BALTIMORE GAS AND ELECTRIC

CHARLES CENTER · P. O. BOX 1475 · BALTIMORE, MARYLAND 21203

July 1, 1985

ARTHUR E. LUNDVALL, JR.
VICE PRESIDENT
SUPPLY

Director of Nuclear Reactor Regulation
Attention: Mr. E. J. Butcher, Jr. Chief
Operating Reactors Branch #3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Calvert Cliffs Nuclear Power Plant
Units Nos. 1 & 2; Dockets Nos. 50-317 and 50-318
Inadequate Core Cooling Instrumentation

Gentlemen:

Your letter dated January 22, 1985 requested additional information regarding our plan and schedule for final implementation of inadequate core cooling instrumentation (ICCI) at Calvert Cliffs. The information requested in Enclosure 1 of your letter is provided below. Our schedule for submitting the implementation report letter described in Enclosure 2 of your letter is May 1, 1988 for Unit 1 and May 1, 1987 for Unit 2.

1. **Describe the status of the RVLMS installation including a schedule for completion of installation and calibration and the description of the final display system for RVLMS.**

Response 1

Our letter dated June 19, 1985 provided our schedule for Heated Junction Thermocouple (HJTC) system installation, calibration, and operator familiarization. A description of the HJTC displays was included in our letter dated April 10,1984. To summarize again, there are three displays associated with this system. The primary display is being developed as part of the new SPDS/plant computer system and will consist of a CRT-based bar graph demarkated into discrete levels corresponding to the sensor locations on the HJTC probe. The design philosophy being applied to this display is described in our letter dated February 4, 1985 (specifically, see response to Question 2 concerning SPDS human factors approach). A safety-grade backup display will be provided on the main control board. This display will be consolidated with the subcooled margin monitor (SMM) and core exit thermocouple (CET) displays. The control board display for the HJTC will consist of a vertical array of eight lights per probe, corresponding to HJTC sensor locations. A second safety grade backup display will be located on each HJTC signal processing cabinet in the Switchgear Room. This is a digital display used for detailed HJTC system diagnostics.

A002
1/1

2. **Provide the completion schedule and detailed plans for upgrading the core exit th:rmocouple system with respect to conformance with the design requirements of NUREG-0737, Item II.F.2. Identify and justify any deviation.**

Response 2

Our letter dated June 19, 1985 provided our schedule for CET installation, calibration and operator familiarization. A detailed description of the CET system and an evaluation of conformance with the criteria of NUREG-0737, Item II.F.2 is provided in Enclosure 1 to this letter.

3. **Provide an evaluation of the final SMM with respect to NUREG-0737 Appendix B design requirements and detailed plans for upgrading the SMM to incorporate CET inputs. Identify and justify any upgraded deviation.**

Response 3

A Combustion Engineering Model 001 Subcooled Margin Monitor system is installed and operational at Calvert Cliffs Units 1 and 2. A description of the SMM and an evaluation of conformance with the criteria of NUREG-0737, Appendix B is provided in Enclosure 2.

We do not plan to incorporate the CET inputs to the SMM. However, we do intend to provide subcooled margin calculations based on CET input on the new plant computer CRT. The SMM will be maintained in its present configuration to give the operators the capability of simultaneously monitoring saturation conditions at both the hot/cold leg and core exit locations. It is felt that this capability allows the operator to better ascertain the status of his pressure control, inventory tracking, and heat removal safety functions.

As a backup to the calculations displayed on the plant computer CRT, the emergency operating procedures include appropriate saturation curves. The operator can use these curves to quickly identify the degree of subcooling in the reactor vessel head area based on direct CET and RCS pressure readings obtained from the main control board or the SPDS/plant computer CRT.

4. **Provide an over-all schedule for implementation of the final upgraded ICCI system and the upgraded ICC emergency procedure using CEN-152 Revision 2 guidelines.**

Response 4

Our letter dated June 19, 1985 provided our schedules for completion of the HJTC and CET systems. These schedules include implementation of upgraded emergency operating procedures based on CEN-152, Revision 2.

If you should have any questions, please do not hesitate to contact us.

Very truly yours,

AEL/BSM/vf

Enclosures

cc: D. A. Brune, Esq.
G. F. Trowbridge, Esq.
Mr. D. H. Jaffe, NRC
Mr. T. Foley, NRC

Enclosure (1) to BG&E
letter to NRC dated
July 1, 1985.

Baltimore Gas & Electric Company
Calvert Cliffs Nuclear Power Plant
Units 1 and 2
Core Exit Thermocouples
Licensing Report
July, 1985

Table of Contents

1.0 INTRODUCTION

1.1 Purpose

In response to NRC Generic Letter 82-28, this report describes the design of the Core Exit Thermocouple System modification to be installed in the Calvert Cliffs Nuclear Power Plant Units 1 and 2 pursuant to NUREG-0737, Item II.F.2.

2.0 SYSTEM DESCRIPTION

The primary function of the reactor core exit thermocouples (CET) is to provide temperature data from which gross core power distribution and thermal margins may be inferred. As a result of the Three Mile Island Unit 2 incident, the Nuclear Regulatory Commission has specifically identified CET as an element of the Inadequate Core Cooling (ICC) instrumentation system. Therefore, the function of the CET has been expanded and upgraded to a safety related status.

2.1 Original System

The reactor in-core instrumentation system consists of forty-five fixed in-core detectors inserted into selected instrumentation assemblies. See Exhibit A. Each assembly contains four rhodium self-powered neutron detectors (SPND), a background wire and one CET. These circuits for each assembly are contained in a single multiconductor cable assembly routed to the respective electrical containment penetrations via the refueling pool electrical cable platform interface panel (Q-panel). At the electrical penetration, the SPND and CET circuits are separated into individual twisted shielded pair cables for the SPND and a standard thermocouple Type K cable for the CET. The respective circuits are then routed to the main plant computer for processing and logging. Exhibit B provides additional information.

2.2 Modified System

The following is a description of the modified CET system. Exhibit C is a block diagram of the modified system and provides additional information.

2.2.1 Modifications in the Auxiliary Building

A non-microprocessor based approach has been selected for modifying the CET instrumentation system, to provide continuous on demand selective reading of core exit temperatures. A dual output thermocouple transducer will be added to each CET channel (forty-five per unit). The transducer will produce two independent isolated analog outputs. One isolated output will be used for the safety related CET backup display system. The other will be used for interface with the non-safety related primary CET display system - which is defined as the Main Plant Computer based system.

Each safety related CET backup display transducer signal will be fed to a channel selector switch and trend recorder. Multi-channel trend recorders will record all of the CET channels and will be unaffected by the channel selector switch position. The channel selector switch (located on the Reactivity Controls and Protective System Control Board in the Main Control Room) will allow the operator to select any desired CET for display on a Main Control Board digital indicator. The selector switches are mounted along with the indicators to denote which CET is being monitored and to allow operator selective channel comparison with the primary CET display system.

To meet the requirements for safety related systems, redundancy is necessary for each reactor core quadrant monitoring channel. Each electrical separation group is comprised of individual thermocouple transducers for each channel; multichannel recorders; and channel selector switches and temperature indicators. Since redundant electrical separation groups are provided, channel comparison can be accomplished on the backup display in addition to comparison to the primary display computer information. Plant separation requirements will be provided for these components primarily by the use of structural separation barriers in the mounting panels.

To maximize use of the "in-place" CET cabling, the thermocouple transducers will be located in the Computer Room together with the new trend recorders. The present cable routing for the CETs, from the containment penetration rooms to the Computer Room, will be upgraded to safety related.

2.2.2 Modifications in the Containment Building

To meet redundancy requirements for monitoring each core quadrant and to maintain as much as practical the plant electrical separation requirements for redundant channels, approximately half of each reactor core quadrant CET circuits will be rerouted from the reactor in-core detector probe assembly via the electrical cable platform to the opposite electrical separation group refueling pool interface panel (Q-panel). This is typical of each reactor core quadrant.

Due to environmental qualification concerns with upgrading the in-core instrumentation cable assembly connectors, the containment cable assemblies from the reactor probe to the electrical penetrations will be replaced with qualified assemblies. In addition, the CET circuit portion only of the multi-conductor cable assembly will be rerouted from the existing electrical penetration to an environmentally qualified electrical penetration. New feedthrough modules will be provided as required for the respective qualified electrical penetrations.

2.2.3 Electrical Design

Safety related Class 1E, 110V, single ph. 60 Hz. approximately 200 VA, power will be fed to each of the two channel thermocouple transducer/recorder panels. Power will be fed from the safety related distribution panels at Motor Control Centers within the plant.

In case of a loss of off-site power, there will be a short (10 seconds) interruption in power supply, before it is resumed after the buses are connected to "on-site" diesel power.

Devices powered from these Class 1E sources will be the thermocouple transducers, the multi-point recorders and the digital indicators.

Isolation from the non-Class 1E equipment will be provided by the thermocouple isolation transducers.

The primary display Plant Computer system for CET will be powered by UPS systems and backed-up by instrument AC systems via automatic transfer switches.

Hardware included up to the isolation devices (safety-related): (See Exhibit C).

In-Core Instrument
Assembly (Type K thermocouple) - Unpowered
Cable Assemblies and Connectors - Unpowered
Interface Panels (Q-panels) - Unpowered
Containment penetrations - Unpowered
Isolation Thermocouple Transducers (dual output) - Powered

Hardware included beyond the isolation devices (safety-related, backup display system): (See Exhibit C)

Trend Recorder (multi-point) with Shunt Resistor - Powered
Selector Switch, with Shunt Resistors - Unpowered
Digital Indicator - Powered

Hardware included beyond the isolation devices (non-safety related primary display system): (See Exhibit C)

DAS Multiplexer - Powered
DAS Data Processor - Powered
Plant Computer and SPDS Processor - Powered

2.2.4 Environmental Qualification

The CET modified system will satisfy the seismic and environment qualification criteria of NUREG-0737 item II. F. 2.

