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September 20, 1988

Docket Nos. 50-348
50-364

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Gentlemen:

Joseph M. Farley Nuclear Plant - Units 1 and 2
Inadequate Core Cooling Instrumentation System
Generic Letter 82-28 and NUREG-0737, Item II.F.2
TAC Nos. 45132 and 45133

By letter dated December 10, 1982 the NRC issued Generic Letter 82-28, "Inadequate Core Cooling Instrumentation System". In this letter the NRC requested that Alabama Power Company take the necessary actions to complete the installation of an Inadequate Core Cooling (ICC) instrumentation system in accordance with Item II.F.2 of NUREG-0737. Alabama Power Company has submitted several responses to NUREG-0737 and Regulatory Guide 1.97 in the past that address core-exit temperature, subcooling margin, and reactor vessel water level. In letter dated April 2, 1984 the NRC Staff stated that the core-exit temperature system was evaluated and accepted based on the licensee's commitment to upgrade to meet environmental qualification requirements. The subcooling margin monitor design was approved in Supplement 5 of the Farley Safety Evaluation Report. This letter provides a description of the latest modifications to the ICC instrumentation and supersedes previous submittals to the NRC related to system description. Alabama Power Company hereby requests plant-specific approval of the reactor coolant inventory tracking system (RCITS) installed at Farley Nuclear Plant.

The ICC instrumentation supplied by Combustion Engineering includes a RCITS, a subcooling margin monitor, and core-exit temperature monitors. Alabama Power Company completed the installation, functional testing, and calibration of the RCITS during the Unit 1 seventh and Unit 2 fourth refueling outages. Final installation of the upgraded subcooling margin monitor and core-exit temperature monitor was completed during the Unit 2 fifth and Unit 1 eighth refueling outages. The subcooling monitor modification was not required as a result of the R.G. 1.97 review; however, this function is being included in the ICC cabinet for convenience.

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Alabama Power Company has completed all of the equipment upgrades needed to satisfy the requirements of Generic Letter 82-28 and NUREG-0737 Item II.F.2. Both the Units 1 and 2 RCITS are in use and available to the operators for familiarization and operator training; however, the RCITS will not be declared operable until plant-specific approval is obtained from the NRC. Revisions to the plant emergency operating procedures to incorporate the RCITS instrumentation will be prepared, and a task analysis will be performed using the plant simulator to validate these procedures. These revised procedures will be implemented upon receipt of plant-specific design and installation approval from the NRC. Existing plant emergency operating procedures include the use of core-exit temperature and the subcooling margin monitor. This sequence of implementation is consistent with the milestones stated in NRC letter dated April 2, 1984.

The technical guidelines for incorporating the RCITS into the plant-specific emergency operating procedures is provided by the Westinghouse Owner's Group generic emergency operating guidelines as modified by Westinghouse to reflect the Combustion Engineering heated junction thermocouple system. These technical guidelines are provided as Enclosure 2 of this letter. Alabama Power Company requests NRC approval of these guidelines for developing plant-specific emergency operating procedures.

A request for a change to the technical specification to incorporate the RCITS will be made by a separate letter in accordance with a schedule agreed to by the NRC project manager. Alabama Power Company will request in this submittal that implementation of the technical specification be deferred until: 1) resolution of a warranty claim with Combustion Engineering regarding three installed probes that have inoperable sensors is completed (currently scheduled for the Unit 1 9th and Unit 2 6th refueling outages); 2) procedure guidance provided as Enclosure 2 to this letter is approved by the NRC; 3) plant-specific approval of the RCITS is received from the NRC. Alabama Power Company will use the RCITS with prudence in relation to operator action until plant-specific approval has been obtained from the NRC. The three installed probes with inoperable sensors are the only known deviations from design expectations. The information provided herein is based on the current design; however, the ICC instrumentation may be modified in the future.

Provided as Attachment 1 to this letter is Alabama Power Company's response to the Appendix to Generic Letter 82-28. Attachment 2 responds to Enclosure 2 of the NRC letter dated April 2, 1984 which outlines the milestones for implementation of the RCITS.

If there are any questions, please advise.

