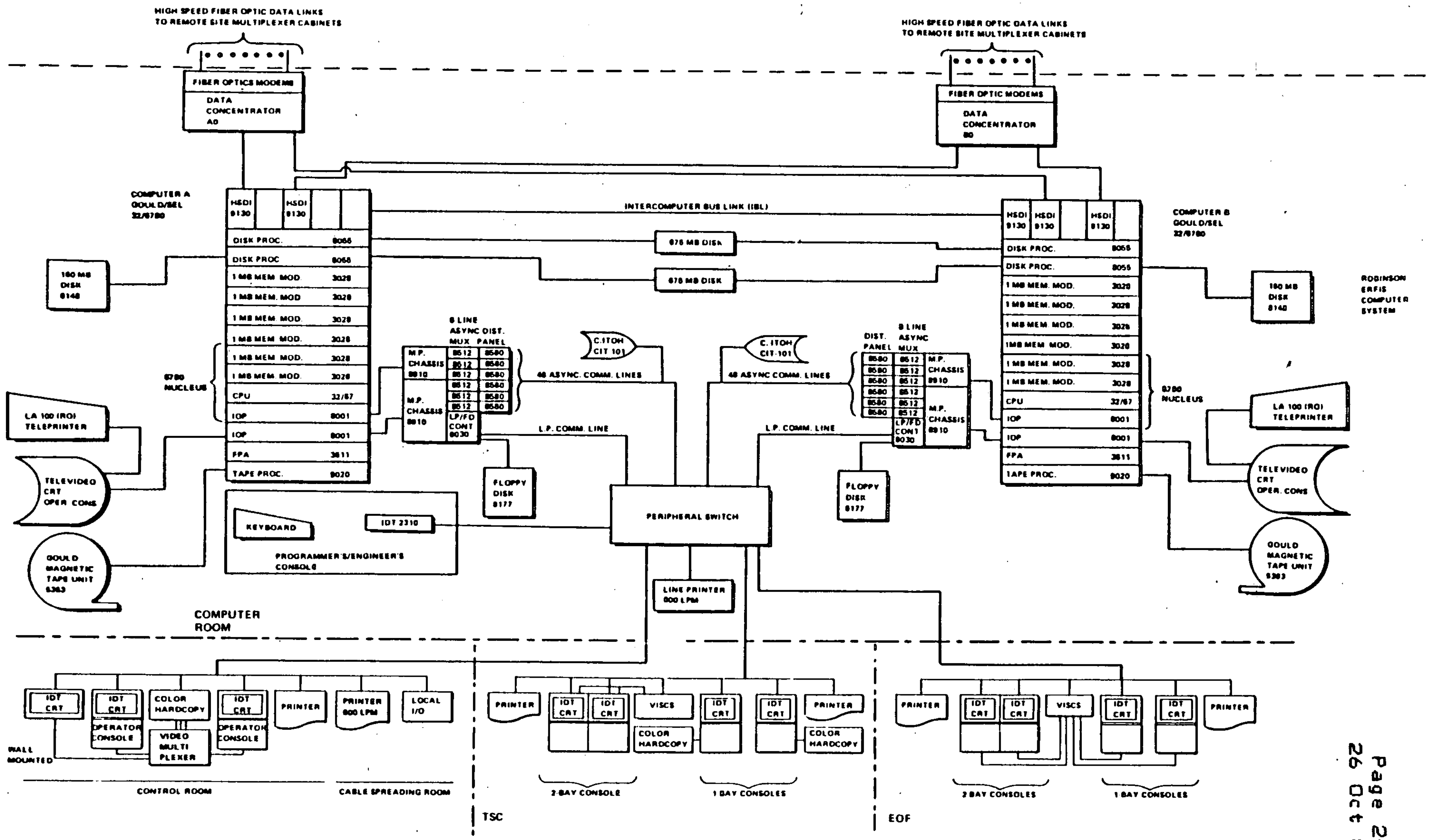


FIGURE 2-1. ROBINSON PLANT ERFIS BLOCK DIAGRAM

2. The electronics for signal conditioning, scanning and digitizing the input signals

3. The communications and control equipment for each location.

Where required to maintain separation between Train "A" and Train "B" signals at a location, two dual data links are provided. A total of six (6) dual data links are to be provided between the multiplexers and the Data Concentrators. In addition, the fiber optic cables for four (4) more data links will be provided.

The Data Concentrator is a high-performance microprocessor which receives, decodes and buffers the data collected from up to ten (10) data links to remote multiplexers and makes it available to host computers. To accommodate the data links, two Data Concentrators are provided as a subsystem. Two Data Concentrators are provided for redundancy. Each Data Concentrator communicates with each remote multiplexer via a high-speed, fiber-optic link. Figure 2-2 shows a block diagram of the data acquisition configuration. Figure 2-3 shows the cabinet and point allocation for Phase I implementation. An additional 368 analog and 512 digital non-1E input points (with two data links) shown in Figure 2-4, will be implemented in Phase IV (1987 outage). None of the points listed for these two cabinets are allocated at this time.

2.2 COMPUTER SYSTEM HARDWARE

The Computer System consists of two Gould SEL 32/6780 computers. They are configured with an interprocessor link, dual-ported disk units, a peripheral switch and a variety of peripherals. Table 2-1 provides a detailed list of the hardware in the computer system. As shown in Figure 2-1, the system is configured to support failover to backup units for critical hardware to provide maximum availability for the ERFIS.

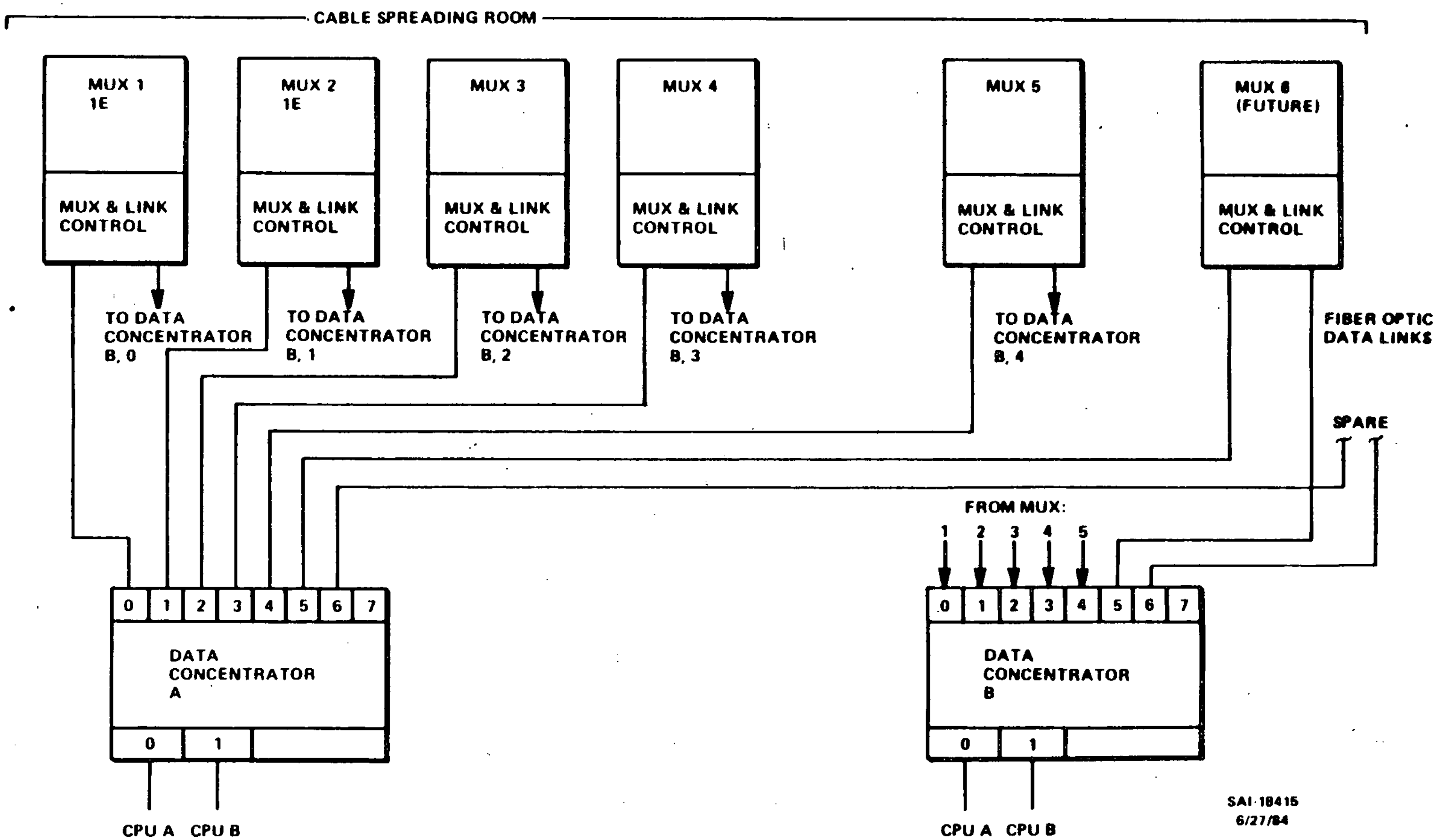
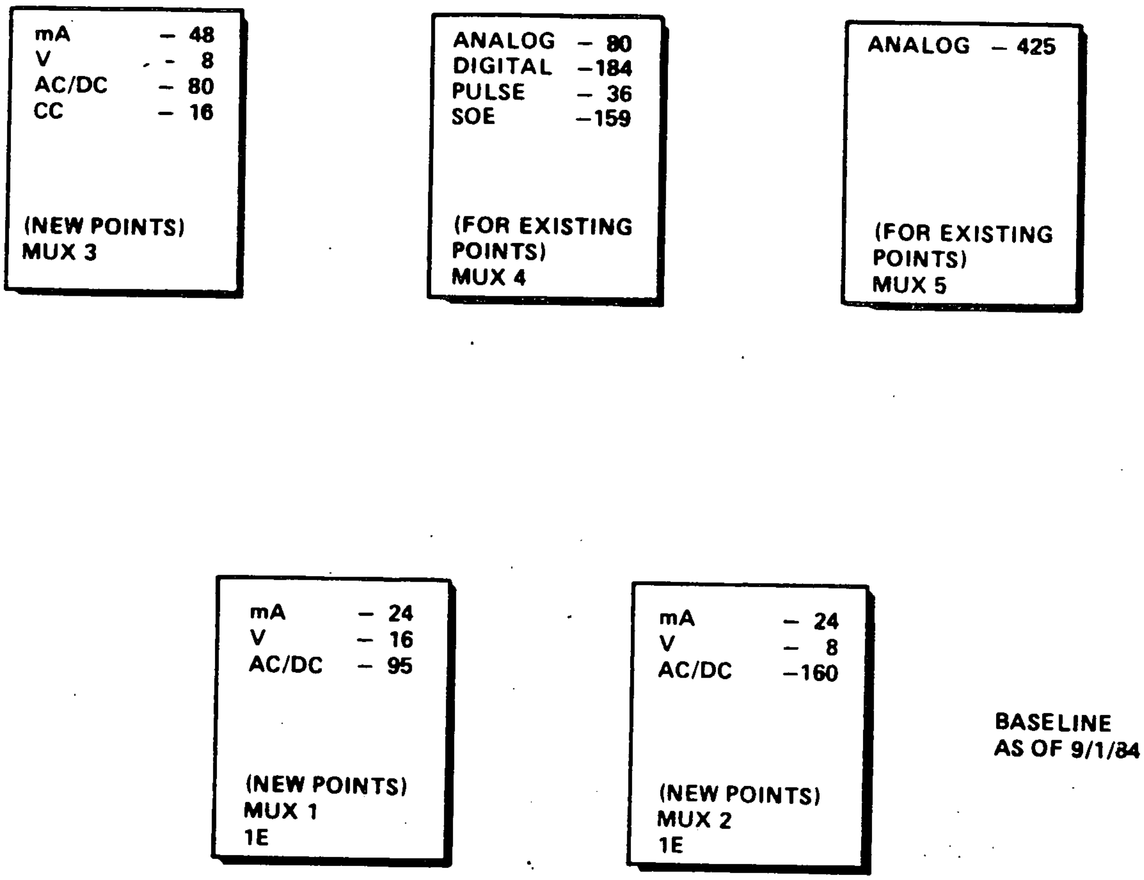


FIGURE 2-2. DATA ACQUISITION HARDWARE BLOCK DIAGRAM



SAIC-18745
10/25/84

FIGURE 2-3. MUX CABINET AND POINT ALLOCATION (Phase I)
CABLE SPREADING ROOM

mA/V	=	96
RTD	=	32
T/C	=	56
SOE	=	144
DIG.	=	112
PULSE	=	14
(NEW POINTS)		
MUX 6		

mA/V	=	88
RTD	=	32
T/C	=	64
SOE	=	128
DIG	=	96
PULSE	=	14
(NEW POINTS)		
MUX 7		

SAI-18711
6/27/84

FIGURE 2-4. MUX CABINET AND POINT ALLOCATION (Phase IV)
CABLE SPREADING ROOM

TABLE 2-1

LIST OF COMPUTER SYSTEM HARDWARE

Two computer systems each consisting of:

- Gould/SEL 32/6780 Central Processing Unit (CPU) Nucleus with:
  - o CPU, IPU, 4 MB MOS Memory, IOP chassis, Video Terminal Unit, Cabinet
  - o Disc Subsystem 600MB (Dual Port)
  - o Disc Processor (additional)
  - o 8 Line Asynchronous Interface (6 ea)
  - o RS-232C Distribution Panel (6 ea)
  - o Magnetic Tape Subsystem (45 ips)
  - o HSD/Host Interface for Data Concentrator (2 ea)
  - o Peripheral Cabinet (2 ea)
  - o Floppy Disc Unit
  - o Teleprinter (RO)
  - o Video Terminal Unit
  - o Line Printer/Floppy Disc Controller
  - o System Disc Unit (160MB)

Common (shared) hardware between both computer systems:

- High Speed Data Link (HSDL)
- Data Products 600 LPM Line Printer
- Peripheral/Communications Switch Subsystem
- DataLink Ready Limited Distance modems as required to ensure data integrity.
- Local CPU I/O Chassis with Analog and Digital Outputs
- Peripheral Cabinet (1 ea)

The SEL 32/6780 Computer is a high-speed, general purpose, digital computer specifically designed for data acquisition and realtime applications. The SEL 32/6780 consists of a standard CPU and also contains an additional Internal Processing Unit (IPU). The IPU has the capability to perform CPU functions in parallel with the CPU except that it cannot perform I/O operations, system services and interrupt instructions.

The SEL 32/6780 has a large instruction set that includes fixed and floating point arithmetic instructions. A special look-ahead feature enables the CPU to overlap instruction execution with memory accessing. This feature reduces program execution time. The SEL 32/6780 may be configured with up to 16 million bytes (4 million words) of physical memory.

General features of the SEL 32/6780 computer are:

1. Byte oriented memory (8-bit byte plus one parity bit) which can be addressed and altered as bit, byte, halfword (2-byte), word (4-byte), and doubleword (8-byte) quantities.

2. Indexed addressing capability of entire memory.

3. Base register mode allows programs to occupy entire logical address space of 16 MB.

4. Eight high-speed, base level registers used with base register mode instructions to calculate logical addresses.

5. Eight general purpose registers that may be used for arithmetic, logical, and shift operations, as well as masking, linking, and indexing (up to 7 registers).

6. Realtime priority interrupt system of up to 112 levels with automatic identification and priority assignment; external interrupt levels which can be individually enabled, disabled and requested by programs.

7. Automatic traps (for error or fault conditions) that have masking capability and maximum recoverability under program control.

8. A comprehensive instruction set that includes the following:

   a. Bit, byte, halfword, word and doubleword operations.

   b. Register-to-register operations with halfword instructions to improve program execution time.

   c. Fixed-point integer arithmetic operations in single and double precision formats.

   d. Full complement of logical operations (AND, OR, Exclusive OR) for byte, halfword, word and doubleword operands.

   e. Comparison operations for bit, byte, halfword and doubleword operands.

   f. Call Monitor and Supervisor Call instructions that allow a program access to operating system functions.

   g. Shift operations (left and right) of word or doubleword, including logical, circular, and arithmetic shifts.

9. Built-in reliability and maintainability features:

   a. Full parity checking of all memory accesses.

   b. Address stop feature that permits operator or maintenance personnel to:

      o Stop on any instruction address

      o Stop on any memory read reference address

      o Stop on any memory write reference address

10. CPU traps which detect a variety of CPU and system fault conditions to enable a high degree of system recoverability.

Communication between the major elements of the SEL 32/6780 is via the SELBUS. This bus is a 184-line bidirectional bus that sends and receives data between the CPU, the memory subsystem, the disk, I/O subsystem etc., on 32 data lines at a continuous data rate of 26.67 million bytes per second. Twenty-four lines are used for addressing purposes for the subsystem to perform read or write operations. Both data and address lines operate concurrently with the transfers occurring every 150 nanoseconds.

2.3 DISPLAY HARDWARE

The Display Subsystem consists of Color Graphic Display Units mounted in various consoles located in the Control Room, Computer Room and in the Technical Support Center (TSC)/Emergency Operations Facility (EOF) at the Robinson Plant. Hardcopy will be provided by the Seiko D-SCAN Color Hardcopier, Video Image Storage and Copy System (VISCS) by Science Applications International Corporation (SAIC), and by Digital Equipment Corporation (DEC) LA-100 dot matrix character printers.

Also included with the display subsystem is the communication equipment required for the data communications from the various locations to the computers in the computer room. Detailed lists of the hardware at each location is provided in Table 2-2.

The Color Graphic Display Unit provided is the Model 2312 manufactured by Industrial Data Terminals (IDT). Significant features of the IDT unit are provided in Table 2-3.

The Programmer/Engineer Console, located in the Computer Room, will be a single-bay console with a display unit.

Three display units will be located in the Control Room. Two will be mounted in the single-bay operators' consoles and one will be rack mounted which will share a keyboard with one of the operators' consoles.

The TSC will have four display units, two mounted in the double-bay console (one keyboard) and two in single-bay consoles.

The EOF will contain four display units, two mounted in the double-bay console (one keyboard) and two in the single-bay consoles.

Communication to the various displays and character printers located in the computer room will be via direct RS-232C cables. Communication to the displays and printers in the Control Room will be via limited distance short haul modems. The communication lines to the EOF and TSC devices will be multiplexed and switched (under software control) between the ERFIS and the ERFIS Simulator, located in the training room.

TABLE 2-2

DISPLAY HARDWARE DISTRIBUTION BY LOCATION

1. COMPUTER ROOM
   - o Programmer/Engineer's Console with:
     - IDT 2312 Color-Graphic Display Unit

2. CONTROL ROOM
   - o 1 DEC LA-100 Receive-Only (RO) Character Printers
   - o 1 Rack-mounted IDT 2312 Color Graphic Display Unit with 25 inch monitor
   - o 2 Operator Consoles with:
     - IDT 2312 Color-Graphic Display Units
   - o Seiko D-SCAN Color Hardcopier
   - o DataLink Ready Limited Distance Modems

3. TECHNICAL SUPPORT CENTER (TSC)
   - o 2 DEC LA-100 Receive-Only (RO) Character Printers
   - o Dual Bay Console with:
     - 2 IDT 2312 Color-Graphic Display Units with one keyboard, keyboard switch and short haul modem
   - o 2 Single-Bay Consoles with:
     - IDT 2312 Color-Graphic Display Units
   - o 2 Seiko D-SCAN Color Hardcopy Devices
   - o Video Image Store Copy System (VISCS)

4. EMERGENCY OPERATIONS FACILITY (EOF)
   - o 2 DEC LA-100 Receive-Only (RO) Character Printers
   - o Dual Bay Console with
     - 2 IDT 2312 Color-Graphic Display Units with one keyboard, keyboard switch and short haul modem
   - o 2 Single-Bay Consoles with:
     - IDT 2312 Color-Graphic Display Units
   - o Video Image Store Copy System (VISCS)

TABLE 2-3

IDT FEATURES

1. Display Generator
   - 51 lines with 85 characters per line
   - Predefined Character codes with capability to define graphic symbols
   - 8 Colors
   - Independent character blink
   - Independent background/foreground colors and reverse video
   - Protected fields, timeout, data field type and data field highlighting through the automatic Interactive Data Entry Function
   - Capability to download special figures and picture files, callable with a single command, in local RAM and Bubble memory.
   - Two 512x512 image memory planes
   - Dot address and scroll lock pixel
   - Refresh Rate - 60Hz
   - 19.2 KB RS-232C communication port

2. CRT MONITOR
   - 19 or 25 inch diagonal display
   - 60-Hz Refresh Rate
   - Convergence controls in locked drawer

3. KEYBOARD
   - UPPER CASE selection and lock
   - Numeric Keypad of 12 keys (may be user programmable)
   - Cursor/Scroll pad, containing scroll up scroll down, cursor left, cursor right, and home keys
   - Color selection and dedicated function keys
   - LED condition indicators for reset, graph, local, large characters, special function, XOFF, and upper case lock.

The Video Image Store Copy System (VISCS)is designed to allow the IDT 2312 color-graphic CRTs to share a single Versatec V-80 printer/plotter as a hardcopy device and to use a single 50-megabyte Winchester disk for softcopies. When a hardcopy of an IDT display is requested, the VISCS:

1. Captures the entire IDT display in one refresh time (16.67 ms).

2. Converts the colors to grey-scale textures.

3. Performs 4:3 aspect ratio conversion on a per raster line basis.

4. Transmits the converted line to the V-80 printer/plotter.

5. Continues converting and transmitting until done.

A Winchester fixed-media, 50 megabyte disk is used to retain the softcopies of up to 200 IDT displays. One to four IDT 2312 color-graphic CRTs may be connected to the VISCS. In addition, the VISCS also provides a single serial RS-232 interface which will operate from 300 to 19200 baud. The serial port offers either X-ON/X-OFF or Clear-To-Send (CTS) line protocol and data compression to provide maximum line utilization. The serial line allows the host to use the V-80 printer/plotter in both the print mode and plot mode.

The Seiko D-SCAN Color Hardcopier video accepts inputs from up to four IDT monitors and produces color reproductions of the screen on plain paper or clear polyester film. Primary specifications are:

- Frame access time - 0.5 sec.
- Copy time - 60 sec.
- Aspect Ratio - 1:1
- Max Plot size - 8.5" x 6.72"

The DEC LA-100 printer is a serial, asynchronous printer using 7 X 9 dot-matrix characters in normal 240 cps mode and has a switch selectable letter quality (33 X 18 dot-matrix) mode.

Tractor-feed, continuous-feed, and single-feed paper operation is standard. In the 240 cps mode, printing is bidirectional with special techniques employed in which the printhead skips blank spaces rapidly to the next printable character. Two typefaces are supplied with the printer which are selectable from the host computer or locally. Character horizontal pitch is variable at 5, 6, 6.6, 8.25, 10, 12, 13.2, or 16.5 characters per inch, while vertical pitch is fixed at .135 inches. An internal status check mode is activated by a switch on the upper panel.

CHAPTER 3

ERFIS SOFTWARE OVERVIEW

This chapter provides an overview of the applications software to be delivered for the CP&L Robinson Unit 2 ERFIS system.

The ERFIS software system consists of the following major functional subsystems:

1. Applications Executive Subsystem
2. Data Base Management Subsystem
3. Data Acquisition Subsystem
4. Man-Machine Interface Subsystem
5. Log Generation/Reporting Subsystem
6. Data Archival/Retrieval Subsystem
7. SPDS Subsystem
8. NSSS/BOP Subsystem
9. Software Support Services Subsystem
10. Applications Software Utilities Subsystem
11. Special Software Subsystem.

The primary functions performed by each of these subsystems is summarized in the following paragraphs.

3.1 APPLICATIONS EXECUTIVE SUBSYSTEM

The Applications Executive Subsystem controls:

1. ERFIS system initialization and startup
2. Plant mode identification
3. Task maintenance
4. Primary/Backup, inter-CPU, High-Speed Data Link (HSDL) communications
5. Peripheral health monitoring and switching
6. System failover
7. System full/partial restart.

3.2 DATA BASE MANAGEMENT SUBSYSTEM

The Data Base Management Subsystem is responsible for generation and maintenance of the ERFIS system data base and global-common memory areas. Primary functions performed by this subsystem include:

1. Initialization and loading of system runtime data base
2. Interactive maintenance of runtime data base
3. Maintenance of Point I/O List data base definitions:
    a. Addition of new points
    b. Deletion of existing points
    c. Modification of defined point parameters.

3.3 DATA ACQUISITION SUBSYSTEM

The Data Acquisition Subsystem is responsible for the realtime collection and processing of point data inputs to the ERFIS. Primary functions of this subsystem include:

1. DAS hardware/software initialization
2. Field-input point data collection/validation
3. Analog input point EU conversion
4. Digital input point logical state inversion
5. Derived point calculations
6. Transform point computations
7. Point alarm monitoring
8. Data quality tagging
9. Archive data queueing
10. Current Values Table maintenance.

3.4 MAN-MACHINE INTERFACE SUBSYSTEM

The Man-Machine Interface Subsystem is responsible for the outputs to and inputs from the operator console CRT/keyboards. Primary functions of this subsystem include:

1. Display of general system status and date/time
2. Display of "menus" of available system functions/displays
3. Interactive processing/validation of alphanumeric and function key keyboard entries
4. Activation/control of selected system functions and/or displays.

3.5 LOG GENERATION/REPORTING SUBSYSTEM

The Log Generation/Reporting Subsystem is responsible for creating all hardcopy log/report outputs to the line printer(s). Subsystem functions include both "periodic" (i.e., automatic) and "on-demand" (i.e., operator selected) printed outputs. Logs/reports generated/output by this subsystem include:

1. System Monitoring Reports:

   a. System Restart Log

   b. System Failover Log

   c. Device Assignment Log

2. Point Review Logs:

   a. Historical Digital Input Point Alarm Log

   b. Historical Analog Input Point Alarm Log

   c. Historical Pseudo-Analog Point Alarm Log

   d. Historical Substitute Value Point Log

   e. Historical Point Out-of-Scan Log

   f. Current Point Alarm Log

   g. Current Alarm Delete Log

   h. Sensor Calibration Report

   i. Data base Change Log

   j. Post-Trip Review Log

   k. Variable Format Report Generator

3. Group Logs/Reports:

a. Sequence-of-Events Report

b. Trend Group Report

c. Trend Group Summary Report

d. SOE Assignment Summary Report

e. ALB Assignment Summary Report

f. Analog Trend Pen Assignment Summary Report.

3.6 DATA ARCHIVAL/RETRIEVAL SUBSYSTEM

The Data Archival/Retrieval Subsystem is responsible for storing and retrieving selected point data. The following historical data archive files are generated/maintained by this subsystem:

1. Short-Term Archival File. A circular disk-resident file containing the most-recent 14 hours of selected point data values which have been scanned/calculated by the system. Upon event declaration, the 2 hours of pre-event data are retained followed by the next 12 hours of post-event data to comprise an "event set".

2. Mid-Term Archival File. A circular disk-resident file containing the most-recent 2 weeks of point data values averaged at 10-minute intervals.

3. Long-Term Archival File. Permanent storage files (i.e., magnetic tape) of the Mid-Term Archival File for historical purposes.

4. Transaction File. A circular disk-resident file containing the most-recent 14 hours of "transaction" messages generated by the system (e.g., point alarms, SOE events, data base changes, hardware/software errors, system failovers, etc.).

3.7 SAFETY PARAMETER DISPLAY SUBSYSTEM

The Safety Parameter Display Subsystem (SPDS) is responsible for processing, monitoring, and displaying information regarding "plant safety parameters". The SPDS displays conform to and execute under the control of the ERFIS Man-Machine Interface Subsystem.

3.8 NSSS/BOP SUBSYSTEM

The Nuclear Steam Supply System (NSSS)/Balance of Plant (BOP) Performance Calculations Subsystem software provides the functions of the Plant Process Computer Applications programs. The programs include: Watch, Xenon Follow, Xenon Predict/Boration, Boron Follow, Incore Thermocouple, Movable Detector, Primary Plant Performance, and the Secondary Plant Performance (BOP) calculations. The applications programs in the NSSS subsystem are programs converted from the Westinghouse P2500 series of PC software. The Secondary Plant Performance program incorporates changes to reflect plant specific modeling.

3.9 SOFTWARE SUPPORT SERVICES SUBSYSTEM

The Software Support Services Subsystem contains general-purpose software functions used by other ERFIS subsystems. General categories of routines include:

1. System data base interface routines
2. Global common data access/retrieval routines
3. Graphic I/O routines
4. Data conversion/validation routines
5. Mathematical computations routines
6. Operating System service utilities interface routines.

3.10 APPLICATIONS SOFTWARE UTILITIES SUBSYSTEM

The Applications Software Utilities Subsystem contains utility programs available within the ERFIS system. Software in this subsystem includes:

1. Off-line hardware diagnostic utilities
2. On-line health monitoring utilities
3. Error Message File maintenance utilities
4. Display Editor/Compiler programs

3.11 SPECIAL SOFTWARE SUBSYSTEM

The Special Software Subsystem contains the software packages/options which were purchased to support the vendor-supplied operating system and the ERFIS applications system. This software includes:

1. System Resource Monitoring (SRM) Package
2. MPX Operating System modifications and upgrades
3. Symbolic Debugger.

CHAPTER 4

ERFIS SYSTEM DOCUMENTATION

The ERFIS hardware/software system documentation is organized into thirteen (13) volumes:

1. Volume 1 - Functional Specification Document:

   a. CP&L Specification requirements

   b. SAIC proposal commitments

   c. Requirements added/changed/deleted during contract negotiations, CDR, and other formal meetings with CP&L

   d. Appendix A - Console Operational Philosophy

   e. Appendix B - Point I/O List Description;

2. Volume 2 - Hardware Design Document:

   a. Detailed description of hardware subsystems and components

   b. Drawings and maintenance documentation

   c. Physical layout drawings

   d. Equipment lists

   e. Wiring diagrams

f. Intercabinet cabling diagrams

g. Power cabling diagrams

h. Engineering termination lists

i. Reference manuals

j. Maintenance manuals;

3. Volume 3 - Software Detailed Design Document:

a. Software design overview

b. Software nomenclature

c. Software standards

d. Detailed descriptions of software subsystems and modules;

4. Volume 4 - Software Interface Document:

a. Global Common tables

b. Disk/Tape I/O files

c. Intertask communications

d. Memory Maps

e. Disk Maps;

5. Volume 5 - Test Plan Document

6. Volume 6 - Test Procedures Document

7. Volume 7 - Glossary of Terms

8. Volume 8 - ERFIS Operator's Manual

9. Volume 9 - Diagnostic User's Guide
10. Volume 10 - System Build Procedures Document
11. Volume 11 - Training Outline Document
12. Volume 12 - NSSS/BOP Subsystem Description Document
13. Volume 13 - SPDS Subsystem Description Document

CHAPTER 5

IMPLEMENTATION CONCEPT

Since the H. B. Robinson Steam Electric Plant - Unit 2 is an operational plant, it is necessary that installation and testing of the ERFIS and the application programs be accomplished without interrupting normal plant operations. To do this, a four-phased ERFIS installation and acceptance testing approach will be utilized. The phases are keyed to the project schedule of the Robinson Plant Unit 2.

5.1 PHASE I INSTALLATION AND ACCEPTANCE TESTING

Phase I of the ERFIS installation and acceptance testing will occur during the Robinson Plant Unit 2 steam generator outage. During this phase the ERFIS and the plant upgrade application programs will be designed, developed, and factory tested at the Science Applications International Corporation (SAIC) facilities.

While the ERFIS and plant upgrade application programs are being developed and tested at SAIC facilities, the following modifications will be made to the Robinson Plant during the steam generator outage:

1. Penetrations in the floors, ceilings, and walls for cable routings.

2. Construction of floor anchor pads for ERFIS multiplexer cabinets.

3. Construction and installation of mounting hardware for the Control Room CRT monitor.

4. Installation of power distribution panel and power cabling in the control room.

5. Installation of mounting hardware for T-connectors in the Westinghouse P-250 computer input/output cabinets.

6. Installation of all field, and computer and peripheral equipment cables.

5.2 PHASE II INSTALLATION AND ACCEPTANCE TESTING

Phase II of the ERFIS installation and acceptance testing will occur on a non-interference basis after the Robinson Plant again becomes operational following the steam generator outage.

During this phase, the following activities will be accomplished at the Robinson Plant:

1. The ERFIS computers and peripherals will be installed in the TSC/EOF building.

2. The multiplexer cabinets with electronics will be installed in the cable spreading room (three permanent cabinets and two temporary cabinets).

3. The field cables will be terminated at the multiplexer cabinets.

4. Power will be supplied to the multiplexer cabinets.

Following these installation activities, an integrated system test of the ERFIS will be conducted using a test set to provide input signals into the multiplexer cabinets.

5.3 PHASE III INSTALLATION AND ACCEPTANCE TEST

Phase III will be accomplished during the Robinson Plant 1985 refueling outage. During this outage the following activities will take place:

1. Installation of T-connectors in the Westinghouse P-250 input/output cabinets so that these signals may be shared by the ERFIS and the Westinghouse P-250 system in a parallel operating mode.

2. Tap the input signals into the field cables which were terminated at the permanent multiplexer cabinets during Phase II.

3. Loop test all input/output signals to the permanent multiplexer cabinets.

4. Install the CRT monitor, the consoles with CRTs, the printers, and the hard copy device in the control room and terminate these peripherals to the ERFIS computers.

Upon completion of these installation activities, a Field Performance Test will be conducted using live input signals from the plant sensors. Following this Field Performance Test, the ERFIS will be operational with the Westinghouse P-250 system operating in parallel with the ERFIS.

5.4 PHASE IV INSTALLATION AND ACCEPTANCE TESTING

Phase IV will take place during the Robinson Plant Unit 2 1987 refueling outage. During this outage, the following activities will be accomplished:

1. The Westinghouse P-250 system will be removed from the plant.

2. The multiplexer electronics in the two temporary multiplexer cabinets will be removed from these cabinets and installed in the P-250 input/output cabinets.

3. The temporary multiplexer cabinets will be removed from the plant.

4. Additional inputs shown in Figure 2-4 will be installed.

Following these installation activities, the ERFIS and application programs will be fully operational.

CONTROL ROOM DESIGN REVIEW
DETAILED PROGRAM PLAN AND
IMPLEMENTATION GUIDELINES
FOR
H.B. ROBINSON STEAM ELECTRIC GENERATING PLANT
UNIT 2

DECEMBER, 1984

TABLE OF CONTENTS

SECTION 1.0 REVIEW PLAN

1.1 INTRODUCTION

This Program Plan has been prepared in response to NUREG-0737, clarification of TMI Action Plan Requirements, para. I.D. 1, and paragraph 5.2.a of NUREG-0737 Supplement 1, Requirements for Emergency Response Capability (Generic Letter No. 82-33). This program plan describes the Control Room Design Review (CRDR) that will be conducted for the H.B. Robinson Steam Electric Generating Plant (HBR), Unit 2, owned and operated by Carolina Power and Light Company (CP&L). The format of this report follows that recommended by NUREG-0700, Guidelines for Control Room Design Reviews, published September 1981, paragraph 5.1, as follows:

1. Review Plan
2. Management and Staffing
3. Documentation and Document Control
4. Technical Approach
5. Assessment and Design Solutions

This program plan addresses the acceptance guidelines stated in Section 2 of the October 1981 Draft of NUREG-0801, Evaluation Criteria for Detailed Control Room Design Review, and in Section 2.0 "Planning Phase" of NUREG-0700. The HBR CRDR Program Plan also recognized and is responsive to each of the nine criteria by which the NRC evaluates CRDR Program Plan submittal by licensees. Table 1 identifies each of these evaluation, criteria, and the specific section(s) of this Program Plan that describes compliance with each criterion for the HBR CRDR.

TABLE 1
COMPLIANCE WITH CRDR PROGRAM PLAN EVALUATION CRITERIA

Criteria	HBR CRDR Program Plan Section Demonstrating Compliance
1. Establishment of a qualified multidisciplinary review team.	Section 2.0
2. Function and task analyses to identify control room operator tasks and information and control requirements during emergency operations.	Section 3.4
3. Comparison of display and control requirements with a control room inventory.	Section 3.5
4. Control room survey to identify deviations from accepted human factors principles.	Section 4.3
5. Assessment of HEDs to determine which HEDs are significant and should be corrected.	Section 4.0
6. Selection of design improvements.	Section 4.3
7. Verification that selected design improvements will provide necessary correction.	Section 4.2
8. Verification that improvements will not introduce new HEDs.	Section 4.2
9. Coordination of control room improvements with changes from other programs such as SPDS, operator training, Reg. Guide 1.97 instrumentation, and upgraded EOPs.	Section 1.2

1.2 BACKGROUND

1.2.1 General

This Program Plan report describes how CP&L plans to complete a Control Room Design Review (CRDR) for H.B. Robinson, Unit 2. The CRDR is part of a broad effort within the nuclear industry to evaluate the adequacy of control rooms to support safe and effective operations. Guidance for the CRDR has been provided by the Nuclear Regulatory Commission (NRC) in the form of various NUREGs and regulatory guides. CP&L has used all relevant guidance in developing this Program Plan and has dedicated the necessary resources to this CRDR to ensure success of the project.

1.2.2 Integration

Although the CRDR is specifically directed toward evaluating the control room (CR) (including remote shut down panels), CP&L recognizes interfaces between the CRDR and other related activities, such as the design of a Safety Parameter Display System (SPDS), implementation of Reg. Guide 1.97 requirements, development of Emergency Operating Procedures, operator training, implementation of Emergency Response Facilities and the inclusion of post-accident monitoring (PAM) instrumentation. The organization of this plan considers coordination of the CRDR with these related efforts and reflects the balances and orderly approach CP&L has followed to implement all NUREG-0737 requirements.

1.2.3 H.B. Robinson

The H.B. Robinson Steam Electric Generating Plant, Unit 2 is a Westinghouse Pressurized Water Reactor (665 Mwe) located in Hartsville, South Carolina. It began commercial operation in March of 1971.

1.2.4 CR-1580 Review

CP&L conducted a review of the H. B. Robinson, Unit 2 control room in 1981 in accordance with the guidance provided in NUREG/CR-1580. In the current effort, the earlier review will be updated to the current NUREG-0700 standards.

1.2.5 Program Plan Objectives

This Program Plan provides a means to ensure that an adequate CRDR will be conducted. It will also clearly define the roles and responsibilities of the review team members as defined in NUREG-0737.

1.3 CRDR PROGRAM STRUCTURE

1.3.1 CRDR Phases

The CRDR is to be conducted in three phases as follows:

a. Phase I - Project Planning

The objective of this first phase was to develop a plan for conducting the review that describes project milestones, schedules, review methods, personnel responsibilities, and project interfaces.

Submission of this Program Plan to the NRC completes the planning phase.