All new equipment being purchased for this modification as well as those items being upgraded to safety related, will be qualified to the applicable NUREG and IEEE standards under the Baltimore Gas and Electric Company's environmental qualification program for the respective plant area conditions. Major new equipment/hardware which is included in this category are:

- o Thermocouple Isolation Transducer
- o Containment Multiconductor Cable Assemblies and Connectors
- o Containment Penetration Feedthrough Modules
- o Probe Assembly Mating Connectors

Major items which are in the upgrading category are:

- o Reactor In-core Instrument Assembly
- o Original Thermocouple Cable from the Containment Penetration to the Computer Room

The Seismic Class IE evaluations can be divided into four (4) primary categories:

A. Main Control Board Modifications
B. Temperature Transducer/Recorder Panel Mounting Analysis
C. Electrical Raceway Support Design

Original CET system raceways which are being upgraded will be walked down and evaluated for safety related Class IE considerations. Any modifications determined necessary will be detailed or noted for field implementation.

New CET system raceway will be installed consistent with the plant standards and the established approach for any new Cable Spreading Room conduits.

D. Miscellaneous

This category encompasses such items as review of component specifications for seismic Class 1E requirements and review/evaluation for upgrading the refueling pool electrical interface panels (Q-panel). No seismic evaluations are presently considered necessary for the refueling pool electrical platforms or the containment electrical penetrations.

3.0 SYSTEM TESTING

The CET modification will undergo a functional testing phase after installation completion. Calibration procedures will be developed and/or revised to include the new instruments, and surveillance procedures established per BG&E approved practices. Environmental qualification will be accomplished under BG&E's ongoing environmental qualification program and will conform to IEEE 323, 344 and NUREG-0588 requirements, as applicable.

4.0 DISPLAY SYSTEMS

4.1 Primary Display

The primary display system will be accomplished using the new plant computer system which includes the Safety Parameter Display System (SPDS) as one of its elements.

The SPDS will contain a page on the CRT display which will include Inadequate Core Cooling information as follows:

(a) The highest four individual CET for each reactor core quadrant (Range 200 - 1800 F as stated in NUREG-0737 Item II.F.2 Attachment 1). Actual current design is a range of 31 - 2000 F.

(b) The reactor core subcooled margin based on CET and pressurizer pressure input (Range 0 - 250 F).

(c) Reactor vessel level above the fuel alignment plate based on the new Heated Junction Thermocouple installation (Range 0 - 185 inches in eight steps).

(d) Loop subcooled margin based on the installed subcooled margin instruments. (Range 0 - 250 F).

It is not planned to utilize a core map display to portray CET temperature readings. Rather a listing of CET readings will be available from the plant computer which can be manually related to individual CET locations as necessary.

The alarm system for the plant computer is consistent with operator procedure requirements. The alarm task works with data tables and alarm tables to inform the operator of any abnormal conditions. All analog and digital alarm points are classified and displayed according to priority levels established when the plant computer software is generated.

Each priority level is associated with a specific color, and the point name, priority number, or other fields or areas appear in color or in a reverse video state. Specific fields or areas are made to blink if an alarm occurs.

The plant computer alarm capabilities and its display system are used by the SPDS to ensure that the displayed information is readily perceived and comprehended by the operator. Specifically the Human Factors Program is discussed in Reference C. Within the letter BG&E responses to Questions 2 and 3 deal with the Human Factor Program and Data Validation respectively and with the handling of Critical Safety Function Alarms.

A typical page of the current design of the SPDS with a legend for format design is in Exhibit D. Typical SPDS format methodology is explained in the attached Exhibit E, and the current design of the inadequate core cooling information display is shown in Exhibit F.

4.2 Backup Display

The backup CET display will consist of digital indicators (capable of displaying each CET with a range of 200 to 2300 F located on the Reactivity Controls and Protective System Control Board (CO5) in the Main Control Room. The digital indicators will be grouped in an overall human engineered Inadequate Core Cooling modification for the main control board. The Inadequate Core Cooling instrumentation displays included in this area are the Subcooled Margin Monitor digital displays, the Reactor Vessel Level light displays, and the CET digital indicators. A typical design is included as Exhibit G.

As recommended in CEN-152, general direction is provided in each emergency operating procedure requiring the use of at least two independent indications where available to evaluate and corroborate specific plant conditions. This action helps ensure the operability of any one indication. For a CET temperature Thot and TCold instrumentation, subcooled margin based on Thot/Tcold, and multiple CET displays are available to perform the operability check. The safety function status checks in each procedure ensure these parameters are reviewed periodically during an event. CEN-152 provides additional information on the safety function checks.

4.3 Use of the CET Displays

The following uses are identified for the core exit temperature monitoring:

- Prior to entry into shutdown cooling (SDC), the Reactor Coolant Pumps (RCPs) are secured. During the period prior to SDC initiation reactor coolant system temperatures are trended using CET to ensure stable core temperatures.

- Once through cooling (feed and bleed using power operated relief valves) is being added in the emergency operating procedures. A core exit temperature of 560 F is the proposed initiation criterion. After once through cooling is established CET are used to monitor core temperatures. During once through cooling, subcooled margin (SCM) is maintained up to 200 F based on CET. Use of CET for this purpose is recommended in the emergency procedure guidelines (CEN-152) developed by Combustion Engineering for the owners group. To meet CEN-152, the operator will be directed to check CET subcooling as an alternate action to determining Thot/Tcold subcooling. The CET subcooling is on the primary display; and as a backup to that, the emergency operating procedures will include a pressure

temperature graph to contain all pertinent operating curves. With CET backup display and reactor coolant system pressure available on the main control board, the operator can determine the position with respect to the subcooled curves and ensure subcooling based on CET is satisfactory.

- During natural circulation conditions, subcooled margin is maintained between 30 F and 200 F based on CET. Use of CET for this purpose is recommended in the emergency procedure guidelines (CEN-152) developed by Combustion Engineering for the owners group. To meet CEN-152, the operator will be directed to check CET subcooling as an alternate action to determine Thot/Tcold subcooling.

  The new emergency operating procedures specify the use of CET temperature and subcooled margin in accordance with direction from CEN-152. Training on these procedures is currently in progress and is being accomplished as described in Reference D.

4.4 Human Factors Engineering

In order to ensure that Human Factors Engineering principles are applied in the design of the inadequate core cooling displays, the preliminary design of the displays has been reviewed by the Detailed Control Room Design Review (DCRDR) Team. In addition, the ICC instrumentation system will be included in the Information and Control Characteristics Review (ICCR) to be incorporated into the DCRDR. The ICCR is being developed by Combustion Engineering from the Emergency Procedures Guidelines (CEN-152) as an alternative to task analysis.