Respectfully submitted,

ALABAMA POWER COMPANY

W. G. Hairston, III

WGH,III/BHW:dst-TS7

Attachments

cc: Mr. L. B. Long
Dr. J. N. Grace
Mr. E. A. Reeves
Mr. G. F. Maxwell

ATTACHMENT 1

Checklist
for Plant-Specific Review of
Inadequate Core Cooling (ICC) Instrumentation System

For J. M. Farley Nuclear Plant - Units 1 & 2 **Docket No.** 50-348, 50-364

Operated by: Alabama Power Company

The following items for review are taken from NUREG-0737, pp II.F.2-3, and 4. Responses should be made to full requirements in NUREG-0737, not abbreviated forms below. Applicants should provide reference to either the applicant's submittal or the generic description under the column labled "Reference." These items are required to be reviewed on a plant specific basis by NUREG-0737 for all plants. Differences from the generic descriptions provided by Westinghouse, the Westinghouse Owner's Group, Combustion Engineering, or Combustion Engineering Owner's Group must be indicated by "yes or no" in the column labled deviations and must be justified. Under the Column labeled schedule, either indicate that your documentation of the item is complete or provide a proposed schedule for your submittal.

	Reference	Deviations	Schedule
1. Description of the proposed final system including:			
a. a final design description of additional instrumentation and displays;	Enclosure 1	No	Complete
b. detailed description of existing instrumentation systems.	Enclosure 1	No	Complete
c. description of completed or planned modifications.	Enclosure 1	No	Complete
2. A design analysis and evaluation of inventory trend instrumentation, and test data to support design in item 1.	CEN-185, Supplements 1, 2, and 3*	No	Complete
3. Description of tests planned and results of tests completed for evaluation, qualification, and calibration of additional instrumentation.	CEN-185, Supplements 1, 2, and 3*	No	Complete

*CEN-185 with Supplements 1, 2, and 3 were transmitted to the NRC by Combustion Engineering owner's group letters dated September 15, 1981; November 25, 1981; and September 30, 1982.

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)*	CEN-185 * (Section 8)	No	Complete
5. Describe computer, software and display functions associated with ICC monitoring in the plant.	Enclosure 1	No	Complete
6. Provide a proposed schedule for installation, testing and calibration and implementation of any proposed new instrumentation or information displays.	Safety Parameter Display System (SPDS)	No	See Alabama Power Company letter to NRC dated December 1, 1987
7. Describe guidelines for use of reactor coolant inventory tracking system, and analyses used to develop procedures.	Enclosure 2 & Attachment 2 Item 2	No	Complete
8. Operator instructions in emergency operating procedures for ICC and how these procedures will be modified when final monitoring system is implemented.	See Cover Letter		
9. Provide a schedule for additional submittals required**	Technical Specification		(See Cover Letter)

II.F.2 Attachment 1 (for Core Exit Thermocouples)

In response to item 4 in the above checklist, the following materials should be included to show that the proposed system meets the design and qualification criteria for the core exit thermocouple system.

1. Provide diagram of core exit thermocouple locations or reference the generic description if appropriate. (See Enclosure 3)

2. Provide a description of the primary operator displays including: (See Enclosure 3)
   a. A diagram of the display panel layout for the core map and description of how it is implemented, e.g., hardware or CRT display.
   b. Provide the range of the readouts.
   c. Describe the alarm system.
   d. Describe how the ICC instrumentation readouts are arranged with respect to each other.

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. (See Enclosure 3)

4. Describe the use of the primary and backup displays. What training will the operators have in 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. (See Enclosure 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. (See Enclosures 3, 4, 5 and Alabama Power Company letter to NRC dated December 29, 1986.)

6. Describe what parts of the systems are powered from the 1E power sources used, and how isolation from non-1E 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. (See Enclosures 3 and 5.)

7. Confirm the environmental qualification of the core exit thermocouple instrumentation up to the isolation device. (See Enclosure 3)

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 SMM, the reactor coolant inventory tracking system, the core exit thermocouples and the display systems.