NRC staff comments upon review of this Program Plan will be taken into account in implementing the plan. Any requirements or changes to the plan will be documented in the final summary report on the CRDR.

b. Phase II - Review and Assessment

The second phase of the CRDR will involve collection, reduction and analysis of data pertaining to the adequacy of the CR design from a human factors perspective, and assessment of any human engineering discrepancies (HEDs) identified during this process. This assessment procedure will include:

1) A determination of the error potential and consequences of each HED.

2) Identification of HED resolutions

3) Assurance that no additional HEDs are introduced as a result of these resolutions.

At the conclusion of Phase II, a Final Summary Report describing the methods, results and implications of the CRDR will be submitted to the NRC. This report will also describe CP&L's plans and schedules for correction of the HEDs at H.B. Robinson.

c. Phase III - Implementation

The final phase in the CRDR will be to implement the resolutions or backfits for the HEDs. Backfit specifications will be reviewed prior to implementation to ensure that they fulfill the CRDR recommendations. Correct implementation will also be verified.

Figure 1-1 outlines, in general, the phases, and task flow for conducting the CRDR. A brief discussion of the activities conducted in each phase of the review is described below. For more detailed descriptions of the objectives, approach, data collection methodology, and specific evaluation methods, refer to Section 3.0, Technical Approach of this plan.

1.3.2 Project Planning

This plan is the output of the Project Planning Phase. Acceptance of this document essentially concludes Project Planning. The guidelines provided in NUREG-0700 and draft NUREG-0801 form the primary basis of this document.

1.3.3 Control Room Review

The CR review and assessment phase is subdivided into the following six tasks:

- Operating Experience Review
- Conduct Surveys
- System Functions and Task Analysis
- Control Room Inventory
- Verification of Task Performance
- Validation of Control Room Functions

The six tasks are described below:

1.3.3.1 Operating Experience Review - This task is composed of operator interviews where a significant number of operators will be interviewed. Interviews consist of general and detail questions on plant operations.

1.3.3.2 Conduct Control Room Surveys - Much of the detailed assessment of the control room is conducted via a total of 14 surveys. The surveys to be conducted are:

- o Ambient Noise - Direct measurements of noise levels are taken and compared to individual guidelines items.

- o Illumination - Measurements are taken under various ambient conditions (e.g., emergency lighting) and are compared to individual guidelines items.

- o CR Environment (HVAC) - Assessments are made by direct measurement of the parameters listed below and comparison of the data to the NUREG-0700 guidelines:
  - Temperature
  - Humidity
  - Ventilation

- o Workspace - The CR workspace is evaluated by checklist survey and direct measurements which address the following:
  - Workspace Arrangement
  - Document Organization, Use and Storage
  - CR Access

- Conventions - The CR is evaluated by survey for the conventions listed below and data are subsequently compared to NUREG-0700 guidelines:
  - Coding methods (color, shape, pattern, etc.)
  - Standardization of abbreviations and acronyms
  - Consistency of control use
  - Consistency of display movement or indication

- Controls - Controls are evaluated by measurements, observations and other assessment methods.

- Displays - Displays are evaluated by measurements, observations or other assessment methods.

- Computer System - Computer systems are assessed by measurements, observations or other assessment methods.

- Emergency Equipment - Data are collected by walk-throughs, emergency garment use, and speech intelligibility analysis.

- Labels and Location Aids - Labels and location aids are evaluated by measurements, observations and other assessment methods.

- Annunciator System - The annunciator system is evaluated by measurements, observations or other assessment methods.

- o Anthropometrics - Reach and visual access to CR components are analyzed, given physical configuration of boards, panels, layout, etc. The data are subsequently compared to checklist item requirements.

- o Communications - Communications systems are evaluated by guidelines and speech intelligibility of communications modes is analyzed.

- o Maintainability - Checklist and questionnaire data concerning operator-maintained components (trend recorders, bulbs, etc.) are collected.

Survey data are collected from preconstructed task plans which contain checklists, interview forms, and methods for direct measurements of CR parameters, such as noise levels, light levels, etc. The guidance for the conduct of the survey is found in NUREG-0700.

1.3.3.3 System Functions and Task Analysis (SFTA) - The task analysis procedure is a descriptive process which extracts generic operator action and information requirements from systems function data, converts these requirements to a plant-specific level, and documents the results in a tabular format for use as an input into the Verification of Task Performance Capabilities and the Validation of Control Room Functions.

These procedures are organized into four major activities which are:

1. Convert the HP Basic Westinghouse Owners Group (WOG) System Review and Task Analysis (SRTA) into a plant-specific "Revision 1 SFTA".

2. Generate a list of plant-specific actions and information requirements for each task, organized by task.

3. Reorganize the listing so that all action requirements of a given type and all information requirements of a given type are collected together. Type refers to a group of action or information requirements which all have the same system, subsystem, plant component, and parameter.

4. Summarize each action type and each information type in list form such that required ranges, values and precisions or other parameteric information is summarized for each parameter.

1.3.3.4 Control Room Inventory - A comprehensive inventory of control room instrumentation, controls and other equipment will be developed. The inventory will include the necessary information (e.g. type of component, application/function, range, divisions, location) required to verify the availability of the required displays and controls (see paragraph 1.3.3.5). The inventory process is described in detail in paragraph 3.5 of this plan.

1.3.3.5 Verification of Task Performance Capabilities - This analysis is composed of two subtasks: Verification of instrument/control availability, and verification of human engineering suitability. The first, verification of availability, determines whether the instrumentation and controls required by the control room operator are actually available to the operator for completion of the tasks identified in the task analysis. The control room inventory and the task action and information requirements from the SFTA are the two major inputs to this task. The SFTA documentation describes the instruments and controls and their main characteristics which are necessary for the required tasks, whereas the control room inventory lists the components which are actually available. A comparison of these lists will determine if a required instrument or control is not available.

The second subtask, verification of human engineering suitability, will examine the components for characteristics which may degrade operator task performance, and which are not necessarily apparent in a control room survey. This analysis will focus on practical suitability considerations such as task required ranges, values, precisions or response times.

The primary products of the verification phase are the documentation of missing task related instrumentation and/or controls and the identification of problems regarding component suitability.

1.3.3.6 Validate Control Room Functions - This involves analysis of workload and distribution of workload for operators for specific tasks and event sequences. The primary means of analysis are traffic analysis and walk and talk-through simulation of task sequences. Checklists will be used to aid in the validation of CR functions.

1.3.4 Assessment and Design Solutions

The basic procedure to be employed in assessment and in identifying and selecting enhancements and design solutions is based on NUREG-0700, exhibit 4-2, and the process discussed in NUREG-0801 (draft-Oct. 1981).

1.3.4.1 Assess Discrepancies - Assessment is discussed in Section 4.0 of this plan. In general, the assessment process is outlined below:

- o Assess extent of deviation from NUREG-0700 guidelines
- o Estimate increase in human error for the discrepancy
- o Determine if discrepant component is safety function related
- o Determine if errors in using discrepant component(s) could lead to violation of tech specs or unsafe operation
- o Assignment of category and priority, based on the above.

1.3.4.2 Analysis of Correction by Enhancement - Discrepancies selected for correction are first examined for possible correction by enhancement (labeling, demarcation, procedure aids, etc.). Where it is determined that correction by enhancement is not possible, the discrepancy is analyzed for correction by design alternatives.

1.3.4.3 Analysis of Correction by Design Alternative - Design alternatives will be identified by examining the HED, referring to task analysis data, and identifying potential constraints (e.g., availability of equipment, Reg. Guide 1.97, etc.). The acceptability of design alternatives will be verified by reapplication of NUREG-0700 Guidelines and task analysis.

1.3.4.4 Assessment of Extent of Correction - For all HEDs selected for correction, the extent of correction (by enhancement or redesign) will undergo evaluation. In addition, the correction will be reviewed to ensure that no new HEDs are introduced into the control room as a result of the change.

1.3.5 Implementation

The final phase in the CRDR will be to implement the corrective actions for the HEDs. As suggested in NUREG-0801, the implementation of corrective actions will be scheduled according to the respective priorities of the HEDs (see paragraph 4.2). Since the implementation process is expected to extend beyond the CRDR, CP&L intends to maintain an ongoing review activity to ensure that all HED resolutions are properly implemented.

As part of this ongoing activity, all HED resolutions will be evaluated to ensure that each resolution is completed and adequate. This activity will also ensure that no new HEDs will have been introduced into the control room as a result of the resolution. If, for some reason an HED cannot be fully corrected, CP&L will assess the potential impact on operator performance. This assessment will be documented and submitted as an amendment to the Final Summary Report.

The implementation process is discussed in Section 7.0 of this plan.

1.4 GLOSSARY OF TERMS

Since there are differences in usages of terms (even among practitioners within the same field), the following definitions are provided to reduce ambiguity.

CONTROL ROOM: For the purpose of this plan, the control room is defined to include the primary operating area of the main control room and the auxiliary shutdown panels.

CONTROL ROOM DESIGN REVIEW: The control room design review as required by NUREG-0660, Item I.D.1 and implemented in accordance with NUREG-0700.

CRDR PROGRAM PLAN: A work plan designed to provide high-level guidance on the scheduling and performance of the CRDR.

ENHANCEMENTS: Surface modifications that do not involve major physical changes, for example, demarcation, labeling changes and painting.

FINAL SUMMARY REPORT: Final summary report of the results of the CRDR as required by NUREG-0660, Item I.D.1 and in accordance with Generic Letter 82-33.

FUNCTION: An activity performed by one or more system constituents (people, mechanisms, structures) to contribute to a goal.

FUNCTIONAL ALLOCATION: The distribution of functions among the human and machine constituents of a system.

FUNCTIONAL ALLOCATION REVIEW: The examination of system goals to determine what function they require; also, examination of the required functions to determine how the functions may be allocated and executed; primarily, the identification of established functions and examination of how they are allocated and executed.

HUMAN ENGINEERING DISCREPANCY (HED): A departure from some benchmark of system design suitability for the roles and capabilities of the human operator.

HED ASSESSMENT TEAM (HEDAT): Those individuals of the CRDR Team who have the responsibility for review and assessment of all HED reports.

HUMAN FACTORS ENGINEERING: The science of optimizing the performance of human beings, especially in industry; also, the science of designing equipment for efficient use by human beings.

OBJECTIVE (MISSION, GOAL): The end-product as a result of a coordinated group of activities.

LICENSED OPERATOR: Any individual currently licensed by the NRC who manipulates a control or directs another to manipulate a control that directly affects reactivity (SRO or RO).

SIGNIFICANT HEDs: Those HEDs which, alone or in combination with other HEDs, may (in the judgement of the HEDAT) increase the potential for operator error to an unacceptable level and/or may have serious impact on system performance.

SUBTASK: An activity (action step) performed by a person (or machine) directed toward achieving a single task.

SYSTEM: A whole which functions as a whole by virtue of the interdependence of its parts: an organization of interdependent constituents that work together in a patterned manner to accomplish some purpose.

SYSTEM ANALYSIS: Examination of a complex organization and its constituents to define (usually, but not necessarily, in mathematical terms) their relationships, and the means by which their actions and interactions are regulated to achieve goal states.

TASK: A specific action, performed by a single system constituent -- person or equipment -- that contributes to the accomplishment of a function. In NUREG-0700, only tasks allocated to people, in particular to control room operators, are addressed in detail. Moreover, in accordance with Generic Letter 83-22, only tasks associated with emergency systems will be evaluated.

VALIDATION: The process of determining if the physical and organizational design for operations is adequate to support effective integrated performance of the functions of the control room operating crew.

VERIFICATION: The process of determining if instrumentation, controls, and other equipment meet the specific requirements of the tasks performed by operators.

1.5 ACRONYMS

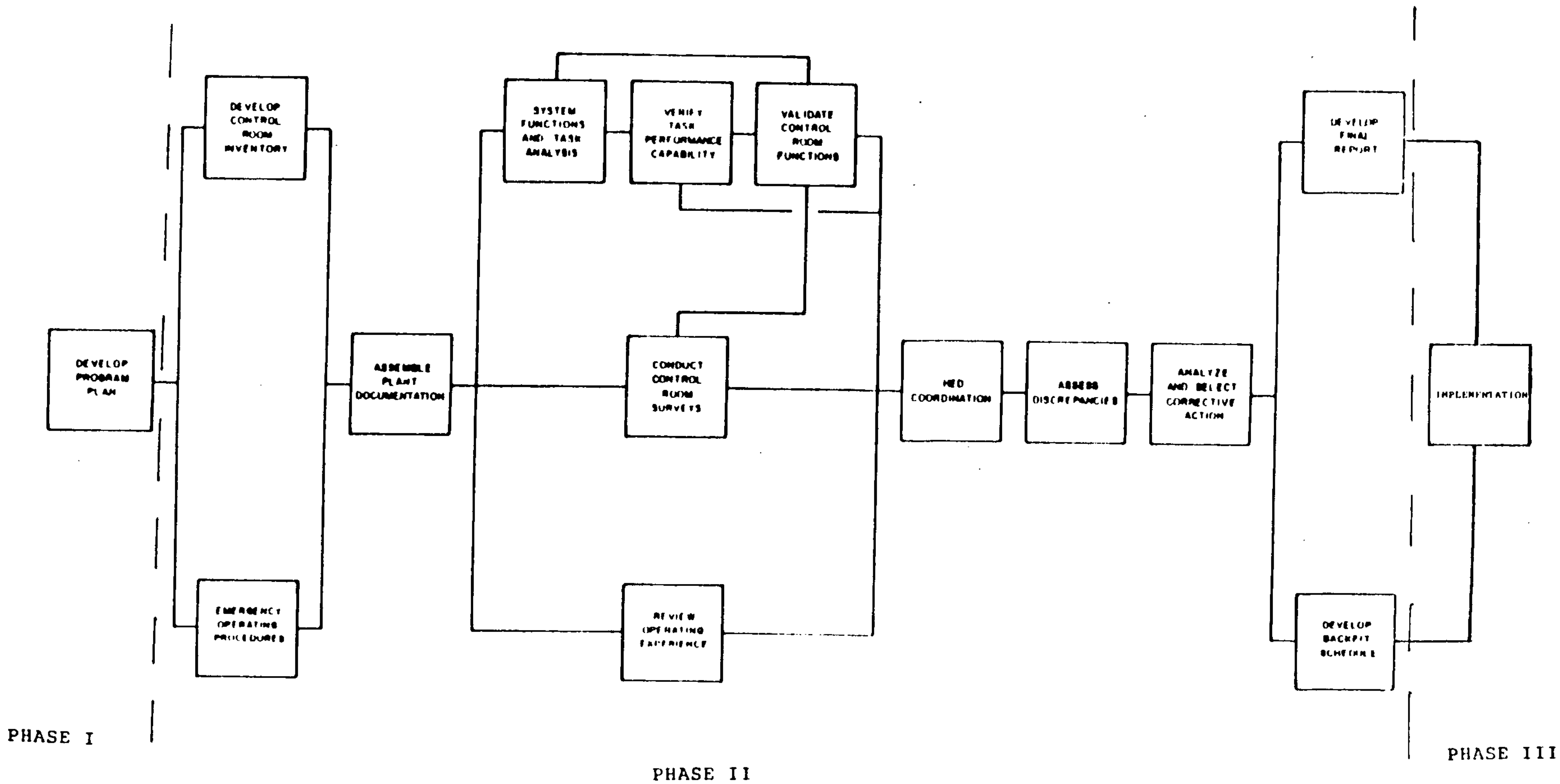
A number of acronyms have been used in this report. They are presented to facilitate the reader's use and comprehension of the report.

CR	Control Room
CRDR	Control Room Design Review

ERG	Emergency Response Guidelines (WOG)
EOP	Emergency Operating Procedure
HBR	H. B. Robinson Steam Electric Generating Plant
HE	Human Engineering
HED	Human Engineering Discrepancy
HEDAT	Human Engineering Discrepancy Assessment Team
HF	Human Factors
HFS	Human Factors Specialist
I&C	Instrument and Control
INPO	Institute for Nuclear Power Operation
LDE	Lead Discipline Engineer
LHFS	Lead Human Factors Specialist
NRC	Nuclear Regulatory Commission
OER	Operating Experience Review
PWR	Pressurized Water Reactor
RO	Reactor Operator
SFTA	System Function Task Analysis
SOC	Site Operations Coordinator
SPDS	Safety Parameter Display System
SRO	Senior Reactor Operator
STA	Shift Technical Advisor
WOG	Westinghouse Owners Group

THE TASK FLOW/RELATIONSHIPS OF THE CONTROL ROOM DESIGN REVIEW

FIGURE 1-1



SECTION 2.0 MANAGEMENT AND STAFFING

2.1 INTRODUCTION

a. The quality of the review effort and the results of the CRDR depend upon the composition, balance, and management of the review team. The CP&L CRDR team has been assembled to include representatives from the various human factors, operations and engineering disciplines necessary to insure optimum performance of the review team. The structure and functions of the team have been established to allow for maximum flexibility and interaction between team members and station personnel, yet retain a rational organizational structure.

b. The management and staffing is most easily described in terms of the CP&L structure that is responsible for initiating and supporting this project, the review team composition and the functional responsibilities.

c. Subsequent paragraphs of this section describe the:

1) CP&L Management Support Structure
2) CRDR Team Composition and Responsibilities
3) CRDR Team Task Responsibilities

2.2 CP&L MANAGEMENT SUPPORT

Establishment of the CP&L CRDR project and the development of the project team was initiated by the Manager - Robinson Nuclear Project and the General Manager. Directly below this level of management are the Manager - Operations followed by the Principle Engineer - Operations. It is this level of management that has the direct responsibility for the review team and its on-going support. Figure 2-1 illustrates this upper management organization.

2.3 CRDR TEAM

2.3.1 General

a. The CRDR team and structure of the dedicated core team is shown in Figure 2-2. This core group will be supplemented on an as-required basis by the remaining individuals. This support group is composed of representatives from all required disciplines such as operations, nuclear, mechanical, electrical, industrial, and human factors engineering.

b. Within the core CRDR team, individuals have been designated as members of the Human Engineering Discrepancy Assessment Team (HEDAT). Principle responsibilities of the HEDAT will be to review and assess all HED reports as described in Section 4.0 and, to develop recommended resolutions, and establish preliminary scheduling of all backfit activities.

2.3.2 CRDR Core Team

2.3.2.1 Structure and Function - The core team is structured as illustrated in Figure 2.2. As can be seen, the primary management structure is comprised of the HEDAT members. This, as stated earlier, enhances the review team's ability to rapidly respond at a competent technical level to the broad spectrum of review activities on a day-to-day basis. Core team resumes will be provided in the summary report to document the proven track record of this team as managers, administrators, supervisors and technical experts.

2.3.2.2 Lead Discipline Engineer - The Lead Discipline Engineer (LDE) for the CRDR is Principle Engineer of Operations and has the overall responsibility for insuring that the review is conducted as planned and scheduled. He will also serve as the coordinator between the CRDR and all NUREG-0787 activities.

2.3.2.3 Site Operations Coordinator - The Site Operations Coordinator (SOC) for the CRDR is a Operations Engineer and will work closely with the LDE to insure the review is conducted as planned and scheduled. As the team manager, he will review the project's progress, identify any problems concerning schedules and planning and, with the aid of the team coordinators, he will resolve any coordination problems. The SOC will be responsible for day to day CRDR activities and reporting project status and progress to CP&L/H. B. Robinson Management. As the review team's technical leader he will insure that adequate technical resources are applied to all review activities. As a member of HEDAT, he will function as the team leader and be responsible for insuring strict adherence to HEDAT review procedures.

2.3.2.4 System Integration Team Leader - The System Integration Team Leader (SITL) (a contractor to HBR) has the overall responsibility for implementing the CRDR as planned and scheduled. The SITL will work directly for the SOC and direct the CRDR tasks.

2.3.2.5 Lead Human Factors Specialists - The Lead Human Factors Specialist (LHFS) (a human factors consultant) for the CRDR will be primarily responsible for insuring the technical quality of human factors work and the availability of appropriate human factors specialists as required throughout this project. The LHFS will work closely with the SOC and will coordinate all HF activities with the SITL. The LHFS will be directly responsible to the SOC for the progress of the HF areas of the project and will report any deviations from planned activities, methods or procedures in a timely manner. The LHFS will also be responsible for technical justifications related to any proposed methodological or procedural changes. As a member of the HEDAT, the LHFS will establish accurate and realistic statements on the human performance aspects for all identified problems and will also suggest resolutions to HEDs that will not create other HF problems.

2.3.2.6 Operations Support - The Operations Support personnel, as indicated in Figure 2-2 are committed to the CRDR for direct support in the System Function Task Analysis and the Verification and Validation tasks. They will also be available on an as-needed basis for engineering support throughout the project.

2.3.2.7 Human Factors Specialists - Human Factors support personnel, (human factors consultants), are committed to this project for direct support of all data collection; data reduction and analysis; and HED generation, analysis, and resolution. Also, in support of this project is a pool of human factors support personnel that represent diverse and current specialized experience backgrounds in human factors. The support group, will be directed by the HF Project Manager, and will be available on an as-needed basis throughout the review.

2.3.3 Review Team Support Members

2.3.3.1 General - Review Team Support members have been assigned support roles from the various required disciplines to insure an appropriate level of technical quality for the project. Although not assigned full-time, their availability has been assured by CP&L management directive and has been pre-planned to the degree possible during the initial planning and implementation phases of the project. Individual disciplines represented in this support group include but will not be limited to:

1) Operations
2) Training
3) Engineering
4) Maintenance

2.3.3.2 Operations - Experienced operators participate in various phases and activities of this project. Of particular concern will be their contribution to the Operating Experience Review (OER) described in paragraph 3.2. They will also furnish additional assistance during the verification of task performance activities, validation of CR functions processes, and the clarification of HEDs as

required. Each operator will have specific, unique experiential information that, when required, can contribute significantly to appropriate HED resolutions.

2.3.3.3 Engineering - The engineering representative will be primarily involved in the control room inventory process and HED assessment tasks. Intimate knowledge of plant instrumentation from the I&C viewpoint will also utilize during the verification of availability of CR functions.

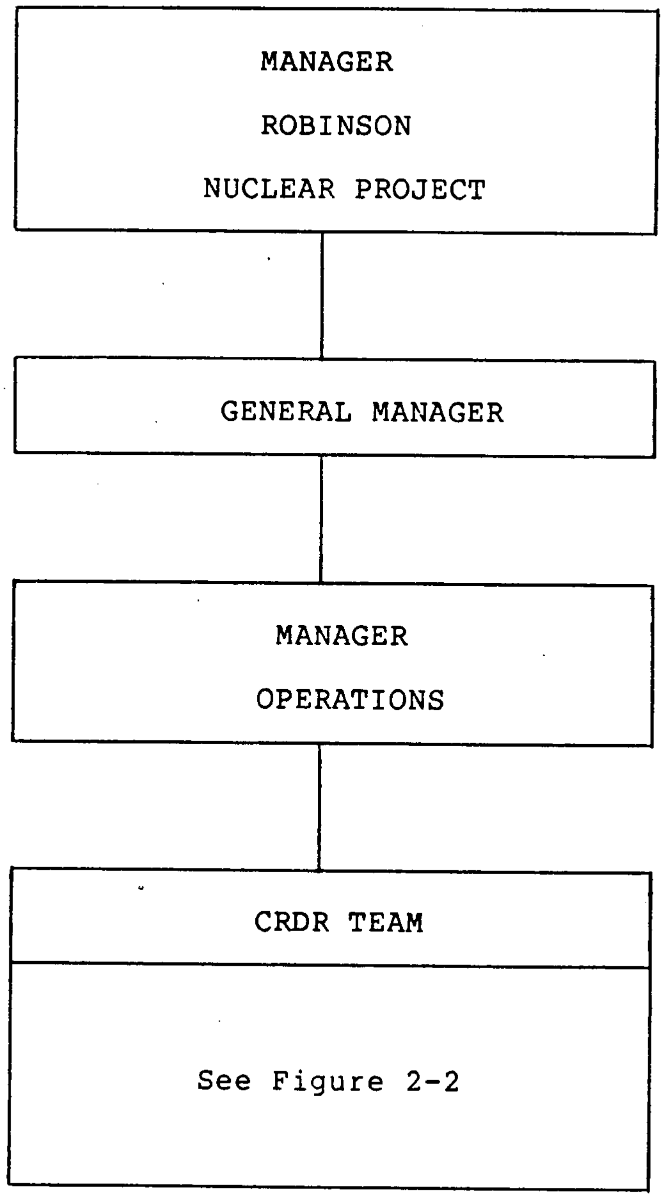
2.3.3.4 Training Representatives - The training representatives will be primarily involved in the System function task analysis and will contribute adjunct information on operational scenarios and cognitive task elements.

2.3.3.5 Maintenance - The maintenance engineer will be primarily involved in the resolution of HEDs and the implementation of backfits.

2.3.4 <u>CRDR Team Task Responsibilities</u>

a. Figure 2-3 illustrates, in matrix format, the task responsibility by team member. It should be recognized that the dynamic aspects of the CRDR will probably introduce requirements to adjust or supplement these anticipated assignments with additional team members. Any such changes of a significant nature will be documented and explained in the CRDR Final Summary Report.

CP&L MANAGEMENT ORGANIZATION



CP&L CRDR PROJECT MANAGEMENT SUPPORT
FIGURE 2-1

H. B. ROBINSON CR[illegible] PROJECT TEAM

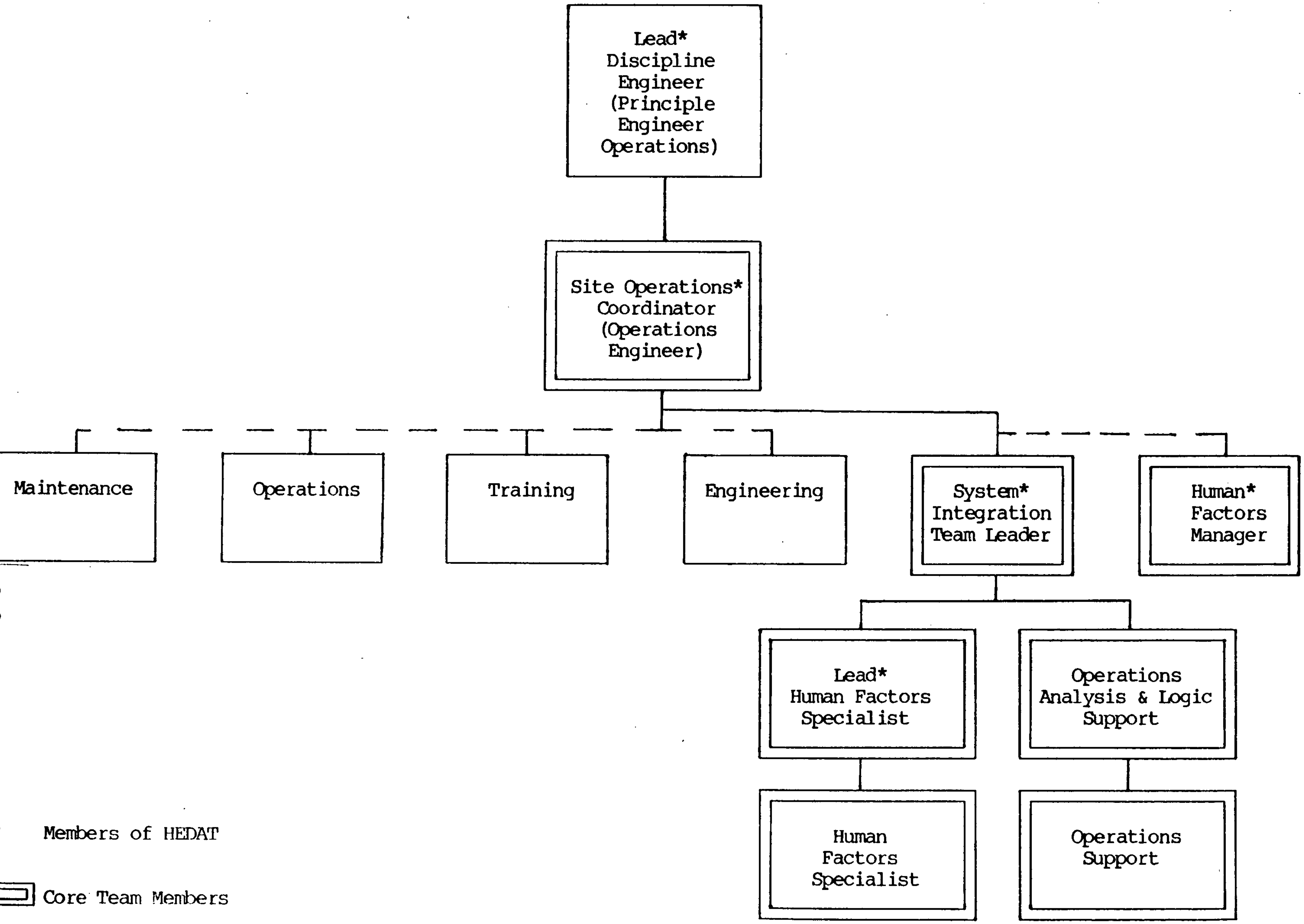


FIGURE 2-2

CRDR (PROJECT MANAGEMENT) TASK RESPONSIBILITIES

Figure 2-3

TASK	LDE	SOC	SITL	LHFS	HFS	OS
1. Program Definition	*	*	X	*		
2. Master Schedule Preparation and Revisions	*	*	X	*		
3. Sub-schedule Preparation and Revisions	o	*	*	X	*	
4. Detail Schedule for Plant-Specific CRDR Preparation and Revisions		o	X	*	*	
5. Periodic Update Reports	o	o	*	X	*	
6. Define CRDR Human Factors Requirements	*	*	*	X	*	
7. Conduct Plant-Specific Review (CRDR)		*	*	X	*	*
8. Review HEDs and Determine Corrective Actions	X	X	X	X	*	*
9. Present Recommended Corr. Actions to Management and Assess Program	o	o	o	X	*	*
10. Final Summary Report Preparation				X	*	
11. Final Summary Report Review	X	*	*			
12. Final Summary Report Approval	o	o	o			
13. Final Summary Report Delivery	*	X				
14. Implementation of Corrective Actions (Phase III)	X	*	*	*		*
15. Review of Corrective Actions (Phase III)	X	*	o	o		

X = Primary Responsibility
* = Support Responsibility
o = Approval Authority

LDE = Lead Discipline Engineer
SOC = Site Operations Coordinator
SITL = System Integration Team Leader
LHFS = Lead Human Factors Specialist
HFS = Human Factors Specialist
OS = Operations Support

SECTION 3.0 TECHNICAL APPROACH

3.1 INTRODUCTION

3.1.1 General

This section of the Program Plan describes the procedures to be used by CP&L to review the completeness and suitability of the H.B. Robinson, Unit 2 Control Room. As suggested in NUREG-0700, the specific objectives of the review effort will be:

a. To determine whether the control room provides the system status information, control capabilities, feedback, and performance aids necessary for the control room operators to accomplish their functions and tasks effectively.

b. To identify characteristics of the existing room instrumentation, controls, other equipment, and physical arrangement that may detract from operator performance.

Throughout the review process, CP&L will focus on ensuring that the functions and tasks assigned to the operators can be accomplished in an effective manner within the existing control room.

3.1.2 Method

The review process planned by CP&L will be conducted in six activities that parallel those described in Section 3 of NUREG-0700. Each of these activities is described below.

3.1.2.1 Operating Experience Review - The objective of the Operating Experience Review (OER) is to identify any characteristics in the design, layout or operation of the Control Room that may contribute to or alleviate operator performance problems. The focus during this activity is on control room characteristics of concern that are reflected by the experience of the control room operators. This activity will be conducted by interviews with licensed plant operating personnel.

Any problems identified during the OER will be reviewed to determine their causes and effects. Where appropriate, HEDs will be written and scheduled for assessment.

3.1.2.2 Control Room Surveys - The objective of the control room surveys is to evaluate the Control Room against established principles of human engineering as contained in Section 6 of NUREG-0700. Surveys will be conducted through the application of methods and procedures which use the Section 6 guidelines as criteria. Any deviation from the guidelines will be noted. HEDs will then be written and scheduled for assessment.

3.1.2.3 System Functions and Task Analysis - A System Functions and Task Analysis (SFTA) will be conducted to identify information and control requirements associated with operator tasks performed during emergency conditions. These requirements will serve as evaluation criteria during the Verification of the Control Room Functions.

Any problems in the design or layout of the control room identified during the SFTA will be noted, and HEDs will be written and scheduled for assessment.

3.1.2.4 Control Room Inventory - In order to ensure the availability of required instrumentation and controls, a comprehensive inventory of all control room components will be prepared. The inventory will be organized by major control room panels, and will serve as a reference document during the Verification of Task Performance Capabilities activity.

3.1.2.5 Verification of Task Performance Capabilities - Task performance capabilities will be verified by ensuring that all operator information and control requirements identified during the SFTA are met both in terms of the availability of the components and human factors suitability of the components. Any requirements not met will be identified, and HEDs will be written and scheduled for assessment.

In addition, any control room components that are identified as unnecessary will be subject to consideration for relocation outside the primary operating area.

3.1.2.6 Validation of Control Room Functions - The final activity in the review process will be to ensure that all operator functions can be performed within the existing control room. This activity will employ walk-through, talk-through exercises using selected event sequences identified during the SFTA. Any problems identified in performing control room functions will be documented and HEDs will be written and scheduled for assessment.

3.1.3 Products

The product of the review process will be a set of human engineering discrepancies identified in the control room. These HEDs will specify the type and extent of the problem, the potential impact on operator performance in relation to plant operation, and a suggestion for corrective action.

A detailed description of the review process is presented in the following sections.

3.2 OPERATING EXPERIENCE REVIEW

3.2.1 Introduction

The Operating Experience Review (OER) will identify CR design attributes and procedural activities that may contribute to or alleviate operator performance problems.

3.2.2 Operations Personnel Survey

3.2.2.1 General - The Operations Personnel Survey (OPS) will focus on the analysis of experiential information to identify potential problems that may have contributed to degraded operator performance. Additionally, information will be solicited which identifies design features which appear to enhance operator performance.

3.2.2.2 Structured Interviews - A stratified sample of operators will be selected for structured interviews. This sample will include a representative sample of licensed operators (SROs and ROs). The format of the interview will systematically address and document details concerning the following areas from NUREG-0700:

1) Workspace
2) Anthropometrics
3) Emergency Equipment
4) Heating, Ventilation and Air Conditioning
5) Illumination
6) Ambient Noise
7) Maintainability (Operator Performed)
8) Communications
9) Annunciator System
10) Controls
11) Displays
12) Labels and Location Aids
13) Computer System
14) Conventions

In addition, operators will be encouraged to provide any other comments or concerns they may have regarding the design or operation of the control room.

3.2.2.4 Response Analysis - All response data will be reviewed and tabulated. Questionnaire/Interview checklists constructed from specific guidelines contained in Section 6.0 of NUREG-0700 will be used to aid in the analysis of all responses. A negative response which identifies a deviation from guidelines or a potential human performance problem will result in the generation of an HED report. All HED reports will be assessed by the HEDAT during the assessment and implementation phase.

3.3 CONTROL ROOM SURVEYS

3.3.1 Introduction

a. The CR surveys are planned to follow the guidance of NUREG-0700. Human factors specialists, in concert with experienced operations and engineering personnel, will measure and observe a number of CR design features. Central to this survey effort are the HF guidelines contained in Section 6.0 of NUREG-0700. These guidelines will be used as the criteria to which all survey data will be compared.

b. The surveys have been organized, and methodology has been developed which parallels the structure of Section 6.0 of NUREG-0700. Fourteen specific surveys are planned which are:

1) Workspace
2) Anthropometrics
3) Emergency Equipment
4) HVAC
5) Illumination
6) Ambient Noise
7) Maintainability
8) Communications
9) Annunciator Systems
10) Controls
11) Displays
12) Labels and Location Aids
13) Computer System
14) Conventions

c. In order to facilitate data collection, reduction, and analysis and to support the review documentation requirements, task plans have been developed for each of the above 14 survey areas. Each of these tasks plans direct the data collection, data analysis and HED report generation based upon a mix of four basic data collection procedures. These are:

1) Measurements
2) Observations
3) Questionnaires/Interviews
4) Document Reviews

Each of these task plans uses one or more of these procedures to collect the data needed to evaluate the task plan-designated area of CR design. Task plan organization, and these procedures are explained in more detail in paragraph 3.3.2. (A sample task plan is provided in Appendix A.)

3.3.2 Task Plan Procedures

a. Each task plan contains an identical format and outline. Content is varied only where necessary for the particular design area discussed. A typical task plan outline is as follows:

1.0 Objectives
2.0 Review Team
3.0 Criteria Summary
4.0 Procedures
5.0 Equipment/Facility Requirements
6.0 Inputs and Data Forms Listing
7.0 Required Outputs/Expected Results
8.0 Figures and Tables (if required)
9.0 Procedure Exceptions (if any)

Appendix A - Detailed Criteria (from NUREG-0700)
Appendix B - Data Collection/Analysis Forms
Appendix C - Criteria-to-Procedure Matrix
Appendix D - Task Plan Critique

b. Sections 1.0 through 8.0 of the text are brief summaries intended primarily to familiarize the task conductor with the overall task requirements. Upon completion of the task, the task conductor completes Section 9.0, if necessary, and submits a completed Task Plan Critique from Appendix D to the CP&L technical reviewer. The critique is to identify any difficulties or problems with the task plan and is not a central part of the review process. The important and detailed criteria and procedural information are contained in Appendix A and B of each task plan.

c. Appendix A contains a subset of the guidelines from NUREG-0700, Section 6.0. Each guideline is worded identical to the NUREG-0700 guideline and the NUREG-0700 guideline paragraph number is preserved for ease of cross-referencing. When taken in total, all 14 of the Task Plan criteria sets represent subsections 6.1 through 6.7 of NUREG-0700.

The last two subsections, 6.8 and 6.9 of NUREG-0700 Section 6.0, are used as criteria for the SFTA and the verification and validation activities. The task plans, themselves, occur in the same order as the Section 6.0 subsections of NUREG-0700 and, with one main exception, are titled similar to the Section 6.0 subsection titles. For example, the Annunciator System Review Task Plan (TP-3.1) incorporates as criteria the guidelines contained in NUREG-0700 Section 6.3. The main exception to this approach is that Section 6.1 - Workspace, of NUREG-0700, was further subdivided into seven task plans that, in general, follow the additional breakdown of Section 6.1. Thus, General Layout - 6.1.1 becomes the Workspace Task Plan, Workstation Design - 6.1.2 becomes the Anthropometrics Task

Plan, Emergency Equipment - 6.1.4 becomes the Emergency Equipment Task Plan, and Environment - 6.1.5 becomes HVAC, Illumination, Ambient Noise, and Maintainability Task Plans. The guidelines in Section 6.1.3 - Multi-Unit Control Rooms, was integrated into all other task plans as appropriate.

d. Some minor exceptions to this general classification scheme for the evaluation criteria occurred that was caused, primarily, by individual interpretations of specific guideline statements. As an example, 6.1.1.6b of NUREG-0700, while appropriately in subsection 6.1 - Control Room Workspace, explains the need for dedicated communication links between the supervisor's office and the control room (note that it also refers to guideline 6.2.1.7 - Point-to-Point Intercom Systems).