REACTOR CORE MAP

UNIT NO. 1

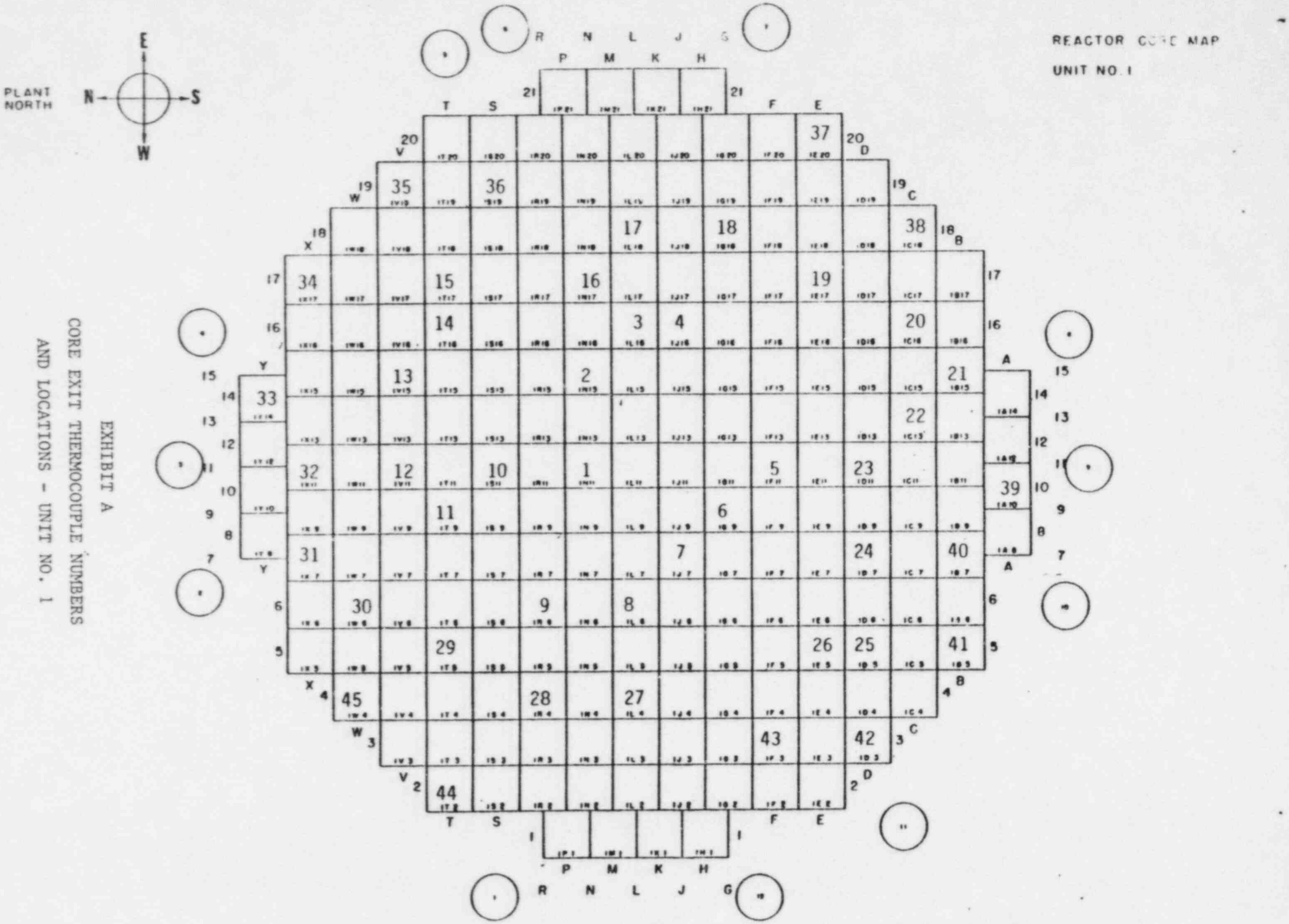
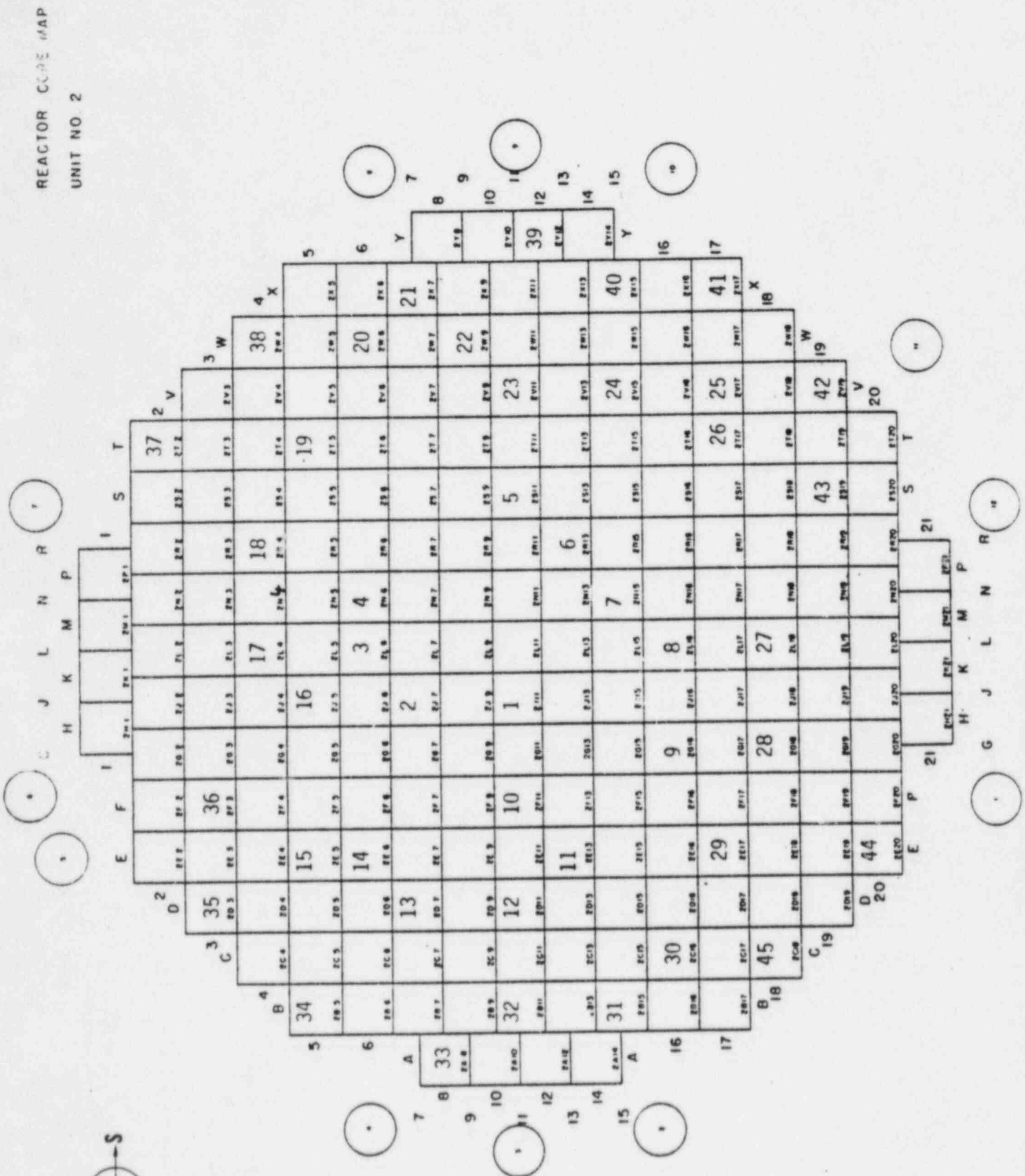


EXHIBIT A

CORE EXIT THERMOCOUPLE NUMBERS AND LOCATIONS - UNIT NO. 1



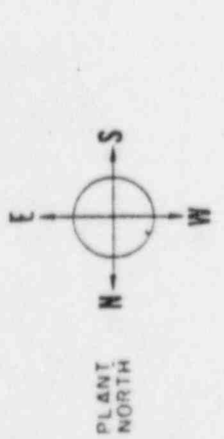
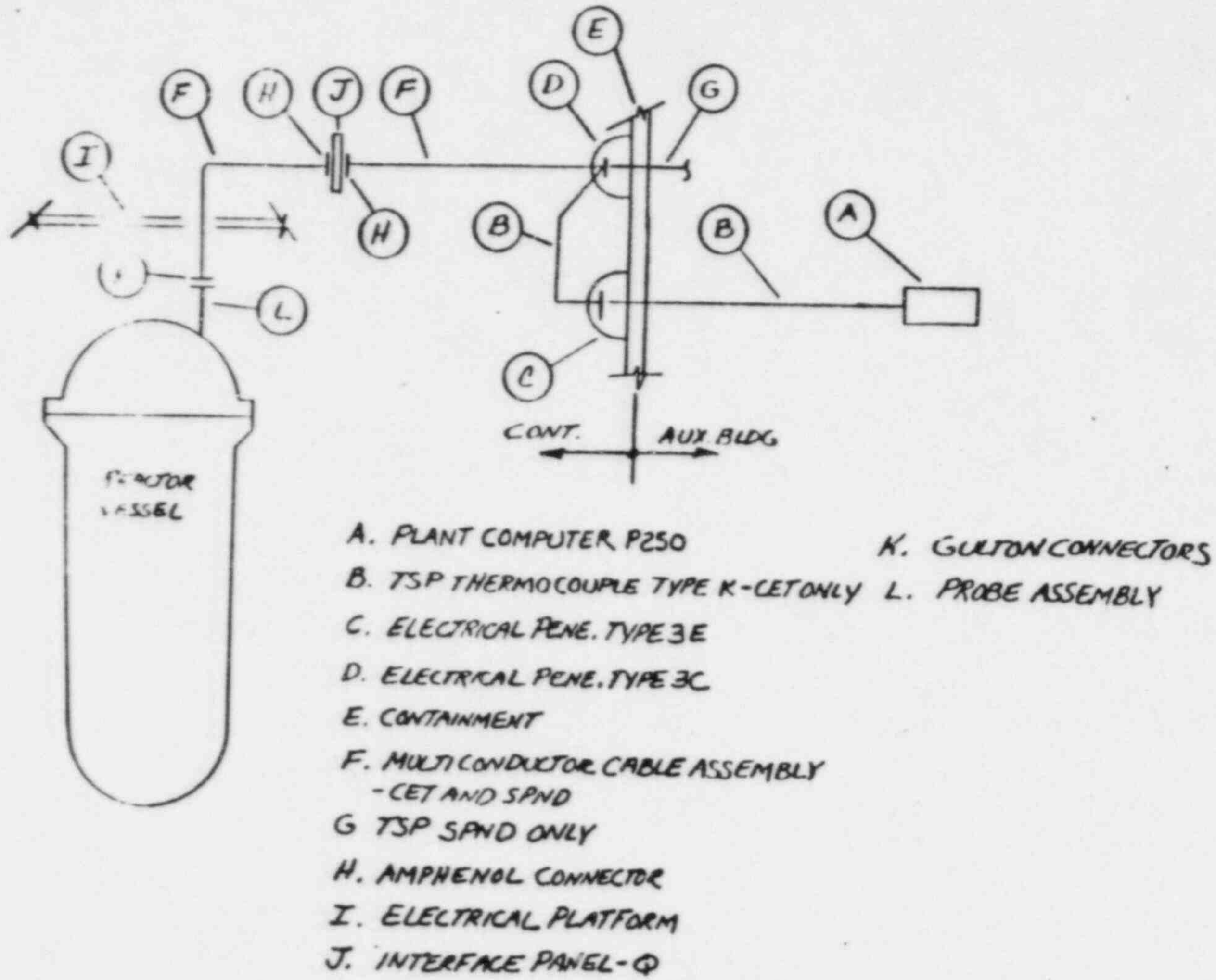