	Reference	Deviations
1. Environmental qualification	See Enclosure 5	None
2. Single failure analysis	See Enclosure 5	None
3. Class 1E power source	See Enclosure 5	None
4. Availability prior to an accident	See Enclosure 5	None
5. Quality Assurance	See Enclosure 5	None
6. Continuous indications	See Enclosure 5	None
7. Recording of instrument outputs	See Enclosure 5	None
8. Identification of instruments	See Enclosure 5	None
9. Isolation	See Enclosure 5	None

**For the users of either Combustion Engineering Heated Junction Thermocouple (HJTC) System or Westinghouse Differential Pressure (dp) system a detailed response to the plant specific items stated below should be provided.

	Reference	Deviations
A. Westinghouse dp System		
1. Describe the effect of instrument uncertainties on the measurement of level.	N/A	
2. Are the differential pressure transducers located outside containment?	N/A	
3. Are hydraulic isolators and sensors included in the impulse lines?	N/A	
B. CE HJTC System		
1. Discuss the spacing of the sensors from the core alignment plate to the top of the reactor vessel head. How would the decrease in resolution due to the loss of a single sensor affect the ability of the system to detect an approach to ICC?	See Enclosure 6	None

ATTACHMENT 2

Provided below are Alabama Power Company's responses to the milestones for implementation of ICC instrumentation as outlined in Enclosure 2 of NRC letter dated April 2, 1984:

Item 1

Submit final design description (by licensee) (complete the documentation requirements of NUREG-0737, Item II.F.2, including all plant-specific information items identified in applicable NRC evaluation reports for generic approved systems).

Response

A complete description of the final design of the ICC instrumentation system, along with the complete documentation of NUREG-0737, Item II.F.2, is being provided in Enclosure 1 of this letter.

Item 2

Approval of emergency operating procedure (EOP) technical guidelines (by NRC).

Response

The Farley-specific emergency operating procedures for the RCITS will be based upon the generic emergency operating guidelines that were submitted to the NRC by the Westinghouse Owner's Group (WOG) and subsequently approved for implementation. However, the WOG generic guidelines reflect the Westinghouse differential pressure level indication system. Alabama Power Company requested Westinghouse to prepare emergency operating procedure guidelines for the Combustion Engineering heated junction thermocouple system that is installed at Farley. These technical guidelines were prepared and reviewed by the same persons within Westinghouse that participated in the preparation of the Westinghouse Owner's Group generic guidelines. Alabama Power Company requests approval from the NRC to use the technical guidelines included as Enclosure 2 for developing plant-specific emergency operating procedures that reflect the heated junction thermocouple system. Farley-specific emergency operating procedures for the RCITS will be prepared, validated on the plant simulator, and implemented upon receipt of plant-specific design and installation approval from the NRC.

Item 3

Inventory Tracking Systems (ITS) installation complete (by licensee).

Response

The RCITS was installed in Farley Unit 1 during the seventh refueling outage and in Unit 2 during the fourth refueling outage.

Item 4

ITS functional testing and calibration complete (by licensee).

Response

The RCITS was functionally tested and calibrated at the factory before shipment to the site and again after installation for both units.

Item 5

Prepare revisions to plant operating procedures and emergency procedures based on approved EOP guidelines (by licensee).

Response

The plant emergency operating procedures will be revised to incorporate the RCITS based upon the Westinghouse technical guidelines (Enclosure 2), if approved by the NRC. (See response to Item 2.)

Item 6

Implementation letter report to NRC (by licensee).

Response

The cover letter addresses the issues specified in the NRC April 2, 1984 letter for Implementation Letter Report Content. (See Item 2 above for EOP technical guidelines.) Test results are available on site for NRC review.

Item 7

Perform procedure walk-through to complete task analysis portion of ICC system design (by licensee).

Response

A task analysis will be performed on the RCITS utilizing the revised emergency operating procedures. These procedures will be validated on the plant simulator which reflects the plant control room configuration.

Item 8

Turn on system for operator training and familiarization.

Response

The RCITS has been installed in the control room for the past cycle for both units. The system will be used with prudence by the operators until plant-specific design and installation approval is obtained from the NRC.

Item 9

Approval of plant-specific installation (by NRC).

Response

Alabama Power Company requests plant-specific approval of the RCITS installed at Farley Nuclear Plant.

Item 10

Implement modified operating procedures and emergency procedures (by licensee).