   It is believed that the evaluation of that design will be easier to accomplish if 6.1.1.6b appeared as a criterion in the Communications Task Plan.

e. Appendix B in each task plan is subdivided into as many subappendices (e.g., B1, B2, B3, etc.) as is necessary to describe the detailed data collection and analysis procedures used for that plan. Appendix B1 is always measurements data forms and directions, B2 is always an Operator Interview/Questionnaire, B3 is always an Observations Checklist, and B4 is always a Document Review Checklist. B5 through B9 are additional analyses directions and supplement forms as required. To preserve consistency from task plan to task plan, Appendices B1 through B4 always exist. As an example, if measurements are not required data for the Conventions Survey Task Plan, an Appendix B1 - Measurements sheet is inserted, in place, with the notation of "not required". In this way,

it is possible to conduct any or all of a given type of procedure across one or more task plans during a review. This flexibility allows for optimizing the review data collection and analysis activities to fit the review scheduling, personnel availability constraints, and equipment access constraints, all without adversely impacting data quality or review comprehensiveness.

Of special interest here, is that the Interview/-Questionnaire sections of each of the 14 task plans (with the addition of operationally related criteria from Sections 6.8 and 6.9 of NUREG-0700) constitute the prepared structured interview that is described in paragraph 4.2.3.

f. Appendix C provides a criteria matrix for all the guidelines contained in Appendix A. The Criteria Matrix provides a crosswalk for the guidelines and defines the data collection methods and the suggested data sources required for evaluation of each guideline.

g. The various data types are determined by the NUREG-0700 criteria. Measurement data are those data which must be numerically compared to the NUREG-0700 guidelines for evaluation. These consist of such design features as display height, noise levels, or illumination levels. Observation data are those data that a trained human factors specialist can adequately evaluate by observing the design feature. These consist of such features as procedure and document storage, office locations, and restroom facilities. Questionnaire/Interview data are data that require a knowledge of the equipment, frequently operational, before such data can be adequately or realistically evaluated. These consist of such features as the possible

meaning attached to color codes, identification of degraded illumination characteristics in certain indicator lights, or controls that are extremely difficult to operate. Documentation Review data are data that must (or may) be obtained by reviewing available documents that pertain to the design and/or operation of the plant. These consist of such design features as the availability and adequacy of a dictionary of standard terms, abbreviations, and acronyms, or an administrative procedure for the control of temporary labels.

h. As each data type collection procedure is complete, the task conductor may choose to proceed to the next data collection procedure, or may choose to reduce, analyze, and generate HED reports (if any) on the just-completed data collection step. This additional flexibility allows for involving plant personnel (who are members of the CRDR Project Team) in a manner in which they are either frequently but moderately involved, or infrequently but heavily involved in reviewing HED reports and furnishing needed plant information into the review process.

i. All task plan procedures require that, before an HED report can be generated, the collected data must be compared to one or more referenced criterion. In comparing the data to the criteria, the task conductor will annotate the checklist column next to the criterion guideline as either yes, no, or N/A. For all "no" check marks, an HED report is then generated and the HED report number is entered in the criterion comments column. As a cross-reference, the data collection appendix number and the guideline paragraph number are entered on the HED report form. Once this process is complete for each data point within a task plan, and all task plans are complete, the surveys and

reviews of the human factors suitability of the evaluated design (independent of the task requirements) are completed and documented.

j. Copies of all completed task plans are filed in the Review Data File.

3.4 SYSTEM FUNCTIONS AND TASK ANALYSIS

3.4.1 Introduction

The objective of this activity is to establish the information and control requirements and the performance criteria for the tasks which operators are required to accomplish under emergency conditions. These requirements and criteria will serve as benchmarks for the examination of the adequacy of control room instrumentation and other equipment.

3.4.2 Method

a. The procedure to be employed by CP&L in conducting the System Functions and Task Analysis (SFTA) involves the development of plant-specific task analysis data base from generic task analytic background information and generic emergency response guidelines. Throughout this process, the emphasis will be on identifying and analyzing operator action and information requirements from the plant-specific task analysis for those tasks performed under emergency conditions which provide emergency response capabilities with respect to maintaining critical plant safety functions (i.e., containment integrity, reactivity control, RCS inventory control and heat transfer).

The task analysis methods and procedures documented herein are based on the Westinghouse Owner's Group (WOG) Emergency Response Guidelines (ERGs), Revision 1, and the WOG HP Basic System Review and Task Analysis (SRTA).

b. The Revision 1 WOG ERGs is considered a validated data base (NRC-WOG meeting of 29 March 1984) which defines the generic plant systems and functions, including the primary action/information requirements and allocates the functions between the human and the machine. The Revision 1 ERGs are used as the basis for the CP&L emergency response procedures development and the basis for the task analysis methods described in this program plan. The WOG System Review and Task Analysis (SRTA) will also serve as a data base for the plant-specific H. B. Robinson System Function Task Analysis.

c. The WOG SRTA is a joint program to the ERG development program. It provides a systematic compilation of the operator tasks, instrumentation and control requirements contained in the ERGs. The SRTA documents, which consist of TASK/SYSTEM SEQUENCE MATRICES and ELEMENT TABLES (see Figures 3-1 and 3-2) consist of the following:

- Identify individual operator task requirements
- Identify sequential operator task requirements
- Identify individual instrumentation requirements
- Identify individual control requirements.

d. There is a Task/System Sequence Matrix (Figure 3-1) for each ERG guideline and its function is to identify and inventory the tasks and subtasks associated with each ERG guideline. Essentially, the Task/System Sequence Matrices subdivide the Element Table data base and provides a table of contents for each subdivision.

e. The Element Tables (Figure 3-2) constitute the central document in the ERG SRTA program. It identifies the requirements that the user must address in the determination of the action and information requirements.

f. The first step in the HBR SFTA process is to convert the HP Basic SRTA into a plant-specific revision. This document, called, "HBR System Function Task Analysis," will consist of plant-specific Task/System Sequence Matrix Tables and Element Tables. The HBR SFTA will be based on the plant-specific emergency response guidelines, the EOP/ERG Transition Document and related background information. Difference in tasks/steps and instrumentation and control requirements in the Rev. 1 ERGs to the HBR SFTA will be documented within the Transition Document.

The EOP/ERG Transition Document tracks the difference from the WOG ERGs to the plant specific EOPs. The Transition Document consist of the following section:

- o List of differences between the ERG Low Pressure reference plant and H. B. Robinson.
- o Step deviation forms which explain any variance between a HBR step and a WOG step.
- o Derivation for the instrument values used in the HBR EOPs.

The HBR Task/System Sequence Matrices will reflect task/step differences and sequence changes. The HBR Element Tables will contain the plant-specific tasks, plant-specific knowledge requirements, plant-specific instrumentation and control requirements and the plant-specific task actions (or steps).

g. The next step in the SFTA process is to generate a list of plant-specific action and information requirements for each task within the HBR SFTA. This information will be tabulated on the ACTION-INFORMATION REQUIREMENTS DETAILS (AIRD) forms, (see figure 3-3). The AIRD form breaks down each task into behavioral elements. A behavioral elements is defined by the various behavioral or physical properties of an action requirement or information requirement. The names of these properties appear as column headers for columns 2 through 10 of the table. Some of these properties are plant specifics and require input from plant operations/engineering personnel.

h. When all AIRD forms are complete the forms are sorted by task name, so that all the forms with the same task name are together. Within each of these stacks the forms are ordered by step within the EOP.

i. The next step is to summarize the information and control requirements associated with a given type of behavioral element. Behavioral element types that are the same are defined as having the following characteristics:

   1. Their verbs agree as to class, e.g., they are either action verbs or information verbs such as, observe, monitor, start, stop etc.

   2. Their system/subsystem, component, and parameter are all the same.

   The ACTION-INFORMATION REQUIREMENTS SUMMARY (AIRS) form will be used to summarize information and control requirements across tasks and elements. See Figure 3-4.

3.4.3 Products

The product of the SFTA process will be a detailed listing of operator information and control requirements. This list will be used as input to the verification of task performance capabilities to assess the availability and suitability of instruments and equipment used by the control room operators. In addition, the results of the HBR SFTA will be used to assist in the selection of event sequences to be analyzed during the validation of control room functions.

3.5 DEVELOP CONTROL ROOM INVENTORY

3.5.1 Introduction

The objective of the control room inventory is to develop a comprehensive listing of all instrumentation, controls, and equipment contained in the control room. This list will be used in subsequent tasks to determine the adequacy of CR components for supporting operator information and control requirements identified during the task analysis.

The CR inventory will also aid in integrating multiple HEDs that may be associated with a particular component with a particular component or type of component. This will ensure a complete, integrated data file which will aid in the implementation of backfits.

3.5.2 Method

Project personnel will conduct a systematic review of relevant control room documentation (e.g., instrument lists, engraving lists, FSAR, etc.) to develop the CR inventory.

The inventory sheets will record the following information for all components:

- Component nomenclature or description
- Component labels
- Component characteristics (i.e., scale ranges)
- Panel
- Subpanel
- System
- Subsystem
- Physical location of item in CR

3.5.3 Products

The product of the CR inventory will be a comprehensive list of all instrumentation, controls and equipment contained in the control room. The CR inventory will be used to assist in the verification of available CR instrumentation (see paragraph 3.6).

3.6 VERIFICATION OF TASK PERFORMANCE CAPABILITIES

3.6.1 Introduction

The objective of this activity is to ensure the availability and suitability of required control room instrumentation and controls. As recommended in NUREG-0700, this activity will be conducted in two parts: verification of availability and verification of suitability.

3.6.2 Verification of Availability

Verification of availability will be accomplished through a comparison of the operator information and control requirements identified during the task analysis to the results of the control room inventory. The comparison will be conducted on a panel-by-panel basis to verify the presence or absence of instruments and equipment that provide each task sequence analyzed during the SFTA. Any information or control requirement that is not satisfied will be documented as an HED.

3.6.3 Verification of Suitability

Verification of suitability will involve examination of the human engineering characteristics of instrumentation and equipment identified during the verification of availability. During this process, selected guidelines from NUREG-0700 and criteria derived from

the task analysis will be used to determine the suitability of CR components. This process will consider such aspects of components design as adequacy of display range, usability of displayed values, relative location of related components, and other characteristics not easily evaluated without reference to specific task sequences. Any deviations from established criteria will be noted as HEDs.

3.6.4 Products

The results of the verification of task performance capabilities will be any discrepancies noted in the availability or suitability of instrumentation, controls and other equipment required by the control room operators to perform emergency response tasks. Such discrepancies will be recorded on the standard HED form and assessed during the assessment and implementation phase. In some cases, HEDs identified during the verification process will not result directly from a Section 6.0 guideline but may result from task analysis derived criteria. Such HEDs will be properly annotated and the criteria described.

3.7 VALIDATION OF CONTROL ROOM FUNCTIONS

3.7.1 Introduction

The objective of this activity is to determine if the functions allocated to the control room operating crew during emergencies can be accomplished effectively within: 1) the structure of defined emergency procedures, and 2) the design of the control room as it exists. As with Verification of Task Performance Capabilities, Validation of Control Room Functions is an extension of the SFTA. In this case, emphasis is placed on determining the adequacy of the control room design for supporting operator task sequences.

3.7.2 Method

The principal activities during this task involve observation of operators walking through selected event sequences. The following process will be employed during this task:

1) A set of scenarios will be prepared to define the emergency operating sequences to be included in the validation effort. The SFTA will be used to ensure that the sequences chosen represent all emergency interface requirements.

2) H.B. Robinson EOPs associated with the selected sequences will be obtained.

3) All participants in the validation effort will be briefed concerning the objectives and procedures of the walk-throughs, including assumptions concerning the status of the plant at the onset of the event sequence.

4) Control room personnel will be observed as they perform the selected sequences. The operators will be instructed to describe their actions as they perform the selected sequences, including:

   - o cues by which they initiate a task

   - o sources of information (displays, procedures, knowledge, etc.)

   - o application of information, including any conversions or uncertainties

   - o controls selected and expected system response

- methods for verifying system response and selection of alternative actions if response is not obtained

- indications that sequence is proceeding as expected

- indication that sequence is complete

- other comments, as appropriate.

During this process, the observers may interrupt the operators to obtain clarification or additional information.

5) Observers will record significant operator comments, as well as any observations that relate to the performance of CR functions.

6) The results of the observations will be analyzed to identify any problems with the CR layout, location of related components, operator workload, or other human engineering concerns. Any HEDs observed during the validation process will be noted and recorded.

   Observers will record: 1) any difficulties the operators had in responding to the event, 2) the impact on operator performance of any previously identified HEDs, and 3) any additional discrepancies identified during this task.

3.7.3 Products

The results of the validation process will be used by the HEDAT primarily to assess the impact of previously identified HEDs on actual operator performance. If additional HEDs are identified during the validation process they will be recorded and assessed in the same manner as other HEDs.

_________ Task/Systems Sequence Matrix

____

Page _____ of _____

Operator Tasks | Systems

Task	Master Task	Task Title	SEQUENCE	REACTOR TRIP ACTUATION	ESF ACTUATION	NUCLEAR INSTRUMENTATION	CONTROL ROD INSTRUMENTATION	RADIATION INSTRUMENTATION	CONTAINMENT INSTRUMENTATION	REACTOR COOLANT	SAFETY INJECTION	RESIDUAL HEAT REMOVAL	CHEMICAL AND VOLUME CONTROL	COMPONENT COOLING WATER	SERVICE WATER	CONTAINMENT SPRAY	CONTAINMENT ATMOSPHERE CONTROL	MAIN STEAM	MAIN FEEDWATER AND CONDENSATE	AUXILIARY FEEDWATER	STEAM GENERATOR BLOWDOWN	ELECTRICAL POWER	PNEUMATIC POWER	OTHER

TASK/SYSTEM SEQUENCE MATRICES
FIGURE 3-1

FIGURE 3-2

ELEMENT TABLE
HBR SFTA

TASK ______

Function -

Task -

Task Objective

o

Task Decision (Criteria) Requirements

o

Task Knowledge Requirements

o

Task Instrument (Criteria) Requirements

Task Action (Criteria) Requirements

Task Control Capability (Criteria) Requirements

Consequences of Task Error/Omission

ACTION-INFORMATION REQUIREMENTS DETAILS (AIRD)

Sheet ______ of ______

PLANT: ______________________ UNIT: __________

EOP NO: __________ EOP NAME: ______________________ ORIGINATOR: __________ DATE: __________

ERG NO: __________ REVIEWER: __________ DATE: __________

STEP NO: __________ STEP NAME: ______________________

STEP OBJECTIVE: ______________________

REMARKS:

BEHAVIORAL ELEMENTS											
Action	Verb	System	Component/ Equipment No.	Parameter	Direction	State/Value	Units/Rate	Precision	Trending Required?	Comments	On AIRS Sh No

FIGURE 3-3

ACTION-INFORMATION REQUIREMENTS SUMMARY (AIRS)

Sheet ______ of ______

PLANT: ______________________ UNIT: ________

ORIGINATOR: ______________ DATE: ______________

REVIEWER: ______________ DATE: ______________

SORT BLOCK
REQS TYPE: Act ________ Info ________
SYSTEM : ________
COMPONENT: ________
PARAMETER: ________

SUMMARY OF REQUIREMENTS BLOCK
VALUE/RANGE: ________
UNITS: ________
PRECISION: ________
RESPONSE TIME: ________

REMARKS:

VERIFICATION SUMMARY BLOCK

DEVICE		PASS	FAIL
I.D. No	PANEL		

INDIVIDUAL DETAILS

ERG NO.	Step No.	Action	Verb	Direction	State/Value	Units/Rate	Precision	Trending Required?	Comments

FIGURE 3-4

SECTION 4.0 ASSESSMENT PHASE

4.1 INTRODUCTION

NUREG-0700 defines a Human Engineering Discrepancy or HED as "a departure from some benchmark of system suitability for the roles and capabilities of the human operator". Section 6 of NUREG-0700 contains these design benchmarks or guidelines. While it can be expected that the CRDR process will produce reports of Human Engineering Discrepancies, it does not follow that all discrepancies will necessarily degrade operator performance to the point that plant safety would be affected. The objective of the assessment process is for the HED Assessment Team (HEDAT) to evaluate the relative significance of the HEDs produced during the review phase. The HEDAT will separate those HEDs that are unlikely to degrade performance from those that may degrade performance.

4.2 PRIORITIZATION

a. The approach to be employed by CP&L in assessing HEDs involves prioritization of each HED based on estimations of the potential for error and the consequence of errors resulting from the HED. Assessment of the potential for error will be based on:

   o component design factors (e.g., extent of deviation from guideline, conformance to plant design conventions),

   o task factors (e.g., difficulty, frequency, time demands), and

   o human factors (physical performance; sensory and perceptual performance).

b. Once the potential for error has been established, the consequences of the error will be estimated for each HED by the HEDAT. Error consequence will be defined in terms of the potential impact on plant safety by considering the system/functions affected by the error. HEDs related to systems and functions identified as safety-related during the SFTA or which increase the probability of an error that could result in violation of technical specification or unsafe operation will receive the highest rating.

c. An HED will be assigned a category number of I, II, III or IV (See Figure 4-1) based on the following criteria:

- Category I - An HED will be assigned a category I when the discrepancy may lead to an error which has safety consequences or may result in a violation of a technical specification. Also if an HED was written because there is a history of the error occurring it will be assigned a category I.

- Category II - An HED will be assigned a category II when the discrepancy has been determined to be of valid concern but there is no documented cases of the error occurring.

- Category III - An HED will be assigned a category III when the discrepancy has been determined to have a low probability of error and there is no documented cases of the error occurring.

- Category IV - An HED will be assigned a category IV when the discrepancy has no impact on operator performance and has no probability of error.

d. The HEDAT will analyze all Category I, II and III HEDs for disposition. Category IV HEDs, while considered optional for correction, will be assessed for their cumulative and interactive effects on all other HEDs. Those Category IV HEDs shown to possess the above effects will be recategorized to the appropriate category.

The next step in this procedure is for the HEDAT to identify those HEDs which can be corrected by enhancements, training of operators, and/or procedural revisions. The remaining HEDs will be analyzed to identify and provide design improvement alternatives. Since there is a limit to the number of changes which can be made as a result of this review, a cost-benefit analysis will also help determine which corrections are the most feasible and acceptable from a human engineering point of view.

4.3 CORRECTION

Regardless of the HED priority ranking, potential corrective action will be identified by the HEDAT for all HEDs. The basic procedure to be employed in identifying and selecting corrective actions involves:

- o Analysis for correction by enhancements
- o Analysis for correction by design alternatives
- o Assessment of the extent of correction.

4.3.1 Analysis for Correction by Enhancement

Discrepancies selected for correction are first examined for possible correction by enhancement (labeling, demarcation, operator aids, etc.). Each HED is considered and where such correction is possible, the discrepancy is reassessed for its effect on operator performance. Where it is determined that correction by enhancement is not possible, the discrepancy is analyzed for correction by design alternatives.

4.3.2 Analysis for Correction by Design Alternative

Discrepancies not correctable by surface enhancement may require a design effort. Corrective action may involve simple modification to the communication, lighting or alarm system, or alterations to the control boards. In either case, identification of design alternatives will be achieved by examination of the HED, reference to task analysis data, and identification of potential constraints (e.g., availability of equipment, Reg. Guide 1.97). The backfit design development process, if used, will also consider the need to minimize cost of the change and its impact on the existing design. Multiple design alternatives will be considered, as appropriate. Cost and schedule estimates will also be considered for each proposed change. The impact of each proposed design change on operator training, plant maintenance and documentation will also be considered, as will the reduction in probability of operator error.

4.3.3 Assessment of the Extent of Correction

For all HEDs selected for correction, the extent to which each discrepancy will be corrected (by enhancement or redesign) will undergo HEDAT evaluation. This evaluation process will be applied to ensure that no new HEDs are created by the correction, other corrections are not invalidated and the correction is in compliance with human engineering guidelines. (This process will be described in more detail in the Summary Report.) The HED solutions should ideally eliminate all discrepancies and bring the control room into full compliance with the intent of the guidelines. However, discrepancies which are not fully corrected will be identified and documented by the review team and a justification will be prepared for each one.

4.3.4 Scheduling of Corrections

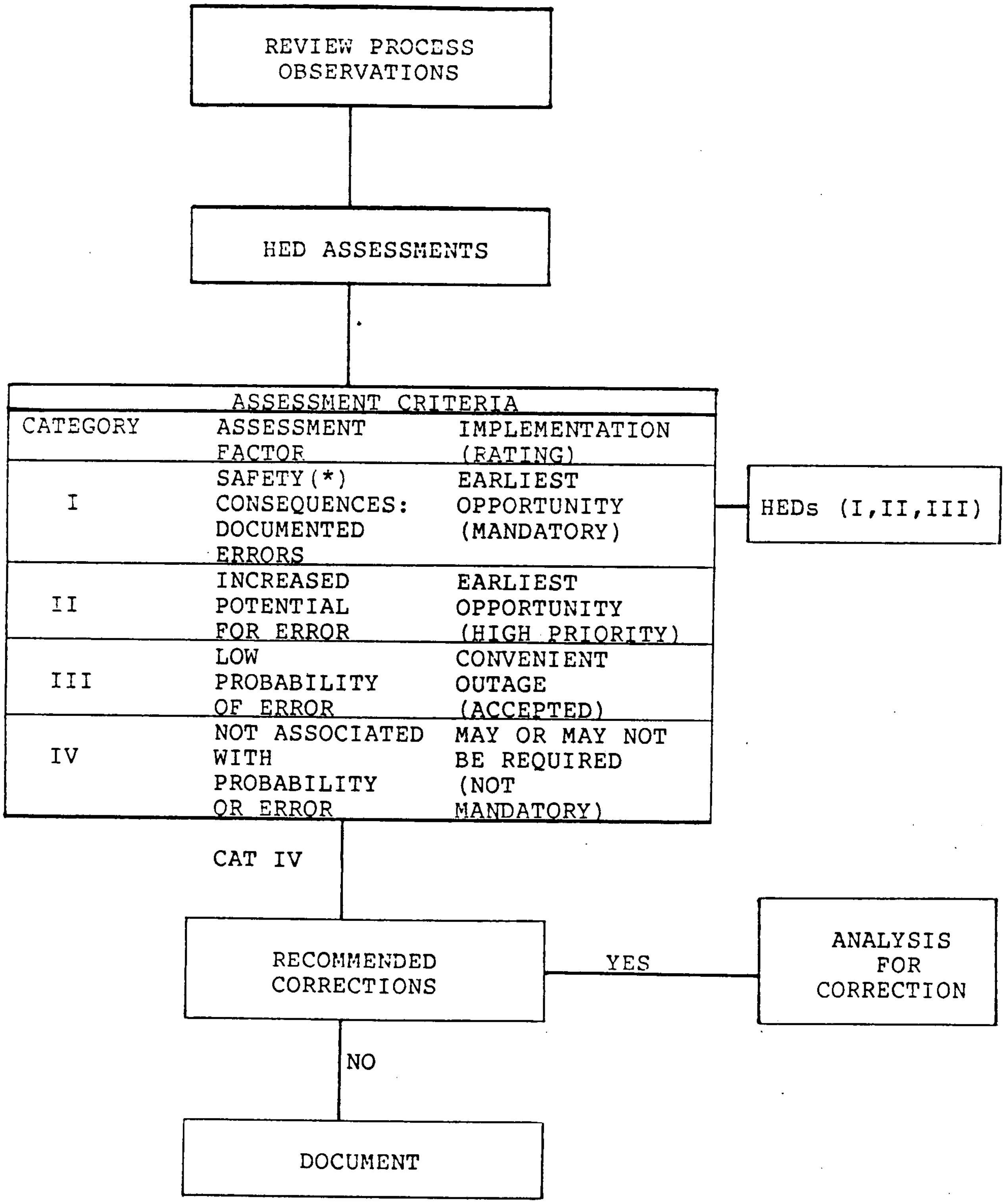
HEDAT-approved solutions to HEDs will be scheduled for implementation. The category guidelines established in Paragraph 4.2 of this plan will be used as a basis for the corrective action schedule. Additional considerations in the development of the implementation schedule will be:

- Safety consequences of operator errors that could be caused by the discrepancy

- Integration with other NUREG-0737 Supplement 1 programs

- Plant operation constraints

- Operator training/retraining requirements
- Outage schedules
- Equipment procurement schedules.



ASSESSMENT CRITERIA

CATEGORY	ASSESSMENT FACTOR	IMPLEMENTATION (RATING)
I	SAFETY(*) CONSEQUENCES: DOCUMENTED ERRORS	EARLIEST OPPORTUNITY (MANDATORY)
II	INCREASED POTENTIAL FOR ERROR	EARLIEST OPPORTUNITY (HIGH PRIORITY)
III	LOW PROBABILITY OF ERROR	CONVENIENT OUTAGE (ACCEPTED)
IV	NOT ASSOCIATED WITH PROBABILITY OR ERROR	MAY OR MAY NOT BE REQUIRED (NOT MANDATORY)

(*) EXAMPLE: RESULTS IN UNSAFE OPERATION OR VIOLATION OF TECHNICAL SPECIFICATIONS

HED ASSESSMENT
FIGURE 4-1

SECTION 5.0 DOCUMENTATION AND DOCUMENT CONTROL

CP&L recognizes the critical role of document control during the CRDR process. To this end, the RTL will be responsible for controlling all project documentation, including: letters and memos, progress reports, interim reports, HED reports, and summary reports. All final versions of primary project documents will be assigned a unique designator prior to distribution, and a hard copy will be maintained in a central project file.

The primary emphasis in the documentation control system will be the control of the review project documents to ensure an accessible and fully auditable review data file. The system to be used is also compatible with the existing document control system currently in place as HBR.

SECTION 6.0 FINAL SUMMARY REPORT

Upon completion of the CRDR, a summary of the results will be prepared and submitted to the NRC for review. The Final Summary Report will describe the results of the CRDR and will be submitted within six months after startup from cycle 10. The report will summarize the CRDR process, provide summary descriptions of the identified human engineering discrepancies and their proposed corrective actions. It will also provide implementation schedules for each corrective action and describe the process that will be used to assess changes to ensure additional HEDs aren't created by the changes. It will also describe any modifications or revisions made to this Program Plan and will include the project team resumes and report any changes in Review Team Personnel. Samples of the procedures used in the CRDR and sample data forms will be provided.

The details of the CRDR, along with complete documentation, will be maintained as part of the permanent station records and will be available for an on-site review.

SECTION 7.0 IMPLEMENTATION PHASE

The following general procedure will be followed to implement the recommendations:

1. The HEDs to be corrected will be ordered according to the priorities described in paragraph 4.2 of this plan.

2. The station's outage work schedule will be reviewed to arrange manpower and time, as necessary, to implement the corrective actions.

3. Upon completion of each HED's recommended correction, the responsible department will notify the SOC who will arrange for the corrections to be reviewed by an HFS.

   The Implementation Phase will be described in detail as part of the Final Summary Report.

APPENDIX A
SAMPLE TASK PLAN

TP-3.1 HBR
May 1, 1983

HUMAN FACTORS TASK PLAN

FOR THE

ANNUNCIATOR SYSTEM REVIEW

ANNUNCIATOR SYSTEM

RECORD OF REVISIONS

Rev. No.	Rev. Date	Description

TABLE OF CONTENTS

APPENDICES

ANNUNCIATOR SYSTEM

1.0 OBJECTIVES

a. To assess to what degree the annunciator system conforms to the criteria in NUREG-0700.

b. To identify and document any features in the annunciator system design that do not conform to the criteria in NUREG-0700.

2.0 REVIEW TEAM SELECTION AND RESPONSIBILITIES

a. A human factors specialist to conduct the data collection and analysis and to prepare the task report.

b. A client nuclear operations specialist to supply plant systems information concerning alarm parameters and alarm response procedures.

c. A client plant engineer/opertor to assist in identifying relevant plant systems information.

3.0 CRITERIA

The criteria are from NUREG-0700; paragraphs 6.3.1.1; 6.3.1.2a through d(2); 6.3.1.3a through d; 6.3.1.4a and b; 6.3.1.5a through b(3); 6.3.2.1a through f; 6.3.3.1a through b(2); 6.3.2.2a and b; 6.3.3.1a through c(3); 6.3.3.2a through f(2); 6.3.3.3a through f; 6.3.3.4a through d; 6.3.3.5a through d(6); 6.3.4.1a through d(2); 6.3.4.2a through c; 6.3.4.3a and b; 6.5.1.6a through c(2) and e(1) through 3(3); and 6.6.6.2a, b, and c (see Appendix A).

4.0 PROCEDURES

4.1 General Instructions

4.1.1 Preparation and Conduct of Procedures

a. Prior to conduct of this task, ensure that all required data forms, plant documentation, engineering drawings, equipment, and materials are available. Ensure that permission has been obtained for all required access to the control room or other plant areas.

b. Record all exceptions, deviations, or changes to these procedures in Section 9.0 of this Task Plan. Number each entry sequentially, starting with 1. Include an explanation (technical justification) as to why the exception, deviation, or change was made.

4.1.2 Task Plan Critique

Upon completion of this task, fill out the Task Plan Critique contained in Appendix D. Submit the completed critique to your supervisor or project manager.

4.2 Data Collection

a. Data are collected using various methods and procedures consisting of measurements, observations, interviews and questionnaires, and document reviews. Appendix C illustrates the distribution of the criteria for the various methods.

b. Measurements and observations should be made for all items contained on the Measurement data forms and Observations checklists contained in Appendix B.

c. The operator interviews (Appendix B) should be administered to a significant number of the licensed reactor operators for the plant. Administration may be conducted singly or in a group, but should be proctored or monitored.

d. The results of the System Function and Task Analysis tasks should be reviewed for annunciator-relevant data in reference to NUREG-0700 guidelines 6.3.3.1; 6.3.1.4a; 6.3.3b and d(2); 6.3.3.4a and c; 6.3.4.3a; and 6.6.6.2a(1), (2), and (3).

e. In addition to the review results from d, above, plant documentation should be reviewed to verify the items listed in the Document Review Checklist in Appendix B. The required plant documents include:

   1. Annunciator Response Procedures

   2. Administrative Procedures relevant to annunciators.

4.3 Analysis

a. All deviations from the criteria shall be recorded on Human Engineering Discrepancy (HED) reports (Appendix B). Recorded information shall include the instrument or instruments involved (e.g., auditory alarm horns, specific light tiles, etc.), a description of the problem including the 0700 paragraph number of the criteria, and a recommended solution.

b. Data collection method(s) shall also be recorded on the HED form (see Appendix B). Where data from two or more sources are contradictory, resolution of the conflict through data review and client interview shall be made.

c. Use the analysis aids from Appendix B for all data reduction and analysis. Upon completion of all analyses, ensure that the criteria in Appendix A are properly annotated (as specified in the analysis aids).

d. Submit the completed task plan to your immediate supervisor for review. Upon project management approval, initiate Task Report 3.1.

5.0 EQUIPMENT AND FACILITY REQUIREMENTS

a. Access to the control room.

b. Sound level meter.

c. Protractor and tape measure.

d. Flash comparator.

6.0 INPUTS AND DATA FORMS

a. Annunciator Response Procedures

b. Annunciator Administrative Procedures

c. Completed Task Reports for:

   1. System Function and Task Analysis

   2. Labels and Location Aids

   3. Maintainability

d. Criteria List (Appendix A)

e. The following from Appendix B:

   1. Measurements Data Forms

   2. Interview Forms

   3. Observations Checklist

   4. Documentation Review Checklist

   5. Analysis Aids

   6. HED Report Forms

f. Criteria Matrix (Appendix C)

g. Task Plan Critique Form (Appendix D)

7.0 OUTPUTS AND RESULTS

a. Completed HEDs

b. Completed Task Report.

8.0 FIGURES AND TABLES

None

9.0 PROCEDURE EXCEPTIONS

The following exceptions, deviations, and changes were made to these procedures during conduct of the task (include a statement of justification on each item):

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	N/A	YES	NO	COMMENTS
6.3.1.1 GENERAL SYSTEM DESIGN Annunciator warning systems are the primary control room interface to immediately alert the operator to out-of-tolerance changes in plant condition. Annunciator warning systems consist of three major subsystems: (a) an auditory alert subsystem, (b) a visual alarm subsystem, and (c) an operator response subsystem (see Exhibit 6.3-1). Together, these three subsystems should be designed to provide a preferred operational sequence for annunciator warnings as indicated in Exhibit 6.3.2.				
6.3.1.2 ALARM PARAMETER SELECTION				
a. SETPOINTS - The limits or setpoints for initiating the annunciator warning system should be established to meet the following goals:				
(1) Alarms should not occur so frequently as to be considered a nuisance by the operators.				
(2) However, setpoints should be established to give operators adequate time to respond to the warning condition before a serious problem develops.				
b. GENERAL ALARMS —				
(1) Alarms that require the control room operator to direct an auxiliary operator to a given plant location for specific information should be avoided.				
(2) If general alarms must be used, they should only be used for conditions that allow adequate time for auxiliary operator action and subsequent control room operator actions.				

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	N/A	YES	NO	COMMENTS
6.3.1.2 (Cont'd)				
c. MULTICHANNEL OR SHARED ALARMS —				
(1) Annunciators with inputs from more than one plant parameter setpoint should be avoided. Multi-input alarms that summarize single-input annunciators elsewhere in the control room are an exception.				
(2) Where multi-input annunciators must be used, an alarm printout capability should be provided. The specifics of the alarm should be printed on an alarm typer with sufficient speed and buffer storage to capture all alarm data.				
(3) A reflash capability should be provided to allow subsequent alarms to activate the auditory alert mechanism and reflash the visual tile even though the first alarm may not have been cleared.				
d. MULTI-UNIT ALARMS —				
(1) Alarms for any shared plant systems should be duplicated in all control rooms.				
(2) When an item of shared equipment is being operated from one control room a status display or signal should be provided in all other control rooms which could potentially control this equipment.				

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	N/A	YES	NO	COMMENTS
6.3.1.3 FIRST OUT ANNUNCIATORS				
a. REACTOR SYSTEM --				
(1) A separate first out panel should be provided for the reactor system.				
(2) The first out panel should consist of separate annunciator tiles for each of the automatic reactor trip functions.				
(3) In the event of a reactor trip, the tile associated with the event should illuminate, and no other.				
b. TURBINE-GENERATOR SYSTEM -- A separate first out panel, similar in function to the reactor system panel, is recommended.				
c. POSITION - First out panels should be located directly above the main control work station for the system.				
d. APPLICATION - First our annunciators should conform to the general auditory, visual, and operator response guidelines of this section.				
6.3.1.4 PRIORITIZATION				
a. LEVELS OF PRIORITY --				
(1) Prioritization should be accomplished using a relatively small (2-4) number of priority levels.				

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	N/A	YES	NO	COMMENTS
6.3.1.4a (Cont'd) (2) Prioritization should be based on a continuum of importance, severity, or need for operator action in one or more dimensions, e.g., likelihood of reactor trip, release of radiation. Exhibit 6.3-3 provides an example of prioritization based on three levels of prioritization. b. PRIORITY CODING - (1) Some method for coding the visual signals for the various priority levels should be employed. Acceptable methods for priority coding include color, position, shape, or symbolic coding. (2) Auditory signal coding for priority level is also appropriate. See Guideline 6.2.2.3 for recommended coding techniques. 6.3.1.5 CLEARED ALARMS a. AUDITORY SIGNAL - Cleared alarms should have a dedicated, distinctive audible signal which should be of finite duration. b. VISUAL SIGNAL - The individual tile should have one of the following: (1) A special flash rate (twice or one-half the normal flash rate is preferred, to allow discrimination), or (2) Reduced brightness, or				

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	N/A	YES	NO	COMMENTS
6.3.1.5b (Cont'd)				
(3) A special color, consistent with the overall control room color coding scheme, produced by a differently colored bulb behind the tile.				
6.3.2.1 SIGNAL DETECTION				
a. INTENSITY - The signal should be such that operators can reliably discren the signal above the ambient control room noise. A nominal value of 10 dB(A) above average ambient noise is generally adequate.				
b. CONTROL - Signal intensity, if adjustable, should be controlled by administrative procedure.				
c. LIMITS - The signal should capture the operator's attention but should not cause irritation or a startled reaction.				
d. DETECTION - Each auditory signal should be adjusted to result in approximately equal detection levels at normal operator work stations in the primary operating area.				
e. RESET - The annunciator auditory alert mechanism should automatically reset when it has been silenced.				
f. IDENTIFICATION - The operator should be able to identify the work station or the system where the auditory alert signal originated. Separate auditory signals at each work station within the primary operating area are recommended.				

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	N/A	YES	NO	COMMENTS
6.3.2.2 AUDITORY CODING				
a. LOCALIZATION				
(1) Auditory coding techniques should be used when the operator work station associated with the alarm is not in the primary operating area.				
(2) Coded signals from a single audio source should not be used to identify individual work stations within the primary operating area.				
b. PRIORITIZATION - Coding may be used to indicate alarm priority. (See Guideline 6.3.1.4.)				
6.3.3.1 VISUAL ANNUNCIATOR PANELS				
a. LOCATION - Visual alarm panels should be located above the related controls and displays which are required for corrective or diagnostic action in response to the alarm. (See Exhibit 6.3-4.)				
b. LABELING -				
(1) Each panel should be identified by a label above the panel.				
(2) Panel identification label height should be consistent with a subtended visual angle of at least 15 minutes when viewed from a central position within the primary operating area.				

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	N/A	YES	NO	COMMENTS
6.3.3.2 VISUAL ALARM RECOG AND IDENT				
a. FLASHING - The specific tile(s) on an annunciator panel should use flashing illumination to indicate an alarm condition.				
b. FLASHRATE - Flash rates should be from three to five flashes per second with approximately equal on and off times.				
c. FLASHER FAILURE - In case of flasher failure of an alarmed tile, the tile should illuminate and burn steadily.				
d. CONTRAST DETECTABILITY - There should be high enough contrast between alarming and steady-on tiles, and between illuminated and nonilluminated tiles, so that operators in a normally illuminated control room have no problem discriminating alarming, steady-on, and steady-off visual tiles.				
e. "DARK" ANNUNCIATOR PANELS - A "dark" annunciator panel concept should be used. This means that under normal operating conditions no annunciators would be illuminated; all of the visual tiles of the annunciator panels would be "dark."				
f. EXTENDED DURATION ILLUMINATION - If an annunciator tile must be "ON" for an extended period during normal operations (e.g., during equipment repair or replacement), it should be:				
(1) Distinctively coded for positive recognition during this period, and				
(2) Controlled by administrative procedures.				

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	N/A	YES	NO	COMMENTS
6.3.3.3 ARRANGEMENT OF VISUAL ALARM TILES				
a. MATRIX ORGANIZATION - Visual alarms should be organized as a matrix of visual alarm tiles within each annunciator panel.				
b. FUNCTIONAL GROUPING - Visual alarm tiles should be grouped by function or system within each annunciator panel. For example area radiation alarms should be grouped in one panel, not spread throughout the control room.				
c. LABELING OR AXES -				
(1) The vertical and horizontal axes of annunciator panels should be labeled with alphanumerics for ready coordinate designation of a particular visual tile.				
(2) Coordinate designation is preferred on the left and top sides of the annunciator panel.				
(3) Letter height for coordinate designation should be consistent with a subtended visual angle of at least 15 minutes as viewed from a central position within the primary operating area.				
d. PATTERN RECOGNITION -				
(1) The number of alarm tiles and the matrix density should be kept low (a maximum of 50 tiles per matrix is suggested).				
(2) Tiles within an annunciator panel matrix should be grouped by subsystem, function, or other logical organization.				