EXHIBIT A

CORE EXIT THERMOCOUPLE NUMBERS

AND LOCATIONS - UNIT NO. 2

EXHIBIT B
CET ORIGINAL SYSTEM



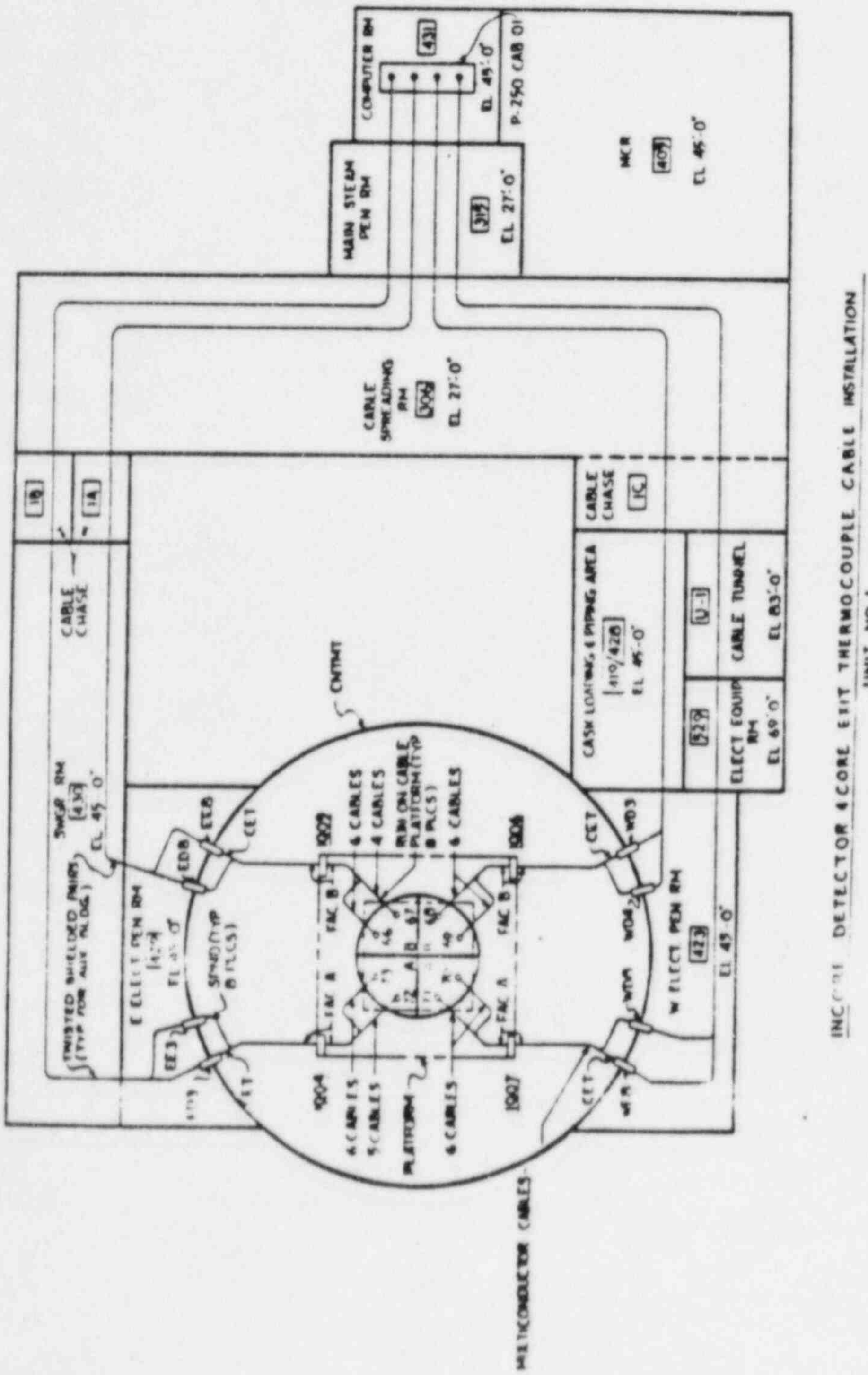


EXHIBIT B

UNIT 1 CET ORIGINAL SYSTEM

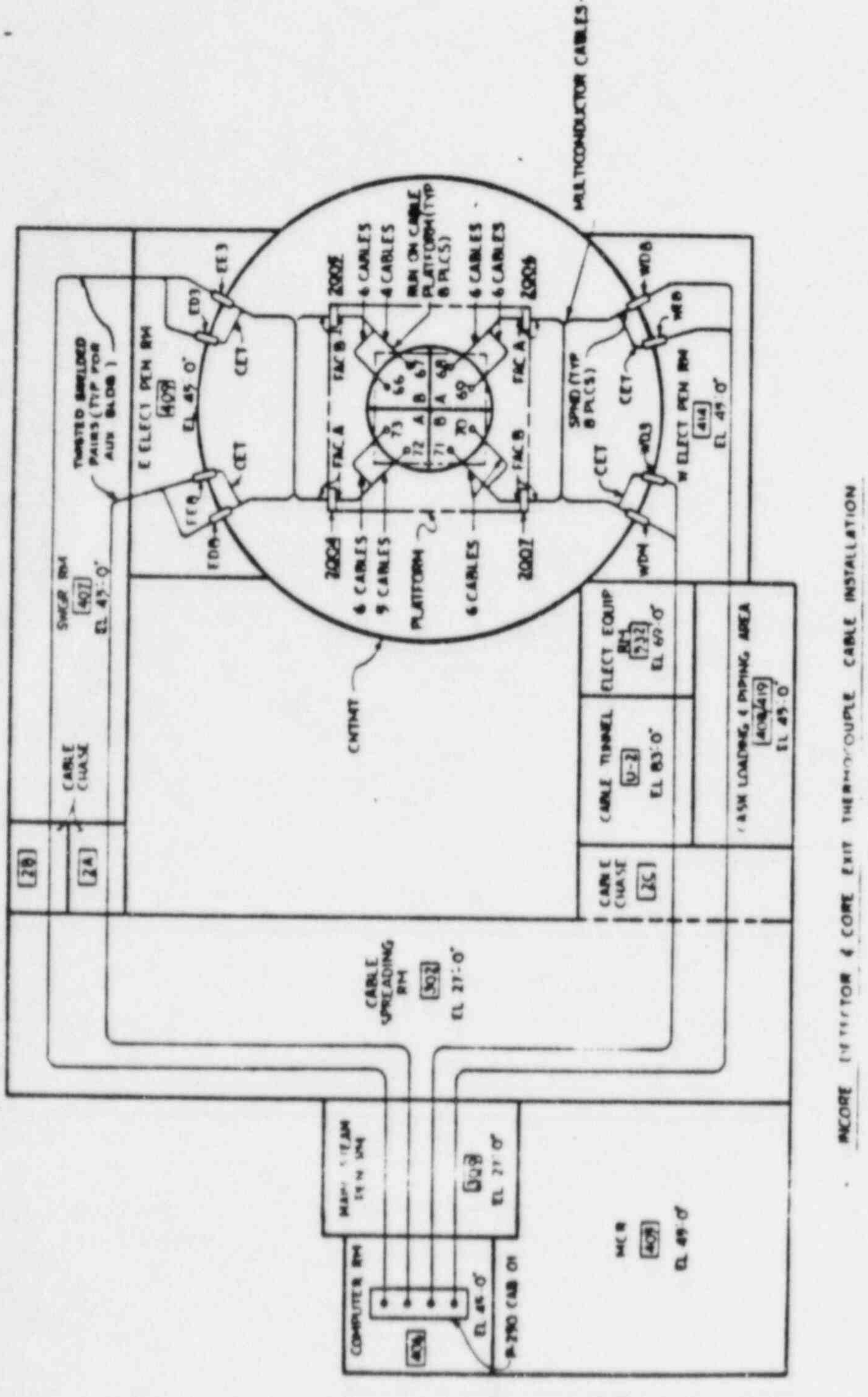
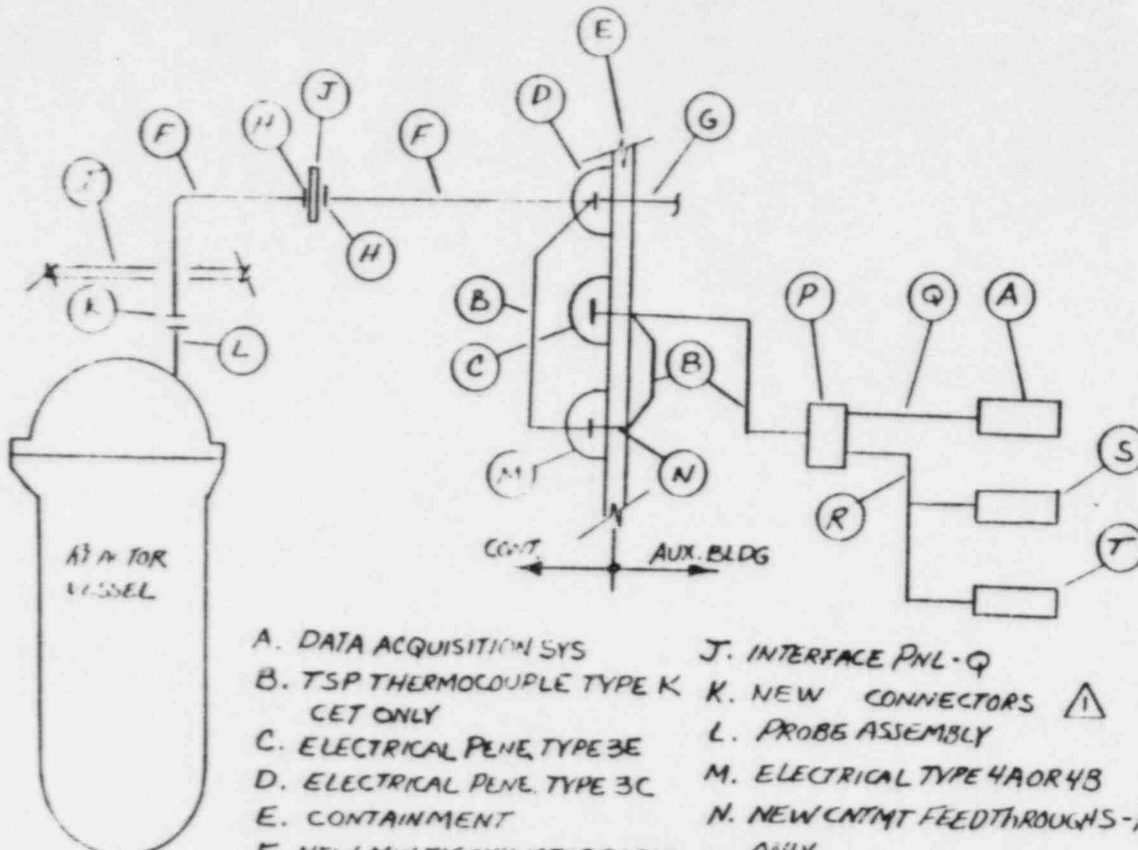