Response

The revised plant-specific emergency operating procedures will be implemented upon receipt of plant-specific design and installation approval from the NRC. Alabama Power Company requests approval of the Westinghouse technical guidelines for developing emergency operating procedures that reflect the heated junction thermocouple system (Enclosure 2).

ENCLOSURE 1

Inadequate Core Cooling System Description

I. Introduction

The Inadequate Core Cooling (ICC) Monitoring System is a safety grade processing and display system which meets the NRC requirements to provide the capability to monitor the approach to, existence of, and recovery from potential reactor core inadequate cooling situations. The requirements addressed by the ICC Monitoring System are defined in Paragraph II.F.2 of NUREG 0737 "Clarification of TMI Action Plan" and Generic Letter 82-28. Inadequate core cooling monitoring requirements are met by measuring and displaying margin to saturation, reactor vessel water level above the core, and core exit temperatures.

The objectives of the ICC Monitoring System include:

- Inadequate reactor core cooling instrumentation signal processing and isplav.
- Class 1E control room display of inadequate reactor core cooling instrument signals.
- Isolation and data linking of 1E signals to the Safety Parameter Display System.
- Upgrading the existing core exit thermocouple system to meet Class 1E requirements.
- Instrumentation to provide the capability for direct monitoring of the reactor coolant inventory inside the reactor vessel.

II. Description of RCITS

A. Design Features of RCITS

The Heated Junction Thermocouple System (HJTCS) is designed as a simple, reliable, accident monitoring instrumentation system with the intent of providing information to the plant operator concerning reactor coolant inventory in the reactor vessel. Major design features are as follows:

- Designed to Safety Grade Class 1E requirements.
- Installed in the reactor vessel to provide the capability of measuring coolant inventory in the reactor vessel.
- Designed to minimize handling during refueling operations.
- Designed with no moving parts.
- Designed with no in-containment electronic components.
- Designed to allow testing of system availability during plant operation.