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	N/A	YES	NO	COMMENTS
6.3.3.3 (Cont'd)				
e. OUT-OF-SERVICE ALARMS - Cues for prompt recognition of an out-of-service annunciator should be designed into the system.				
f. BLANK TILES - Blank or unused annunciator tiles should not be illuminated (except during annunciator testing).				
6.3.3.4 VISUAL TILE LEGENDS				
a. UNAMBIGUOUS - Annunciator visual tile legends should be specific and unambiguous. Wording should be in concise, short messages.				
b. SINGULARITY - Alarms which refer the operator to another, more detailed annunciator panel located outside the primary operating area should be minimized.				
c. SPECIFICITY - Tile legends should address specific conditions; for example, do not use one alarm for HIGH-LOW, TEMPERATURE-PRESSURE.				
6.3.3.5 VISUAL TILE READABILITY				
a. DISTANCE - The operator should be able to read all the annunciator tiles from the position at the work station where the annunciator acknowledge control is located.				
(1) Letter height should subtend a minimum visual angle of 15 minutes, or .004 x viewing distance. The preferred visual angle is 20 minutes, or .006 x viewing distance.				

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	N/A	YES	NO	COMMENTS
6.3.3.5a (Cont'd)				
(2) Letter height should be identical for all tiles, based on the maximum viewing distance. Separate calculations should be made for stand-up and sit-down work stations.				
b. TYPE STYLE - The size and style of lettering should meet the following:				
(1) Type styles should be simple.				
(2) Type styles should be consistent on all visual tiles.				
(3) Only upper-case type should be used on visual tiles.				
c. LEGEND CONTRAST - Legends should provide high contrast with the tile background.				
(1) Legends should be engraved.				
(2) Legends should be dark lettering on a light background.				
d. LETTER DIMENSIONS AND SPACING -				
(1) Stroke-width-to-character-height ratio should be between 1:6 and 1:8.				
(2) Letter width-to-height ratio should be between 1:1 and 3:5.				
(3) Numeral width-to-height ratio should be 3:5.				
(4) Minimum space between characters should be one stroke width.				

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	N/A	YES	NO	COMMENTS
6.3.3.5d (Cont'd)				
(5) Minimum space between words should be the width of one character.				
(6) Minimum space between lines should one one-half the character height.				
6.3.4.1 CONTROLS (See Exhibit 6.3-5).				
a. SILENCE -				
(1) Each set of operator response controls should include a silence control.				
(2) It should be possible to silence an auditory alert signal from any set of annunciator response controls in the primary operating area.				
b. ACKNOWLEDGE				
(1) A control should be provided to terminate the flashing of a visual tile and have it continue at steady illumination until the alarm is cleared.				
(2) Acknowledgement should be possible only at the work station where the alarm originated.				
c. RESET				
(1) If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared.				

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	N/A	YES	NO	COMMENTS

6.3.4.1c (Cont'd)

(2) The reset control should silence any audible signal indicating clearance and should extinguish tile illumination.

(3) The reset control should be effective only at the work station for the annunciator panel where the alarm initiated.

d. TEST

(1) A control to test the auditory signal and flashing illumination of all tiles in a panel should be provided.

(2) Periodic testing of annunciators should be required and controlled by administrative procedure.

6.3.4.2 CONTROL SET DESIGN

a. POSITIONING OF REPETITIVE GROUPS - Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations. This is to facilitate "blind" reaching.

b. CONTROL CODING - Annunciator response controls should be coded for easy recognition using techniques such as:

(1) Color coding:

(2) Color shading the group of annunciator controls;

(3) Demarcating the group of annunciator controls; or

(4) Shape coding, particularly the silence control. (See Exhibit 6.3-5, Example 2.)

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	N/A	YES	NO	COMMENTS
6.3.4.2 (Cont'd) c. NONDEFEATABLE CONTROLS - Annunciator control designs should not allow the operator to defeat the control. For example, some pushbuttons used for annunciator silencing and acknowledgement can be held down by inserting a coin in the ring around the pushbutton. This undesirable design feature should be eliminated. 6.3.4.3 ANNUNCIATOR RESPONSE PROCEDURES a. AVAILABILITY - Annunciator response procedures should be available in the control room. b. INDEXING - Annunciator response procedures should be indexed by panel identification and annunciator tile coordinates. 6.5.1.6 COLOR CODING a. REDUNDANCY - In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color. b. NUMBER OF COLORS - (1) The number of colors used for coding should be kept to the minimum needed for providing sufficient information. (2) The number of colors used for coding should not exceed 11.				

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	N/A	YES	NO	COMMENTS
6.5.1.6 (Cont'd) c. MEANING OF COLORS - (1) The meaning attached to a particular color should be narrowly defined. (2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists. d. PRINCIPLES OF COLOR SELECTION (1) The primary principle which should be applied in selecting colors for coding purposes which do not have the immediate safety implications of red, green, and amber is to ensure that each color is recognized as different from any other.				

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	N/A	YES	NO	COMMENTS
6.5.1.6d (Cont'd) Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list. The first 9 colors have been selected so as to yield satisfactory contract for red-green-deficient as well as color-normal observers. The remaining 13 colors are useful only for color-normal observers.				
(2) Colors selected for coding should contrast well with the background on which they appear.				
(3) Ambient lighting in the area in which color coding is used will influence the apparent color of the coded element (especially for surface colors). Each color selected for coding should be evaluated under all illumination conditions under which it is used.				
6.6.6.2 DEMARCATION				
a. USE - Lines of demarcation can be used to:				
(1) Enclose functionally related displays.				
(2) Enclose functionally related controls.				
(3) Group related controls and displays.				

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	N/A	YES	NO	COMMENTS
6.6.6.2 (Cont'd) b. CONTRAST - Lines of demarcation should be visually destinctive from the panel background. c. PERMANENCE - Lines of demarcation should be permanently attached.				

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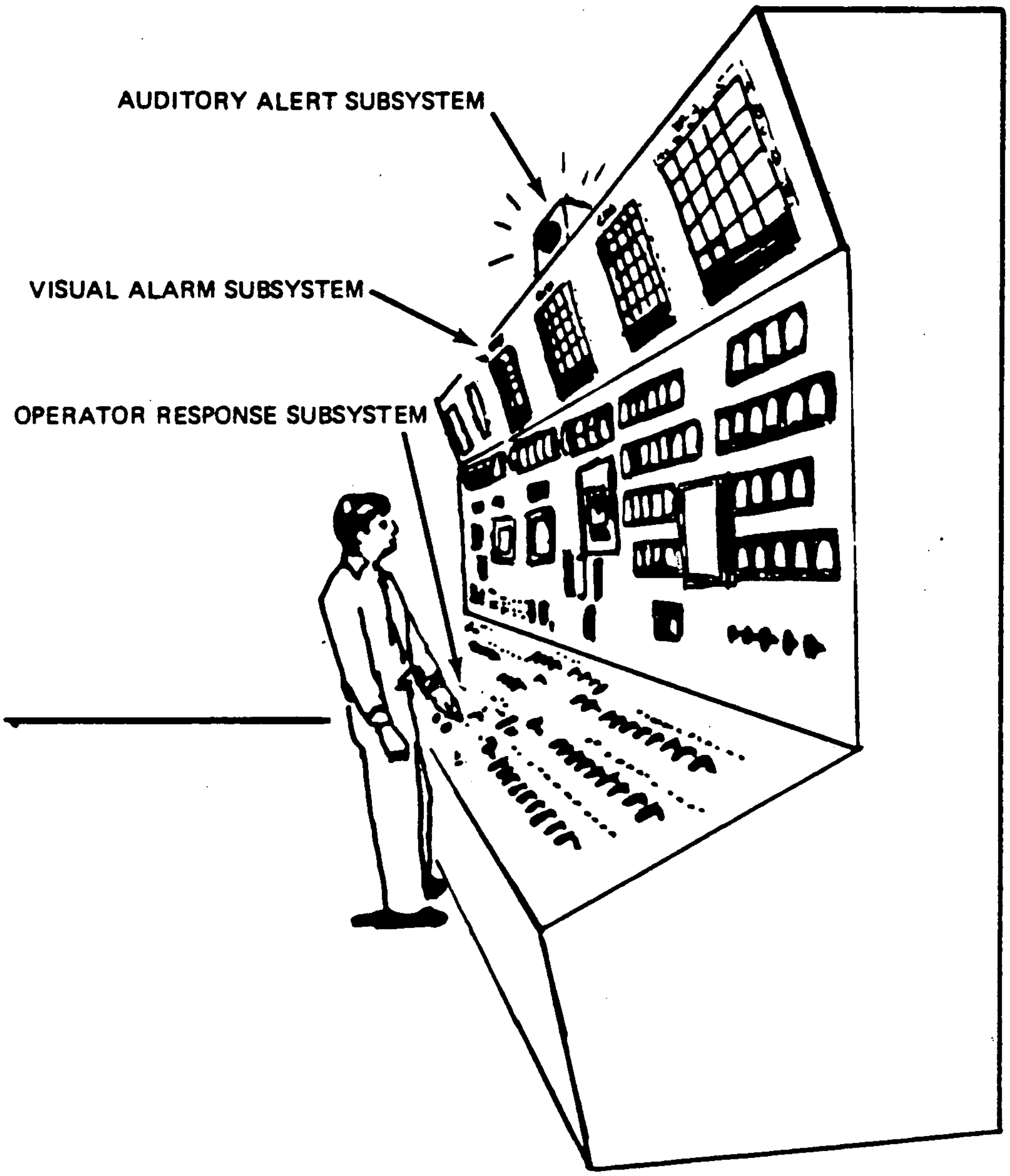

Exhibit 6.3-1
Annunciator Warning System

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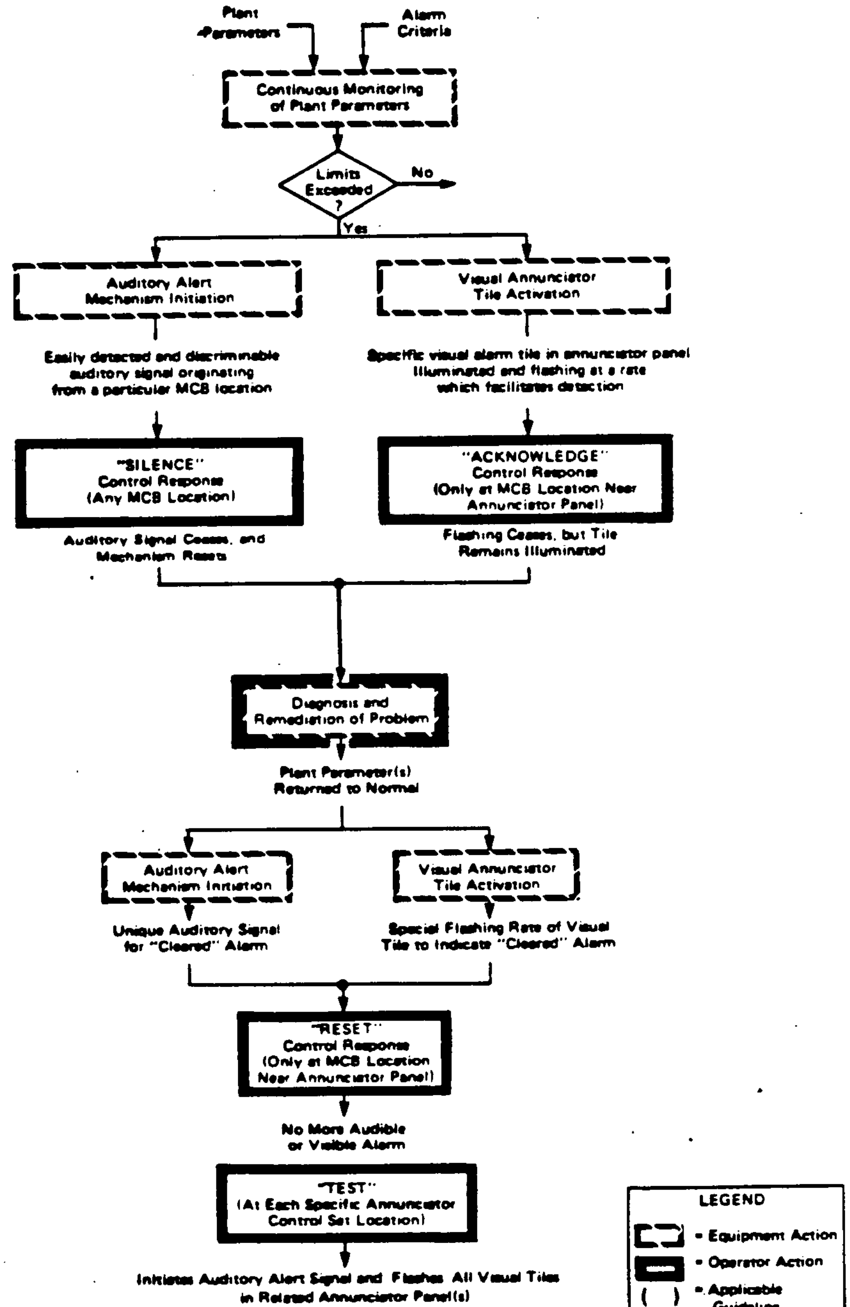

Exhibit 6.3-2
Annunciator System Preferred Operational Sequence

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FIRST PRIORITY ALARMS

- Plant shut down (reactor trip, turbine trip)
- Radiation release
- Plant conditions which, if not corrected immediately, will result in automatic plant shutdown or radiation release, or will require manual plant shutdown.

SECOND PRIORITY ALARMS

- Technical specification violations which if not corrected will require plant shutdown
- Plant conditions which, if not corrected, may lead to plant shut down or radiation releases

THIRD PRIORITY ALARMS

- Plant conditions representing problems (e.g., system degradation) which affect plant operability but which should not lead to plant shutdown, radiation release, or violation of technical specifications

Exhibit 6.3-3
Three-Level Annunciator Prioritization Example

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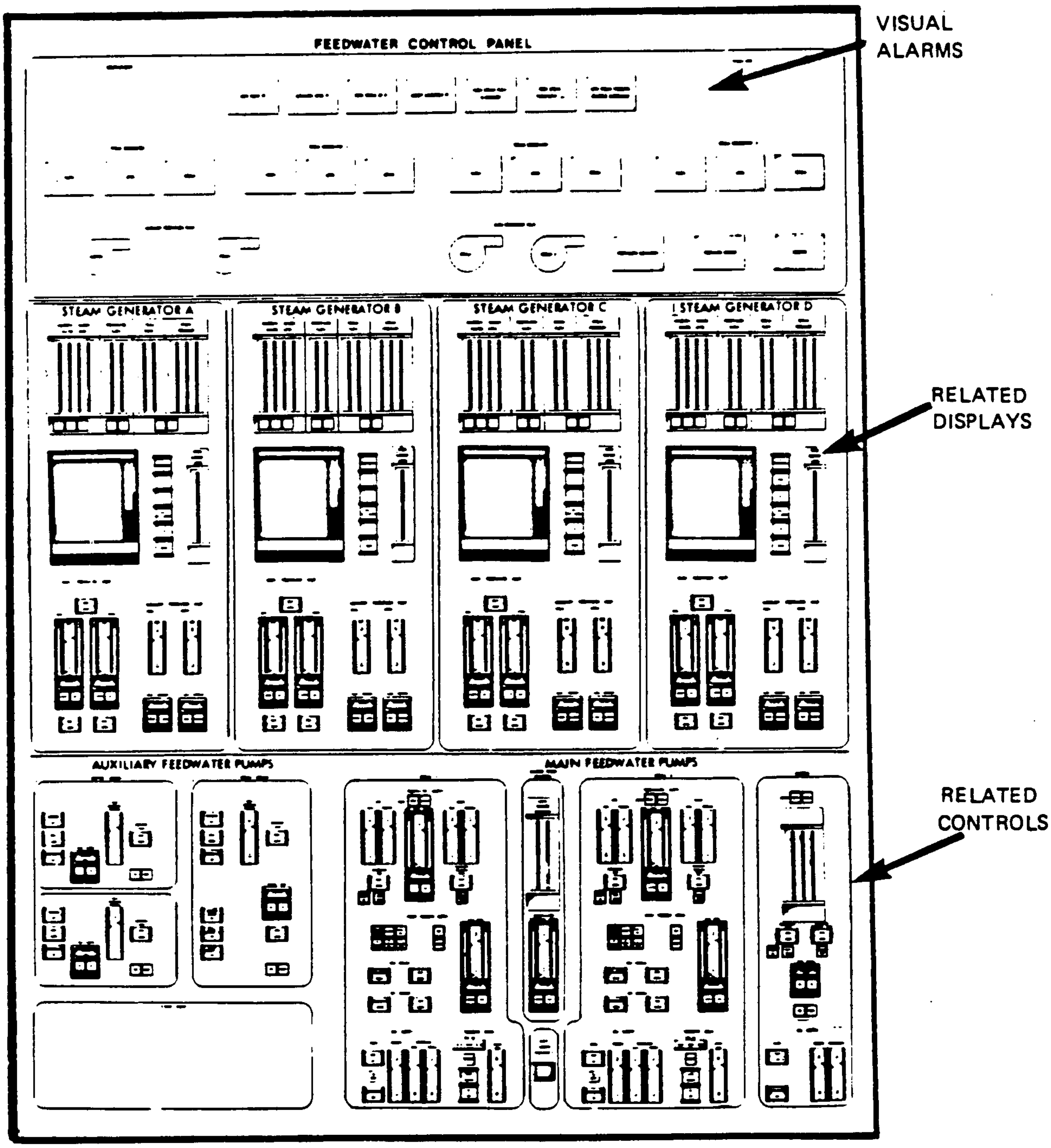

Exhibit 6.3-4
Visual Alarms Located Above The Related Controls And Displays
(From Seminars et al., 1979)

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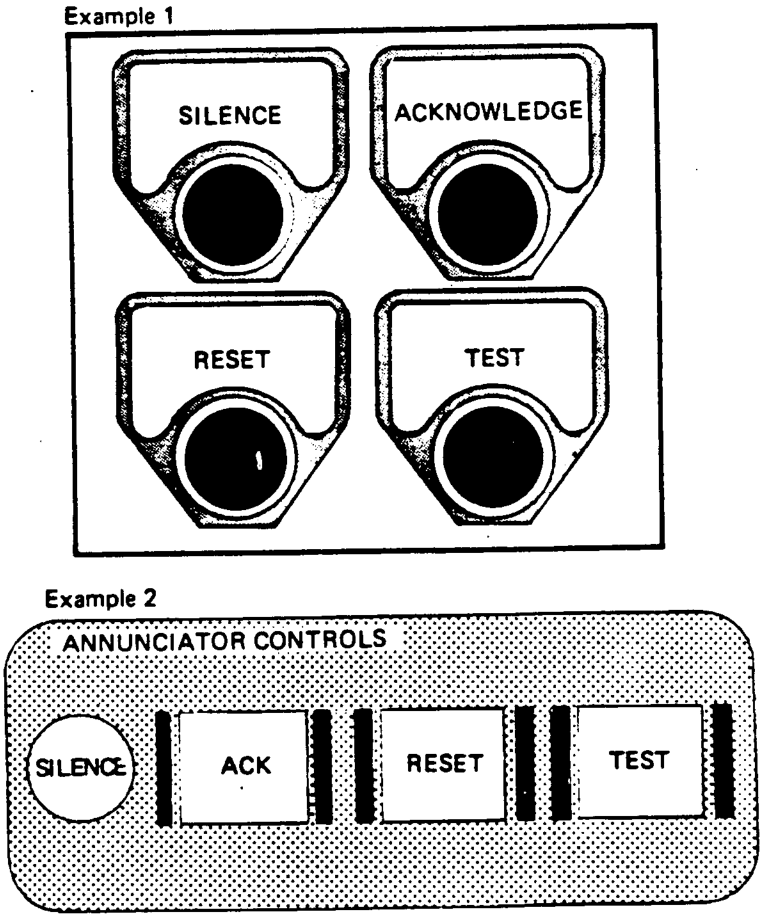

Exhibit 6.3-5
Annunciator Response Controls

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Color Serial or selection number	General color name	ISCC-NBS centroid number	ISCC-NBS color-name (abbreviation)	Munsell renotation of ISCC-NBS Centroid Color
1	white	263	white	2.5PB 9.5/0.2
2	black	267	black	N 0.8/
3	yellow	82	v.Y	3.3Y 8.0/14.3
4	purple	218	s.P	6.5P 4.3/9.2
5	orange	48	v.O	4.1YR 6.5/15.0
6	light blue	180	v.l.B	2.7PB 7.9/6.0
7	red	11	v.R	5.0R 3.9/15.4
8	buff	90	gy.Y	4.4Y 7.2/3.8
9	gray	265	med. Gy	3.3GY 5.4/0.1
10	green	139	v.G	3.2G 4.9/11.1
11	purplish pink	247	s.pPk	5.6RP 6.8/9.0
12	blue	178	s.B	2.9PB 4.1/10.4
13	yellowish pink	26	s.yPk	8.4R 7.0/9.5
14	violet	207	s.V	0.2P 3.7/10.1
15	orange yellow	66	v.OY	8.6YR 7.3/15.2
16	purplish red	255	s.pR	7.3RP 4.4/11.4
17	greenish yellow	97	v.gY	9.1Y 8.2/12.0
18	reddish brown	40	s.rBr	0.3YR 3.1/9.9
19	yellow green	115	v.YG	5.4GY 6.8/11.2
20	yellowish brown	75	deep yBr	8.8YR 3.1/5.0
21	reddish orange	34	v.rO	9.8R 5.4/14.5
22	olive green	126	d.OlG	8.0GY 2.2/3.6

Exhibit 6.5-7
Twenty-Two Colors Of Maximum Contrast
(From Kelly, 1965)

APPENDIX B
DATA FORMS

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APPENDIX B
DATA FORMS

APPENDIX B1.1
MEASUREMENTS DATA

1. LINEAR MEASUREMENT (LABELING)

1.1 Annunciator Light Box (ALB) Summary Labels - 6.3.3.1b(2).

a. If there are no summary labels, check here: ____________

b. If there are summary labels, measure and record in Table 1.1b the following information:

ITEM NO.	ITEM DESCRIPTION
1)	Character height
2)	Character width and/or numeral width
3)	Character stroke width
4)	Character spacing
5)	Word spacing
6)	Line spacing

TABLE 1.1b

Item	ALB-	ALB-	ALB-	ALB-	ALB-	ALB-
1.						
2.						
3.						
4.						
5.						
6.						

APPENDIX B1.1
MEASUREMENTS DATA

1.2 Tile Labeling - 6.3.3.5a(1) and a(2), and 6.3.5.5d(1) through d(6).

a. Measure and record in Table 1.2a the character height(s) used in the tiles. If more than one size character is used, record the height for all of the represented heights. Also measure and record the farthest left and farthest right tile from its associated acknowledge station for each of the represented character heights (start at the left most acknowledge station and number the stations going clockwise around the MCB).

TABLE 1.2a

	Sta 1		Sta 2		Sta 3		Sta 4		Sta 5	
Chr Ht	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt

b. For each acknowledge station in the table above, measure and record in Table 1.2b the height from the floor for the farthest left and farthest right tile from this same table.

TABLE 1.2b

	Tile Height From Floor				
Char Hgt	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5

APPENDIX B1.1
MEASUREMENTS DATA

1.2 (Cont'd)

c. Measure and record the following for each of the different character heights from a, above:

TABLE 1.2c

	Ht (ref)	Char/Num Width	Stroke Width	Char Spacing	Word Spacing	Line Spacing
1.						
2.						
3.						
4.						
5.						
6.						

1.3 Data Reduction and Analysis.

For data reduction and analysis, obtain the appropriate analysis aids from Appendix B5 (ref. B5.1).

APPENDIX B1.2
MEASUREMENTS DATA

2. SOUND MEASUREMENTS (AUDIBLE SIGNALS)

2.1 Annunciator Audible Alarms - 6.3.2.1a.

Measure the sound level in dB(A) for each annunciator audible alarm at each of the following operator positions:

TABLE 2

	Alarm Loc	Safety Systems Pos 1	Safety Systems Pos 2	Reac Cont	Turb Gen	Elec Dist	Rad Mon Console	Op's Desk
1.	____	____	____	____	____	____	____	____
2.	____	____	____	____	____	____	____	____
3.	____	____	____	____	____	____	____	____
4.	____	____	____	____	____	____	____	____
5.	____	____	____	____	____	____	____	____

2.2 Data Reduction and Analysis

For data reduction and analysis, obtain the appropriate analysis aids from Appendix B5 (ref. B5.2).

APPENDIX B1.3
MEASUREMENTS DATA

3. LIGHT MEASUREMENTS (TILE FLASH CHARACTERISTICS) - 6.3.5b(1) and 6.3.3.2b

3.1 Using the Flash Comparator, measure the flash rate of tiles in alarm and in clear. Record the rates.

Alarm Flash Rate: ______________

Cleared Flash Rate: ______________

3.2 Using the Flash Comparator, measure the on-off ratio for the alarm flash rate and cleared flash rate.

On-Off Ratio (Alarm): ______________

On-Off Ratio (Cleared): ______________

APPENDIX B2
OPERATOR INTERVIEW

INSTRUCTIONS

---

1. Read the following to the operators before starting interview:

   a. The following are questions concerning the general layout, functional organization, and operational considerations in your control room. Most of the questions will require a YES or NO answer, with some additional information.

   b. Please mention any issues you feel relevant to this review when you think about them, you do not have to wait for a question on the subject.

   c. If you do not understand a question, please ask for clarification.

   d. All of your answers and your biographical information will be kept in the strictest confidence and will be used to aid in the performance of the detailed control room design review.

PLEASE BEGIN

APPENDIX B2
OPERATOR INTERVIEW

BIOGRAPHICAL DATA:

Name: ______________________________ Age: __________

Sex: __________ Height: __________ Weight: __________

Current Position/Title: ______________________________

1. Do you have a current reactor operator's license? YES _____ NO _____

2. Amount of licensed experience at this plant: ______________________

3. Total amount licensed experience: ______________________

4. Related experience and amount (example: operator-trainee, Hodge NPP Unit 1, 1 year):

5. Education:

   a. Highest level attained: ______________________

   b. Specialized Schools or courses (list):

6. Military experience:

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

1. Do you have a first out annunciator panel where only the tile associated with the reactor trip event illuminates and all subsequent alarms on that panel are "locked out"? YES NO

2. Do you know of any automatic reactor trip functions that do not have a separate annunciator tile on the first out panel (either missing or shared with other functions)? YES NO

3. Are the annunciator panels in the control room identified by a label above each panel? YES NO

4. From your primary operating area, can you read all annunciator panel labels with a minimum of effort? YES NO

5. Is the annunciator system priority coded by color, position, shape, or symbolic coding of the tiles? YES NO

6. If color coding is used, are there more than eleven colors used for coding the panels? YES NO

7. If color coding is used, is the meaning redundant, as an example, if priority coding uses color, does it also use tile position? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

8. Is there only one meaning attached to each color used for coding the tiles? YES NO

9. Are all meanings attached to any color coded tiles standard to those color meanings throughout your control room? YES NO

10. For color coded tiles is: YES NO

a. red always used for unsafe, danger, immediate operator action required, or as an indication that a critical parameter is out of tolerance?

b. green always used for safe, no operator action required, or as an indication that a parameter is within tolerance? YES NO

c. amber (yellow always used for hazard (potentially unsafe), caution, attention required, or as an indication that a marginal value or parameter exists? YES NO

11. Do you know of any unnecessary color coding on the annunciator tiles or panels? YES NO

12. For colors used in tile coding, are any difficult to tell apart? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

13. Are auditory signals priority coded by pulse, frequency change (warbling), intensity, or different frequencies for different signals? YES NO

14. If you have separate alarm horns, can you easily identify the work station or system where the auditory signal originated? YES NO

15. Do you have different alarm horns for work areas not at the main control board? YES NO

16. If the auditory alarm signal has only one source, is the sound coded to direct you to different work areas? YES NO

17. Do any of the alarm horns startle or irritate you? YES NO

18. If you have different alarm horns, do any of them sound too loud or too soft in comparison to the others at your normal work station? YES NO

19. Do you have a silence control with each set of response controls in your primary operating area? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

20. Is a control provided which terminates a flashing visual tile, but allows a steady illumination until the alarm is cleared? YES NO

21. Can you acknowledge an alarm from more than one response control area? YES NO

22. If cleared alarms do not reset automatically, do you have a control to reset them yourself? YES NO

23. Does the reset control silence the auditory signal as well as extinguish the illumination? YES NO

24. Does the reset control operate from more than one response control area? YES NO

25. Can you defeat any of the annunciator controls, such as locking out the audible alarm or locking down the acknowledge control? YES NO

26. Can you test the auditory and flashing illumination signals of all tiles for each panel? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

27. Is there an administrative procedure that controls the periodic testing of all annunciators? YES NO

28. Are all tiles dark on annunciator panels when no alarm is indicated? YES NO

29. Can you easily tell if a tile is normally on for an extended duration during normal operating conditions? YES NO

30. Are you immediately aware if an annunciator tile is out of service? YES NO

31. Can you immediately determine when the flasher of an alarm tile fails? YES NO

32. Do you know of any alarms that occur so frequently that you consider them a nuisance? YES NO

33. Do you know of any alarms that do not give you ample time to respond to a warning condition? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

34. When responding to an alarm tile, can you readily locate the controls and displays required for corrective or diagnostic action? YES NO

35. Do you have access to annunciator response procedures in the control room? YES NO

36. Do you know of any alarms which require you to obtain additional information from a source outside the control room area? YES NO

37. Are there too many alarms which require additional information from panels outside your operating area? YES NO

38. If alarms are used that require information outside the control room, do they allow you ample time to respond? YES NO

39. Are alarms provided for shared equipment in all control rooms? YES NO

40. If there a status display or signal provided for shared equipment in all control rooms which indicates that the equipment is currently being operated? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

41. Do you have any tiles with dual messages such as HIGH-LOW? YES NO

42. Does the multi-input alarm have a reflash capability that reflashes the visual tile after an auditory alert event if the first alarm has not been cleared? YES NO

43. Do multi-input annunciators provide you will an alarm printout? YES NO

44. Does the multi-input alarm typer have sufficient speed to print the alarm data fast enough for your needs? YES NO

45. Does the alarm typer ever skip or loose information, or garble (mix up) the printing? YES NO

APPENDIX B3
OBSERVATIONS CHECKLIST

INSTRUCTIONS

---

1. Using the attached checklist, make all the noted observations.
2. Record all necessary information in the comments column to justify an N/A check and to detail a NO check.
3. Ensure that all comments for NO checks include component, instrument, panel, equipment, etc., identification and location information.
4. Initiate HED reports on all NO checks per the directions contained in the checklist analysis aids.

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
1. A separate first out panel should be provided for the reactor system - 6.3.1.3a(1).				
2. A separate first out panel is recommended for the turbine-generator system that is functionally similar to the reactor system panel - 6.3.1.3b.				
3. First out panels should be located above their main work stations - 6.3.1.3c.				
4. All first our panels should conform to the general auditory and visual items in the rest of this checklist - 6.3.1.3d.				
5. A small number (2-4) of levels of priority coding are used - 6.3.1.4a(1).				
6. Priority coding of color, position, shape, or symbol is used for visual signals - 6.3.1.4b(1).				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
7. Any color used on tiles are on ALB panels should contrast with the control board color - 6.5.1.6e(1).				
8. Any color used for tile coding should be recognizable from all other tile code colors for all illumination conditions - 6.5.1.6e(3).				
9. Auditory signal priority coding may be used - 6.3.1.4b(2).				
10. If more than one, each auditory signal should sound at approximately equal loudness at normal work stations in the primary operating area - 6.3.2.1d.				
11. An auditory signal should capture the operator's attention but should not irritate or cause a startled reaction - 6.3.2.1c.				
12. Separate auditory signals at each work station within the primary operating area are recommended - 6.3.2.1f.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
13. The operator should be able to identify the work station or area where the auditory alert originated - 6.3.2.1f.				
14. The auditory signal should automatically reset when silenced - 6.3.2.1e.				
15. When an alarm clears (or is cleared) there should be a dedicated, distinct audible signal with a finite duration - 6.3.1.5a.				
16. Auditory alert signal's, if adjustable, should be controlled by administrative procedure - 6.3.2.1b.				
17. The specific title(s) in an ALB should visually flash to indicate an alarm condition - 6.3.3.2a.				
18. In case of flasher failure, an alarming tile should illuminate and burn steadily - 6.3.3.2c.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
19. Contrast between tiles should present no problem discriminating between alarming, steady-on, and steady-off conditions - 6.3.3.2d.				
20. Under normal (nonalarmed) conditions no annunciator tiles should be illuminated - 6.3.3.2e.				
21. If a tile must be on for an extended period during normal operations it should be distinctively coded for positive recognition during this period (see also 6.3.3.2f(2), item 2c on the Document Review Checklist) - 6.3.3.2f(1).				
22. Cleared tiles should have either a special flash rate, a reduced brightness, or a special color - 6.3.1.5b(1) through b(3).				
23. All tiles associated with a given acknowledge control should be readable when operating that control - 6.3.3.5a.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
24. Character style on all tiles should be simple - 6.3.3.5b(1).				
25. Character style should be consistent on all tiles - 6.3.3.5b(2).				
26. Character style should be uppercase on all tiles - 6.3.3.5b(3).				
27. Tile legends should have high contrast with the tile background - 6.3.3.5c.				
28. Tile legends should be engraved - 6.3.3.5c(1).				
29. Tile legends should be dark and opaque on a light and translucent background - 6.3.3.5c(2).				
30. Tile legends should be specific, unambiguous, concise, and short - 6.3.3.4a.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
31. Tile legends should address specific conditions, HIGH TEMP, or LOW PRESS, not HIGH-LOW TEMP-PRESS - 6.3.3.4c.				
32. Tiles should be organized as a matrix within each ALB - 6.3.3.3a.				
33. The vertical and horizontal axes of the ALBs should be alpha-numerically labeled for tile designation coordinates - 6.3.3.3c(1).				
34. Coordinate designators are preferred at the left and top sides of the ALBs.				
35. Character height for the coordinate labels should be the same height as those used in tile legends - 6.3.3.3c(3).				
36. The number of tiles in an ALB should be kept low, with a maximum of 50 tiles per ALB suggested - 6.3.3.3d(1).				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
37. Cues for prompt recognition of an out-of-service annunciator should be designed into the system - 6.3.3.3e.				
38. Blank or unused tiles should not be illuminated except during annunciator testing - 6.3.3.3f.				
39. Demarcation lines may be used to enclose functionally related tiles - 6.6.6.2a(1).				
40. Demarcation lines may be used to group tiles with their related controls and/or displays - 6.6.6.2a(1) through a(3).				
41. If used, demarcation lines should be visually distinctive from the panel background - 6.6.6.2b.				
42. If used, demarcation lines should be permanently attached - 6.6.6.2c.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
43. ALBs should be located above the controls and displays required for corrective or diagnostic action when they alarm - 6.3.3.1a.				
44. Each ALB should be identified by a label directly above it - 6.3.3.1b(1).				
45. Each set of annunciator controls should include a silence control - 6.3.4.1a(1).				
46. An acknowledge control should be provided that terminates the flashing and causes the tile to continuously illuminate until it has cleared - 6.3.4.1b(1).				
47. If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared - 6.3.4.1c(1).				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
48. A control to test the auditory alarm and the flashing illumination of all tiles in a panel (i.e., in one or more ALBs) should be provided - 6.3.4.1d(1).				
49. Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations - 6.3.4.2a.				
50. Annunciator controls should be coded differently than other panel controls either by color, demarcation, or shape - 6.3.4.2b(1) through b(4).				
51. Shape coding is preferred for the silence control - 6.3.4.2b(4).				
52. Annunciator control designs should not allow the operator to defeat the control operations such as inserting a coin into a control guard ring - 6.3.4.2c.				
53. Annunciator response procedures should be available in the control room - 6.3.4.3a.				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

INSTRUCTIONS

Collect the following documents and review them for the information contained in the attached checklist:

1. Administrative Procedures concerning annunciators
2. Annunciator Response Procedures
3. Results from the following task reports:
   a. Convention Survey
   b. System Function Task Analysis
   c. Labeling Survey
4. Ensure that all comments for NO checks include component, instrument, panel, equipment, etc., identification and location information.
5. Initiate HED reports on all NO checks per the directions contained in the checklist analysis aids.

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
1. ANNUNCIATOR RESPONSE PROCEDURES				
a. Response procedures should be indexed by panel I.D. and tile coordinates - 6.3.4.3b.				
b. Annunciators with inputs from more than one plant parameter set point should be avoided (multi-input alarms that summarize single-input alarms elsewhere in the control room are an exception - 6.3.1.2c(1).				
2. PLANT ADMINISTRATIVE PROCEDURES				
a. Periodic testing of annunciators should be required and controlled by administrative procedures-6.3.4.1d(2).				
b. If audible alarm intensity is operator- adjustable, it should be controlled by administrative procedures - 6.3.2.1b.				
c. When annunciator tiles must be on for an extended period during normal operations, it should be controlled by administrative procedures (see also 6.3.3.2f(1), item 19 on the Observations Checklist) - 6.3.3.2f(2).				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
3. SFTA REVIEW REPORT				
a. The annunciator warning system should be designed as the primary alerting interface with the operator for out-of-tolerance conditions. It should consist of three major subsystems: auditory alerts, visual alarm, and operator response. These three subsystems should function to provide a preferred operational sequence for annunciator warnings - 6.3.1.1.				
b. Visual alarm tiles should be grouped by function, system, subsystem, or other logical organization within ALBs - 6.3.3.3b and d(2).				
c. Prioritization of annunciators should be based on a continuum of importance, severity, or need for operator action in one or more dimensions such as, the likelihood of a reactor trip or the likelihood of a release of radiation - 6.3.1.4a(2).				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
d. Tile legends should address specific conditions rather than a range of conditions and/or parameters. As an example, separate tiles should be used to indicate temperature-low, temperature-high, pressure-low, and pressure-high, rather than a single tile with the legend HIGH-LOW TEMP-PRESS - 6.3.3.4c.				
e. If used, demarcation lines enclose functionally relate groups of tiles either separately or with their related controls and displays - 6.6.6.2a(1), a(2), and a(3).				

APPENDIX B5.1
MEASUREMENTS ANALYSIS

1. LINEAR MEASUREMENT (LABELING)

1.1 ALB Summary Labels - 6.3.3.1b(2).

a. If there are no summary labels, check N/A for criterion 6.3.3.1b(2) in Appendix A.

b. If there are summary labels, calculate the visual angels for each label for the operator positions listed in Table 1.1b.