EXHIBIT B

UNIT 2 CET ORIGINAL SYSTEM

EXHIBIT C

MODIFIED CET SYSTEM



A. DATA ACQUISITION SYS
B. TSP THERMOCOUPLE TYPE K CET ONLY
C. ELECTRICAL PENE. TYPE 3E
D. ELECTRICAL PENE. TYPE 3C
E. CONTAINMENT
F. NEW MULTICONDUCTOR CABLE ASSEMBLY-CET AND SPND
G TSP SPND ONLY
H. NEW QUALIFIED CONNECTORS
I. ELECTRICAL PLATFORM
J. INTERFACE PNL-Q
K. NEW CONNECTORS ⚠
L. PROBE ASSEMBLY
M. ELECTRICAL TYPE 4A OR 4B
N. NEW CNTMT FEEDTHROUGHS - PENE. 4A ONLY.
P. TEMPERATURE TRANSDUCER
Q. INSTRUMENTATION CABLE - NSR ANALOG
R. INSTRUMENTATION CABLE - SR ANALOG
S. RECORDER
T. MAIN CONTROL ROOM DISPLAY SYS

EXHIBIT D

PLANT COMPUTER

TYPICAL SPDS FORMAT DESIGN

LEGEND FOR FORMAT DESIGN

The following explanations are correlated to the appropriate designations on Page D-4:

1. Format border and all separation lines - low contrast CYAN.

A. Title of format - Low contrast CYAN.

B. Month, Date, and Year - High contrast CYAN.

C. Hour, Minutes, and Seconds - High contrast CYAN.

D. 'Unit' - Low contrast CYAN.

E. Unit Designator ('1' or '2') - High contrast CYAN.

F. 'Page of Pages' - Low contrast CYAN.

G. Page Numbers - High contrast CYAN.

H. RBG - Red, Blue, Green - Reverse Video.

I. All the Critical Safety Function (CSF) blocks are reverse video - Green (Low Contrast), Yellow (High Contrast), Red (High Contrast), or Magenta (High Contrast).

J. All titles for the parameters - Low contrast CYAN.

K. All Parameter Scales - Low contrast CYAN.

L. All vertical bars - High contrast YELLOW or RED - Low contrast GREEN.

M. All digitals below vertical bars - Low contrast GREEN and High contrast YELLOW or RED. Trend indication - plus (+), minus (-), or blank (static) and no change are Low contrast CYAN.

N. Identification of valve, system, or equipment - Low contrast CYAN.

O. Status of Valves, systems, or equipment - High contrast GREEN, RED or white.

P. This type of indication is not found on all of the display pages. 'Source' designates the source being used for the 'CHG PUMP FLOW'. 'SOURCE' is in Low contrast CYAN.

Q. This is the space to designate the 'SOURCE'. The 'SOURCE' can be 'BAST', 'RWT', or 'VCT'. These are displayed in High contrast CYAN.

R. 'ALARM/INDICATION' - This poke point, or touch point for touch CRTs, is for immediate access to the alarm/indication listing for this particular CSF. 'ALARM/INDICATION' is static but it is displayed in High contrast CYAN.

S. Paging poke points or touch points for CRTs with touch screens. These are static (e.g., the labels do not change). Because of their importance these are in High contrast CYAN. The abbreviations used are consistent with those found on the keyboard.

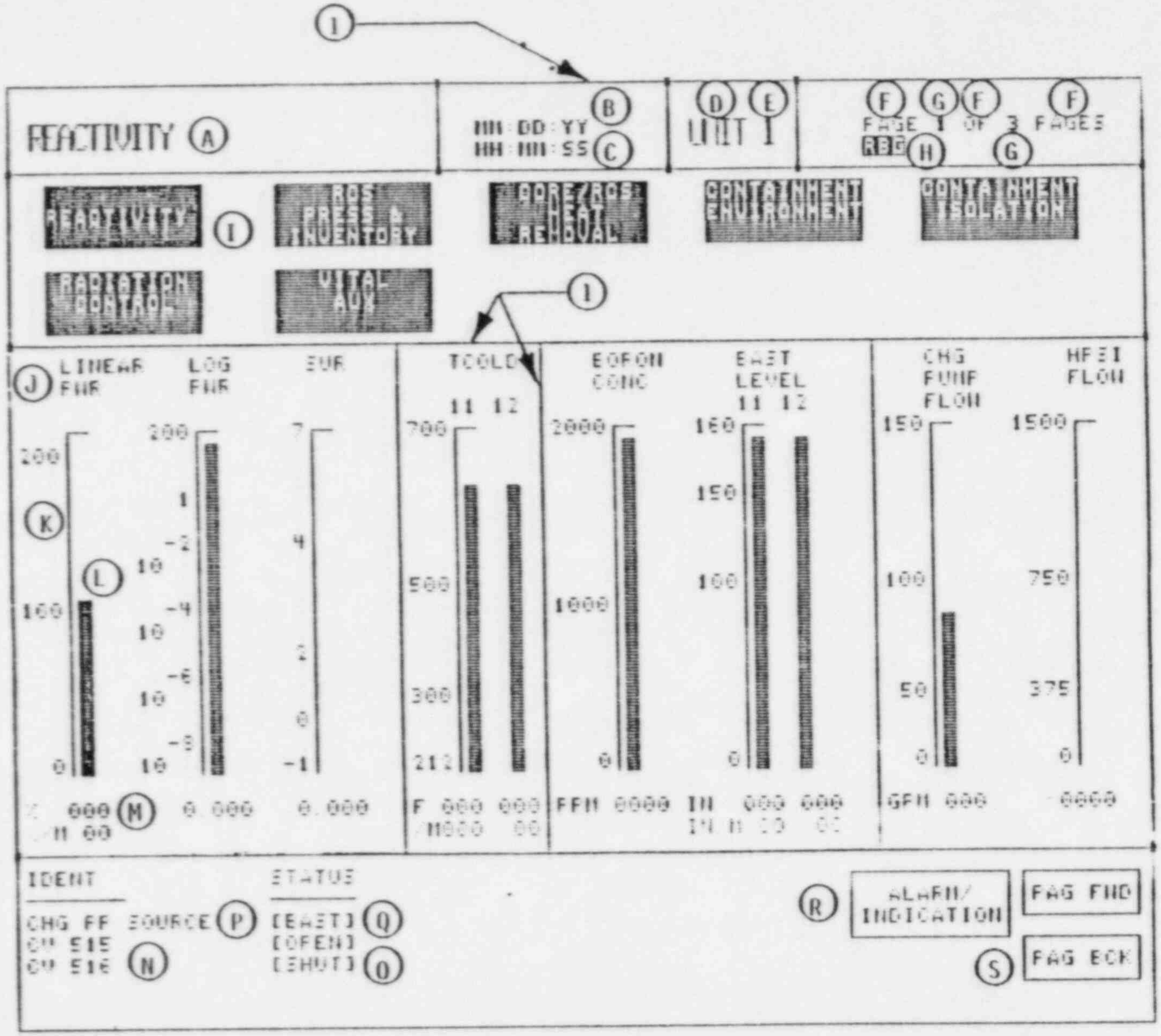

REACTIVITY
MM:DD:YY
HH:MM:SS
UNIT 1
PAGE 1 OF 3 PAGES
REACTIVITY
RCS PRESS & INVENTORY
CORE/RCS HEAT REMOVAL
CONTAINMENT ENVIRONMENT
CONTAINMENT ISOLATION
RADIATION CONTROL
VITAL AUX
LINEAR PWR
LOG PWR
TCOLD
11 12
BORON CONC
BAST LEVEL
11 12
CHG PUMP FLOW
HPSI FLOW
IDENT
STATUS
CHG PP SOURCE
[BAST]
[OPEN]
[SHUT]
ALARM/ INDICATION
PAG FWD
PAG BCK

EXHIBIT E

PLANT COMPUTER

TYPICAL SPDS DISPLAY FORMAT METHODOLOGY

CALVERT CLIFFS DISPLAY HIERARCHY AND METHODOLOGY

1. SPDS Display Hierarchy

   Each Critical Safety Function (CSF) has one or more pages associated with it. The SPDS user can call up any CSF display by depressing a fixed key. Once the user is in the CSF, he can page forward (PAG FWD) or page backwards (PAG BCK) within a CSF set.

2. CSF Points

   A tabular display page is provided for each CSF to present all the I/O signals associated with that CSF. The status of the signal is also noted on that tabular display page.

3. CSF Methodology and Response Prioritization

   The CSFs at the top of every display, present the user with status of the CSF on all levels of the display hierarchy at all times.

   The CSFs and alarm conditions are prioritized with higher priority function towards the left.

   User addresses highest alarms first (e.g. red over yellow, left over right). If a higher priority alarm comes in, the user should cease actions on a lower level safety function/alarm to address the higher level alarm.

4. Critical Safety Functions (CSF) Boxes

   Green (Low Contrast) - Safety margins and safety limits being maintained.

   Yellow (High Contrast) - CSF margins decreased - attention is necessary.

   Red (High Contrast) - CSF margin substantially decreased - action is required.

   Magenta (but is overriden by Red/Yellow) - One or more gates in the algorithm for that CSF are invalid due to missing data or failed sensor.

   Magenta (small solid box at right hand corner of CSF) - Parameter in that CSF is invalid but the algorithm gate is still functional.

5. Parameter Vertical Bars and Digital Readouts

   The parameter vertical bars change color to agree with the alarm condition for that parameter. The color code is as follows:

Cyan - Not applicable to SPDS parameters

Green (Low Contrast) - No decreased margins detected - Vertical bars, digital values, and minus (-) or plus (+) signs change color.

Yellow (High Contrast) - parameter margin decreased - vertical bars, digital values, and minus (-) or plus (+) signs change color.

Red (High Contrast) - Parameter limit exceeded - Vertical bars, digital values, and minus (-) or plus (+) signs change color.

The Alarm Scale found in Part III of each format description relates to this color code. A BG&E SPDS I/O List presents the alarm scale for each parameter in a particular CSF.

6. Reverse Video

This technique is used to get the SPDS user's attention. All the CSF windows at the top of each display page are reverse video in green, yellow, red, or magenta, depending on the CSF alarm condition. If the digital value below the vertical bar is invalid, it too will be in reverse video.