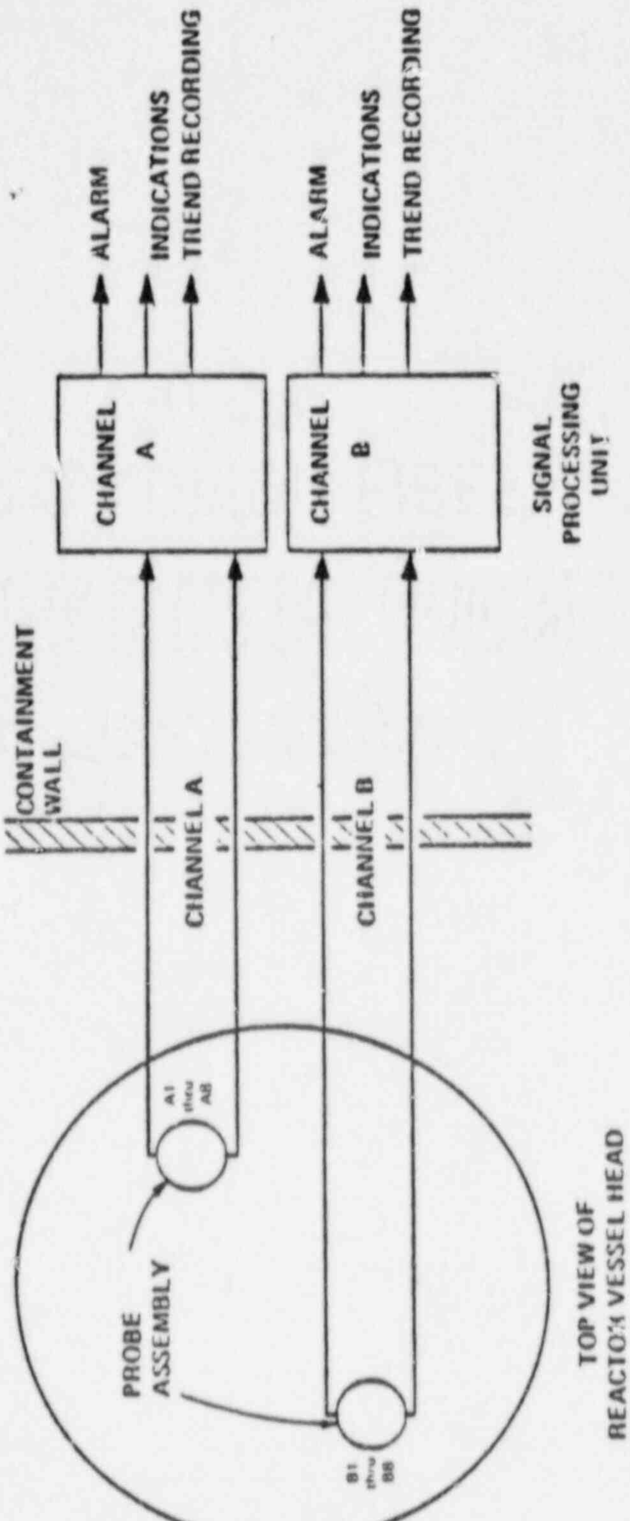
B. System Configuration

The overall system functional configuration is shown in Figure 1. As indicated in the figure, the system consists of two (2) independent safety channels. Each channel consists of one probe assembly, cabling, signal processing equipment, and an operator interface (display). Probe assemblies are located in the upper guide structure of the reactor vessel. Signal processing equipment and operator interfaces are located outside of containment. The cabling connects the HJTC probes to the signal processing equipment.