TABLE 1.1b

		MCB							
	ALB Ident	Safety Systems Pos 1	Safety Systems Pos 2	Reac Cont	Turb Gen	Elec Dist	Rad Mon Console	Op's Desk
1.	____	____	____	____	____	____	____	____
2.	____	____	____	____	____	____	____	____
3.	____	____	____	____	____	____	____	____
4.	____	____	____	____	____	____	____	____
5.	____	____	____	____	____	____	____	____
6.	____	____	____	____	____	____	____	____
7.	____	____	____	____	____	____	____	____

Calculations (use extra sheets, as needed):

APPENDIX B5.1
MEASUREMENTS ANALYSIS

c. If all visual angles in Table 1.1b are 15 minutes of arc or greater, check YES for criterion 6.3.1b(2) in Appendix A.

d. If there are visual angles in Table 1.1b less than 15 minutes of arc, record on an HED report form the position(s) and label(s) where this is so. Include the code number TP-3.1B5.1.1 in data collection description. For criterion 6.3.3.1b(2) in Appendix A, check the NO column and record the HED report number and the code number, TP-3.1B5.1.1 in the COMMENTS column.

1.2 Tile Labels - 6.3.3.51(1) and d(1) through d(6).

a. Calculate the visual angles for each character height at its farthest left and farthest right location for each work station in Table 1.2a, below.

TABLE 1.2a

ALB NO/ Chr Ht	Sta 1		Sta 2		Sta 3		Sta 4		Sta 5	
	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt
___	___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___	___
___	___	___	___	___	___	___	___	___	___	___

Calculations (use extra sheets, as required):

APPENDIX B5.1
MEASUREMENTS ANALYSIS

b. If all visual angles in Table 1.2a are 15 minutes of arc or greater, check YES for criterion 6.3.3.5a(1) in Appendix A.

c. If any visual angles in Table 1.2a are less than 15 minutes of arc, record on an HED report form the position(s) and tile legend(s) where this is so. Include the code number TP-3.1B5.1.2 in the data collection description. For criterion 6.3.3.5a(1) in Appendix A, check the NO column and record the HED report number and the code number, TP-3.1B5.1.2, in the COMMENTS column.

d. Compare the character dimensions and legend measurements for each character height recorded with criteria 6.3.3.5d(1) through d(6).

e. If all character heights and legends meet the criteria, check the YES column for these criteria in Appendix A.

f. If all character dimensions or legend measurements fail to meet the criteria, record on an HED report from the tile coordinates, character height implicated, and a description of the failure. Include the code number TP-3.1B5.1.2 in the data collection description. For criteria 6.3.3.5d(1) through d(6) in Appendix A, check the NO column and record the HED report number and the code number TP-3.1B5.1.2, in the COMMENTS column.

APPENDIX B5.2
MEASUREMENTS ANALYSIS

2. SOUND MEASUREMENTS (AUDIBLE SIGNALS)

2.1 Annunciator Audible Alarms - 6.3.2.1a.

a. Obtain the average ambient noise level in db(A) from the Ambient Noise Survey Task Report (TR-1.6) and record below:

Average noise level: ______________ db(A)

b. Based upon the below adjustment factors, reduce each measured annunciator alarm level and record in Table 2.1b.

Absolute Difference Between Measured Level (Lm) And Average Noise Level (Ln)	Subtract This Amount From Measured Level (Lm) And and Record In Table 2.1b
4	2.2
5	1.7
6	1.3
7	1.0
8	.8
9	.6
10	.4
11	.3
12	.3
13	.2
14	.2
15	.1

TABLE 2.1b

		MCB							
	Alarm Loc	Safety Systems Pos 1	Safety Systems Pos 2	Reac Cont	Turb Gen	Elec Dist	Rad Mon Console	Op's Desk
1.	____	____	____	____	____	____	____	____
2.	____	____	____	____	____	____	____	____
3.	____	____	____	____	____	____	____	____
4.	____	____	____	____	____	____	____	____
5.	____	____	____	____	____	____	____	____

APPENDIX B5.2
MEASUREMENTS ANALYSIS

c. Compare all adjusted dB(A) levels in Table 2.1b to the average noise level.

d. If all adjusted audible alarm levels are at least 10 dB(A) above the average noise level check the YES column for criterion 6.3.2.1a in Appendix A.

e. If any adjusted alarm levels are less than 10 dB(A) above the average noise level, record each occurrence on an HED report form. Include the code number TP3.1B5.2.1 in the data collection description. For criterion 6.3.2.1a in Appendix A, check the NO column and record the HED report number and the code number, TP3.1B5.2.1 in the COMMENTS column.

APPENDIX B5.3
MEASUREMENTS ANALYSIS

3. LIGHT MEASUREMENTS (TILE FLASH CHARACTERISTICS)

3.1 Alarmed Flash Characteristics - 6.3.3.2b.

a. From the recorded data, determine if the alarmed flash rate is between 3 to 5 flashes per second and that the on-off ratio is approximately 1:1.

b. If both parameters meet the criteria, check the YES column for criterion 6.3.3.2b in Appendix A.

c. If either parameter fails to meet the criteria, record the discrepancy on an HED report form. Include the code number TP-3.1B5.3.1 in the data collection description. For criterion 6.3.3.2b in Appendix A check the NO column and record the HED number and the code number, TP-3.1B5.3.1, in the COMMENTS column.

3.2 Cleared Flash Rate - 6.3.1.5b(1).

a. From the recorded data, determine if the cleared flash rate is approximately double or 1/2 the alarmed flash rate.

b. If the cleared flash rate passes the criterion, check the YES column for criteria 6.3.1.5b(1) in Appendix A.

c. If the cleared flash rate fails to meet the criterion, record the discrepancy on a HED report form. Include the code number TP-3.1B5.3.2 in the data collection description. For criterion 6.3.1.5b(1) in Appendix A, check the NO column and record the HED number and the code number, TP-3.1B5.3.2, in the COMMENTS column.

APPENDIX B.6
OPERATOR INTERVIEW ANALYSIS

1. GENERAL

   a. Review all questionnaires for completeness of biographical information and question responses.

   b. Delete incomplete and unusable questionnaires from the data base. If required by contract reschedule these interviews for correction/completeness.

   c. When the data base assembly is complete perform the analysis, below.

2. BIOGRAPHICAL DATA

   a. Assemble biographical data and determine ranges and distributions for all relevant dimensions.

   b. Using appropriate statistics, determine the distribution (or its approximation) for this data.

3. RESPONSE DATA

   a. Summarize all responses and determine percent frequency response for each negative answer.

   b. Obtain the control copy of Appendix A - Criteria from the Conventions Task Plan (TP-8.1) for use in the next steps.

   c. For each positive answer, check the YES column for that criteria in Appendix A of this task plan. Do the same in the Conventions Task Plan Appendix A for criteria 6.5.1.6b(2) and c(2).

   d. Also add the data collection code number, TP-3.1B6n (with n the question number), in the REMARKS column of the Conventions Task Plan Appendix A.

   e. For each negative answer, initiate Preliminary HEDs (PHEDs) for discrepancy review. Record response frequency data, 0700 criteria number, and data collection code number on each PHED.

   f. The 0700 criteria numbers are contained in List 3b.

   g. For each negative answer, check the NO column and record the data collection code number and PHED number in the REMARKS column for the appropriate criteria in Appendix A of this task plan. Do the same for the Conventions Task Plan Appendix A for the criteria listed in c, above.

   h. Submit all PHEDs to your immediate supervisor.

   i. Subsequent verification, validation, and disposition of all PHEDs will be conducted per TP-10.1 (HED Review Procedure).

APPENDIX B6
OPERATOR INTERVIEW ANALYSIS

LIST 3b

1. 6.3.1.3a(3)
2. 6.3.1.3a(2)
3 6.3.3.1b(1)
4. 6.3.3.1b(2)
5. 6.3.1.4b(1)

6. 6.5.1.6b(2) & e(1)
7. 6.5.1.6a
8. 6.5.1.6c(1)
9. 6.5.1.6c(2)
10. 6.5.1.6c(2)

11. 6.5.1.6b(1)
12. 6.5.1.6e(1)
13. 6.3.1.4b(2) & 6.3.2.2b
14. 6.3.2.1f

15. 6.3.2.2a(1)
16. 6.3.2.2a(2)
17. 6.3.2.1c
18. 6.3.2.1d
19. 6.3.4.1a(1) & (2)

20. 6.3.4.1b(1)
21. 6.3.4.1b(2)
22. 6.3.4.1c(1)
23. 6.3.4.1c(2)
24. 6.3.4.1c(3)

25. 6.3.4.2c
26. 6.3.4.1d(1)
27. 6.3.4.1d(2)
28. 6.3.3.2e
29. 6.3.3.2f

30. 6.3.3.3e
31. 6.3.3.2c
32 6.3.1.2a(1)
33. 6.3.1.2a(2)
34. 6.3.3.1a

35. 6.3.4.3a
36. 6.3.1.2b(1)
37. 6.3.3.4b
38. 6.3.1.2b(2)
39. 6.3.1.2d(1)

40. 6.3.1.2d(2)
41. 6.3.3.4c
42. 6.3.1.2c(3)
43. 6.3.1.2c(2)
44. 6.3.1.2c(2)
45. 6.3.1.2c(2)

APPENDIX B7
OBSERVATIONS ANALYSIS

1. For each checklist item checked YES, also check the YES column for that criteria in Appendix A and enter the date collection code number, TP-4.1B3.n (where n is the checklist item number) in the COMMENTS column.

2. For each checklist item checked NO, initiate an HED report. Enter the HED report number in the COMMENTS column of the checklist for that item. Include all necessary information on the HED report concerning identification of the discrepancy and the criteria (checklist item) not met.

3. Find the appropriate criterion or criteria in Appendix A from the reference number in the checklist item. Check the NO column and enter the HED number and the data collection code number in the COMMENTS column for that criterion or criteria.

APPENDIX B8
DOCUMENTATION REVIEW ANALYSIS

1. For each checklist item checked YES also check the YES column for the appropriate criteria in Appendix A. Enter the data collection code number TP4.1B4.n (n is the checklist item number) in the COMMENTS column.

2. For each checklist item checked NO, initiate an HED report. Enter the HED report number in the COMMENTS column of the checklist for that item. Include all necessary information on the HED report concerning identification of the discrepancy and the criteria (checklist item) not met.

3. Find the appropriate criterion or criteria in Appendix A from the reference number in the checklist item. Check the NO column and enter the HED number and the data collection code number in the COMMENTS column for that criterion or criteria.

4. When reviewing task report data, do not initiate duplicate HED reports. When an HED report has already been initiated for a specific discrepancy during the conduct of another task, update that HED report with the relevant information from this task data. Also update and cross-reference the criteria lists in Appendix A of both sets of task documentation.

APPENDIX B9
HUMAN ENGINEERING DISCREPANCY (HED) REPORT

____
PLANT/UNIT

ORIGINATOR: ______________________ HED NO.: ______________

VALIDATED BY: ______________________ DATE: ______________

a) HED TITLE: ____

____

b) ITEMS INVOLVED:

c) PROBLEM DESCRIPTION AND 0700 PARA. NUMBER:

d) DATA COLLECTION DESCRIPTION AND CODE NUMBER:

e) SPECIFIC HUMAN ERROR(s):

APPENDIX B9
HED REPORT (CONTINUED)

________________ HED NO.: ________

f) SUGGESTED BACKFIT:

REVIEW AND DISPOSITION:

APPENDIX C
CRITERIA MATRIX

APPENDIX C
CRITERIA MATRIX

Criteria Distributed Across Data Collection Methods

Notes:

1. The following codes apply to the matrix columns:

   M - Measurement (instruments and or measuring devices required)

   O - Observations (observation notes taken)

   I - Interview

   D - Document Review (documentation review to include engineering drawings, CWDs, etc.)

   A - Auditory Criteria

   V - Visual Criteria

   C - Controls Criteria (physical characteristics)

   L - Location/Arrangement

   P - General Physical

   F - Functional Criteria (usually requires some operational data for verification)

   Data sources listed are suggested. Alternatives should be used when those listed are not available or are not adequate.

APPENDIX C
CRITERIA MATRIX

CRITERIA NUREG-0700 para number	Crit type	DATA COLLECTION METHODS M	O	I	D	SUGGESTED DATA SOURCES	REMARKS
6.3.1.1	F				X	SFTA Rpt	also in RP-9.0 (SFTA)
6.3.1.2a(1)	F			X		Ops	
a(2)	F			X		Ops	
b(1)	F			X		Ops	
b(2)	F			X		Ops	
c(1)	F				X	Ann Resp Procs	
c(2)	F			X		Ops	
c(3)	F			X		Ops	
d(1)	F			X		Ops	
6.3.1.3a(1)	PF		X			Pnl	
a(2)	PF			X		Ops	
a(3)	PF			X		Ops	
b	PF		X			Pnl	
c	PF		X			Pnl	
d	PF		N/A			All	see text para. 4.2a
6.3.1.4a(1)	PF		X			Pnl	
a(2)	PF			X		SFTA Rpt	also in RP-9.0 (SFTA)
b(1)	F		X	X		Pnl	
b(2)	F		X			Pnl	
	F		X			Pnl	
	F	X	X			Pnl	
	F		X			Pnl	
b(3)	F		X			Pnl	
6.3.2.1a	F	X				CR	
b	F		X		X	CR, Admin Procs	
c	F		X	X		CR, Ops	
d	F		X	X		CR, Ops	
e	F		X			CR	
f	F		X	X		CR, Ops	
6.3.2.2a(1)	PF			X		Ops	
a(2)	F			X		Ops	
b	F			X		Ops	
6.3.3.1a	P		X			Pnl	
b(1)	P		X			Pnl	
b(2)	P	X				CR	
c(1)	P		N/A				in TP-1.8 (Maint)
c(2)	P		N/A				in TP-1.8 (Maint)
c(3)	P		N/A				in TP-1.8 (Maint)

APPENDIX C
CRITERIA MATRIX

CRITERIA NUREG-0700 para number	Crit type	DATA COLLECTION METHODS M	O	I	D	SUGGESTED DATA SOURCES	REMARKS
6.3.3.2a	F		X			Pnl	
b	F	X				Pnl,Comp Spc	
c	F		X			Pnl	
d	P	.	X			Pnl	
e	PF		X			Pnl, Ops	
f(1)	PF		X	X		Pnl, Ops	
f(2)	PF				X	Admin Proces	
6.3.3.3a	P		X			Pnl	
b	PF				X	SFTA Rpt	also in RP-9.0 (SFTA)
c(1)	P		X			Pnl	
c(2)	P		X			Pnl	
c(3)	P		X			Pnl	also in TP-6.1 (Labels)
d(1)	P		X			Pnl	
d(2)	PF				X	SFTA Rpt	also in TP-9.1 (SFTA)
e	F			X		Ops	
f	F		X			Pnl	
6.3.3.4a	P		X		X	Pnl, SFTA	also in RP-9.0 (SFTA)
b	PF			X		Ops	
c	PF		X	X	X	Pnl, Ops, SFTA Rpt	also in RP-9.0 (SFTA)
6.3.3.5a	P		X			Pnl	
a(1)	P	X				Pnl	
a(2)	P	X				Pnl	
b(1)	P		X			Pnl	
b(2)	P		X			Pnl	
b(3)	P		X			Pnl	
c	P		X			Pnl	
c(1)	P		X			Pnl	
c(2)	P		X			Pnl	
d(1)	P	X				Pnl	
d(2)	P	X				Pnl	
d(3)	P	X				Pnl	
d(4)	P	X				Pnl	
d(5)	P	X				Pnl	
d(6)	P	X				Pnl	

APPENDIX C
CRITERIA MATRIX

CRITERIA		DATA COLLECTION METHODS					
NUREG-0700 para number	Crit type	M	O	I	D	SUGGESTED DATA SOURCES	REMARKS
6.3.4.1a(1)	P		X	X		Pnl, Ops	
a(2)	PF		X	X		Ops	
b(1)	F		X	X		Pnl, Ops	
b(2)	F			X		Ops	
c(1)	F		X	X		Pnl, Ops	
c(2)	F			X		Ops	
c(3)	F			X		Ops	
d(1)	F			X	X	Pnl, Ops	
d(2)	F			X	X	Ops, Admin Procs	
6.3.4.2a	P		X			Pnl	
b(1)	P		X			Pnl	
b(2)	P		X			Pnl	
b(3)	P		X			Pnl	
b(4)	P		X			Pnl	
c	P		X	X		Pnl, Ops	
6.3.4.3a	P		X	X	X	CR, Ops, SFTA Rpt	also in RP-9.0 (SFTA)
6.5.1.6a	F			X		Ops	(see Note 1)
b(1)	P			X		Ops	(see Note 1)
b(2)	P			X		Ops	(see Notes 1 and 2)
c(1)	F			X		Ops	(see Note 1)
c(2)	F			X		Ops	(see Notes 1 and 2)
6.5.1.6d(1)	P		N/A				in TP-8.1 (Conv)
d(2)	P		N/A				in TP-8.1 (Conv)
d(3)	F		N/A				in TP-8.1 (Conv)
e(1)	P		X			Ops	(see Note 1)
e(2)	P	X				Pnl	(see Note 1)
e(3)	P	X				Pnl	(see Note 1)
6.6.6.2a(1)	F		X		X	Pnl,SFTA Rpt	also in RP-9.0 (SFTA)
a(2)	F		X		X	Pnl,SFTA Rpt	also in RP-9.0 (SFTA)
a(3)	F		X		X	Pnl,SFTA Rpt	also in RP-9.0 (SFTA)
b	VC		X			Pnl	also in TP-6.1 (Labels)
c	P		X			Pnl	also in TP-6.1 (Labels)

APPENDIX C
CRITERIA MATRIX

NOTES:

1. These criteria also in the following task plans:

TP-4.1	Controls Survey
TP-5.1	Displays Survey
TP-6.1	Labels Survey
TP-7.1	Computers System Review
RP-9.0	SFTA (in TP-9.9, CR Function Validation).

2. These criteria also in TP-8.1, Conventions.

APPENDIX D
TASK PLAN CRITIQUE

APPENDIX D
TASK PLAN CRITIQUE

INSTRUCTIONS

1. Attach a copy of Section 4.0.
2. Fill in the required information and answer all questions.
3. Explain all NO answers in detail.
4. When complete, turn in to your immediate supervisor.

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1. Name of Respondent: ______________________________
2. Name of Plant: ______________________________
3. Date of Survey: ______________________________
4. Were all of the criteria correct and appropriate for this task (do not explain criteria that were N/A because System/CR did not have that design feature)? YES NO

5. Did the task plan instructions present the easiest and best methodology for performing the assessment? YES NO

6. Were the data collection forms adequate? YES NO

H. B. ROBINSON UNIT 2

REGULATORY GUIDE 1.97

SUBMITTAL

(953JSK/ccc)

TABLE OF CONTENTS

(953JSK/ccc)

H. B. ROBINSON NUCLEAR POWER PLANT
COMPLIANCE WITH REGULATORY GUIDE 1.97, REV. 3 REPORT

I. INTRODUCTION

Regulatory Guide 1.97 provided guidance to nuclear power plants on instrumentation which should be provided to monitor plant variables and systems during and following an accident. This document provides CP&L's response to this guide through a description of the instrumentation and information systems which are currently installed or planned for incorporation into the HBR design. These systems will enable plant operators to assess plant and environs over their anticipated ranges for accident conditions and take appropriate actions to ensure plant safety.

II. DESIGN BASIS

The guidelines for selecting variable to be monitored were established in accordance with Regulatory Guide 1.97, Revision 3 and NUREG-0737, Supplement 1. A compliance table is included which summarizes H. B. Robinson's design for each variable as it compares to the Regulatory Guide 1.97 requirements. Following compliance table, a separate sheet is provided for each variable which provides a brief discussion of Regulatory Guide 1.97 compliance and CP&L's position on compliance with the requirements. The variables were selected to provide information consistent with the five classifications described in the regulatory guide as follows:

Type A Permit the control room operators to take specific pre-planned, manually-controlled actions for which no automatic control is provided and which may be required for safety systems to accomplish their functions during design basis events.

Type B Determine if the following plant safety functions are being performed: reactivity control, core cooling, maintaining reactor coolant system integrity, and maintaining containment integrity (including radioactive effluent control).

Type C Determine if there is potential for causing a breach or monitor a breach of the barriers to fission product releases (i.e., fuel cladding, reactor coolant pressure boundary, containment).

Type D Verify proper operation of individual safety systems and other systems important to safety.

Type E Determine the magnitude of release of radioactive materials and to readily assess such releases to allow for appropriate action to be initiated as early as possible for protection of the public.

The classifications are not mutually exclusive as instrumentation may be included as more than one type of variable, as well as being used for normal operations. The Type A variables were selected based on an evaluation of the design basis events included in Chapter 15, "Accident analysis," of the H. B. Robinson Unit 2 (HBR2) FSAR, or events enveloped by the Chapter 15 analyses, and the HBR2 operating procedures.

Events involving natural phenomena, such as fires, floods, and non-mechanistic low energy line breaks were not included in this review. The Type B, C, D, and E variable listed in the compliance table represent adequate instrumentation to monitor and assess systems and variables following an accident at HBR2.

III. DESIGN CRITERIA

Design and qualification categories are assigned in accordance with the regulatory guide based upon whether the variable is considered to be a key variable for system status indication or for backup or diagnosis. A key variable is that single variable (or minimum number of variables) that most directly indicates the accomplishment of a safety function (Types B and C), the operation of an individual safety system (Type D) or radioactive materials release (Type E). Key Type A, B, or C variables are Category 1 and the backup variables are Category 3. For Type A, all variable are considered as key variables. For Types D and E, key variables are Category 2 while backup variables are Category 3. The CP&L classification adheres strictly to this policy, whereas, the Regulatory Guide 1.97 Table 3 categories may deviate from this general philosophy.

In describing existing instrumentation, no credit is taken for future Emergency Response Facility Information System (ERFIS) or Safety Parameter Display System (SPDS) indications in the Control Room nor is any credit taken for future TSC/EOF instrumentation/indication. However, the H. B. Robinson ERFIS will eventually include channels of each of the variables listed in this submittal. Existing RG 1.97 instrumentation channels will be available on ERFIS once the original installation is complete. New channels of instrumentation added for RG 1.97 will be treated as modifications to ERFIS and added after ERFIS's original installation. ERFIS channels will be available for call up and trending from the Control Room.

The radiation monitoring system (RMS) is scheduled to be replaced and will meet requirements of RG 1.97 for the Type and Category indicated. The compliance table reflects the design of the radiation monitors as currently installed.

Instrumentation located in mild environments is considered to be environmentally qualified. To identify high radiation areas, anticipated post-accident radiation levels for zones within the Auxiliary Building are obtained from the General Arrangement Drawing of Reactor Auxiliary Building, Radiation Shielding Design Review. Other areas not shown on this General Arrangement Drawing, including the

turbine Deck, Fuel Handling Building, Monitor Building on top of the Auxiliary Building, and Yard, are considered to be mild environments. The pipe alley inside the Auxiliary Building is identified as a harsh environment on the general arrangement drawing mentioned above, as well as being a harsh environment for certain High Energy Line Break (HELB) events.

The environmental qualification of electrical equipment at H. B. Robinson is based on the criteria applicable at the time of installation. Pre-TMI instruments must be qualified to the applicable DOR guidelines and post-TMI instruments should be qualified to the appropriate IEEE standards. The qualification of many items located in harsh environments has been addressed by CP&L's responses to IEB 79-01B. The environmental qualification of equipment in these IEB 79-01B submittals is considered adequate to meet Reg. Guide 1.97 requirements for environmental qualification.

To date, the seismic and environmental review for RG 1.97 has considered only the sensing and indicating components of the instrumentation channels. Qualification (seismic and environmental as applicable to the entire instrumentation channel) will be addressed as part of a planned engineering analysis by CP&L to verify adequate qualification and proper isolation of safety circuits.

For RG 1.97 Category 1 and 2 instrumentation, seismic and environmental test reports and analyses will be obtained and reviewed to determine acceptability to RG 1.97 requirements in accordance with CP&L's position regarding these requirements. If unacceptable, CP&L will take actions as described in the individual variables' supplemental information sheets.

The cables initially installed at H. B. Robinson were not required to meet the electrical separation requirements of Regulatory Guide 1.75 for safety and non-safety circuits. For this reason, power supplies are identified by their standby sources (i.e., diesel-backed, battery-backed or just station power) instead of by a Class 1E or non-Class 1E designation. Cabling for new channels added to comply with Regulatory Guide 1.97 will be designed to meet the intent of Regulatory Guide 1.75 and to satisfy the requirements of Appendix R of 10 CFR 50.

The information included in the compliance table is based on the assumption that the modifications affecting RG 1.97 variables which were planned for installation during the Steam Generator Replacement outage will be implemented as planned.

IV. H. B. ROBINSON POSITION ON DESIGN AND QUALIFICATION CRITERIA

H. B. Robinson's position statements on the requirements of Regulatory Guide 1.97, Rev. 3 Table 1, Design and Qualification Criteria for Instrumentation are given below. The applicable requirements are addressed individually for Category 1, 2, and 3 variables.

Design and Qualification Criteria - Category 1

Paragraph 1.0 - Equipment Qualification:

H. B. Robinson is an operating plant licensed prior to Regulatory Guide 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants." H. B. Robinson will commit to ensuring environmental qualification per our Equipment Qualification submittal of March 2, 1984. Additionally, H. B. Robinson will only qualify equipment located in a harsh environment to these requirements. Thus, equipment forming part of an instrumentation loop and which is located in a mild environment may not be qualified by testing.

Seismic qualification of existing equipment is in accordance with H. B. Robinson's FSAR for the original plant design. New equipment (installed after TMI) will be seismically qualified in accordance with CP&L document HBR-83-002, Rev. 1, "Seismic Considerations for Equipment for H. B. Robinson Steam Electric Plant - Unit 2."

Paragraph 2.0 - Redundancy:

A single failure analysis is planned for RG 1.97 Category 1 variables with less than 3 channels of indication to determine if the failure of one accident monitoring channel results in information ambiguity that would lead operators to defeat or fail to accomplish a required safety function. Such ambiguities will be corrected by providing a third channel of instrumentation if one of the following measures cannot be done:

1. Cross-checking with an independent channel that monitors a different variable bearing a known relationship to the failed monitoring channel.

2. Perturbing the measured variable to determine the failed channel by observing the response on each instrument.

3. Using portable instrumentation to validate the correct channel.

Category 1 instrumentation channels shall be electrically divisionalized and handled in accordance with H. B. Robinson's FSAR design requirements for divisionalized channels and circuits.

Paragraph 3.0 - Power Source:

All Category 1 instrument channels shall be powered by plant emergency power sources designed in accordance with H. B. Robinson's FSAR criteria and commitments.

Paragraph 4.0 - Channel Availability:

H. B. Robinson agrees with the intent of this position.

(953JSK/ccc)

Paragraph 5.0 - Quality Assurance:

The quality assurance requirements invoked for the currently installed equipment were the Corporate Quality Assurance Program requirements in effect at the time of the purchase. As part of the implementation of this regulatory guide, H. B. Robinson will ensure that the equipment associated with Category 1 instrument channels are on the plant's Q-List such that the current H. B. Robinson Quality Assurance Program requirements will be invoked for future procurement, maintenance, and design change activities. Adherence to the requirements of the regulatory guides listed in this paragraph will be done if they are in the H. B. Robinson QA Program commitments.

Paragraph 6.0 - Display and Recording:

H. B. Robinson's specific position on each variable is given in the Compliance Tables.

Design and Qualification Criteria - Category 2

Paragraph 1.0 - Equipment Qualification

H. B. Robinson's position on these criteria for Category 2 instruments are the same as given for Paragraph 1.0 above. Instruments that are not part of a safety-related system will not be seismically qualified unless H. B. Robinson's FSAR invokes seismic requirements for the associated system.

Paragraph 3.0 - Power Source:

H. B. Robinson's specific position on each variable is given in the Compliance Tables.

Paragraph 4.0 - Channel Availability:

H. B. Robinson agrees with the intent of this position.

Paragraph 5.0 - Quality Assurance:

H. B. Robinson's position on quality assurance requirements for Category 2 safety-related instruments is the same as stated for Category 1 equipment. For nonsafety-related Category 2 instruments, the need for quality assurance requirements will be evaluated on a case-by-case basis. In general, quality assurance program requirements will not be imposed on nonsafety-related Category 2 instruments.

Paragraph 6.0 - Display and Recording:

H. B. Robinson's specific position on each variable is given in the Compliance Tables.

Design and Qualification Criteria - Category 3

Paragraph 5.0 - Quality Assurance:

H. B. Robinson concurs with this position with the understanding that environmental qualification testing is not necessary in selecting equipment for the service environment.

Paragraph 6.0 - Display and Recording:

H. B. Robinson's specific position on each variable is given in the Compliance Tables.

Design and Qualification Criteria Applicable to Categories 1 and 2

Paragraph 8.0 - Equipment Identification:

H. B. Robinson believes the identification of instruments for post-accident monitoring falls into the realm of human factors engineering and must take into consideration all current activities such as control board review, new emergency guidelines and procedures. By incorporating these activities and Regulatory Guide 1.97 into a integrated project (SECY-82-111), the NRC has ensured that human factors engineering and integration is achieved. H. B. Robinson will not commit to labeling the instruments but will develop a philosophy regarding instrument channel identification as part of the SECY-82-111 project. We believe this meets the intent of the guideline position.

Paragraph 9.0 - Interfaces:

An engineering analysis will be performed for RG 1.97 instrumentation installed post TMI to determine the need for additional isolation devices. Isolation devices will be provided between the monitoring instrument channel and other user circuits only if the other circuit is designed to less stringent requirements, and the engineering analysis requires its use.

Design and Qualification Criteria Applicable to Categories 1, 2, and 3

Paragraph 7.0 - Range:

H. B. Robinson's specific position on each variable is given in the Compliance Tables.

Paragraph 10.0 - Servicing, Testing, and Calibration:

Servicing, testing, and calibration procedures will be established and performed on a frequency necessary to maintain instrumentation capability. The frequency of servicing, testing, and calibration will be established from equipment experience data. Equipment replacement due to end of qualified life will be conducted under

the IEB 79-01B environmental qualification program. The capability to service, test, and calibrate the instruments during plant operation will be provided where necessary and feasible to do so.

The utilization of design features such as locked cabinets and seals to allow establishment of controlled access to equipment setpoint, calibration, and other adjustments is employed on a limited basis. For those cabinets not locked, H. B. Robinson relies on procedure controls and personnel training.

Periodic checking, testing, calibrations, and calibration verification for protection instrumentation is in accordance with IEEE-338-1971, "Trial - Use Criteria for the Periodic Testing of Nuclear Power Generating Stations Protective Systems."

Paragraph 11.0 - Human Factors:

This will be reviewed and considered as part of the Detailed Control Room Design Review.

Paragraph 12.0 - Direct Measurement:

H. B. Robinson's specific position on each variable is given in the Compliance Tables.

V. H. B. ROBINSON VARIABLE EXCEPTIONS

There are five variables specifically listed in Reg. Guide 1.97, Rev. 3 Table 3 which are not included in the H. B. Robinson variable list. The variables and the reasons for their omission are presented below:

1. Reactor Coolant Pump Status - RCS Loop Flow is used by CP&L in place of Reactor Coolant Pump Status due to its more definitive indication of how much flow is provided for each loop.

2. Quench Tank (PRT) Temperature - Reg. Guide 1.97 recommends inclusion of Quench Tank Level, Pressure, and Temperature indications. However, PRT level and PRT pressure are the only indications needed to act as backup to the pressurizer PORV and pressurizer safety relief valve position (which are designated as primary variables - i.e. Category 2). Additionally, PRT design pressure is 100 psig. A rupture disc limits pressure to approximately 100 psig; therefore, the temperature range specified in RG 1.97 (50°F - 750°F) will not produce a reading above approximately 300°F. Further, since the PRT is under saturated conditions, PRT pressure will provide the means for determining temperature.

3. Containment Sump Water Temperature - Sump temperature is not required for RHR operation or assurance that NPSH requirements are met as NPSH calculations conservatively assume the presence of saturated water. Numerous parameters in the reactor coolant system as well as containment parameters such as temperature and pressure

are available to help determine plant conditions. Sump level indicates the quantity of water present and the above parameters indicate its source. Therefore, containment sump water temperature measurement is omitted.

4. Radiation Exposure Rate - CP&L does not consider the function of this variable to be consistent with the purpose of a Type E variable (i.e., to determine the magnitude of an offsite release). Portable radiation monitoring equipment is provided for determining where access in the plant may or may not be allowed to service or operate equipment.

5. Component Cooling Water Flow to Engineered Safety Feature (ESF) System - The Component Cooling Water (CCW) Flow to ESF System components variable is being addressed by a combination of variable which are listed below:

CCW Header Flow	D2
CCW Surge Tank Level	D2
CCW to Residual Heat Removal (RHR) Pumps Low Flow Indication	D3
CCW to Safety Injection (SI) Pumps Low Flow Indication	D3
CCW to Containment Spray (CS) Pumps Low Flow Indication	D3
CCW Pump Status	D3

The CCW Header Flow indications is downstream of all three CCW pumps. This parameter provides an indication of the total flow going to all ESF components. The CCW Surge Tank Level provides indication that an adequate surge volume and suction head for the CCW pumps is available. The valves in the lines going to the RHR, SI, and CS pumps are manually operated and required by administrative controls to be open prior to plant startup. As backup to the header flow, the low flow indications on the CCW lines at the discharge from the RHR, SI, and CS pumps are used. One low flow indication exists for the three SI pumps and one low flow indication for both CS pumps exists. Each RHR pump has a low flow indication. Also the CCW pumps status are backup variables.

COMPLIANCE TABLE

LEGEND

The compliance table for each type variable (Type A, B, C, D, and E) consists of various subjects that are described below. These subjects are based on information contained in Reg. Guide 1.97, Rev. 3 and NUREG-0737, Supplement 1. Following the compliance tables are additional sheets for each variable that provide a discussion of the variable's compliance to Reg. Guide 1.97, Rev. 3, and the CP&L position regarding the variable's status. Only one of these sheets is provided for each variable event though the variable may appear more than once in the compliance tables. This sheet appears in the highest category in which the variable is listed.

Given below is a description of the subjects that appear on the compliance table for each type variable:

Safety Function	=	The areas of safety that collectively define each variable type. For Types B, C, D, and E these have been provided by Reg. Guide 1.97 Table 3.
Variable	=	Individual variable whose status reflects the accomplishment of the corresponding safety function, as determined by CP&L.
Sensor	=	Those transmitters, detectors, and sensors that monitor the status of the variable.
Cat	=	The category (1, 2, or 3) assigned by CP&L for the variable.
RG 1.97 or HBR	=	Reg. Guide 1.97 or H. B. Robinson.
Range	=	Range of the sensor and/or indicator. If the range of the sensor and indicator are different, the most conservative value is used.
EQ	=	Environmental qualification.
SQ	=	Seismic qualification.
Power	=	Power supply to the sensor.
Redundant	=	Redundant channels.
Sensor Location	=	Physical location of the sensor.
Display	=	Type of display or indication.
Recorder	=	Strip chart recorder.
Comments	=	Comments and remarks concerning the variable's design or Reg. Guide 1.97 requirements.

COMPLIANCE TABLE

LEGEND

For each variable, two rows of information are included. The first is titled RG 1.97 and lists the Regulatory Guide 1.97 requirements for the category shown (i.e., the category chosen by CP&L). The second row summarizes the design of the existing instrumentation at H. B. Robinson. The nomenclature used for each row is shown below:

For RG 1.97

EQ	=	Yes	(for Category 1 and 2 instrumentation where environmental qualification is required).
	=	NR	(for Category 3 instrumentation where environmental qualification is not required).
SQ	=	Yes	(for Category 1 instrumentation where seismic qualification is required).
	=	NR	(for Category 2 and 3 instrumentation where seismic qualification is not required).
Power	=	Standby	(for Category 1 instrumentation where standby power is required).
	=	Reliable	(for Category 2 instrumentation where highly reliable power is required).
	=	NR	(for Category 3 instrumentation where no specific requirements are given).
Redundant	=	Yes	(for Category 1 instrumentation where redundancy is required).
	=	NR	(for Category 2 and 3 instrumentation where no specific requirements are given).
Display	=	Continuous	(for Category 1 instrumentation where continuous Control Room indication is required).
	=	On Demand	(for Category 2 and 3 instrumentation where only display on demand indication is required).
Recorder	=	Yes	(for instrumentation that requires at least one channel be recorded).
	=	NR	(for instrumentation that has no requirements regarding Control Room recorders).

For HBR

EQ	=	Yes	(for instrumentation considered to be environmentally qualified).
	=	79.01B	(for instrumentation whose environmental qualification is addressed by the CP&L 79.01B responses).
	=	No	(for instrumentation not considered to be environmentally qualified).
	=	NR	(for instrumentation not required to be environmentally qualified).
SQ	=	Yes	(for instrumentation considered to be seismically qualified).
	=	No	(for instrumentation not considered to be seismically qualified).
	=	NR	(for instrumentation not required to be seismically qualified).
	=	ORIG	(for instrumentation considered to be seismically qualified per design and installation to the original plant seismic criteria).
Power	=	DB	(for instrumentation whose power source is diesel-backed).
	=	BB	(for instrumentation whose power source is battery-backed).
	=	Stn	(for instrumentation whose power source is not diesel or battery-backed but is only station power).
	=	IA	(for pneumatic sensors supplied by instrument air system).
	=	TBD	(for instrumentation whose power source is to be determined).
Redundant	=	Yes	(for instrumentation that has more than one channel; does not necessarily imply compliance with single failure, RG 1.97 separation criteria, or channel independence).
	=	NR	(for instrumentation that does not require redundant channels).
	=	No	(for instrumentation that does not have redundant channels).
Sensor Location	=	CV	(for sensors inside the Containment).
	=	AB	(for sensors inside the Auxiliary Building).
	=	TB	(for sensors inside the Turbine Building).
	=	FHB	(for sensors inside the Fuel Handling Building).
	=	Yard	(for sensors outside the Containment, Auxiliary Building, Turbine Building, and Fuel Handling Building).

Display	=	RTGB	(for instrumentation continuously indicated in the Control Room).
	=	On Demand	(for instrumentation where only display on demand indication, including the plant computer, is provided).
	=	Local	(for instrumentation indicated somewhere other than the Control Room).
	=	None	(for instrumentation with no indication).
Recorder	=	Yes	(for instrumentation with at least one channel recorder in the Control Room).
	=	No	(for instrumentation with no Control Room recorder).
	=	NR	(for instrumentation not required to be recorded in the Control Room).