7. SPDS Display Format Descriptions

The basic display set consists of seven top level displays. Each display format is divided into four parts. Part I is the title block, Part II is the Critical Safety Function Blocks, Part III is the data block, and Part IV is for system status information or presents information aids to the user.

The Plant Operating Summary display presents the seven Critical Safety Functions (CSFs). Five of these CSFs are defined in NUREG-0737, Supplement 1. The summary display and successive CSF displays make use of vertical bars and digital values of the displayed parameter.

The initial seven CSFs form the basis for the titles of the second and third level displays

The seven critical safety functions displays are:

- Reactivity
- RCS Press & Inventory
- Core/RCS Heat Removal
- Containment Environment
- Containment Isolation
- Radiation Control
- Vital Auxiliaries

The following are support displays for the CSFs. They do display CSF status at the top of each display format:

- CEA Bottom Limit Relay Status Matrix
- Press/Temp Plot Display Page
- RCS Press & Inventory P&ID Display Page

- Electrical Buses
- Tabular display pages for the points and values and alarm status of all the signals for the associated CSF.

8. Normal Up Display

When the SPDS is turned on or "booted", the display page that will appear on the SPDS is the 'Plant Operating Summary' display format.

EXHIBIT F

PLANT COMPUTER

SPDS INADEQUATE CORE COOLING INFORMATION DISPLAY

CORE AND RCS HEAT REMOVAL-ALARM/INDICATION

I. TITLE BLOCK

Common to all displays, the title block is located across the top of the display format. The following are contained.

A - Display name
B - Month, date, year
C - Hour, minute, seconds
D - Unit designator
E - Page number
F - Indication of color gun status

II. FUNCTION BLOCK

Common to all displays, the function block is located below the title block and contains the seven CSFs. The CSFs are:

A - REACTIVITY (Reactivity Control)
B - RCS PRESS & INVENTORY (RCS Pressure and Inventory)
C - CORE/RCS Heat Removal
D - Containment Environment
E - Containment Isolation
F - Radiation Control
G - VITAL AUX (Vital Auxiliaries)

NOTE: ALL CSF BLOCKS ARE POKE POINTS AND TOUCH POINTS ON TOUCH SCREEN CRTs.

CORE/RCS HEAT REMOVAL DISPLAY (PAGE 2)

III. PARAMETERS

PARAMETER, SCALE, UNITS	ALARM SCALE
A - SG PRESS, 0-1200, PSIA	GREEN - > 880 and < 920 PSIA YELLOW - ≥ 920 and ≤ 880 PSIA RED - ≥ 985 and ≤ 703 PSIA
B - PZR PRESS, 0-3000, PSIA	GREEN - > 1900 and < 2300 PSIA YELLOW - ≥ 2300 and ≤ 1900 PSIA RED - ≥ 2400 and ≤ 1740 PSIA
C - LOOP SUB CLD MARGIN, 0-250°F	GREEN - > 30 and < 200°F YELLOW - ≤ 30°F RED - ≥ 200 and ≤ 10°F
D - VESSEL LEVEL (BKR STATUS), NOTE 1	GREEN - NO VOID DETECTED YELLOW - N/A RED - VOID DETECTED
E - CORE T/C STATUS, 31-2000,°F	GREEN - < 625°F YELLOW - ≥ 625°F RED - ≥ 650°F
F - CORE SUB CLD MARGIN 0-250°F	GREEN - > 30 and < 200°F YELLOW - ≤ 30°F RED - ≥ 200 and ≤ 10°F

IV. SUBSYSTEM STATUS

ID	STATUS
RCP	[ON/OFF]

V. ALARM/INDICATION MENU

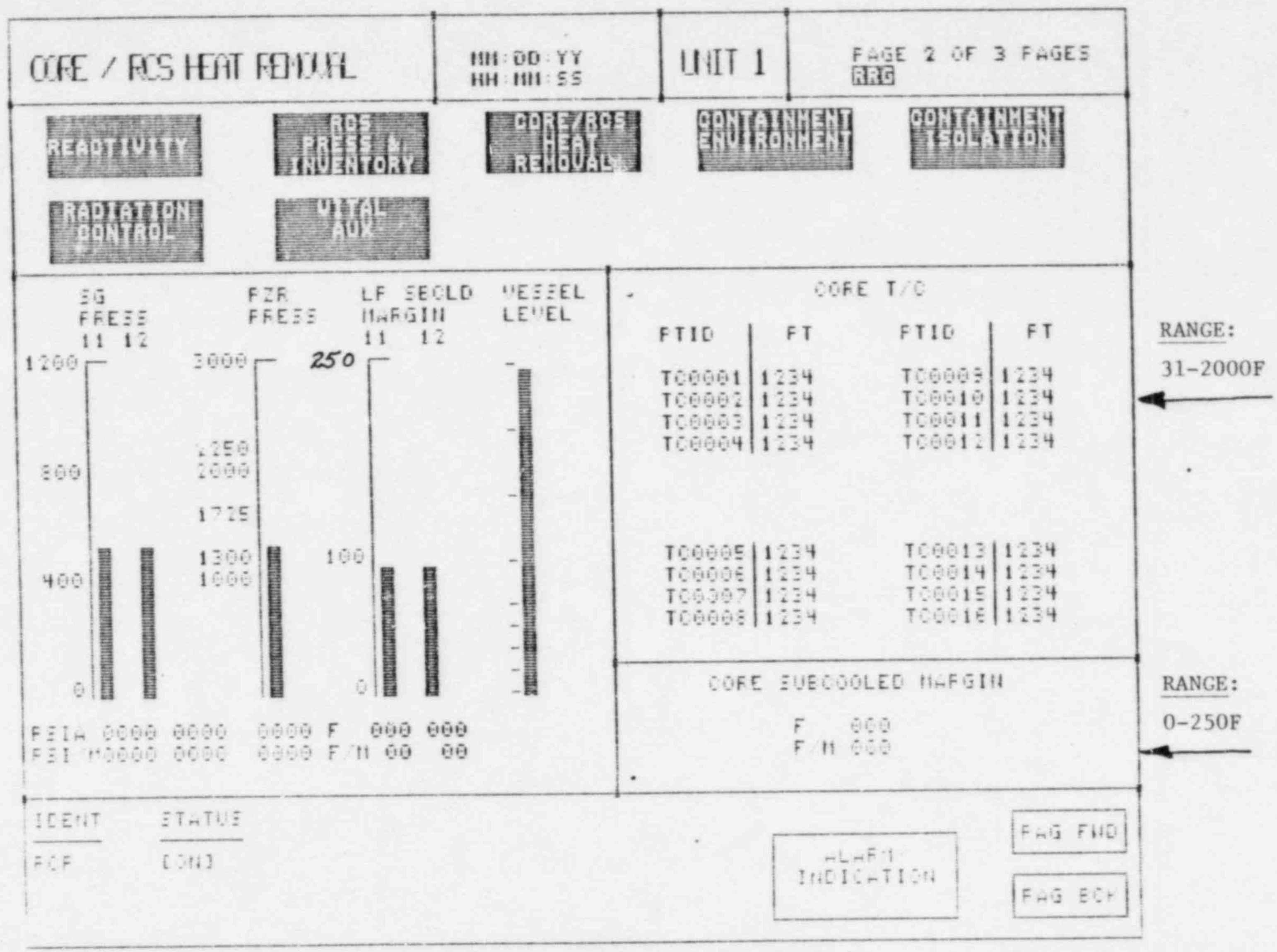
Poke point to access lower level pages for tables with:

a) algorithm alarm gate status

VI. PAGING POKE POINTS

A - PAG FWD (Page Forward)
B - PAG BCK (Page Backward)

NOTE 1: VESSEL LEVEL INDICATION IS INVALID IF ANY RCP IS RUNNING OR A TROUBLE CHANNEL TRIP.


CORE / RCS HEAT REMOVAL
MM:DD:YY
HH:MM:SS
UNIT 1
PAGE 2 OF 3 PAGES
RRG
REACTIVITY
RCS PRESS & INVENTORY
CORE/RCS HEAT REMOVAL
CONTAINMENT ENVIRONMENT
CONTAINMENT ISOLATION
RADIATION CONTROL
VITAL AUX
SG PRESS 11 12
PZR PRESS
LP SBCLD MARGIN 11 12
VESSEL LEVEL
1200
800
400
0
3000
2250
2000
1725
1300
1000
250
100
0
PSIA 0000 0000 0000 F 000 000
PSI M0000 0000 0000 F/M 00 00
CORE T/C
FTID
FT
TC0001 1234
TC0002 1234
TC0003 1234
TC0004 1234
TC0009 1234
TC0010 1234
TC0011 1234
TC0012 1234
TC0005 1234
TC0006 1234
TC0007 1234
TC0008 1234
TC0013 1234
TC0014 1234
TC0015 1234
TC0016 1234
CORE SUBCOOLED MARGIN
F 000
F/M 000
IDENT
STATUS
RCP
[ON]
ALARM INDICATION
PAG FWD
PAG BCK
RANGE:
31-2000F
RANGE:
0-250F