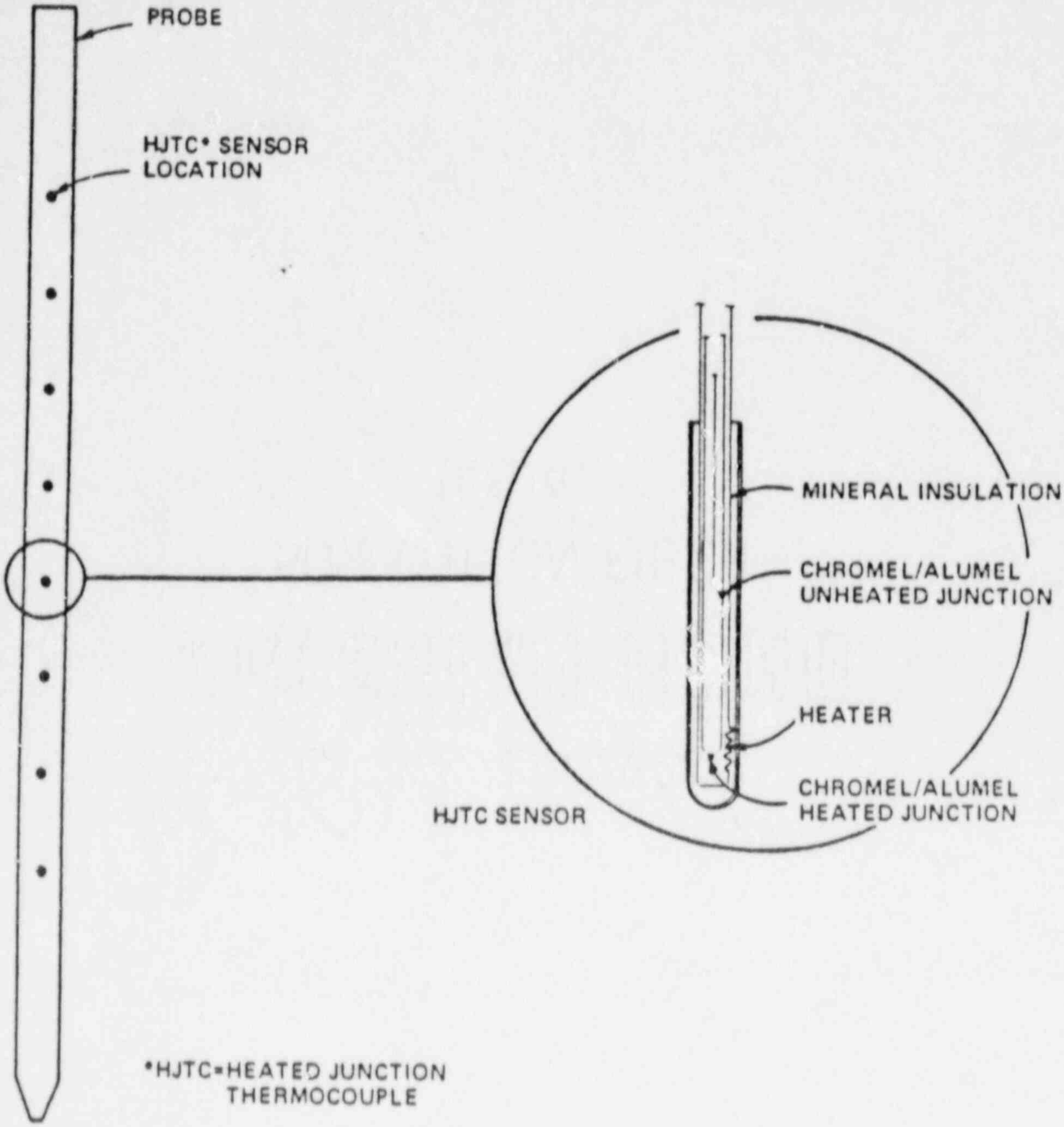
a. Probe Assemblies

The HJTCS measures reactor coolant liquid inventory with discrete HJTC sensors located at different levels within a separator tube running from the top of the core to the reactor vessel head. The basic principle of system operation is the detection of a temperature difference between adjacent heated and unheated thermocouples.

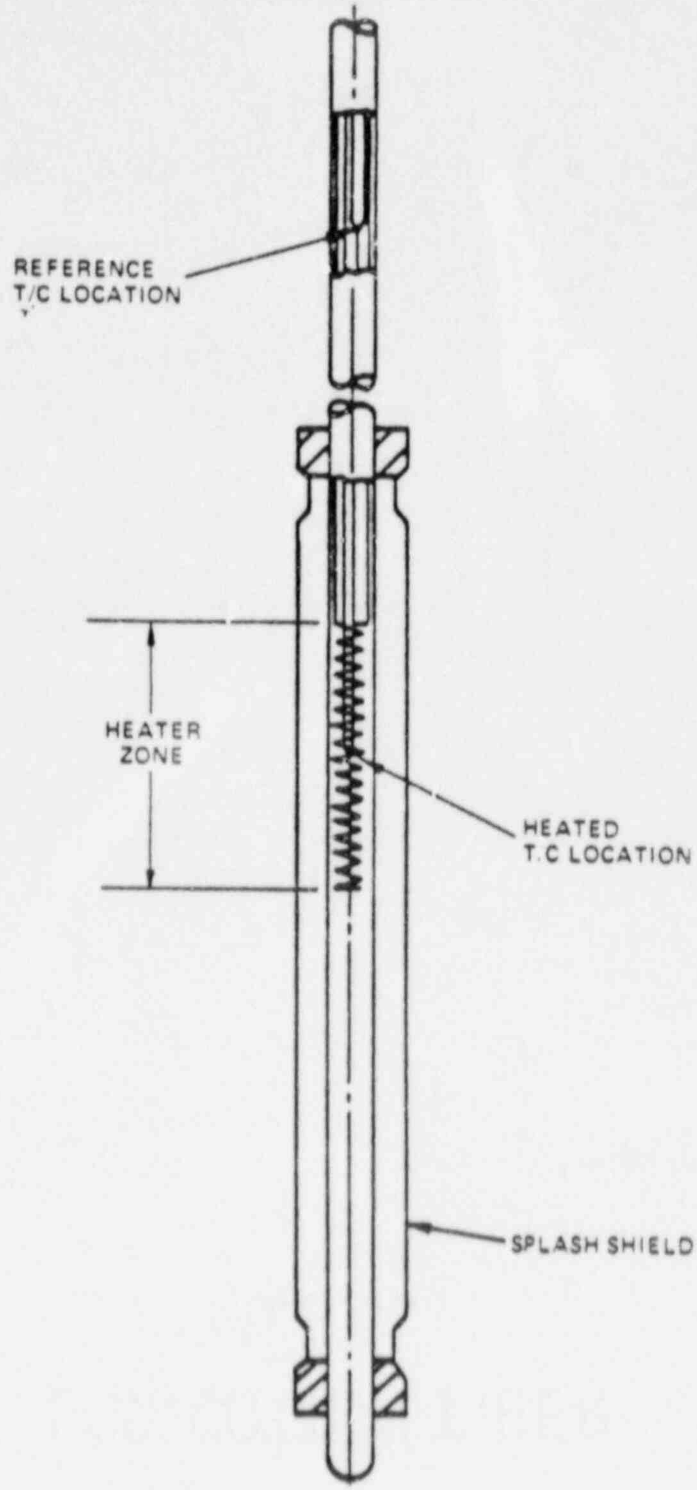
As pictured in Figures 2 and 3, the HJTC sensor consists of a Chromel-Alumel thermocouple near a heater (or heated junction) and another Chromel-Alumel thermocouple positioned away from the heater (or unheated junction). In a fluid with relatively good heat transfer properties, the temperature difference between the thermocouple is large.