TYPE A

VARIABLES

TABLE A

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Reactivity Control	Neutron Flux (Source Range)	N31 N32	1	RG 1.97 HBR	Plant Specific 10^0 - 10^6 cps	Yes No	Yes No	Standby N31=DB N32=BB	Yes Yes	-- CV	Continuous RTGB	Yes Yes(2)	
Core Cooling	RCS Pressure (WR)	PT-402	1	RG 1.97 HBR	Plant Specific 0-3000 psi	Yes 79-01B	Yes (1)	Standby DB	Yes No	-- CV	Continuous RTGB	Yes Yes	Recorder has a DB power supply.
Core Cooling	Core Exit Temperature	T1 thru T51	1	RG 1.97 HBR	Plant Specific 100-700°F	Yes No	Yes No	Standby DB	Yes Yes(3)	-- CV	Continuous On Demand	Yes No	All T/Cs have same power supply.
Core Cooling	RCS Hot Leg Water Temperature	TE-413 TE-423 TE-433	1	RG 1.97 HBR	Plant Specific 50-650°F	Yes No	Yes No	Standby DB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	One recorder provides only RTGB indication for all 3 channels, BB power supply.
Core Cooling	RCS Cold Leg Water Temperature	TE-410 TE-420 TE-430	1	RG 1.97 HBR	Plant Specific 50-650°F	Yes No	Yes No	Standby DB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	One recorder provides only RTGB indication for all 3 channels, DB power supply.
Core Cooling	RWST Level	LT-948	1	RG 1.97 HBR	Plant Specific 0-100%	Yes (1)	Yes (1)	Standby BB	Yes No	-- Yard	Continuous RTGB	Yes No	
Core Cooling	CST Level	LT-1454A LT-1454B	1	RG 1.97 HBR	Plant Specific 0-100%	Yes Yes	Yes ORIG	Standby Ch.A=DB Ch.B=DB	Yes Yes	-- Yard	Continuous RTGB	Yes No	Mild environment

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RCS Integrity	Containment Water Level	LT-801 LT-802	1	RG 1.97 HBR	Plant Specific 3.5-423.5"	Yes 79-01B	Yes (1)	Standby LT-801=BB LT-802=DB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	Instruments span both the sump and the bottom of containment.
RCS Integrity	Containment Pressure	PT-956 PT-957	1	RG 1.97 HBR	Plant Specific -5-126 psig	Yes Yes	Yes (1)	Standby PT956=DB PT957=BB	Yes Yes	-- AB	Continuous RTGB	Yes Yes	Mild environment
RCS Integrity	Containment Area Radiation (Hi-Range)	R-32A R-32B	1	RG 1.97 HBR	Plant Specific $1\text{-}10^7$ R/Hr	Yes (1)	Yes (1)	Standby R-32A=DB A-32B=BB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	
RCS Integrity	SG Blowdown Radiation Level	R-19	1	RG 1.97 HBR	Plant Specific 4×10^{-5}-3.5×10^{-2} μCi/cc	Yes Yes	Yes No	Standby BB	Yes No	-- AB	Continuous RTGB	Yes Yes(4)	Mild environment
RCS Integrity	Steam Generator Level (NR)	LT-474 LT-475 LT-476 LT-484 LT-485 LT-486 LT-494 LT-495 LT-496	1	RG 1.97 HBR	Plant Specific 0-100%	Yes 79-01B	Yes (1)	Standby Ch.1=DB Ch.2,3 =BB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	Channel 1 = LT-474, -484, -494 Channel 2 = LT-475, -485, -495 Channel 3 = LT-476, -486, -496

TYPE A

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RCS Integrity	Steam Generator Pressure	PT-474 PT-475 PT-476 PT-484 PT-485 PT-486 PT-494 PT-495 PT-496	1	RG 1.97 HBR	Plant Specific 0-1400 psig	Yes Yes	Yes (1)	Standby Ch. 1,2 = BB Ch.3=DB	Yes Yes	-- TB	Continuous RTGB	Yes No	Ch. 1 = PT-474, -484, -494. Ch. 2 = PT-475, -485, -495. Ch. 3 = PT-476, -486, -496. Mild environment
RCS Integrity	Pressurizer Level	LT-459 LT-460 LT-461	1	RG 1.97 HBR	Plant Specific 0-100%	Yes 79-01B	Yes (1)	Standby LT-459=DB LT-460, LT-461=BB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	
Containment	Containment Hydrogen Conc.	AET-8100-1 AET-8110-2	1	RG 1.97 HBR	Plant Specific 0-10% H_2	Yes (1)	Yes (1)	Standby Ch.1=BB Ch.2=DB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	Ch.1=AET-8100-1 Ch.2=AET-8110-2 PT-8101-1 and PT-8110-2 provide pressure inputs.
Containment	CS Addition Tank Level	LT-949	1	RG 1.97 HBR	Plant Specific 0-100%	Yes Yes	Yes (1)	Standby BB	Yes No	-- AB	Continuous RTGB	Yes No	Mild environment

TYPE A FOOTNOTES

(1) Information is available that discusses the instrument's generic qualification; however, no specific comparison has been made with the HBR-specific profiles or parameters.

(2) A RTGB recorder is available for the operator to record any 2 of 8 NIS channels. Recorder is on a diesel-backed power supply.

(3) 51 core thermocouples provided to monitor a representative cross section of the 157 fuel assemblies.

(4) May be assigned by operator as 1 of 24 pens on Radiation Monitoring System multi-channel recorder. Recorder is on a battery-backed power supply.

Variable: Neutron Flux (Source Range)

Category : A1

Compliance: Environmental qualification is not considered necessary for the source range detectors as they are used by the operator to detect inadvertent boron dilution during shutdown conditions. Any such inadvertent boron dilution at power conditions would be detected by reactor protection circuitry and a reactor trip initiated. Thus, the use of the source range detectors will only be required during non-accident conditions; and therefore are not required to be qualified to operate under accident conditions.

The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of seismic qualification and control room recording capability. As discussed above, the variable may be considered environmentally qualified to its service conditions.

CP&L Position: CP&L will install new neutron flux detector systems which are seismically and environmentally qualified. These systems will combine the source and intermediate range channels. In addition, the range of the existing NIS recorder will be modified to properly record the source range channel.

Variable: RCS Pressure (WR)

Category: A1, B1, B3, C1

Compliance: For the core cooling safety function of Type B variables, RCS pressure is shown as a Category 3 variable. RCS pressure provides an indication of subcooling margin and thus, indirectly provides information as to the accomplishment of core cooling. Core exit temperature provides the most direct indication of core cooling and is given as Category 1 for this safety function while RCS serves as backup/verification indication and is a Category 3.

As a Type C variable, RCS pressure is not shown for the containment safety function. RCS pressure provides indication of a potential breach of the RCPB which then infers a potential breach of containment. However, since RCS pressure is already shown as the primary variable for potential breach of the RCPB, containment pressure is shown as the primary indication for a potential breach of containment. Thus, for the containment safety function, containment pressure is assigned as Category 1 and RCS pressure is not considered necessary.

The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of seismic qualification and redundancy. Seismic qualification may be considered acceptable following a comparison of the instrument's test results to the HBR specific profiles.

CP&L Position: The seismic qualification data for these transmitters is being evaluated against the HBR profiles. If this data is unacceptable, the transmitters will be replaced with seismically qualified units. An RTGB indicator will be installed for 1 of the existing extended range pressurizer pressure channels (PT-500 or PT-501) to satisfy redundancy requirements.

Variable: Core Exit Temperature

Category: A1, B1, C1, D2

Compliance: The core exit temperature variable is assigned as Category 1 for the core cooling safety function of the Type B variables. This variable is considered to provide the most direct and most unambiguous indication that core cooling is being accomplished and is, therefore, assigned as the primary variable. RCS pressure and hot and cold leg temperatures can only infer that core cooling is being accomplished by providing the basis of the subcooling margin. Thus, these variables are included as backup variables to the core exit temperature.

The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of range, environmental qualification, seismic qualification, electrical independence, control room indication, and control room recording capability.

CP&L Position: New thermocouples which are environmentally and seismically qualified will be installed. Separate control room indicators will be installed for 16 of the new thermocouples (2 channels of 8 thermocouples with independent power supplies for each channel). These signals will also be routed to a new multi-pen recorder with switchable inputs. All new channels will meet RG 1.97 range requirements.

Variable: RCS Hot Leg Water Temperature

Category: A1, B3, D2

Compliance: RCS hot leg temperature is given as a Category 3 for the core cooling safety function of the Type B variables. Since core exit temperature provides the most direct indication that core cooling is being accomplished, it has been assigned as Category 1. The RCS hot leg temperature indication provides backup/verification indication to the core exit temperature.

The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of environmental qualification, seismic qualification, and channel independence. The design does not meet the requirements of RG 1.97 Type B for range.

CP&L Position: The existing RTDs will be replaced with RTDs which are environmentally and seismically qualified and which meet the range requirements of RG 1.97. Two new RTGB indicators will be installed to display two of the channels.

Variable: RCS Cold Leg Water Temperature

Category: A1, B3, D2

Compliance: RCS cold leg temperature is given as a Category 3 for the core cooling safety function of the Type B variables. Since core exit temperature provides the most direct indication that core cooling is being accomplished, it has been assigned as Category 1. The RCS cold leg temperature indication provides backup/verification indication to the core exit temperature.

RCS cold leg temperature is not included for the reactivity control safety function for the Type B variables because the control rod position and RCS boron concentration were considered as more appropriate backup indications to neutron flux. Reactivity control may be directly inferred from either RCS boron concentration or control rod position but not from RCS cold leg temperature. Thus, RCS cold leg temperature provides a somewhat superficial backup indication to neutron flux and is not provided for the reactivity control safety function.

The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of environmental qualification, seismic qualification and channel independence. The design does not meet the requirements of RG 1.97 Type B for range.

CP&L Position: The existing RTDs will be replaced with RTDs which are environmentally and seismically qualified and which meet the range requirements of RG 1.97. Two new RTGB indicators will be installed to display two of the channels.

Variable: Refueling Water Storage Tank (RWST) Level

Category: A1, D3

Compliance: For the Type D variables, RWST level is given as a Category 3 variable for the RHR safety function. RHR flow provides primary indication that the system is supplying water for decay heat removal and like RHR heat exchanger outlet temperature, it is given as Category 2. RWST level only indicates the availability of a suction head and not whether the function of the RHR system is being achieved. Thus, RWST level is assigned as backup/verification indication for the Type D variables.

The existing design of this variable does not meet the requirements of RG 1.97 in the areas of seismic qualification, environmental qualification, range, redundancy, and control room recording capability.

CP&L Position: The seismic and environmental test data for the transmitter is being reviewed to ensure its adequacy. The existing installation provides indication over 97% of the tank volume. This range exceeds the minimum Tech. Spec. requirement and covers the range where a manual shift to recirculation is required. Therefore, the existing range is considered to be adequate.

A new RWST level channel with RTGB indication will be installed to provide redundancy. Trend information will be provided on demand for both channels on the ERFIS.

Variable: Condensate Storage Tank (CST) Level

Category: A1, D3

Compliance: For the Type D variables, CST Level is given as a Category 3 variable for the Auxiliary Feedwater System safety function. AFW flow provides primary indication that the system is supplying feedwater to the steam generators and is given as Category 2. CST level only indicates the availability of the primary suction head of the AFW pumps and not whether the function of the AFW System is being achieved. Thus, CST level is assigned as backup/verification indication for the Type D variables.

The existing design of this variable does not meet the requirements of RG 1.97 in the areas of range and control room recording capability.

CP&L Position: The existing range provides indication over 97% of the tank capacity, greatly exceeds the Tech. Spec. requirements and covers the range where manual realignment of the pumps would be required. Therefore, no modifications to expand the existing range are required.

Trend information will be provided on demand for both channels on the ERFIS.

Variable: Containment Water Level

Category: A1, B3, C3, D3

Compliance: Containment water level lacks the ability to provide the operator with an effective indication of whether a breach within containment is from the primary or secondary side. Since the containment high range radiation monitors afford this capability, they have been assigned as Category 1 for Types B and C. Thus, the containment water level provides backup/verification indication to the containment high range radiation monitors and it is shown as Category 3 for Types B and C.

USNRC letter dated 4/10/84 states that the containment water level monitors for HBR meet the requirements of item II.F.1.5 of NUREG-0737, except for environmental qualification which was not a part of the NRC review.

This variable does not meet the requirements of RG 1.97 Category 1 in the area of seismic qualification. The variable may be determined to be seismically qualified following a comparison of qualification test reports to the HBR specific profiles.

CP&L Position: CP&L will review the seismic and environmental qualification data to ensure its adequacy.

Variable: Containment Pressure

Category: A1, B1, B3, C1, C3, D3

Compliance: For the RCS integrity safety function of the Type B variables, and the RCPB integrity safety function of the Type C variables, containment pressure is given as a Category 3 variable due to its inability to distinguish between primary and secondary side leaks. Because containment high range radiation monitors can alert the operator of a primary side breach within containment (and thus most probably an RCPB breach), they are assigned as Category 1. Thus, the containment pressure indication is considered as backup to the containment high range radiation level.

The containment cooling safety function of the Type D variables is met by two separate H. B. Robinson systems; containment spray and containment recirculation cooling. The variables assigned as Category 2 for this safety function (Containment Spray Flow, Containment Coolers Service Water Low Flow, Containment Coolers Fan Motor Status, and Containment Spray Addition Tank Level) provide primary indication of the containment spray system operability and of the containment coolers operability. Containment pressure provides indication of whether the overall containment cooling function is being achieved, not whether the individual safety systems are operating. Thus, containment pressure is assigned as a Type D Category 3.

USNRC letter dated 4/10/84 states that the containment pressure monitors for HBR meet the requirements of item II.F.1.4 of NUREG-0737, except for environmental qualification which was not a part of the NRC review.

The existing design of this variable does not meet the requirements of a RG 1.97 Category 1 variable in the area of seismic qualification. Seismic qualification may be determined to be acceptable following a comparison of the instrument's test results to the HBR specific profiles.

CP&L Position: The seismic qualification data for the transmitters is being evaluated against HBR profiles. If this data is unacceptable, the transmitters will be replaced with seismically qualified units. In addition, the existing indicators will be relabeled to indicate the channel range of -5 to 126 psig.

Variable: Containment Area Radiation (Hi-Range)

Category: A1, B1, C1, E2

Compliance: For the Type E variables, the containment area radiation (hi-range) variable provides primary indication of the containment radiation safety function. Thus, per the guidelines of RG 1.97 which states that key variables for Type E be assigned as Category 2, the containment area radiation (hi-range) variable is a Category 2.

The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of environmental qualification and seismic qualification. Seismic and environmental qualification may be determined to be acceptable following a comparison of the instrument's test results to HBR specific profiles.

CP&L Position: The seismic and environmental qualification data for the transmitters is being evaluated against the HBR profiles. If the results are unacceptable, the detectors will be replaced with seismically and environmentally qualified detectors.

Variable: Steam Generator Blowdown Radiation Level

Category: A1, B1, C1, D3, E3, E2

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of seismic qualification, range, and redundancy.

CP&L Position: The existing steam generator blowdown monitor will be replaced under the Radiation Monitoring System TAR (84-036). The new steam generator blowdown monitor will meet the requirements of RG 1.97 Category 1.

Variable: Steam Generator (SG) Level (NR)

Category: A1

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the area of seismic qualification. Seismic qualification may be determined to be acceptable following a comparison of the instrument's test results to the HBR specific profiles.

CP&L Position: The seismic qualification data for the transmitters is being evaluated against the HBR profiles. If the data is unacceptable, the transmitters will be replaced with seismically and environmentally qualified units.

Variable: Steam Generator (SG) Pressure

Category: A1, B1, C1, D2

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of seismic qualification and control room recording capability.

CP&L Position: The seismic qualification data for the transmitters is being evaluated against HBR profiles. If the data is unacceptable, the transmitters will be replaced with seismically qualified units.

Trend information will be provided on-demand using the ERFIS.

Variable: Pressurizer Level

Category: A1, D3

Compliance: For the Type D variables, pressurizer level is given as backup/verification indication. The primary variables (T_{hot}, T_{cold}, Pressurizer Pressure) provide indication that the RCS is maintaining its proper temperature and pressure. Pressurizer level only provides indication that an adequate surge volume is available for transient pressure conditions. Thus, the pressurizer level is considered backup indication and is assigned as a Category 3.

The existing design of this variable does not meet the requirements of RG 1.97 in the areas of seismic qualification and range.

CP&L Position: The seismic qualification data for the transmitters is being evaluated against the HBR profiles. If unacceptable, the transmitters will be replaced with seismically and environmentally qualified units.

The existing range covers all but minimum volumes in the top and bottom of the pressurizer and is adequate to determine when the heaters are covered and when the pressurizer is approaching a water solid condition. As discussed above, pressurizer pressure and hot leg temperature are used to determine saturation margin. Therefore, no changes to the existing level instrumentation range are planned.

Variable: Containment Hydrogen Concentration

Category: A1, C1, D2

Compliance: USNRC letter dated 4/10/84 stated that the HBR containment hydrogen monitoring system was evaluated for all NUREG 0737 requirements except for environmental qualification and implementation schedule and found to be acceptable.

This variable does not meet the requirements of RG 1.97 Category 1 in the areas of seismic and environmental qualification. Seismic and environmental qualification may be determined to be acceptable following a comparison of the instrument's qualification test results to the HBR specific profiles.

CP&L Position: The seismic and environmental qualification data is being evaluated against HBR profiles. If the data is unacceptable, the monitors will be replaced with qualified units.

Variable: Containment Spray (CS) Addition Tank Level

Category: A1, D2

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Category 1 in the areas of redundancy, seismic qualification, and control room recording capability.

CP&L Position: The seismic qualification data for the transmitter is being evaluated against the HBR profiles. If the data is unacceptable, the transmitter will be replaced with a qualified unit.

A new level indicating channel will be installed to provide redundancy. Trend information for both channels will be provided on demand using the ERFIS.

TYPE B

VARIABLES

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Reactivity Control	Neutron Flux (Intermediate Range)	N35 N36	1	RG 1.97	10^{-6} % - 100% F.P.	Yes	Yes	Standby	Yes	--	Continuous	Yes	Recorder NR45 records any 2 of 8 NIS channels that the operator chooses
				HBR	10^{-11} - 10^{-3} amps (2)	No	No	N35=DB N36=BB	Yes	CV	RTGB	Yes	
Reactivity Control	Control Rod Position	RPI	3	RG 1.97	Full in or not full in	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-144"	NR	NR	Stn.	NR	CV	RTGB	NR	
Reactivity Control	RCS Boron Concentra-tion	AT-4124 or Grab Sample	3	RG 1.97	0-6000 ppm	NR	NR	NR	NR	--	On Demand	NR	Grab samples obtained via the PASS or normal sampling
				HBR	(3)	NR	NR	NR	NR	AB	None	NR	
Core Cooling	Core Exit Temperature	T1 thru T51	1	RG 1.97	200-2300°F	Yes	Yes	Standby	Yes	--	Continuous	Yes	Diverse indication provided by the 51 channels. All T/Cs have same power supply
				HBR	100-700°F	No	No	DB	No	CV	On Demand	No	
Core Cooling	RCS Cold Leg Temperature	TE-410 TE-420 TE-430	3	RG 1.97	50-700°F	NR	NR	NR	NR	--	On Demand	NR	All 3 cold leg temp-erature indications are only indicated on RTGB recorder TR-410 & the plant computer.
				HBR	50-650°F	NR	NR	DB	Yes	CV	RTGB	Yes	
Core Cooling	RCS Hot Leg Temperature	TE-413 TE-423 TE-433	3	RG 1.97	50-700°F	NR	NR	NR	NR	--	On Demand	NR	All 3 hot leg tempera-ture indications are only indicated on RTGB recorder TR-413 and the plant computer.
				HBR	50-650°F	NR	NR	DB	Yes	CV	RTGB	Yes	
Core Cooling	RCS Pressure (WR)	PT-402	3	RG 1.97	0-3000 psig	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-3000 psi	NR	NR	DB	NR	CV	RTGB	Yes	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Core Cooling	Reactor Vessel Water Level	LT-511AA LT-511AB LT-511BA LT-511BB LT-511BC LT-511AC	3	RG 1.97	Bottom of hot leg to top of vessel	NR	NR	NR	NR	--	On Demand	NR	System is being installed.
				HBR	Bottom to top of vessel	NR	NR	BB	Yes	AB	RTGB	Yes	
Core Cooling	RCS Subcooling Margin	CCM-520 CCM-521	3	RG 1.97	200°F sub-cooling to 35°F superheat	NR	NR	NR	NR	--	On Demand	NR	PT-456=Ch.1 PT-457=Ch.2
				HBR	200°F sub-cooling to 2250° F superheat	NR	NR	Ch.1=BB Ch.2=DB	Yes	CV	RTGB	NR	
RCS Integrity	RCS Pressure (WR)	PT-402	1	RG 1.97	0-3000 psig	Yes	Yes	Standby	Yes	--	Continuous	Yes	Recorder has DB power supply.
				HBR	0-3000 psi	79-01B	(1)	DB	No	CV	RTGB	Yes	
RCS Integrity	SG Blowdown Radiation Level	R-19	1	RG 1.97	NR	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	$4x10^{-5}$ -$3.5x10^{-2}$ μCi/cc	Yes	No	BB	No	AB	RTGB	Yes(4)	Mild environment.
RCS Integrity	Containment Area Radiation (Hi Range)	R-32A R-32B	1	RG 1.97	NR	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	$1\text{-}10^7$R/hr	(1)	(1)	R-32A=DB R-32B=BB	Yes	CV	RTGB	Yes	
RCS Integrity	Containment Pressure	PT-956 PT-957	3	RG 1.97	0-design pressure	NR	NR	NR	NR	--	On Demand	NR	Design pressure = 42 psig
				HBR	0-120 psig	NR	NR	PT956=DB PT957=BB	Yes	AB	RTGB	Yes	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RCS Integrity	Containment Water Level (WR)	LT-801 LT-802	3	RG 1.97 HBR	Plant Specific 3.5-423.5"	NR NR	NR NR	NR LT-801=BB LT-802=DB	NR Yes	-- CV	On Demand RTGB	NR Yes	Instruments span both the sump and the bottom of the containment.
RCS Integrity	Condenser Air Ejector Radiation Level	R-15	3	RG 1.97 HBR	NR $1.3x10^{-5}$ -10^{-1} μCi/cc	NR NR	NR NR	NR BB	NR NR	-- TB	On Demand RTGB	Yes Yes(4)	
RCS Integrity	Containment Particulate/ Noble Gas Radiation Level	R-11 R-12	3	RG 1.97 HBR	NR R-11: $3x10^{-10}$-3.5 $x10^{-7}$ μCi/cc (particulate) R-12: $6x10^{-6}$-10^{-1} μCi/cc (noble gas)	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	Yes Yes(4)	Sample pump is powered from station power.
RCS Integrity	Containment Area Radiation Level (Lo Range)	R-2	3	RG 1.97 HBR	NR .1 - 10^4 mr/hr	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	Yes Yes(4)	
RCS Integrity	Incore Instrumentation Area Radiation Level	R-7	3	RG 1.97 HBR	NR .1 - 10^4 mr/hr	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	Yes Yes(4)	

T. B

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Containment Integrity	Containment Pressure	PT-956 PT-957	1	RG 1.97	-5 psig to design pressure	Yes	Yes	Standby	Yes	--	Continuous	Yes	Design pressure = 42 psig, Mild environment.
				HBR	-5-126 psig	Yes	(1)	PT-956=DB PT-957=BB	Yes	AB	RTGB	Yes	
Contain-ment Integrity	Containment Isolation Valve Position(5)	RC-HC-516 RC-HC-553	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB	No	
		RC-550	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Check valve provides redundant isolation
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB	No	
		RC-HC-519A RC-HC-519B	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB	No	
		WD-1786 WD-1787	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		WD-1789 WD-1794	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
	Containment Isolation Valve Position (5) (continued)	WD-1721 WD-1722	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		WD-1723 WD-1728	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		SGB-FCV-1930A	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		SGB-FCV-1930B		HBR	Open - closed	No	ORIG	DB	(6)	AB	RTGB(7)	No	
		SGB-FCV-1931A	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		SGB-FCV-1931B		HBR	Open - closed	No	ORIG	DB	(6)	AB	RTGB(7)	No	
		SGB-FCV-1932A	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		SGB-FCV-1932B		HBR	Open - closed	No	ORIG	DB	(6)	AB	RTGB(7)	No	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
	Containment Isolation Valve Position(5) (Continued)	SGB-FCV-1933A	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		SGB-FCV-1933B		HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB(7)	No	
		SGB-FCV-1934A	1	RG 1.97	Clossd - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		SGB-FCV-1934B		HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB(7)	No	
		SGB-FCV-1935A	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		SGB-FCV-1935B		HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB(7)	No	
		CC-716A CC-716B	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB	No	
		CC-730	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB	No	
		CC-FCV-626	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
		CC-735		HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB	No	
		CC-HC-739	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB	No	

TYPE B

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
	Containment Isolation Valve Position(5) (Continued)	CVC-200A CVC-200B CVC-200C CVC-204A CVC-204B	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	CVC-200A, -200C, & -204A are powered from same power source. CVC-200B, -204B are powered from same power source.
				HBR	Open - closed	No for -200A, B,C (8)for -204A,B	ORIG	BB	(6)	CV for -200A, B,C AB for -204A, B	RTGB	No	
		CVC-381	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB	No	
		PS-956A PS-956B	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		PS-956C PS-956D	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		PS-956E PS-956F	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		PS-956G PS-956H	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
	Containment Isolation Valve Position(5) (Continued)	IA-1716	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB(7)	No	
		RM-1 RM-4	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB(7)	No	
		RM-2 RM-3	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB(7)	No	
		HVAC-V12 -6 HVAC-V12 -7	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source. 79-01B response (5/83) shows V12-6 as non-harsh environment.
				HBR	Open - closed	V12-6=Yes V12-7=No	ORIG	DB	(6)	Yard for V12-6 CV for V12-7	RTGB(7)	No	
		HVAC-V12 -8 HVAC-V12 -9	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
				HBR	Open - closed	V12-8= (8) V12-9= No	ORIG	DB	(6)	AB for V12-8 CV for V12-9	RTGB(7)	No	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
	Containment Isolation Valve Position(5) (Continued)	HVAC-V12 -10	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source.
		HVAC-V12 -11		HBR	Open - closed	V12-10 =(8) V12-11 =No	ORIG	DB	(6)	AB for V12-10 CV for V12-11	RTGB(7)	No	
		HVAC-V12 -12	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Both valves are powered from same power source. 79-01B response (5/83) shows V12-12 as non-harsh environment.
		HVAC-V12 -13		HBR	Open - closed	V12-12= Yes V12-13= No	ORIG	DB	(6)	Yard for V12-12 CV for V12-13	RTGB	No	
		SI-855	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	BB	(6)	AB	RTGB	No	
		FP-248 FP-249	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB	No	
		FP-256 FP-258	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	Open - closed	(8)	ORIG	DB	(6)	AB	RTGB	No	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
	Containment Isolation Valve Position(5) (Continued)	MS-V1-3A	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Mild environment.
				HBR	Open - closed	Yes	ORIG	BB	(6)	TB	RTGB	No	
		MS-V1-3B	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Mild environment.
				HBR	Open - closed	Yes	ORIG	BB	(6)	TB	RTGB	No	
		MS-V1-3C	1	RG 1.97	Closed - not closed	Yes	Yes	Standby	Yes	--	Continuous	Yes	Mild environment.
				HBR	Open - closed	Yes	ORIG	BB	(6)	TB	RTGB	No	
Containment Integrity	Steam Generator Pressure	PT-474 PT-475 PT-476 PT-484 PT-485 PT-486 PT-494 PT-495 PT-496	1	RG 1.97	NR	Yes	Yes	Standby	Yes	--	Continuous	Yes	PT-474,-484,-494=Ch.1 PT-475,-485,-495=Ch.2 PT-476,-486,-496=Ch.3 Mild environment.
				HBR	0 - 1400 psig	Yes	(1)	Ch.1=BB Ch.2=BB Ch.3=DB	Yes	TB	RTGB	No	
Containment Integrity	Containment Isolation Valve Position(9)	RV1-1 RV1-2 RV1-3	3	RG 1.97	Closed - not closed	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0 - 100% open & open-closed	NR	NR	BB	NR	TB	RTGB	NR	

TYPE B

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
	Containment Isolation Valve Position (9) (Continued)	MS-V1-3A MS-V1-3B MS-V1-3C	3	RG 1.97	Closed - not closed	NR	NR	NR	NR	--	On Demand	NR	These valves are MSIV Bypass Valves which have the same label as the MSIVs (i.e., MS-V1-3A, 3B, 3C)
				HBR	Open - closed	NR	NR	Stn.	NR	TB	RTGB	NR	
		MS-V1-8A MS-V1-8B MS-V1-8C	3	RG 1.97	Closed - not closed	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open - closed	NR	NR	DB	NR	TB	RTGB	NR	

TYPE B FOOTNOTES

(1) Information is available that discusses the instrument's generic qualification; however, no specific comparison has been made with the HBR-specific profiles or parameters.

(2) 10^{-11} - 10^{-3} amps roughly corresponds to 0-120% full power.

(3) Normal sampling provides range of 0-22,000 ppm. PASS sampling provides 0-6000 ppm range.

(4) Can be assigned by operator as 1 of 24 pens on multi-channel RMS recorder. Recorder has a battery-backed power supply.

(5) Isolation valves that receive either a Phase A or Phase B isolation signal (with no check valves or manually operated valves) as defined in EI-1, Rev. 35 (Incident Involving RCS Depressurization).

(6) Redundancy is met by redundant containment isolation barriers as discussed in FSAR 6.2-4.

(7) RTGB indication is ganged with similar containment isolation valves.

(8) Located in the pipe alley and currently under review for post-accident operational requirements.

(9) Isolation valves that do not receive a Phase A or Phase B isolation signal.

Variable: Neutron Flux (intermediate range)

Category: B1

Compliance: The existing design does not meet the requirements of RG 1.97 in the area of environmental and seismic qualification.

CP&L Position: As discussed for the source range monitors, CP&L will install new combination source and intermediate range detector systems which are environmentally and seismically qualified.

Variable: Control Rod Position

Category: B3

Compliance: The Rod Position Indication System complies with all requirements of RG 1.97 Type B Category 3.

CP&L Position: No modifications are required.

Variable: RCS Boron Concentration

Category: B3

Compliance: Although no on-line indication is provided, grab samples from normal sampling points are capable of providing operators with current RCS boron concentration upon request. Grab samples via the PASS can also provide the operators with the same information. Boron sample analysis from both the PASS and normal sample points meet the requirements of RG 1.97, Type B, Category 3.

CP&L Position: No modifications are required.

Variable: Reactor Vessel Water Level

Category: B3, D3

Compliance: This variable is used for backup/verification and is considered to be Category 3. The most direct indication of core cooling is provided by the core exit thermocouples which are shown as Category 1. The Reactor Vessel Level Instrumentation system (RVLIS) is being installed by Mod-526 and is designed to comply with the RG 1.97 requirements for Category 3 variables. The system will measure collapsed liquid water level and relative void content. The proposed design will meet the requirements of RG 1.97 Category 3.

CP&L Position: No modifications to the proposed design are required.

Variable: RCS Subcooling Margin

Category: B3

Compliance: This variable is used for backup/verification and is considered to be Category 3. The most direct indication of core cooling is provided by the core exit thermocouples which are shown as Category 1. Also, RCS subcooling margin is a derived variable calculated from T_{Hot}, T_{Cold}, RCS Pressure and core exit temperature, all of which are Category 1 variables. Thus, the ability to calculate subcooling margin is readily available to the operator and this variable serves as verification. The instrumentation presently installed meets all RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Condenser Air Ejector Radiation Level

Category: B3, C3, E3

Compliance: This instrument provides backup indication of breach of the RCPB to the secondary side and meets the RG 1.97 requirements for Category 3 variables. The steam generator blowdown radiation monitor is provided as the key (Category 1) variable as it operates whether or not the condenser is in use. It is also capable of identifying the faulty steam generator in the event of a Steam Generator Tube Rupture.

CP&L Position: No modifications are required.

Variable: Containment Particulate/Noble Gas Radiation Level

Category: B3, C3, E3

Compliance: These radiation monitors indicate the plant vent and containment radiation levels and act as backup indication of a breach of the RCPB to containment. The containment radiation level (hi range) monitors are shown as the key variables, as they provide extended range capability. The existing noble gas monitor does not meet the RG 1.97 range requirements for Category 3 instruments.

CP&L Position: The existing noble gas monitor and indicator will be replaced under the Radiation Monitoring System TAR (84-036). The new noble gas monitor will meet the requirements of RG 1.97 Category 3.

Variable: Containment Area Radiation Level (Low Range)

Category: B3, C3, E3

Compliance: This radiation monitor indicates low range containment area radiation level and is used as a backup to the high range monitors for indication of a breach of the RCPB to containment. The existing instrumentation meets all requirements of RG 1.97 for Category 3 instruments.

CP&L Position: No modifications are required.

Variable: Incore Instrumentation Area Radiation Level

Category: B3, C3, E3

Compliance: The incore instrumentation radiation monitor provides backup indication of a breach of the RCPB to containment and satisfies all RG 1.97 requirements for Category 3 instruments. The containment area radiation level (hi range) monitors provide extended range coverage and are assigned as Category 1.

CP&L Position: No modifications are required.

Variable: Containment Isolation Valve Position (Valves which receive Phase A or B isolation signal)

Category: B1, C1, D2

Compliance: Dedicated recorders are not considered essential for operator action or information. Operator actions are based on current valve position rather than trend information.

The existing containment isolation valve position indications do not meet the requirements of RG 1.97 for Category 1 and Category 2 variables. The deficient areas include: environmental qualification, individual valve position indications, channel independence, redundancy and control room recording capability.

CP&L Position: Limit switches on all isolation valves located inside containment will be replaced with environmentally qualified switches. All other isolation valves are located in either mild environments or the pipe alley.

Harsh environments occur in the pipe alley under two conditions. The first is following a steam generator blowdown line HELB. Mitigation is accomplished by closing blowdown isolation valves FCV-1930A, -1930B, -1931A, -1931B, -1932A, and -1932B. Limit switches for these six valves will be replaced with qualified limit switches.

The second condition is due to high post-accident radiation levels experienced during recirculation mode. Any containment isolation valve whose final position has been attained prior to entering this mode is considered to have operated in a mild environment. Thus, environmental qualification of these valves' limit switches is not required. Limit switches on valves which may be required to change position during recirculation mode will be replaced with qualified limit switches.

Redundant indications for each valve are not considered necessary based on CP&L's position regarding redundant containment isolation barriers as discussed in FSAR Section 6.2.4. For this reason, independent power supplies for the indications for redundant valves are also not considered to be required.

Individual valve position indications will be provided on-demand on the ERFIS for each of the containment isolation valves. The existing individual and ganged valve position indicating lights will remain on the RTGB.

As discussed above, trend information is not considered essential for valve position. However, trend information will be available on-demand using the ERFIS.

Variable: Containment Isolation Valve Position (Valves which do not receive Phase A or B isolation signal)

Category: B3, C3, D3

Compliance: This group of secondary side valves are not Phase A or B containment isolation valves, but become extensions of containment in the event of a Steam Generator Tube Rupture (SGTR). They include: Main Steam PORVs, Main Steam Isolation Bypass Valves, Main Steam Admission Valves and Warmup Steam Valves to the Steam Driven AFW Pump. Position indication of these valves provides backup indication of containment integrity for Steam Generator Tube Rupture events and is included as a Category 3 variable. Steam Generator Pressure would provide primary indication of containment integrity in the event of a SGTR; thus, it is given as the Category 1 variable.