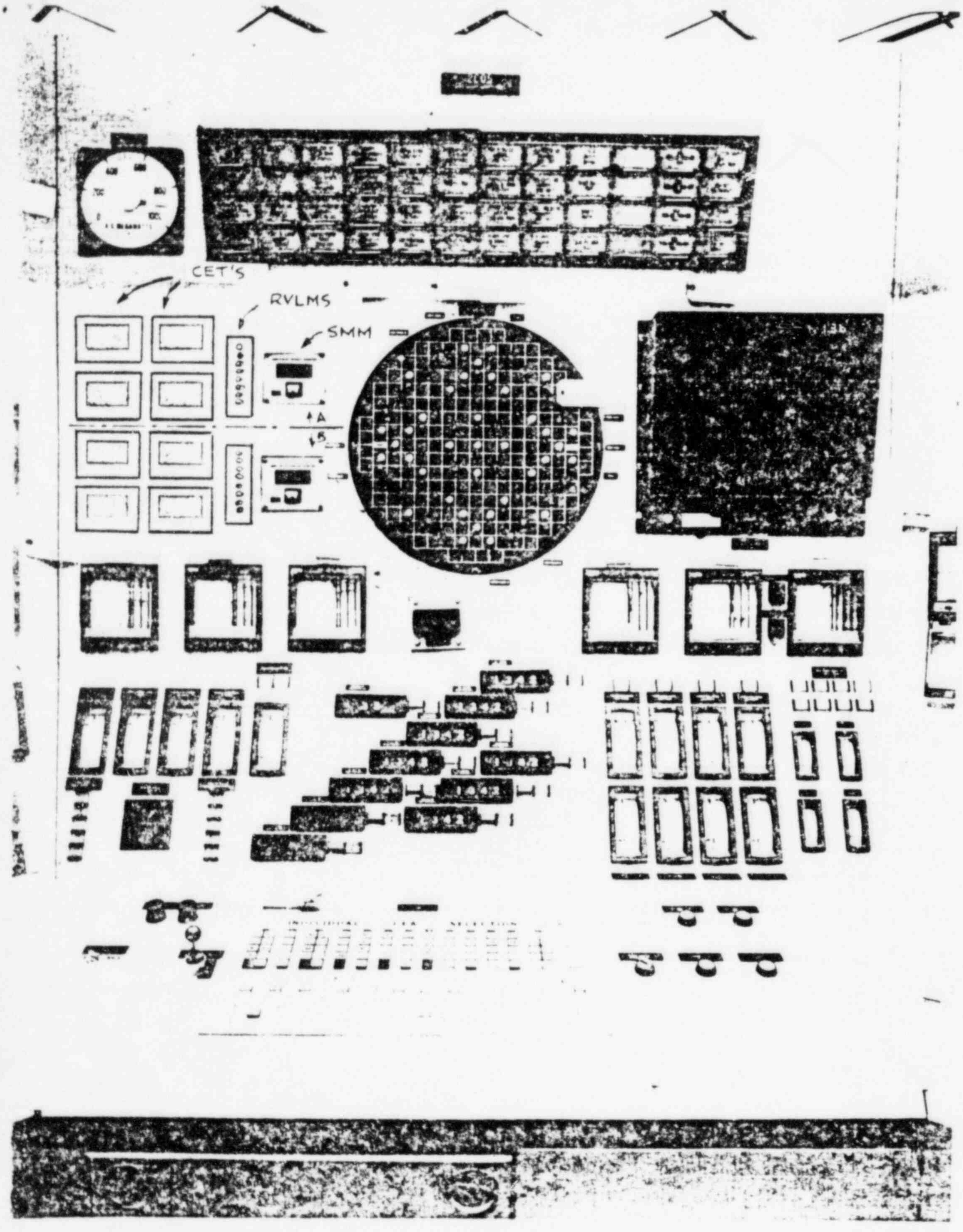


EXHIBIT G
TYPICAL INADEQUATE CORE COOLING DISPLAY
MAIN CONTROL BOARD SECTION 2C05

NRC GENERIC LETTER 82-28 CHECKLIST
NUREG-0737, ITEM II.F.2., REQUIREMENTS
CORE EXIT THERMOCOUPLE SYSTEM

For: Calvert Cliffs Nuclear Power Plant, Units 1 & 2

Docket Nos.: 50-317 and 50-318

Operated By: Baltimore Gas and Electric Company

Item	Reference (Sections refer to this report)	Deviations	Schedule
1. Description of the proposed system including:			
a. a final design description of additional instrumentation and displays;	Section 2.2	Yes	Complete
b. detailed description of existing instrumentation systems;	Section 2.1	No	Complete
c. description of completed or planned modifications.	Section 2.2	Yes	Complete
2. A design analysis and evaluation of inventory trend instrumentation and test data to support design in item 1.	A	No	Complete
3. Description of tests planned and results of tests completed for evaluation, qualification, and calibration of additional instrumentation.	Section 3	No	Complete
4. Provide a table or description covering the evaluation of conformance with NUREG-0737; II.F.2, Attachment 1 and Appendix B (to be reviewed on a plant specific basis)	See attached table	Yes	Complete

NRC GENERIC LETTER 82-28 CHECKLIST
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Docket Nos.: 50-317 and 50-318

Operated By: Baltimore Gas and Electric Company

Item	Reference (Sections refer to this report)	Deviations	Schedule
5. Describe computer, software and display functions associated with ICC monitoring in the plant.	Sections 2.2 and 4.1	Yes	Complete
6. Provide a proposed schedule for installation, testing, and calibration and implementation of any proposed new instrumentation or information displays.	See cover letter	Not Applicable	Complete
7. Describe guidelines for use of reactor coolant inventory tracking system, and analyses used to develop procedures.	A	No	Complete
8. Operator instructions in emergency operating procedures for ICC and how these procedures will be modified when final monitoring system is implemented.	Section 4.3	Yes	Complete
9. Provide a schedule for additional submittals required.	Not Applicable		

NRC GENERIC LETTER 82-28 CHECKLIST
NUREG-0737, ITEM 11.F.2., REQUIREMENTS
CORE EXIT THERMOCOUPLE SYSTEM

For: Calvert Cliffs Nuclear Power Plant, Units 1 & 2

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Operated By: Baltimore Gas and Electric Company

Evaluation of conformance with NUREG-0737: II.F.2 Attachment 1

Item	Reference
1. Provide diagram of core exit thermocouple locations or reference generic description if appropriate.	Section 2
2. Provide a description of the primary operator displays including:	
a. A diagram of the display panel layout for the core map and describe how it is implemented, e.g., hardware or CRT display.	Section 4.1 Note: Section 4.1 identifies no core map on the primary display which is a deviation.
b. Provide the range of the readouts	Section 4.1
c. Describe the alarm system.	Section 4.1
d. Describe how the ICC instrumentation readouts are arranged with respect to each other.	Section 4.1
3. Describe the implementation of the backup display(s) (including the subcooling margin monitors), how the thermocouples are selected, how they are checked for operability, and the range of the display.	Section 4.2

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Item	Reference
4. Describe the use of the primary and backup displays. What training will the operators have using the core exit thermocouple instrumentation? How will the operator know when to use the core exit thermocouples and when not to use them. Reference appropriate emergency operating guidelines where applicable.	Section 4.3
5. Confirm completion of control room design task analysis applicable to ICC instrumentation. Confirm that the core exit thermocouples meet the criteria of NUREG-0737 Attachment 1 and Appendix B, or identify and justify deviations.	Section 2.2 Section 4.1, 4.2, and 4.4. Note: Section 4.1 identifies no core map on the primary display which is a deviation.
6. Describe what parts of the systems are powered from the IE power sources used, and how isolation from non-IE equipment is provided. Describe the power supply for the primary display. Clearly delineate in two categories which hardware is included up to the isolation device and which is not.	Section 2.2.3
7. Confirm the environmental qualification of the core exit thermocouple instrumentation up to the isolation device.	Section 2.2.4

NRC GENERIC LETTER 82-28 CHECKLIST
NUREG-0737, ITEM II.F.2., REQUIREMENTS
CORE EXIT THERMOCOUPLE SYSTEM

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Operated By: Baltimore Gas and Electric Company

Response to Appendix B (of NUREG-0737, II.F.2)

Confirm explicitly the conformance to the Appendix B items listed below for the ICC instrumentation, i.e., the core exit thermocouples and the display systems.

Item	Reference	Deviations
1. Environmental qualification	Section 2.2.4	None
2. Single failure analysis	Section 2.2	None
3. Class 1E power source	Section 2.2.3	None
4. Availability prior to an accident	Section 2.2	None
5. Quality Assurance	B	None
6. Continuous indication	Section 2.2	None
7. Recording of instrument outputs	Section 2.2	None
8. Identification of instruments	Section 2.2	None
9. Isolation	Section 2.2.3	None

NRC GENERIC LETTER 82-28 CHECKLIST
NUREG-0737, ITEM II.F.2., REQUIREMENTS
CORE EXIT THERMOCOUPLE SYSTEM

For: Calvert Cliffs Nuclear Power Plant, Units 1 & 2

Docket Nos.: 50-317 and 50-318

Operated By: Baltimore Gas and Electric Company

REFERENCES

(A) Letter from A. E. Lundvall, Jr. (BG&E) to J. R. Miller (NRC) dated April 10, 1984, "Calvert Cliffs Nuclear Power Plant Units Nos. 1 & 2; Dockets Nos. 50-317 and 50-318, Reactor Vessel Level Monitoring System".

(B) BG&E Calvert Cliffs Nuclear Power Plant Units 1 & 2, Updated Final Safety Analysis Report, Section 1 B - Quality Assurance Program.

(C) Letter from A. E. Lundvall, Jr. (BG&E) to J. R. Miller (NRC) dated February 4, 1985, "Calvert Cliffs Nuclear Power Plant Units Nos. 1 & 2; Docket Nos. 50-317 and 50-318, Safety Parameter Display System (SPDS)".

(D) Letter from A. E. Lundvall, Jr. (BG&E) to J. R. Miller (NRC) dated March 14, 1984, "Calvert Cliffs Nuclear Power Plant Units Nos. 1 & 2; Dockets Nos. 50-317 and 50-318, Emergency Operating Procedures Upgrade".

Enclosure (2) to BG&E Letter to NRC dated July 1, 1985

DESIGN DESCRIPTION AND EVALUATION OF SUBCOOLED MARGIN MONITOR TO NUREG-0737, APPENDIX B CRITERIA

1. System Description

The Combustion Engineering Subcooled Margin Monitor (Model 001) is a microcomputer based instrument which uses reactor coolant process signals to continuously display the subcooled margin to saturation. The purpose of the system is to relieve the plant operator of the task of using steam tables along with reactor coolant pressure and temperature observations to determine the margin to saturation during abnormal or emergency operating conditions. The subcooled margin can be displayed in either temperature or pressure units on demand.