The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

TYPE C

VARIABLES

T[illegible]

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Fuel Cladding Integrity	Core Exit Temperature	T1 thru T51	1	RG 1.97	200-2300°F	Yes	Yes	Standby	Yes	--	Continuous	Yes	Diverse indication provided by the 51 channels - all T/Cs have same power supply.
				HBR	100-700°F	No	No	DB	Yes(3)	CV	On Demand	No	
Fuel Cladding Integrity	RCS Activity & Coolant Analysis		3	RG 1.97	Activity: 1/2-100 X Tech Spec Analysis: 10 μCi/ml-10 Ci/ml or TID-14844 source term in coolant volume	NR	NR	NR	NR	--	On Demand	NR	Provided by PASS or other samples.
				HBR	Activity: 1/2-100 X Tech Spec Analysis:1 μ Ci/ml-10 Ci/ml	NR	NR	NR	NR	AB	None	NR	
Fuel Cladding Integrity	Letdown Radiation Level	R-9	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-100K mr/hr	NR	NR	DB	NR	AB	RTGB	NR	
RCS Integrity	RCS Pressure (WR)	PT-402	1	RG 1.97	0-3000 psig	Yes	Yes	Standby	Yes	--	Continuous	Yes	
				HBR	0-3000 psi	79-01B	(1)	DB	No	CV	RTGB	Yes	
RCS Integrity	Containment Area Radiation (Hi Range)	R-32A	1	RG 1.97	$1-10^4$ R/hr	Yes	Yes	Standby	Yes	--	Continuous	Yes	
		R-32B		HBR	$1-10^7$ R/hr	(1)	(1)	R-32A=DB R-32B=BB	Yes	CV	RTGB	Yes	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RCS Integrity	SG Blowdown Radiation Level	R-19	1	RG 1.97	10^{-6} -10^{-2} μCi/cc	Yes	Yes	Standby	Yes	--	Continuous	Yes	Mild environment
				HBR	4x10^{-5} -3.5 x10^{-2} μCi/cc	Yes	No	BB	No	AB	RTGB	Yes(4)	
RCS Integrity	Containment Water Level	LT-801 LT-802	3	RG 1.97	Plant Specific	NR	NR	NR	NR	--	On Demand	NR	Instrument covers both narrow and wide range.
				HBR	3.5-423.5"	NR	NR	LT-801=BB LT-802=DB	Yes	CV	RTGB	Yes	
RCS Integrity	Containment Pressure	PT-956 PT-957	3	RG 1.97	-5 psig - 3 x design pressure	NR	NR	NR	NR	--	On Demand	NR	Design pressure = 42 psig; 3 x 42 = 126 psig
				HBR	-5-126 psig	NR	NR	PT-956=DB PT-957=DB	Yes	AB	RTGB	Yes	
RCS Integrity	Primary PORV Position	PCV-455C PCV-456	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	BB	NR	CV	RTGB	NR	
RCS Integrity	Primary Safety Valve Position	RC-551A RC-551B RC-551C	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-120%	NR	NR	BB	NR	CV	RTGB	NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RCS Integrity	Component Cooling Radiation Level	R-17	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	1.6×10^{-4} -2.3 $\times 10^{-1}$ μCi/cc	NR	NR	BB	NR	AB	RTGB	Yes(4)	
RCS Integrity	RCDT Pressure	PT-1004	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-40 psig	NR	NR	DB	NR	CV	Local	NR	
RCS Integrity	RCDT Temperature	TT-1058	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	50-250°F	NR	NR	DB	NR	CV	Local	NR	
RCS Integrity	RCP Standpipe Level	LC-406A LC-406B LC-407A LC-407B LC-408A LC-408B	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Channel A: Normal-High Channel B: Normal-Low	NR	NR	DB	NR	CV	RTGB	NR	
RCS Integrity	Condenser Air Ejector Radiation Level	R-15	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	1.3×10^{-5} -10^{-1} μCi/cc	NR	NR	BB	NR	TB	RTGB	Yes(4)	
RCS Integrity	Containment Particulate/ Gas Radiation Level	R-11 R-12	3	RG 1.97	10^{-6}-10^{-2} μCi/cc -noble gas NR-particulate	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	R-11: 3×10^{-10} -3.5×10^{-7} particulate R-12: 6×10^{-6}-10^{-1} noble gas μCi/cc	NR	NR	BB	NR	AB	RTGB	Yes(4)	

TYPE C

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
RCS Integrity	Containment Area Radiation (Lo-Range)	R-2	3	RG 1.97 HBR	NR .1-10^4 mR/hr	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	Yes Yes(4)	High Range Containment Radiation Monitors are R-32A, R-32B.
RCS Integrity	Incore Instrumentation Area Radiation Level	R-7	3	RG 1.97 HBR	NR .1-10^4 mR/hr	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	Yes Yes(4)	
Containment Integrity	Containment Pressure	PT-956 PT-957	1	RG 1.97 HBR	-5 psig-3 x design pressure 0-120 psig	Yes Yes	Yes (1)	Standby PT-956 = DB PT-957 = BB	Yes Yes	-- AB	Continuous RTGB	Yes Yes	Mild environment. Design pressure = 42 psig.
Containment Integrity	Containment Hydrogen Concentration	AET-8100-1 AET-8110-2	1	RG 1.97 HBR	0-10 Vol. % 0-10% H_2	Yes (1)	Yes (1)	Standby 8100-1=BB 8110-1=DB	Yes Yes	-- CV	Continuous RTGB	Yes Yes	
Containment Integrity	Containment Isolation Valve Position (5)	See Table 1 for Type B Variables											

TYPE C

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Containment Integrity	Steam Generator Pressure	PT-474 PT-475 PT-476 PT-484 PT-485 PT-486 PT-494 PT-495 PT-496	1	RG 1.97	NR	Yes	Yes	Standby	Yes	--	Continuous	Yes	Ch.1=PT-474,-484,-494 Ch.2=PT-475,-485,-495 Ch.3=PT-476,-486,-496 Mild environment
				HBR	0-1400 psig	Yes	(1)	Ch.1,2=BB Ch.3=DB	Yes	TB	RTGB	No	
Containment Integrity	Containment Isolation Valve Position(6)	See Table 3 for Type B Variables											
Containment Integrity	Service Water Radiation Level	R-16	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	$2.7x10^{-5}$ $-2.7x10^{-2}$ μCi/cc	NR	NR	BB	NR	AB	RTGB	Yes	
Containment Integrity	Containment Effluent Monitors: Plant Vent Particulate & Radiogas Monitors	R-11 R-12	3	RG 1.97	10^{-6} -10^{-2} μCi/cc -noble gas NR-particulate	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	R-11: $3x10^{-10}$-3.5 $x10^{-7}$ μCi/cc particulate R-12: $6x10^{-6}$ -10^{-1} μCi/cc noble gas	NR	NR	BB	NR	AB	RTGB	Yes(4)	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
	Main Steamline Monitors	R-31A R-31B R-31C	3	RG 1.97 HBR	$10^{-6}-10^{-2}$ µCi/cc $10^{-1}-10^{3}$ µCi/cc	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	Yes Yes	Recorder is on BB power supply.
	Plant Vent Gas, Particulate, Iodine, Monitors	R-14 R-34 R-35 R-36	3	RG 1.97 HBR	$10^{-6}-10^{-2}$ µCi/cc -noble gas NR-particulate R-14 $2x10^{-5}-1x10^{-1}$ R-34 $10^{-7}-10^{-2}$ R-35 $10^{-3}-10^{2}$ R-36 $10^{1}-10^{5}$ µCi/cc noble gas	NR NR	NR NR	NR R-14=BB R-34,-35 -36=DB	NR NR	-- AB	On Demand R-34=Local R-14,-35, -36=RTGB	Yes R-34=No R-14= Yes(4) R-35,-36 =Yes	R-14,-35 =noble gas monitors. R-34,-36 = noble gas, iodine, particulate monitors.
	Fuel Handling Bldg. Upper Level Exhaust Monitor	R-21	3	RG 1.97 HBR	$10^{-6}-10^{-2}$ µCi/cc $2.3x10^{-6}-10^{-1}$ µCi/cc	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	Yes Yes(4)	Sample pump motor is on DB power supply.
Containment Integrity	Effluent Radioactivity: Fuel Handling Bldg. Basement Monitors	R-20 R-30	3	RG 1.97 HBR	$10^{-6}-10^{3}$ µCi/cc R-20:$1.6x10^{-6}$ - 10^{-1} µCi/cc R-30:$10^{-2}-10^{3}$ µCi/cc	NR NR	NR NR	NR BB	NR NR	-- FHB	On Demand RTGB	Yes Yes(4)	Both sample pump motors are on DB power supply

TYPE C FOOTNOTES

(1) Information is available that discusses the instrument's generic qualification; however, no specific comparison has been made with the HBR specific profiles or parameters.

(2) Post Accident Sampling System (PASS) and grab sample analysis capability complies with the required range.

(3) 51 core thermocouples are provided to monitor a representative cross section of the 157 fuel assemblies.

(4) May be assigned by operator as 1 of 24 pens of the Radiation Monitoring System multi-channel recorder. Recorder has a battery-backed power supply.

(5) Isolation valves that receive either a Phase A or Phase B isolation signal (with no check valves or manually operated valves) as defined in EI-1, Rev. 35 (Incident Involving RCS Depressurization).

(6) Isolation valves that do not receive a Phase A or Phase B isolation signal.

Variable: RCS Activity and Coolant Analysis

Category: C3

Compliance: Core exit temperature provides primary indication of a significant breach or potential breach of fuel cladding due to elevated fuel temperatures. The RCS activity and coolant analysis by grab sample provides backup/verification of a breach to the cladding and indicates the extent of the breach. The grab sample analysis is also used following an event to detect fuel damage caused by thermal/seismic shock. This variable along with the letdown radiation level monitor is used for backup indication and is considered Category 3.

The existing design meets the requirements of RG 1.97 for Category 3 variables.

CP&L Position: CP&L has described the detailed design of the HBR PASS in letters to the NRC dated 8/12/83 and 4/20/84 (Serial Nos. LAP-83-379 and NLS-84-077). This design is considered adequate for analyzing RCS samples.

Variable: Letdown Radiation Level

Category: C3

Compliance: The letdown radiation monitor is capable of detecting high radiation levels in the letdown flow and has been included as a Category 3 variable for backup indication of a fuel cladding breach. This monitor will detect rapid or significant rises in the radiation level while the RCS grab sample analysis is able to detect long-term trends of increasing radioactivity levels.

The existing design meets all requirements of RG 1.97 for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Primary PORV Position and Primary Safety Valve Position

Category: C3, D2

Compliance: This variable has been included as a C3 variable to provide additional backup indication of a breach of the RCPB. This indication is only valid for transients involving higher than normal operating pressure. RCS pressure provides the primary indication of a breach of the RCPB. The variable is included as a D2 as it provides primary information regarding the operation of the PORVs and pressurizer safeties which have specific safety functions for the RCS.

The existing instrumentation meets the requirements for Category 3 variables in RG 1.97 but does not meet the Category 2 requirements for environmental qualification. The primary safety valves' position indicating equipment may be shown to be qualified as a result of the testing currently in progress.

CP&L Position: The position indicating equipment for the primary safety valves will be modified or relocated in accordance with the final recommendations from the test report to provide a qualified installation.

CP&L is currently investigating the qualification status of temperature elements downstream of the PORVs. If these indications are acceptable, the temperatures will be used as backup information and the existing PORV indications left as is. If these indications are unacceptable, CP&L will re-evaluate the existing indications versus the RG 1.97 requirements.

Variable: Component Cooling Radiation Level

Category: C3, D3

Compliance: The variable has been included for backup indication of a breach of the RCPB at the interface between primary side components and the CCW heat exchangers or coolers. The existing instrumentation meets the requirements of RG 1.97 for Category 3 instruments.

CP&L Position: No modifications are required.

Variable: RCDT Temperature or Pressure

Category: C3

Compliance: This variable has been included as a backup indication of breach of the RCPB based on increased leakage from sources which drain to the RCDT and are part of the RCPB.

The existing design does not meet RG 1.97 requirements for Category 3 variables due to the lack of on-demand control room indication.

CP&L Position: CP&L will provide on-demand indication on the ERFIS for RCDT temperature and pressure.

Variable: RCP Standpipe Level

Category: C3

Compliance: This variable has been included to provide backup indication of breach of RCPB due to degradation of one or more of the RCP seals. The existing instrumentation satisfies the requirements of RG 1.97 for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Service Water Radiation Level

Category: C3, D3, E2

Compliance: This variable is included as backup indication of a containment breach through the containment fan coolers (Type C) and loss of a containment cooler (Type D). It is included as the primary indication of a liquid radioactive release due to leaking cooler coils (Type E). The existing instrumentation satisfies the RG 1.97 requirements for Category 2 and 3 variables.

CP&L Position: No modifications are required.

Variable: Containment Effluent Radioactivity: Main Steamline Radiation Level

Category: C3, E2

Compliance: The installed instruments provide the required range as a Type E2 variable and accomplish the desired function of monitoring radiation levels resulting from main steamline PORV and safety valve actuations following a SGTR.

As a Type C variable, the main steamline monitors have an upper range that extends significantly beyond that required by RG 1.97. The steam generator blowdown monitor (R-19) is assigned as Type C Category 1 for the RCPB breach safety function and has a range of 4.5×10^{-5} - 3.5×10^{-2} μCi/cc. This range is considered adequate to meet RG 1.97 range requirements. The SG blowdown monitor has not been included for the containment safety function since its primary purpose is for detection of RCPB breach. Thus, the main steamline monitors act as backup indication of a containment breach and are included for the containment safety function even though their range is not used to meet the RG 1.97 range requirements.

For a SGTR, steam generator pressure provides the primary indication of a containment breach and is assigned as Category 1 for the Type C containment integrity safety function. The main steamline radiation level provides only backup/verification indication and is therefore assigned as Category 3.

The existing design meets the requirements of RG 1.97 for Category 2 and 3 variables.

CP&L Position: No modifications are required.

Variable: Containment Effluent Radioactivity: Main Vent Stack Particulate, Iodine, and Radiogas Monitors

Category: C3, E2

Compliance: As Type C variables these monitors provide indication of effluent radioactivity through the plant vent. Since the effluent can originate from a number of sources in the Fuel Handling Building, Auxiliary Building, and Containment, the indication does not necessarily correspond to a breach of containment. For this reason, the variable was concluded to be a backup variable and was assigned as a Category 3.

The variable provides primary indication of airborne radioactive material released from the plant and is therefore shown as Type E Category 2.

The instrumentation provided does not meet the requirements of Category 2 and 3 variables since no RTGB indication or recording is provided for R-34.

CP&L Position: A new radiation monitor will be installed for this variable under the Radiation Monitoring System TAR (84-036). This new monitor will meet the requirements of RG 1.97 Category 2.

Variable: Containment Effluent Radioactivity: Fuel Handling Building Upper Level Exhaust Monitor

Category: C3, D3, E3

Compliance: As a Type C variable, the indication does not distinguish between radiation directly from Fuel Handling Building sources or indirectly from containment penetrations/hatches. Thus, it is considered as backup indication and assigned as a Category 3.

The variable provides backup indication that the FHB upper Level ventilation system is shut down upon a high radiation alarm, and is thus considered a Type D Category 3 variable.

For Type E, this variable is used as backup indication of airborne radioactive plant releases by monitoring the effluent level upstream of the plant vent. Thus, it is considered a Category 3 variable. The existing instrumentation satisfies all requirements, other than the range as discussed above, for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Effluent Radioactivity: Fuel Handling Building Basement Exhaust Radiation Level

Category: C3, D3, E2

Compliance: Noble gas effluent radioactivity as indicated by this variable, could originate either in the Fuel Handling Building or Containment. Thus, due to its indeterminate nature in identifying a containment breach, the variable is assigned as a Category 3 for Type C. As a Type D Category 3 variable, the FHB basement exhaust radiation level provides backup/verification that the FHB basement ventilation system is shut down following a high radiation alarm.

The variable provides primary indication of airborne radioactive materials released from the plant and is assigned as a Type E Category 2 variable. Sampling with onsite analysis capability is provided by R-20 for radioactive particulate determination. Although no flowrate indication is provided for this flowpath, design flow can be assumed when determining the magnitude of any release.

The existing design meets RG 1.97 requirements for Category 2 and 3 variables.

CP&L Position: No modifications are required.

TYPE D

VARIABLES

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
RHR	RHR Flow	FT-605	2	RG 1.97	0-110% design flow	Yes	NR	Reliable	NR	--	On Demand	NR	Design flow = 7500 gpm (1.1 x 7500 = 8250 gpm)
				HBR	0-8500 gpm	Yes	NR	DB	NR	AB	RTGB	NR	
RHR	RHR Hx. Outlet Temperature	TE-606	2	RG 1.97	40-350°F	Yes	NR	Reliable	NR	--	On Demand	NR	Indicated in Control Room only on recorder TR-604 and on plant computer.
				HBR	50-400°F	No	NR	DB	NR	AB	RTGB	Yes	
RHR	RWST Level	LT-948	3	RG 1.97	Top to Bottom	Yes	NR	NR	NR	--	On Demand	NR	Total volume = 353,000 gal. Minimum volume = 300,000 gal. 0% = 3,000 gal, 100% = 344,000 gal.
				HBR	0-100%	(1)	NR	BB	NR	Yard	RTGB	NR	
RHR	Containment Water Level	LT-801 LT-802	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	Instruments span both the sump and the bottom of containment.
				HBR	3.5-423.5"	NR	NR	LT-801=BB LT-802=DB	Yes	CV	RTGB	Yes	
RHR	RHR System Isolation Valve Position	RHR-744A RHR-744B RHR-750 RHR-751	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	DB	NR	CV	RTGB	NR	

Table D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RHR	RWST Isolation Valve Position	SI-862A SI-862B SI-864A SI-864B	3	RG 1.97 HBR	NR Open-Closed	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	
RHR	Containment Sump to RHR Pump Isolation Valve Position	SI-860A SI-860B SI-861A SI-861B	3	RG 1.97 HBR	NR Open-Closed	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	
SI	Accumulator Level	LT-920 LT-922 LT-924 LT-926 LT-928 LT-930	2	RG 1.97 HBR	10-90% Volume 0-100%	Yes (1)	NR NR	Reliable LT-920, -924, -928 = BB LT-922, -926, -930 = DB	NR Yes	-- CV	On Demand RTGB	NR NR	
SI	Accumulator Pressure	PT-921 PT-923 PT-925 PT-927 PT-929 PT-931	2	RG 1.97 HBR	0-750 psig 0-800 psig	Yes (1)	NR NR	Reliable PT-921, -925, -929=BB PT-923, -927, -931=DB	NR Yes	-- CV	On Demand RTGB	NR NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
SI	Safety Injection Flow (Hot & Cold Leg)	FT-940 FT-943	2	RG 1.97	0-110% design flow	Yes	NR	Reliable	NR	--	On Demand	NR	Design flow rate = 750 gpm; 1.1 x 750 = 825 gpm
				HBR	0-1000 gpm	79-01B	NR	FT-940 = BB FT-943 = DB	NR	AB	RTGB	NR	
SI	Safety Injection Pump Dis-charge Header Pressure	PT-940	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
		PT-943		HBR	0-2000 psig	NR	NR	PT-940 = BB PT-943 = DB	NR	AB	RTGB	NR	
SI	ESF Actuated Valve Positions	SI-841A	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	Both valves have ganged indication on RTGB.
		SI-841B		HBR	Open-Closed	NR	NR	BB	Yes	AB	RTGB	NR	
		SI-867A	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
		SI-867B		HBR	Open-Closed	NR	NR	DB	Yes	AB	RTGB	NR	
		SI-870A	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
		SI-870B		HBR	Open-Closed	NR	NR	DB	Yes	AB	RTGB	NR	
		FW-V2-6A	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
		FW-V2-6B FW-V2-6C		HBR	Open-Closed	NR	NR	DB	NR	TB	RTGB	NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
	ESF Actuated Valve Position (Cont.)	IVSW-PCV-1922A IVSW-PCV-1922B	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	BB	Yes	AB	RTGB	NR	
SI	Accumulator Isolation Valve Position	SI-865A SI-865B SI-865C	3	RG 1.97	Open or Closed	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	DB	NR	CV	RTGB	NR	
RCS	RCS Hot Leg Temperature	TE-413 TE-423 TE-433	2	RG 1.97	NR	Yes	NR	Reliable	NR	--	On Demand	NR	All 3 signals are only indicated on recorder TR-413 on RTGB. Recorder is BB.
				HBR	50-650°F	No	NR	DB	Yes	CV	RTGB	Yes	
RCS	RCS Cold Leg Temperature	TE-410 TE-420 TE-430	2	RG 1.97	NR	Yes	NR	Reliable	NR	--	On Demand	NR	All 3 signals are only indicated on RTGB recorder TR-140, DB power.
				HBR	50-650°F	No	NR	DB	Yes	CV	RTGB	Yes	
RCS	Core Exit Temperature	T1 thru T51	2	RG 1.97	NR	Yes	NR	Reliable	NR	--	On Demand	NR	Diverse indication provided by the 51 channels.
				HBR	100-700°F	No	NR	DB	NR	CV	On Demand	NR	
RCS	Pressurizer Pressure (WR)	PT-500 PT-501	2	RG 1.97	NR	Yes	NR	Reliable	NR	--	On Demand	NR	No indication provided by transmitters, only used for protection circuitry.
				HBR	0-3000 psig	79-01B	NR	PT-500=BB PT-501=DB	Yes	CV	None	NR	
RCS	Primary PORV Position	PCV-455C PCV-456	2	RG 1.97	Closed - not Closed	Yes	NR	Reliable	NR	--	On Demand	NR	
				HBR	Open-Closed	No	NR	BB	NR	CV	RTGB	NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
RCS	Primary Safety Valve Position	RC-551A RC-551B RC-551C	2	RG 1.97	Closed - not Closed	Yes	NR	Reliable	NR	--	On Demand	NR	
				HBR	0-120% open	No	NR	BB	NR	CV	RTGB	NR	
RCS	Reactor Vessel Water Level	LT-511AA LT-511AB LT-511AC LT-511BA LT-511BB LT-511BC	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	System is being installed.
				HBR	Bottom to Top of Vessel	NR	NR	BB	Yes	AB	RTGB	Yes	
RCS	RCS Loop Flow	FT-414 FT-415 FT-416 FT-424 FT-425 FT-426 FT-434 FT-435 FT-436	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	FT-414,-424,-434 = Ch.1 FT-415,-425,-435 = Ch.2 FT-416,-426,-436 = Ch.3 Design flow = 88,500 gpm, 1.2 x 88,500 = 106,200 gpm
				HBR	0-120% design flow	NR	NR	Ch.1 = DB Ch.2 = BB Ch.3 = BB	Yes	CV	RTGB	NR	
RCS	Pressurizer Level	LT-459 LT-460 LT-461	3	RG 1.97	Top to Bottom	NR	NR	NR	NR	--	On Demand	NR	1 channel recorded on RTGB recorder LR-459
				HBR	0-100%	NR	NR	LT-459 = DB LT-460, -461 = BB	Yes	CV	RTGB	Yes	

TYPE D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
RCS	Pressurizer Heater Status	Control Group Backup Group A Backup Group B	3	RG 1.97 HBR	Electric Current On-Off	NR NR	NR NR	NR Stn.	NR Yes	-- CV	On Demand RTGB	NR NR	
RCS	PORV Block Valve Position	RC-535 RC-536	3	RG 1.97 HBR	NR Open-Closed	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	NR NR	
RCS	PRT Pressure	PT-472	3	RG 1.97 HBR	0 - design pressure 0-120 psig	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	NR NR	Design pressure = 100 psig.
RCS	PRT Level	LT-470	3	RG 1.97 HBR	Top to Bottom 0-100%	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	NR NR	
RCS	RCS Subcooling Margin	CCM-520 CCM-521	3	RG 1.97 HBR	NR 200°F subcooled to 2250°F super-heat	NR NR	NR NR	NR Ch.1 = BB Ch.2 = DB	NR Yes	-- CV	On Demand RTGB	NR NR	CCM-520 = Ch. 1, CCM-521 = Ch. 2.

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Main Steam/ Feedwater	SG Level (WR)	LT-477 LT-487 LT-497	2	RG 1.97	From tube sheet to separators	Yes	NR	Reliable	NR	--	On Demand	NR	Only RTGB indication is on recorder LR-477 for all 3 channels. Recorder power supply = DB.
				HBR	From tube sheet to separators	79-01B	NR	LT-477 = DB LT-487, -497 = BB	NR	CV	RTGB	Yes	
Main Steam/ Feedwater	SG Pressure	PT-474 PT-475 PT-476 PT-484 PT-485 PT-486 PT-494 PT-495 PT-496	2	RG 1.97	From atm-pressure to 20% above lowest safety valve setting	Yes	NR	Reliable	NR	--	On Demand	NR	PT-474,-484,-494=Ch. 1 PT-475,-485,-495=Ch. 2 PT-476,-486,-496=Ch. 3 Mild environment.
				HBR	0-1400 psig	Yes	NR	Ch.1=BB Ch.2=BB Ch.3=DB	Yes	TB	RTGB	NR	Lowest safety valve setting=1085 psia (1070 psig) 1.2x1070=1284 psig
Main Steam/ Feedwater	Main Steam Flow	FT-474 FT-475 FT-484 FT-485 FT-494 FT-495	2	RG 1.97	NR	Yes	NR	Reliable	NR	--	On Demand	NR	FT-474,-484,-494=Ch. 1 FT-475,-485,-495=Ch. 2 1 channel for each SG is recorded on FR-478 (DB power), -488 (BB power), or-498 (BB power)
				HBR	$0-4x10^6$ pounds/hr	79-01B	NR	Ch.1=BB Ch.2-DB	Yes	CV	RTGB	Yes	
Main Steam/ Feedwater	SG Blowdown Radiation Level	R-19	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	Mild environment.
				HBR	$4x10^{-5}$ $-3.5x10^{-2}$ μCi/cc	NR	NR	BB	NR	AB	RTGB	Yes (3)	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Main Steam/ Feedwater	Main Feedwater Flow	FT-476 FT-477 FT-486 FT-487 FT-496 FT-497	3	RG 1.97	0-110% design flow	NR	NR	NR	NR	--	On Demand	NR	FT-476,-486,-496=Ch. 1 FT-477,-487,-497=Ch. 2 1 channel for each SG is on RTGB recorder FR-478 (DB power), -488 (BB power), or -498 (BB power). Header design flow = 25,400 gpm ($\cong 1.0 \times 10^7$ lb/hr). $1.1 \times 1.0 \times 10^7 \cong 1.2 \times 10^7$ lb/hr. Loop flow requirement assumed to be .33x $1.2 \times 10^7 \cong 4 \times 10^6$ lb/hr.
				HBR	$0\text{-}4 \times 10^6$ lbs/hr	NR	NR	Ch.1=DB Ch.2=BB	Yes	TB	RTGB	Yes	
Main Steam/ Feedwater	Main Feedwater Temperature	TE-3004 TE-3005 TE-3006	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	To Be Determined	NR	NR	NR	NR	TB	On Demand	NR	
Main Steam/ Feedwater	Main Steam PORV Position	RV1-1 RV1-2 RV1-3	3	RG 1.97	Closed-Not Closed	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-100% open & open-closed	NR	NR	BB	NR	TB	RTGB	NR	
Main Steam/ Feedwater	MSIV Position	MS-VI-3A MS-VI-3B MS-VI-3C	3	RG 1.97	Closed-Not Closed	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	BB	NR	TB	RTGB	NR	
Main Steam/ Feedwater	MSIV Bypass Position	MS-VI-3A MS-VI-3B MS-VI-3C	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	MSIV bypass valves are given same ID no. as the MSIVs
				HBR	Open-Closed	NR	NR	Stn	NR	TB	RTGB	NR	

TYPE D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Main Steam/ Feedwater	Steam Admission to AFW Pump Valve Position	MS-VI-8A MS-VI-8B MS-VI-8C	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	DB	NR	TB	RTGB	NR	
Main Steam/ Feedwater	Condenser Vacuum	PT-1310 PT-1311 PT-1312 PT-1313	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-6" Hg vacuum (PT-1310,-1311) 0-30" Hg vacuum (PT-1312,-1313)	NR	NR	DB	Yes	TB	RTGB	NR	
Main Steam/ Feedwater	Feedwater Control Valve Position	FCV-478 FCV-488 FCV-498	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	No position indication of any kind provided. Only the demand signal from the Auto/Man station on the RTGB is indicated.
				HBR	None	NR	NR	BB	NR	TB	None	NR	
Main Steam/ Feedwater	Feedwater Bypass Valve Position	FCV-479 FCV-489 FCV-499	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	No position indication of any kind provided.
				HBR	None	NR	NR	BB	NR	TB	None	NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Main Steam/ Feedwater	Main Steam Header Pressure	PT-464 PT-466 PT-468 PT-1301	3	RG 1.97 HBR	NR 0-1400 psig for PT-464, -466, -468 0-1500 psig for PT-1301	NR NR	NR NR	NR PT-464, -1301=DB PT-466, -468=BB	NR NR	-- TB	On Demand RTGB	NR NR	
Main Steam/ Feedwater	Condenser Dump Valve Position	PRV-1324A1 PRV-1324A2 PRV-1324B1 PRV-1324B2 PRV-1324B3	3	RG 1.97 HBR	NR Open-Closed	NR NR	NR NR	NR BB	NR Yes	-- TB	On Demand RTGB	NR NR	
AFW	AFW Flow	FT-1425A FT-1425B FT-1425C FT-1426A FT-1426B FT-1426C	2	RG 1.97 HBR	0-110% design flow 0-100%	Yes Yes	NR NR	Reliable FT-1425B, -1426C = DB FT-1425A -1425C, -1426A, -1426B = BB	NR NR	-- TB	On Demand RTGB	NR NR	Motor-driven AFW Pumps in non-harsh environment per 5/83 IEB 79-01B response. Design flowrate = 600 gpm, 1.1x600 = 660 gpm. Design range of flowmeters is 0-900 gpm.
AFW	CST Level	LT-1454A LT-1454B	3	RG 1.97 HBR	Plant Specific 0 - 100%	NR NR	NR NR	NR LT-1454A =DB LT-1454B =BB	NR Yes	-- Yard	On Demand RTGB	NR NR	0%=0 gal, 100% = 193,000 gal. Mild environment.

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
AFW	AFW Pump Discharge Header Pressure	PT-1421A PT-1421B	3	RG 1.97 HBR	NR 0 - 2000 psig	NR NR	NR NR	NR PT-1421A =BB PT-1421B =DB	NR NR	-- TB	On Demand RTGB	NR NR	PT-1421A monitors discharge pressure of motor driven AFW Pump A and/or Pump B as it is on cross-tie between the 2 pumps. PT-1421B monitors discharge pressure of steam driven AFW pump.
AFW	AFW Pump Discharge Valve Position	AFW-V2-14A AFW-V2-14B AFW-V2-14C AFW-V2-16A AFW-V2-16B AFW-V2-16C	3	RG 1.97 HBR	NR Open-Closed	NR NR	NR NR	NR DB	NR NR	-- TB	On Demand RTGB	NR NR	
Contain-ment Cooling	Containment Spray Flow	FT-958A FT-958B	2	RG 1.97 HBR	0 - 110% of design 0 - 1500 gpm	Yes No	NR NR	Reliable FT-958A =DB FT-958B =BB	NR NR	-- AB	On Demand RTGB	NR NR	110% of design flowrate = 1277 gpm for each train.

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Contain-ment Cooling	Containment Coolers Service Water Low Flow	DPS-1698A DPS-1698B DPS-1698C DPS-1698D	2	RG 1.97 HBR	Plant-Specific 0 - 1200 gpm	Yes No	NR NR	Reliable TBD	NR NR	-- AB	On Demand RTGB	NR NR	Low flow alarms provided for each on RTGB annunciator.
Contain-ment Cooling	Containment Coolers Fan Motor Status	FAN HVH-1 FAN HVH-2 FAN HVH-3 FAN HVH-4	2	RG 1.97 HBR	Plant-Specific On-Off	Yes (4)	NR NR	Reliable BB	NR NR	-- CV	On Demand RTGB	NR NR	
Contain-ment Cooling	Containment Spray Addition Tank Level	LT-949	2	RG 1.97 HBR	NR 0 - 100%	Yes Yes	NR NR	Reliable BB	NR NR	-- AB	On Demand RTGB	NR NR	Mild environment.
Contain-ment Cooling	Service Water From Containment Coolers Rad Level	R-16	3	RG 1.97 HBR	NR 2.7×10^{-5} - 2.7×10^{-2} µCi/cc	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	Yes Yes(3)	
Contain-ment Cooling	Containment Spray Pump Status	CS Pump A Motor CS Pump B Motor	3	RG 1.97 HBR	NR On - Off	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Containment Cooling	Containment Spray Addition Tank Isolation Valve Position	SI-845A SI-845B SI-845C	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	DB	NR	AB	RTGB	NR	
Containment Cooling	Containment Spray Pump Discharge Isolation Valve Position	SI-880A SI-880B SI-880C SI-880D	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	Open-Closed	NR	NR	DB	NR	AB	RTGB	NR	
Containment Cooling	Containment Atmosphere Temperature and Pressure	TC-1A TC-2A TC-3A TC-4A TC-5A	3	RG 1.97	40-400°F	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-300°F	NR	NR	TBD	NR	CV	RTGB	NR	
		PT-956 PT-957	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	NR	
				HBR	0-120 psig	NR	NR	PT-956=DB PT-957=BB	NR	AB	RTGB	Yes	
CVCS	Charging Flow	FT-122	2	RG 1.97	0-110% design flow	Yes	NR	Reliable	NR	--	On Demand	NR	Pump design flow = 77 gpm.
				HBR	0-150 GPM	No	NR	BB	NR	AB	RTGB	NR	1.1x77 = 85 gpm.
CVCS	Letdown Flow	FT-150	2	RG 1.97	0-110% design flow	Yes	NR	Reliable	NR	--	On Demand	NR	Letdown design flow equals charging
				HBR	0-150 GPM	Yes	NR	DB	NR	AB	RTGB	NR	design flow.

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
CVCS	RCP Seal Return Flow	FT-154A FT-155A FT-156A FT-154B FT-155B FT-156B	2	RG 1.97 HBR	NR Ch. A = 0-6 GPM Ch. B = 0-1.5 GPM	Yes Yes	NR NR	Reliable FT-154A, FT-154B =DB FT-155A, FT-156A, FT-155B, FT-156B =BB	NR NR	-- CV	On Demand RTGB	NR Yes	2 RTGB recorders (1 for Ch. A, 1 for Ch. B). This is only RTGB indication for Ch. A.
CVCS	Boric Acid Tank Flow to Charging Pump Suction	FT-110	2	RG 1.97 HBR	0-110% design flow 0-150 GPM	Yes Yes	NR NR	Reliable BB	NR NR	-- AB	On Demand RTGB	NR NR	120 gpm=design flow (1.1X120 = 132 gpm)
CVCS	VCT Level	LT-112 LT-115	2	RG 1.97 HBR	Top to Bottom 0-60 " H_2O	Yes Yes	NR NR	Reliable LT-112=DB LT-115=BB	NR NR	-- AB	On Demand RTGB	NR NR	
CVCS	VCT Pressure	PT-117	3	RG 1.97 HBR	NR 0-100 psi	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	NR NR	
CVCS	Charging Pump Status	Chg Pump A Motor Chg Pump B Motor Chg Pump C Motor	3	RG 1.97 HBR	NR On-Off	NR NR	NR NR	NR Pump A= Stn Pump B,C =BB	NR NR	-- AB	On Demand RTGB	NR NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
CVCS	Boric Acid Transfer Pump Status	BATP A motor BATP B motor	3	RG 1.97 HBR	NR On-Off	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	
Component Cooling Water	Component Cooling Water Header Flow	FT-613	2	RG 1.97 HBR	0 - 110% max design flow 5500-22,000 GPM	Yes Yes	NR NR	Reliable DB	NR NR	-- AB	On Demand RTGB	NR NR	Design Flow = 18,000 GPM (1.1 x 18,000 = 19,800)
Component Cooling Water	Component Cooling Water Surge Tank Level	LT-614	2	RG 1.97 HBR	NR 0 - 100%	Yes Yes	NR NR	Reliable DB	NR NR	-- AB	On Demand RTGB	NR NR	Capacity = 2000 gal. Normal volume = 1000 gal. 0% = 130 gal 100% = 2040 gal.
Component Cooling Water	Component Cooling Water Pump Status	CCW Pump A Motor CCW Pump B Motor CCW Pump C Motor	3	RG 1.97 HBR	NR On-Off	NR NR	NR NR	NR Pump A= Stn Pump B,C =BB	NR NR	-- AB	On Demand RTGB	NR NR	
Component Cooling Water	Component Cooling Water Radiation Level	R-17	3	RG 1.97 HBR	NR 1.6×10^{-4} - 2.3×10^{-1} μCi/cc	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	Yes Yes(3)	

TYPE D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Component Cooling Water	Component Cooling Water Temperature to ESF System	TE-610 TE-607	3	RG 1.97 HBR	40-200°F 50-200°F	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	
Component Cooling Water	Component Cooling Water to RHR Pumps Low Flow Indication	FIC-637 FIC-638	3	RG 1.97 HBR	NR 0 - 15 GPM	NR NR	NR NR	NR FIC-637 =DB FIC-638 =BB	NR NR	-- AB	On Demand RTGB	NR NR	RTGB Annunciator provided.
Component Cooling Water	Component Cooling Water to SI Pumps Low Flow Indication	FIC-658	3	RG 1.97 HBR	NR 7.5 - 75 GPM	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	RTGB Annunciator provided.
Component Cooling Water	Component Cooling Water to CS Pumps Low Flow Indication	FIC-657	3	RG 1.97 HBR	NR 4 - 40 GPM	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	NR NR	RTGB Annunciator provided.
Radwaste	Liquid Holdup Tank Level	LT-1001	3	RG 1.97 HBR	Top to Bottom 0 - 100%	NR NR	NR NR	NR IA	NR NR	-- AB	On Demand Local	NR NR	Capacity = 24,250 gal. 0% = 0 gal. 100% = 22,900 gal.

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Radwaste	Gas Decay Tank Pressure	PT-1036 PT-1037 PT-1038 PT-1039	3	RG 1.97	0 - 150% design pressure	NR	NR	NR	NR	--	On Demand	NR	Design Pressure = 150 psig.
				HBR	0 - 150 psig	NR	NR	IA	NR	FHB	Local	NR	
Ventilation	Emergency Ventilation Damper Position	HVH-1 (Normal Intake Damper)	2	RG 1.97	Open-Closed Status	Yes	NR	Reliable	NR	--	On Demand	NR	RTGB annunciator for HVH-1, 2, 3, 4 air flow lost.
				HBR	Open-Closed	No	NR	BB	NR	CV	None	NR	
		HVH-1 (Emerg. Intake Damper)											
		HVH-2 (Normal Intake Damper)											
		HVH-2 (Emerg. Intake Damper)											
		HVH-3 (Normal Intake Damper)											

TYPE D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Ventilation	Emergency Ventilation Damper Position (Cont.)	HVH-3 (Emerg. Intake Damper)											
		HVH-4 (Normal Intake Damper)											
		HVH-4 (Emerg. Intake Damper)											
		Control Room HVA-1 Damper	2	RG 1.97	Open-Closed Status	Yes	NR	Reliable	NR	--	On Demand	NR	Mild environment.
				HBR	Open-Closed	Yes	NR	DB	NR	CV	(5)	NR	
		Control Room HVE-19 Intake Damper											
		Control Room HVE-19 Exhaust Damper											

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Ventilation	Emergency Ventilation Damper Position (Cont.)	Control Room Vent Intake - Outside Damper Control Room Vent Exhaust To Outside Damper											
Ventilation	Control Room Ventilation Cooler Status	ACC-1A ACC-1B	2	RG 1.97 HBR	NR On-Off	Yes Yes	NR NR	Reliable DB	NR NR	--- Yard	On Demand None	NR NR	
Ventilation	Control Room Ventilation Fan Motor Status	HVE-16 HVE-19 HVA-1	2	RG 1.97 HBR	NR On-Off	Yes Yes	NR NR	Reliable DB	NR NR	-- AB	On Demand None	NR NR	
Ventilation	Control Room Ventilation Radiation Level	R-1	3	RG 1.97 HBR	NR .1 - 10K mr/hr	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	Yes (3)	

TYPE D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Ventilation	Fuel Handling Building Exhaust Radiation Level	R-20 R-21 R-30	3	RG 1.97 HBR	NR R-20=$1.6x10^{-6}$ - $1x10^{-1}$ μCi/cc R-21=$2.3x10^{-6}$ - $1x10^{-1}$ μCi/cc R-30=10^{-2} -10^{3} μCi/cc	NR NR	NR NR	NR BB	NR NR	-- R-20, -30 = FHB R-21 = AB	On Demand RTGB	Yes (3)	Sample pumps for R-20, R-21 and R-30 are all on a DB power source.
Power Supply	Bus E1 and E2 Voltage and Current	E1 Voltage E2 Voltage E1 Current E2 Current	2	RG 1.97 HBR	Plant-Specific E1/E2 Voltage = 480 VAC E1/E2 Current = 0-5000 Amps	Yes Yes	NR NR	Reliable (6)	NR NR	-- AB	On Demand (2)	NR NR	Mild environment.
Power Supply	D.C. MCC A&B Voltage and Current	MCC A Voltage MCC B Voltage MCC A Current MCC B Current	2	RG 1.97 HBR	Plant-Specific MCC A/B Voltage = 0 - 150 VDC MCC A Current = 150-1000 Amps MCC B Current = 150-500 Amps	Yes Yes	NR NR	Reliable (6)	NR NR	-- AB	On Demand Local	NR NR	Mild environment.
Power Supply	Instrument Air Header Pressure	PT-1702	2	RG 1.97 HBR	Plant-Specific 0 - 200 psi	Yes Yes	NR NR	Reliable DB	NR NR	--- AB	On Demand RTGB	NR NR	Mild environment.