The SMM consists of temperature and pressure sensors and associated cabling inside containment, and a SMM calculator, display module and associated cabling outside containment. The display and calculator modules are shown in Figure 1. A system functional diagram is provided in Figure 2. The display modules are located on main control board panel 1/2 C05.

Temperature input is provided by redundant RCS cold leg and hot leg RTDs. The temperature sensors have an output range of 212° - 705°F. Pressure input is provided by redundant pressurizer pressure transmitters with an output range of 15 - 3208 psia. The SMM calculator is a dedicated digital process computer which selects the highest temperature and lowest pressure outputs to calculate margin to saturation, using steam tables. The display module has a range of 0 - 100°F of subcooling with an accuracy of 3.1°F. An automatic alarm will occur when subcooled margin drops below 50°F.

2.0 Evaluation of Subcooled Margin Monitor to NUREG-0737, Appendix B: Design and Qualification Criteria

NRC Generic Letter 82-28 requested an evaluation of the SMM for conformance with Criteria 1 through 9 of NUREG-0737, Appendix B. The following paragraphs discuss the conformance of the SMM with these criteria.

2.1 Environmental Qualification

The SMM is environmentally qualified in accordance with 10 CFR 50.49 to function before, durng and after all design basis events for which it is required.

2.2 Single Failure

The SMM consists of two redundant instrument loops. No single failure of instrumentation, auxiliary equipment, or power source will result in a loss of subcooled margin information to the operator.

2.3 Class 1E Power Source

Power for each SMM instrumentation loop is supplied from separate inverter fed, battery backed safety-grade sources.

2.4 Availability Prior to An Accident

Technical Specification 3/4.3.3.6, Post-Accident Monitoring Instrumentation, establishes availability requirements for the SMM.

2.5 Quality Assurance

The SMM is classified as safety-related an conforms with the requirements of the BG&E Quality Assurance Program as described in Section 1B of the Updated FSAR.

2.6 Continuous Indication

Displays are continuous on demand for either temperature or pressure margin.

2.7 Recording of Instrument Outputs

SMM output is recorded for trending purposes by the Technical Support Center (TSC) Computer. This information can be used by emergency response personnel assigned to the TSC to advise the control room operators on the approach to or recovery from inadequate core cooling conditions.

2.8 Identification of Instruments on Control Board

The Subcooled Margin Monitor is clearly identified on the main control board. Use of this instrumentation by operators following an accident is reviewed as part of periodic operator training.

2.9 Isolation Devices

Signal transmission to non-safety grade instrumentation for other uses is through qualified isolation devices.

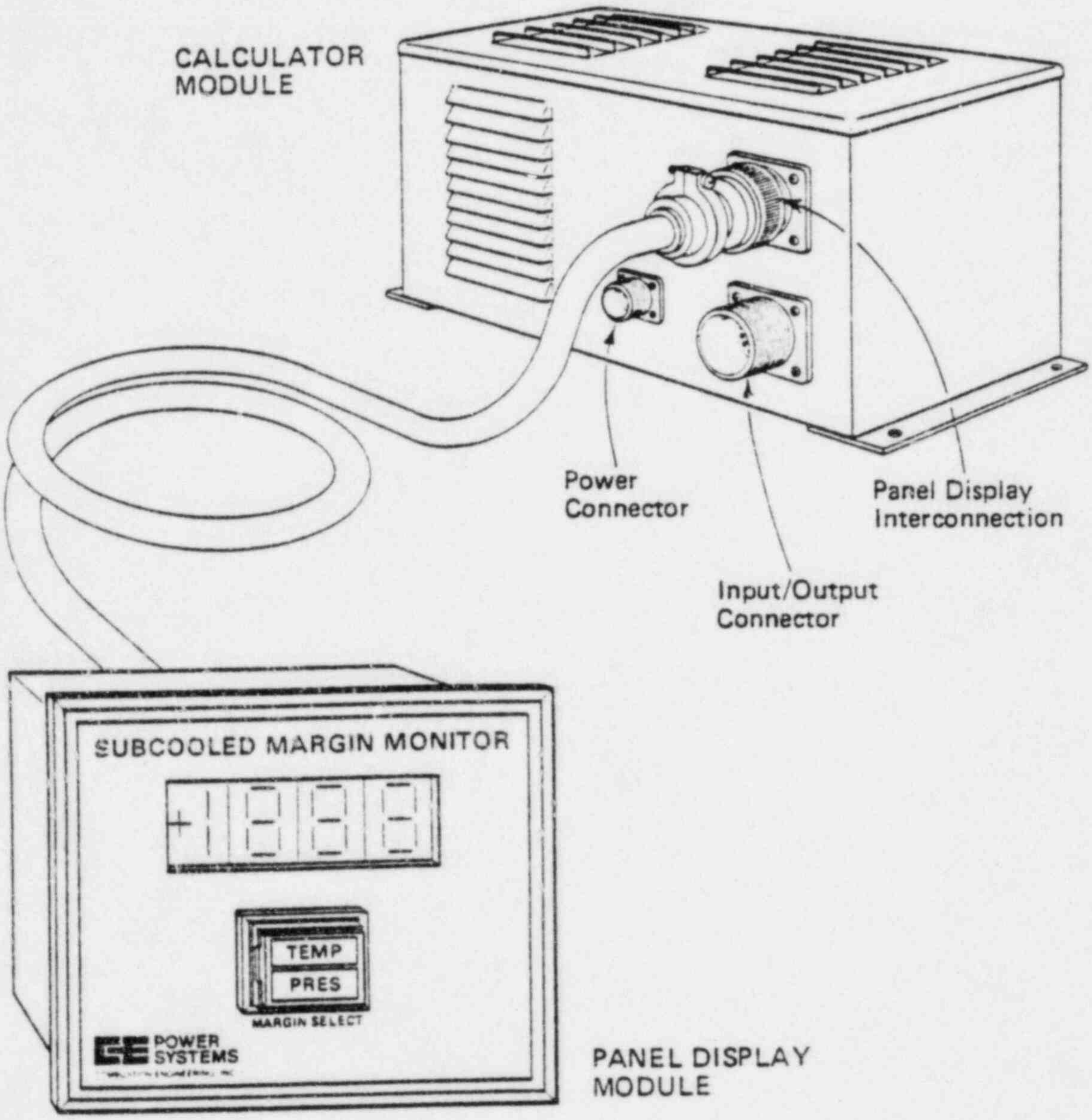

FIGURE 1 SUBCOOLED MARGIN MONITOR

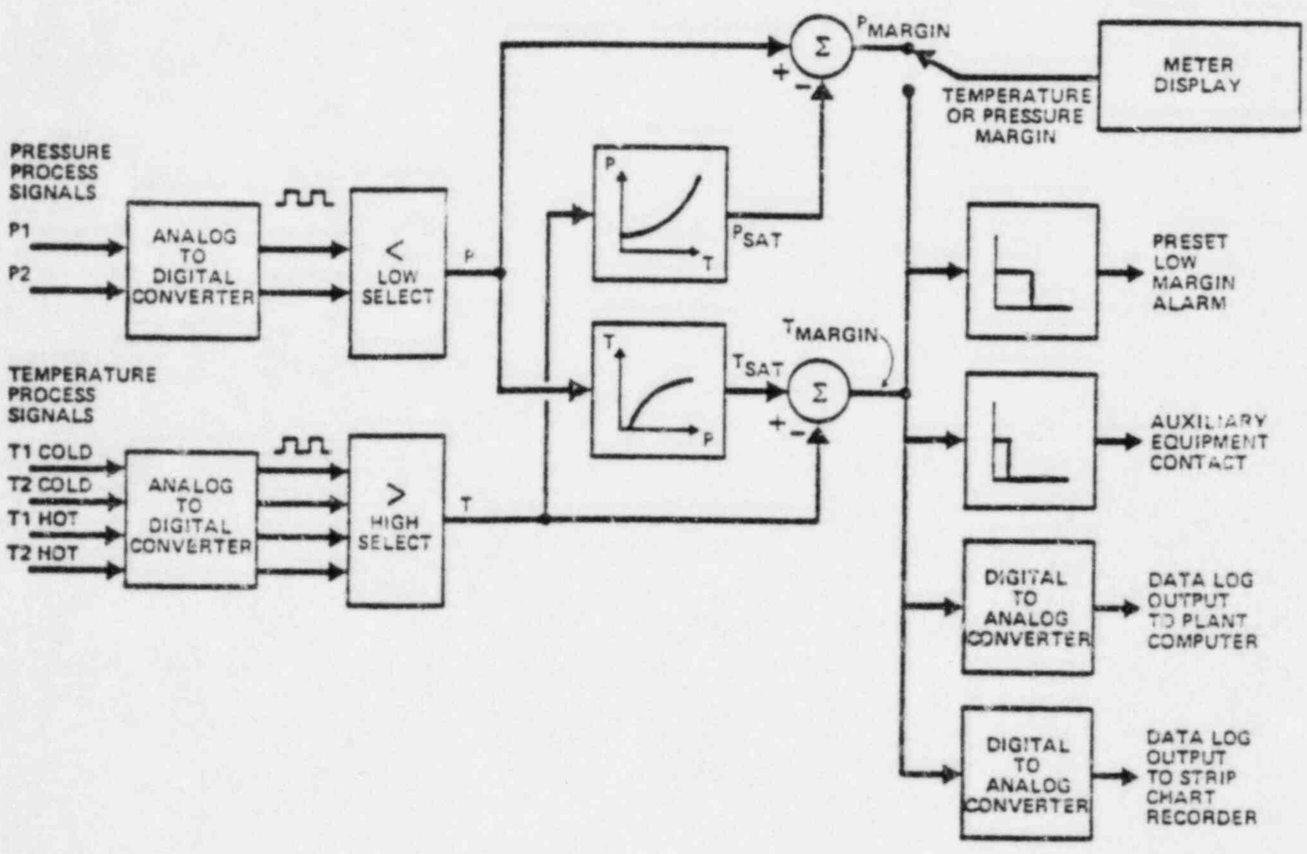

FIGURE 2 GENERALIZED FUNCTIONAL DIAGRAM