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Power Supply	Diesel Generator Breaker Position	DG A Breaker 52/17B DG B Breaker 52/27B	3	RG 1.97 HBR	NR Open-Closed	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	NR NR	
Power Supply	Bus E1-E2 Tie Breaker Position	Bus E1-E2 Tie Breakers 52/22B & 52/29B	3	RG 1.97 HBR	NR Trip-Closed	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	NR NR	
Power Supply	Diesel Generator Voltage	DG A Voltmeter DG B Voltmeter	3	RG 1.97 HBR	Plant-Specific 0 - 600 VAC	NR NR	NR NR	NR (6)	NR NR	-- AB	On Demand Local	NR NR	
Service Water	Service Water Header Pressure	PT-1616 PT-1684	2	RG 1.97 HBR	NR 0 - 100 psi	Yes Yes	NR NR	Reliable DB	NR NR	-- AB	On Demand RTGB	NR NR	Mild environment.
Service Water	Service Water Pump Status	SW Pump A Status SW Pump B Status SW Pump C Status SW Pump D Status	3	RG 1.97 HBR	NR On-Off	NR NR	NR NR	NR BB	NR NR	--- Yard	On Demand RTGB	NR NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Service Water	Service Water Booster Pump Status	SW Booster Pump A Status SW Booster Pump B Status	3	RG 1.97 HBR	NR On-Off	NR NR	NR NR	NR DB	NR NR	-- AB	On Demand RTGB	NR NR	
Containment Isolation	Containment Isolation Valve Position (7)	See Table for Type B Variables	2										
Containment Isolation	Containment Hydrogen Concentration	AET-8100-1 AET-8110-2	2	RG 1.97 HBR	NR 0-10% H_2	Yes (1)	NR NR	NR AET-8100 -1 = BB AET-8110 -2 = DB	NR Yes	-- CV	On Demand RTGB	NR Yes	
Containment Isolation	Isolation Valve Seal Water Tank Pressure	PT-1911	3	RG 1.97 HBR	NR 0 - 150 psi	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	NR NR	

TYPE D

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Containment Isolation	Isolation Valve Seal Water Tank Level	LT-1912	3	RG 1.97 HBR	NR 0 - 100%	NR NR	NR NR	NR DB	NR NR	--- AB	On Demand RTGB	NR NR	
Containment Isolation	Containment Penetration Pressurization System Tank Pressure	PT-1708A PT-1708B PT-1708C PT-1708D	3	RG 1.97 HBR	NR 0 - 100 psi	NR NR	NR NR	NR PT-1708A, D = BB PT-1708B, C = DB	NR NR	--- PT-1708A = TB PT-1708B C, D = AB	On Demand RTGB	NR NR	

TYPE D FOOTNOTES

(1) Information is available that discusses the instrument's generic qualification; however, no specific comparison has been made with the HBR-specific profiles or parameters.

(2) Instruments are active only when buses are being fed by the diesels.

(3) Can be assigned by operator as 1 of 24 pens on multi-channel RMS recorder. Recorder is on a battery-backed power supply.

(4) CP&L response to IE Bulletin 79-01B dated 5/83, states that the containment cooler fan motors are environmentally qualified. Status indication for the motors is assumed to come from the MCCs which is a mild environment.

(5) A single set of lights indicates in the Control Room the demand signals for the following Control Room ventilation damper positions and fan motors: Fan HVE-16, Fan HVE-19, Control Room HVA-1 Damper, Control Room HVE-19 Intake Damper, Control Room Vent Intake from Outside Damper. The positions of each of these components is inferred from the "Normal" or "Emergency" mode of ventilation which is indicated on the set of lights.

(6) No separate power supply, indicates directly from voltage or current supplied.

(7) Isolation valves that receive either a Phase A or Phase B isolation signal (with no check valves or manually operated valves) as defined in EI-1, Rev. 35 (Incident Involving RCS Depressurization).

Variable: Residual Heat Removal (RHR) Flow

Category: D2

Compliance: The existing design meets the requirements of RG 1.97 for a Category 2 variable.

CP&L Position: No modifications are required.

Variable: Residual Heat Removal (RHR) Heat Exchanger Outlet Temperature

Category: D2

Compliance: The existing instrumentation does not meet the requirements of RG 1.97 for range or environmental qualification.

CP&L Position: The existing RTD will be replaced with an environmentally qualified RTD. The existing control room indicator will remain based on its slight deviation from the RG 1.97 requirements and the low probability of the RHR Heat Exchanger Outlet temperature ever dropping below 50°F.

Variable: Residual Heat Removal (RHR) System Isolation Valve Position

Category: D3

Compliance: Present design meets RG 1.97 Category 3 requirements.

CP&L Position: No modifications are required.

Variable: Refueling Water Storage Tank (RWST) Isolation Valve Position

Category: D3

Compliance: Present design meets RG 1.97 Category 3 requirements.

CP&L Position: No modifications are required.

Variable: Containment Sump to RHR Pump Isolation Valve Position

Category: D3

Compliance: Present design meets RG 1.97 Category 3 requirements.

CP&L Position: No modifications are required.

Variable: Accumulator Level

Category: D2

Compliance: The existing instrumentation does not meet RG 1.97 requirements for Category 2 variables for environmental qualification and range. Environmental qualification may be considered to be adequate following the comparison of the transmitters environmental qualification data to HBR specific profiles.

CP&L Position: CP&L considers the existing range of the channels to be adequate to meet Tech. Spec. and operational requirements and provide the operators with sufficient information to determine when the accumulators require isolation or filling.

Evaluation of the environmental qualification of these transmitters is presently under way. If found to be unacceptable, these transmitters will be replaced with environmentally qualified transmitters.

Variable: Accumulator Pressure

Category: D2

Compliance: The existing design does not meet RG 1.97 Category 2 requirements for environmental qualification. Environmental qualification may be determined to be adequate following comparison of the new transmitters' test results with HBR profiles.

CP&L Position: Evaluation of the environmental qualification of the new transmitters is presently under way. If found to be unacceptable, these transmitters will be replaced with environmentally qualified transmitters.

Variable: Safety Injection Flow (Hot and Cold Leg)

Category: D2

Compliance: The existing design meets the requirements of RG 1.97 for Category 2 variables.

CP&L Position: No modifications are required.

Variable: Safety Injection (SI) Pump Discharge Header Pressure

Category: D3

Compliance: The existing design meets all requirements of RG 1.97 for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Engineered Safety Features (ESF) Actuated Valve Position

Category: D3

Compliance: ESF actuated valve position indication meets all requirements for a RG 1.97 Category 3 variable except that SI-841A and SI-841B have ganged indication.

CP&L Position: Existing RTGB indication will remain as is. For valves SI-841A and SI-841B, individual valve position indication will be provided on ERFIS.

Variable: Accumulator Isolation Valve Position

Category: D3

Compliance: For the Type D variables, accumulator isolation valve position is given as a backup variable. Accumulator tank level and pressure provide the most direct indication of the accumulator status and are given as Category 2 variables. Since the accumulator isolation valve position clearly provides backup information to the accumulator tank and level indication, it is classified as a Category 3 variable. The existing design meets the RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Pressurizer Pressure (WR)

Category: D2

Compliance: The existing design does not meet RG 1.97 requirements for Category 2 variables due to the lack of control room indication.

CP&L Position: A new RTGB indicator will be installed and one of the qualified pressurizer pressure transmitters will be modified to provide a signal to this new indicator. This modification is also required to provide redundant indication for the RCS pressure variable (Type A1).

Variable: Reactor Coolant System (RCS) Loop Flow

Category: D3

Compliance: RCS loop flow is given as a backup variable instead of the RG 1.97 recommended reactor coolant pump status (motor current). Reactor coolant pump status only provides an indication of whether the pumps are being powered or not. The RCS loop flow indicates whether each individual pump is providing flow, which is considered a more definitive indication than whether they are being powered. The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Pressurizer Heater Status

Category: D3

Compliance: For the Type D variables, pressurizer heater status is given as a backup variable. Pressurizer pressure provides primary indication of the pressurizer status while pressurizer level and pressurizer heater status act as backup indication to pressurizer pressure. Thus, as backup variables, pressurizer level and pressurizer heater status are assigned as Category 3 variables.

The on-off indication of the pressurizer heater banks at HBR does not meet RG 1.97 range requirements. All other conditions meet RG 1.97 recommendations for a Category 3 variable.

CP&L Position: CP&L considers the present on-off indication to be a reliable indication of determining whether or not the pressurizer heaters are operating.

Variable: Pressurizer PORV Block Valve Position

Category: D3

Compliance: The pressurizer PORV block valve position meets the requirements for RG 1.97 Category 3 variables.

CP&L Position: No modifications are required.

Variable: Pressurizer Relief Tank (PRT) Pressure

Category: D3

Compliance: RG 1.97 recommends monitoring PRT temperature, PRT pressure, and PRT level. However, PRT level and PRT pressure are the only H. B. Robinson indications needed to act as backup to the pressurizer PORV and pressurizer safety valve position which are given as primary variables (i.e., Category 2).

PRT pressure meets all the requirements of a Type D Category 3 variable.

CP&L Position: No modifications are required.

Variable: Pressurizer Relief Tank (PRT) Level

Category: D3

Compliance: RG 1.97 recommends monitoring PRT temperature, PRT pressure, and PRT level. However PRT level and PRT pressure are the only H. B. Robinson indications needed to act as backup to the pressurizer PORV and pressurizer safety valve position which are given as primary variables (i.e., Category 2).

PRT level does not fully meet the range requirements of a Type D Category 3 variable.

CP&L Position: CP&L considers the existing range to be adequate to monitor the operational range of the PRT. Also, this variable together with the PRT pressure variable provide more than adequate backup indication of the pressurizer PORV and pressurizer safety valve positions.

The existing scale on the RTGB indicator (0-100%) will be replaced to denote actual range (i.e., inches of water) or the EOPs will be modified to note the actual volume indicated by the existing 0-100% scale.

Variable: Steam Generator Level (WR)

Category: D2

Compliance: SG level (WR) is identified as a key variable and is therefore classified as Category 2. This is consistent with the RG 1.97 general policy of categorizing key variables for Type D as Category 2. SG level (NR) was also identified previously as a Type A Category 1 variable. The existing design of this variable meets the requirements of RG 1.97 Type D Category 2.

CP&L Position: No modifications are required.

Variable: Main Steam (MS) Flow

Category: D2

Compliance: MS flow or MS safety/relief valve position is recommended by RG 1.97 as a Type D Category 2 variable. No range is recommended by RG 1.97 for MS flow. MS PORV position is identified for HBR as a Category 3 variable providing backup indication to MS flow and SG pressure, which are included as key variables (i.e., Category 2).

The existing design of the variable meets all RG 1.97 Type D Category 2 requirements.

CP&L Position: No modifications are required.

Variable: Main Feedwater Flow

Category: D3

Compliance: The existing design meets all requirements of RG 1.97 for a Type D Category 3 variable.

CP&L Position: No modifications are required.

Variable: Main Feedwater Temperature

Category: D3

Compliance: The existing design meets the requirements of a RG 1.97 Type D Category 3 variable.

CP&L Position: No modifications are required.

Variable: Condenser Vacuum

Category: D3

Compliance: The variable meets all requirements of RG 1.97 Type D Category 3.

CP&L Position: No modifications are required.

Variable: Feedwater Control and Bypass Valve Position

Category: D3

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Type D Category 3 as a result of inadequate RTGB indication.

CP&L Position: CP&L considers the existing demand signal indicated on the RTGB to be adequate to provide the operators with backup indication of steam generator level and pressure indications. Main feedwater flow is also provided as a backup variable and could be used by the operators to clarify any question on actual feedwater control and bypass valve position versus the demand signal for these valves.

Variable: Main Steam (MS) Header Pressure

Category: D3

Compliance: The variable meets all the requirements of RG 1.97 Type D Category 3.

CP&L Position: No modifications are required.

Variable: Condenser Dump Valve Position

Category: D3

Compliance: The variable meets all requirements of RG 1.97 Type D Category 3.

CP&L Position: No modifications are required.

Variable: Auxiliary Feedwater (AFW) Flow

Category: D2

Compliance: The existing design of this variable meets the requirements of RG 1.97 Type D Category 2.

CP&L Position: No modifications are required.

Variable: Auxiliary Feedwater (AFW) Pump Discharge Header Pressure

Category: D3

Compliance: This variable meets the requirements for RG 1.97 Type D Category 3.

CP&L Position: No modifications are required.

Variable: Auxiliary Feedwater (AFW) Pump Discharge Valve Position

Category: D3

Compliance: This variable meets all requirements of RG 1.97 Type D Category 3.

CP&L Position: No modifications are required.

Variable: Containment Spray Flow

Category: D2

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Type D Category 2 in the area of environmental qualification.

CP&L Position: The existing transmitters will be replaced with environmentally qualified transmitters.

Variable: Containment Coolers Service Water Low Flow Indication

Category: D2

Compliance: CP&L provides two key variables (i.e. Category 2) to indicate the heat removal by the containment coolers: 1) containment coolers service water low flow indication and 2) containment coolers fan motor status. In addition, containment atmosphere temperature, containment pressure, and service water from containment coolers radiation level are provided as backup variables (i.e. Category 3). These variables are considered adequate to provide indication of the proper operation of the containment recirculation cooling system.

Containment coolers service water low flow indication does not meet the requirements of a RG 1.97 Category 2 variable due to unacceptable environmental qualification.

CP&L Position: The existing flowmeters will be replaced with environmentally qualified transmitters.

Variable: Containment Coolers Fan Motor Status

Category: D2

Compliance: CP&L provides two key variables (i.e. Category 2) to indicate the heat removal by the containment coolers: 1) containment coolers service water low flow indication and 2) containment coolers fan motor status. In addition, containment atmosphere temperature, containment pressure, and service water from containment coolers radiation level are provided as backup variables (i.e. Category 3). These variables are considered adequate to provide indication of the proper operation of the containment recirculation cooling system.

Containment coolers fan motor status indication meets the requirements of a RG 1.97 Category 2 variable.

CP&L Position: No modifications are required.

Variable: Containment Spray Pump Status

Category: D3

Compliance: This variable meets the requirements of RG 1.97 Category 3.

CP&L Position: No modifications are required.

Variable: Containment Spray Addition Tank Isolation Valve Position

Category: D3

Compliance: This variable meets the requirements of RG 1.97 Type D, Category 3.

CP&L Position: No modifications are required.

Variable: Containment Spray (CS) Pump Discharge Isolation Valve Position

Category: D3

Compliance: Present design meets RG 1.97 Category 3 requirements.

CP&L Position: No modifications are required.

Variable: Containment Atmosphere Temperature and Pressure

Category: D3

Compliance: Containment atmosphere temperature and pressure are included as backup indication of the operation of the containment spray and containment recirculation cooling systems. The variables do not indicate operation of either of these individual containment cooling systems, but rather, the combined effect of both of the containment cooling systems. Containment spray flow and containment spray addition tank level provide primary indication of the operation of the containment spray system while containment coolers service water low flow indication and containment coolers fan motor status provide primary indication of the containment recirculation cooling system. Thus, as backup variables, containment atmosphere temperature and containment pressure are assigned as Category 3.

The containment atmosphere temperature does not meet the range requirements of a RG 1.97 Type D Category 3 variable. Containment pressure is acceptable as a RG 1.97 Type D Category 3 variable.

CP&L Position: CP&L considers the existing range of 0-300°F to be adequate as it exceeds the maximum containment design temperature of 264.7°F.

Variable: Charging Flow

Category: D2

Compliance: The variable does not meet the requirements of RG 1.97 Type D Category 2 in the area of environmental qualification.

CP&L Position: The existing transmitter will be replaced with an environmentally qualified transmitter.

Variable: Letdown Flow

Category: D2

Compliance: The variable meets the requirements of RG 1.97 for Type D Category 2 variables.

CP&L Position: No modifications are required.

Variable: Reactor Coolant Pump (RCP) Seal Return Flow

Category: D2

Compliance: The variable meets the requirements of a RG 1.97 Type D Category 2 variable.

CP&L Position: No modifications are required.

Variable: Boric Acid Tank Flow to Charging Pump Suction

Category: D2

Compliance: The existing instrumentation meets all RG 1.97 Type D2 requirements.

CP&L Position: No modifications are required.

Variable: Volume Control Tank (VCT) Level

Category: D2

Compliance: The variable does not meet the requirements of RG 1.97 Type D Category 2 due to insufficient range.

CP&L Position: The existing range covers 19-82% of the entire VCT volume which encompasses the range of interest to the operators upon which any operational decisions or actions must be based. Therefore, the existing instrumentation is considered to be adequate.

Variable: Volume Control Tank (VCT) Pressure

Category: D3

Compliance: The present design is acceptable to meet RG 1.97 requirements for Type D3 variables.

CP&L Position: No modifications are required.

Variable: Charging Pump Status

Category: D3

Compliance: The present design is acceptable to meet RG 1.97 requirements for Type D3 variables.

CP&L Position: No modifications are required.

Variable: Boric Acid Transfer Pump Status

Category: D3

Compliance: The present design meets RG 1.97 Category 3 requirements.

CP&L Position: No modifications are required.

Variable: Component Cooling Water Header Flow

Category: D2

Compliance: Component cooling water header flow and surge tank level are provided as key variables to assure the operator that adequate flow is being provided and that adequate surge flow and suction head for the CCW pumps is available. CCW pump status, CCW radiation level, and CCW low flow indication on lines to the RHR, SI and CS pumps are provided as backup indications of adequate component cooling.

The existing design does not meet RG 1.97 Category 2 requirements for range.

CP&L Position: CCW flow below the 5500 gpm low range indication can be assumed by the operators to be effectively 0 and is considered adequate by CP&L. Therefore, no modifications are required.

Variable: Component Cooling Water (CCW) Surge Tank Level

Category: D2

Compliance: The existing design meets all RG 1.97 Type D Category 2 requirements.

CP&L Position: No modifications are required.

Variable: Component Cooling Water Pump Status

Category: D3

Compliance: The present design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Component Cooling Water (CCW) Temperature to ESF System

Category: D3

Compliance: The existing design does not fully meet the range requirements of RG 1.97 but does comply with all other requirements for Category 3 variables.

CP&L Position: CP&L considers the existing instrumentation range to be adequate based on the slight deviation from the RG 1.97 requirement. Therefore, no modifications are considered necessary.

Variable: CCW to RHR Pumps Low Flow Indication

Category: D3

Compliance: The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: CCW to SI Pumps Low Flow Indication

Category: D3

Compliance: Existing design meets RG 1.97 requirements for Type D3 variables.

CP&L Position: No modifications are required.

Variable: CCW to CS Pumps Low Flow Indication

Category: D3

Compliance: The present design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Liquid Holdup Tank Level

Category: D3

Compliance: This variable does not meet the requirements of RG 1.97 Type D Category 3 due to the absence of any Control Room indication and insufficient range.

CP&L Position: On-demand indication will be provided on ERFIS using input from the new electronic transmitter which will be installed. CP&L considers the existing range (~94% of total tank volume) as adequate to provide the operator with enough information to take any actions necessary for accident and post-accident conditions.

Variable: Gas Decay Tank Pressure

Category: D3

Compliance: The existing design does not meet the requirements of RG 1.97 Type D Category 3 due to the instrument's inadequate range and no Control Room indication.

CP&L Position: The existing transmitters will be replaced with four electronic transmitters having the range required by RG 1.97. Signals from these electronic transmitters will be routed to ERFIS to provide on-demand indication.

Variable: Emergency Ventilation Damper Position

Category: D2

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Type D Category 2 due to a lack of position indication in the control room for all the dampers.

CP&L Position: CP&L considers the existing low air flow indicators to the four HVAC units in combination with the four motor status indications to each unit as adequate to infer damper position. In addition, the dampers (normal and emergency) are designed to be fail-safe and the solenoids which operate the dampers are environmentally qualified.

For the control room dampers, the existing indication on the RTGB will remain and individual damper positions will be indicated on ERFIS.

Variable: Control Room Ventilation Cooler Status

Category: D2

Compliance: The existing design of the variable does not meet the requirements of RG 1.97 Type D Category 2 due to a lack of Control Room indication.

CP&L Position: CP&L considers the existing room thermometer on the control room thermostat as adequate to indicate control room temperature and infer proper operation of the control room ventilation coolers.

Variable: Control Room Ventilation Fan Motor Status

Category: D2

Compliance: The existing design of this variable does not meet the requirements of RG 1.97 Type D Category 2 due to inadequate Control Room indication.

CP&L Position: CP&L considers the start-stop and recirculation mode switches which control HVA-1, HVE-19, and HVE-16 and which are located on the RTGB as adequate to infer fan status.

Variable: Control Room Ventilation Radiation Level

Category: D3

Compliance: The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Emergency Buses E1 and E2 Voltage and Current

Category: D2

Compliance: Existing design of this variable does not meet the requirements of RG 1.97 Type D Category 2 due to incomplete RTGB indication.

CP&L Position: CP&L considers existing indication as adequate to determine when emergency A.C. buses are being fed from the diesel generators. If the emergency bus voltage and current were normally monitored, no operator actions would be physically possible in the event low voltage or overcurrent conditions occurred. Undervoltage and other automatic protection features would automatically connect the diesels to the emergency buses. Thus, no modifications are considered necessary.

Variable: DC Bus Voltage and Current (MCC A & B)

Category: D2

Compliance: The existing design does not meet RG 1.97 requirements for Category 2 variables as there is no control room indication.

CP&L Position: On-demand indication on ERFIS will be provided for D.C. Bus Voltage and Current (MCCs A & B).

Variable: Instrument Air Header Pressure

Category: D2

Compliance: The existing design meets RG 1.97 requirements for Category 2 variables.

CP&L Position: No modifications are required.

Variable: Diesel Generator Breaker Position

Category: D3

Compliance: The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Bus E1-E2 Tie Breaker Position

Category: D3

Compliance: Present design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Diesel Generator Voltage

Category: D3

Compliance: The existing design does not meet RG 1.97 requirements as no Control Room indication is provided.

CP&L Position: Existing E1/E2 Bus Voltage indications in the Control Room will be relabeled to indicate they are diesel generator voltage indications.

Variable: Service Water Header Pressure

Category: D2

Compliance: The existing design meets RG 1.97 requirements for Category 2 variables.

CP&L Position: No modifications are required.

Variable: Service Water Pump Status

Category: D3

Compliance: The existing design meets the RG 1.97 requirements for a Type D Category 3 variable.

CP&L Position: No modifications are required.

Variable: Service Water Booster Pump Status

Category: D3

Compliance: The existing design meets the RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Isolation Valve Seal Water (IVSW) Tank Pressure

Category: D3

Compliance: The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Isolation Valve Seal Water (IVSW) Tank Level

Category: D3

Compliance: The existing design meets RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Containment Penetration Pressurization System Tank Pressure

Category: D3

Compliance: The existing design meets the RG 1.97 requirements for a Category 3 variable.

CP&L Position: No modifications are required.

TYPE E

VARIABLES

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Containment Radiation	Containment Area High Range Radiation Level	R-32A R-32B	2	RG 1.97 HBR	1-10^7 R/hr 1-10^7 R/hr	Yes (1)	NR NR	Reliable R-32A=DB R-32B=BB	NR Yes	-- CV	On Demand RTGB	Yes Yes	
Containment Radiation	Containment Area Low Range Radiation Level	R-2	3	RG 1.97 HBR	NR .1-10^4 mR/hr	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	Yes Yes(2)	
Containment Radiation	Incore Instrumentation Area Radiation Level	R-7	3	RG 1.97 HBR	NR .1-10^4 mR/hr	NR NR	NR NR	NR DB	NR NR	-- CV	On Demand RTGB	Yes Yes(2)	
Containment Radiation	Containment Particulate/ Gas Radiation Level	R-11 R-12	3	RG 1.97 HBR	NR R-11: $3x10^{-10}$ -$3.5x10^{-7}$ μCi/cc particulate R-12: $6x10^{-6}$ -10^{-1} μCi/cc noble gas	NR NR	NR NR	NR BB	NR NR	-- AB	On Demand RTGB	Yes Yes(2)	
Containment Radiation	Samples of Containment Atmosphere	Gamma Spectrum	3	RG 1.97 HBR	Isotopic Analysis (4)	NR NR	NR NR	NR NR	NR NR	-- AB	On Demand None	NR NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Airborne Radioactive Plant Release	Plant Vent Gas and Particulate Radiation Level	R-14 R-34 R-35 R-36	2	RG 1.97 HBR	10^{-6}-10^{4} μCi/cc -noble gas 10^{-3}-10^{2} μCi/cc -particulate R-14: 2x10^{-5} -1x10^{-1} R-34: 10^{-7}-10^{-2} R-35: 10^{-3}-10^{2} R-36: 10^{1}-10^{5} μCi/cc (noble gas) 10^{-3}-10^{2} μCi/cc (particulate)(5)	Yes Yes	NR NR	Reliable R-14=BB R-34,-35 -36=DB	NR NR	-- AB	On Demand R-14,-35, -36=RTGB R-34=Local	Yes R-34=No R-35,-36 =Yes R-14=Yes	Mild Environment R-14,-35 = noble gas monitors. R-34,-36 = noble gas, particulate, iodine monitors. (2) R-35,-36 recorder has BB power, R-34,-36 sample pump has DB power.
Airborne Radioactive Plant Release	Main Steam-line Radiation Level	R-31A R-31B R-31C	2	RG 1.97 HBR	10^{-1}-10^{3} μCi/cc 10^{-1}-10^{2} μCi/cc	Yes Yes	NR NR	Reliable BB	NR NR	-- AB	On Demand RTGB	Yes Yes	Recorder is on BB power supply. Mild environment.
Airborne Radioactive Plant Release	Fuel Handling Bldg. Lower Level Radiation Level	R-20(Gas) R-30(Gas)	2	RG 1.97 HBR	10^{-6}-10^{2} μCi/cc R-20 1.6x10^{-6} -10^{-1} R-30 10^{-2}-10^{3} μCi/cc	Yes Yes	NR NR	Reliable BB	NR NR	-- FHB	On Demand RTGB	Yes Yes(2)	Detectors are battery-backed. Both sample pumps are diesel-backed. Mild environ.
		R-20 (particulate)	2	RG 1.97 HBR	10^{-3}-10^{2} μCi/cc 10^{-3}-10^{2} μCi/cc	Yes Yes	NR NR	Reliable BB	NR NR	-- FHB	NR NR	NR NR	Sample provided for analysis. No on-line indication.
Airborne Radioactive Plant Release	Plant Vent Flow Rate	No Inst. No.	3	RG 1.97 HBR	0-110% design 0-120,000 scfm	NR NR	NR NR	NR NR	NR NR	-- AB	On Demand Local	NR NR	Design flow = 102,550 scfm. 1.1 x design flow = 112,805 scfm. Local recorder.

TYPE E

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Airborne Radioactive Plant Release	Condenser Air Ejector Radiation Level	R-15	3	RG 1.97	10^{-6} -10^{5} μCi/cc	NR	NR	NR	NR	--	On Demand	Yes	Effluent discharges through common plant vent.
				HBR	$1.3x10^{-5}$ -10^{-1} μCi/cc	NR	NR	BB	NR	TB	RTGB	Yes(2)	
Airborne Radioactive Plant Release	Containment Particulate/ Gas Radiation Level	R-11 R-12	3	RG 1.97	10^{-6} -10^{4} μCi/cc -noble gas 10^{-3} -10^{2} μCi/cc -particulate	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	R-11: $3x10^{-10}$ -$3.5x10^{-7}$ μCi/cc particulate R-12: $6x10^{-6}$ -10^{-1} μCi/cc noble gas	NR	NR	BB	NR	AB	RTGB	Yes(2)	
Airborne Radioactive Plant Release	Fuel Handling Bldg. Upper Level Gas Radiation Level	R-21	3	RG 1.97	10^{-6} -10^{2} μCi/cc	NR	NR	NR	NR	--	On Demand	Yes	Effluent discharges through common plant vent.
				HBR	$2.3x10^{-6}$-10^{-1} μCi/cc	NR	NR	BB	NR	AB	RTGB	Yes(2)	
Airborne Radioactive Plant Release	SG Blowdown Radiation Level	R-19	3	RG 1.97	NR	NR	NR	NR	NR	--	On Demand	Yes	
				HBR	$4x10^{-5}$ -$3.5x10^{-2}$ μCi/cc	NR	NR	BB	NR	AB	RTGB	Yes(2)	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Airborne Radioactive Plant Release	PASS Contain-ment Air and RCS Samples	RCS:											
		AT-4124 (Boron)	3	RG 1.97	0-6000 ppm	NR	NR	NR	NR	--	On Demand	NR	Boron can be measured from 0-6000 ppm by PASS grab samples.
				HBR	0-5000 ppm	NR	NR	DB	NR	AB	Local	NR	
		AT-4125 (pH)	3	RG 1.97	1-13 pH	NR	NR	NR	NR	--	On Demand	NR	
				HBR	2-12 pH	NR	NR	DB	NR	AB	Local	NR	
		AT-4126 (H_2)	3	RG 1.97	0-2000 cc/Kg	NR	NR	NR	NR	--	On Demand	NR	Total gas concent. or dissolved H_2 can be determined from 0-2000 cc/Kg by grab sample via the PASS.
				HBR	0-100%, 0-10%	NR	NR	DB	NR	AB	Local	NR	
		Oxygen	3	RG 1.97	0-20 ppm	NR	NR	NR	NR	--	On Demand	NR	Normal sampling provides range of 0-20 ppm. PASS samples not available for O_2.
				HBR	0-20 ppm	NR	NR	NR	NR	AB	None	NR	
		Chloride	3	RG 1.97	0-20 ppm	NR	NR	NR	NR	--	On Demand	NR	Analysis of grab samples via the PASS.
				HBR	0-20 ppm	NR	NR	NR	NR	AB	None	NR	
		Gross Activity	3	RG 1.97	1μCi/ml-10Ci/ml	NR	NR	NR	NR	--	On Demand	NR	Analysis of grab samples via the PASS.
				HBR	1μCi/ml-10Ci/ml	NR	NR	NR	NR	AB	None	NR	
		Gamma Spectrum	3	RG 1.97	Isotopic Analysis (4)	NR	NR	NR	NR	--	On Demand	NR	Analysis of grab samples via the PASS.
				HBR		NR	NR	NR	NR	AB	None	NR	
		Contm't. Air:											
		Hydrogen	3	RG 1.97	0 - 10 vol. % (3)	NR	NR	NR	NR	--	On Demand	NR	
				HBR		NR	NR	NR	NR	AB	None	NR	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redundant	Sensor Location	Display	Recorder	Comments
Airborne Radioactive Plant Release (Cont.)		Oxygen	3	RG 1.97	0 - 30 vol. %	NR	NR	NR	NR	--	On Demand	NR	
				HBR	(3)	NR	NR	NR	NR	AB	None	NR	
		Gamma Spectrum	3	RG 1.97	Isotopic Analysis	NR	NR	NR	NR	--	On Demand	NR	
				HBR	(4)	NR	NR	NR	NR	AB	None	NR	
Environs Radiation and Radioactivity	Portable Airborne Monitors	Assorted	3	RG 1.97	10^{-9}-10^{-3} μCi/cc	NR	NR	NR	NR	--	On Demand	NR	
				HBR	10^{-9}-10^{-3} μCi/cc	NR	NR	NR	NR	N/A	Local	NR	
Environs Radiation and Radioactivity	Portable Radiation Level Monitors	Assorted	3	RG 1.97	10^{-3} -10^{4} R/hr (beta, photons)	NR	NR	NR	NR	--	On Demand	NR	
				HBR	10^{-3} -10^{4} R/hr	NR	NR	NR	NR	N/A	Local	NR	
Environs Radiation and Radioactivity	Onsite Isotopic Analysis for Airborne and Fixed Radiation Samples	(5)	3	RG 1.97	-----	NR	NR	NR	NR	--	On Demand	NR	
				HBR	-----	NR	NR	NR	NR	N/A	Local	NR	
Meteorology	Wind Direction	No Instr. No.	3	RG 1.97	0-360°	NR	NR	NR	NR	--	On Demand	NR	Local recorder provided.
				HBR	0-540°	NR	NR	DB	NR	Yard	On Demand	No	

Safety Function	Variable	Sensor	Cat	RG 1.97 or HBR	Range	EQ	SQ	Power	Redun-dant	Sensor Loca-tion	Display	Recorder	Comments
Meteorology	Wind Speed	No Instr. No.	3	RG 1.97 HBR	0-50 mph 0-125 mph	NR NR	NR NR	NR DB	NR NR	-- Yard	On Demand On Demand	NR No	Local recorder provided.
Meteorology	Atmospheric Stability	No Instr. No.	3	RG 1.97 HBR	-9 -18°F -50° - 30°F	NR NR	NR NR	NR DB	NR NR	-- Yard	On Demand Local	NR No	Local recorder provided.
Liquid Radioactive Plant Release	Plant Liquid Waste System Effluent Radiation Level	R-18	2	RG 1.97 HBR	NR $2.5x10^{-5}$ - $7x10^{-3}$ μCi/cc	Yes Yes	NR NR	Reliable BB	NR NR	-- AB	On Demand RTGB	Yes Yes(2)	Mild Environment
Liquid Radioactive Plant Release	Service Water from Contain-ment Coolers Radiation Level	R-16	2	RG 1.97 HBR	NR $2.7x10^{-5}$ -2.7 -10^{-2} μCi/cc	Yes Yes	NR NR	Reliable BB	NR NR	-- AB	On Demand RTGB	Yes Yes(2)	Mild Environment
Liquid Radioactive Plant Release	SG Blowdown Radiation Level	R-19	2	RG 1.97 HBR	NR $4x10^{-6}$ -3.5 $x10^{-2}$ μCi/cc	Yes Yes	NR NR	Reliable BB	NR NR	-- AB	On Demand RTGB	Yes Yes(2)	Mild Environment

TYPE E FOOTNOTES

(1) Information is available that discusses the instrument's generic qualification; however, no specific comparison has been made with the HBR-specific profiles or parameters.

(2) Can be assigned by operator as 1 of 24 pens on the Radiation Monitoring System multi-channel recorder. Recorder is on a battery-backed power supply.

(3) Containment air samples can be taken and analyzed for 0-10 vol. % H_2 and 0-30 vol. % O_2 using both normal sampling procedures and via the PASS. Containment Hydrogen Concentration is measured continuously under normal and accident conditions using the Containment Hydrogen monitors.

(4) Onsite isotopic analysis is provided by 2 onsite gamma spectrometers and 2 alpha, beta, gamma spectrometers. In the event of an accident, a CP&L mobile lab would be dispensed to H.B. Robinson to provide additional onsite isotopic analysis capability.

(5) Particulate activity is sampled at R-36 and analyzed in the Hot Lab over the required range. R-34 is not normally used for particulate analysis.

Variable: Samples of Containment Atmosphere

Category: E3

Compliance: The gamma spectrum analysis provides direct indication of the magnitude of radioactive releases via anticipated containment leakage. This indication is less timely and is considered as a backup variable to the containment area high range monitor in determining containment radiation level and as a backup to the effluent monitors in assessing airborne radioactive release.

CP&L does not consider accident sampling capability itself as a safety function for a Type E variable. The HBR capability for sampling the containment atmosphere to perform gross activity and gamma spectrum measurements is identified as a backup variable for the containment radiation and airborne radioactive plant release safety functions.

The capability to assess hydrogen and oxygen content via grab samples is not considered essential to the purpose of Type E variables which is to assess radioactive releases. However, this capability is provided.

CP&L Position: CP&L has described the detailed design of the HBR PASS in letters to the NRC dated 8/12/83 and 4/20/84 (Serial Nos. LAP-83-379 and NLS-84-077). This design combined with the redundant on-line containment hydrogen monitors, is considered adequate for analyzing containment atmosphere samples. CP&L also does not consider the requirement for analyzing containment oxygen and hydrogen samples as essential to the purpose of Type E variables. According to RG 1.97 Rev. 3, Type E variables are "those variables to be monitored as required for use in determining the magnitude of the release of radioactive materials and continually assessing such releases." Since containment hydrogen and oxygen do not contribute directly to assessing the magnitude of radioactive releases there is little basis for classifying them as Type E variables.

Variable: Plant Vent Flow Rate

Category: E3

Compliance: This variable is considered backup instrumentation because CP&L can assume the maximum design flowrate to perform release calculations in the absence of any indication. Therefore, the variable is classified as Category 3.

The existing design does not meet RG 1.97 requirements for control room indication.

CP&L Position: Signals from the existing local indicator will be routed to ERFIS for display on demand in the control room.

Variable: PASS RCS Samples

Category: E3

Compliance: The gamma spectrum and gross activity analysis provide direct indication of RCS radiation levels for use in assessing airborne radioactive releases. This indication is less timely and is used as backup to the effluent monitors.

CP&L does not consider accident sampling capability itself as a safety function for a Type E variable. The HBR capability for sampling the RCS to perform gross activity and gamma spectrum measurements is identified as a backup variable for the airborne radioactive plant release safety function.

The capability to assess hydrogen, oxygen, boron, and chloride concentrations and pH is not considered essential to the purpose of Type E variables, which is to assess radioactive releases. However, this capability is also provided.

The existing design of this variable does not meet the requirements of RG 1.97 Type E Category 3 due to inadequate sampling capability from containment, ECCS pump room and auxiliary building sumps, and inadequate range for pH.

CP&L Position: CP&L has described the detailed design of the HBR PASS in letters to the NRC dated 8/12/83 and 4/20/84 (Serial Nos. LAP-83-379 and NLS-84-077). This design is considered adequate for analyzing RCS samples. CP&L also does not consider the requirement for analyzing RCS boron, pH, H_2, O_2, chloride, and total gas concentration as essential to the purpose of Type E variables. According to RG 1.97 Rev. 3, Type E variables are "those variables to be monitored as required for use in determining the release of radioactive materials and continually assessing such releases." Since RCS boron, pH, H_2, O_2, chloride, and total gas concentration do not contribute directly to assessing the magnitude of radioactive releases, there is little basis for classifying them as Type E variables.

The current range of the PASS pH meter is considered acceptable as any samples beyond this range would be beyond the range of recoverable actions and extending the range would decrease its sensitivity in the normal range.

Variable: Portable Airborne Samplers

Category: E3

Compliance: The existing design meets the requirements of RG 1.97 for a Type E Category 3 variable.

CP&L Position: No modifications are required.

Variable: Portable Radiation Level Monitors

Category: E3

Compliance: The portable radiation level monitors provided at H.B. Robinson meet the requirements of RG 1.97 for a Type E Category 3 variable.

CP&L does not consider area radiation as a safety function applicable to the definition for Type E variables. Determination of radiation exposure rate inside buildings or areas where access is required to service equipment important to safety does not assist in determining the magnitude of a release or the assessment of such a release. Therefore, this safety function and any associated variables have not been included by CP&L.

Access to areas required to service equipment important to safety will be determined through the use of portable instruments.

CP&L Position: No modifications are required.

Variable: Onsite Isotopic Analysis Capability for Airborne and Fixed Radiation Samples

Category: E3

Compliance: The existing design meets the requirements of RG 1.97 Type E Category 3.

CP&L Position: No modifications are required.

Variable: Wind Direction

Category: E3

Compliance: The existing instrumentation complies with the requirements of RG 1.97 for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Wind Speed

Category: E3

Complaince: The existing intrumentation complies with the RG 1.97 requirements for Category 3 variables.

CP&L Position: No modifications are required.

Variable: Atmospheric Stability

Category: E3

Compliance: The existing instrumentation meets the Type E Category 3 requirements of RG 1.97.

CP&L Position: No modifications are required.

Variable: Plant Liquid Waste System Effluent Radiation Level

Category: E2

Compliance: This variable is not required by RG 1.97, but has been included to provide indication of the concentration of any liquid effluents released directly to the environment in the event of a major accident. Flowrate of any liquid effluent can be conservatively assumed to be the design flowrate. The existing instrumentation complies with the requirements for Category 2 instruments found in RG 1.97.

CP&L Position: No modifications are required.