POWER SYSTEMS COMBUSTION ENGINEERING, INC	HJTCS FUNCTIONAL CONFIGURATION	Figure 1



POWER SYSTEMS COMBUSTION ENGINEERING INC	TYPICAL PROBE/SENSOR CONFIGURATION	Figure 2



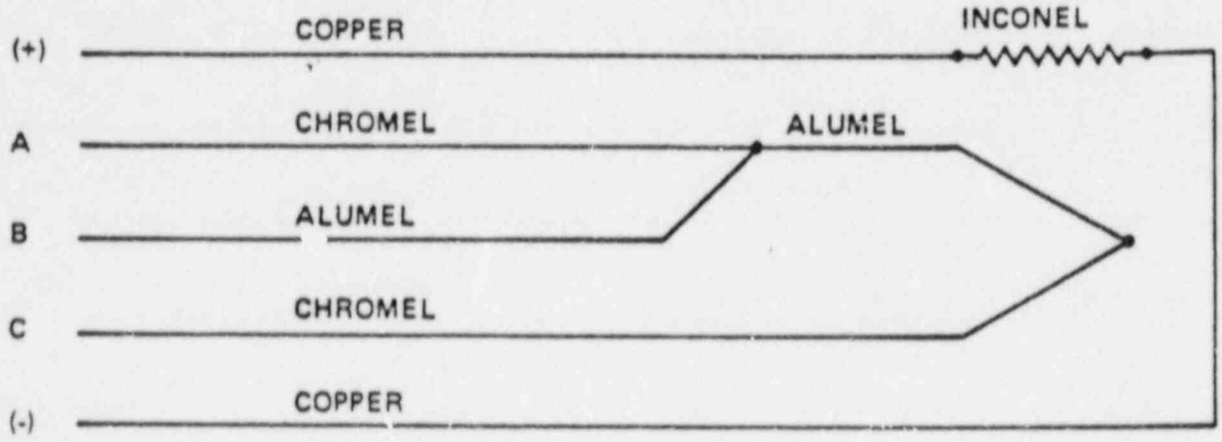
POWER SYSTEMS COMBUSTION ENGINEERING INC	HJTC SENSOR - HJTC/SPLASH SHIELD	Figure 3

Two design features are provided to improve operation of the HJTC System. First, each HJTC is shielded to avoid overcooling due to direct water contact during two phase fluid conditions. The HJTC with the splash shield is referred to as the HJTC sensor (see Figure 3). Second, a string of HJTC sensors is enclosed in a tube that separates the liquid and gas phases that surround it.

The separator tube creates a collapsed liquid level that the HJTC sensors measure. The collapsed liquid level can be related to the average liquid fraction of the fluid in the reactor head volume above the upper fuel alignment plate. This mode of direct in-vessel sensing reduces spurious effects due to pressure, fluid properties, and non-homogeneities of the fluid medium. The string of HJTC sensors and the separator tube are referred to as the HJTC probe assembly.

b. Signal Processing

The heated and unheated thermocouples in the HJTC are connected in such a way that absolute and differential temperature signals are available. This is shown in Figure 4. When water surrounds the heated and unheated thermocouples, their temperature and voltage outputs are approximately equal. $V_{(A-C)}$ on Figure 4 is, therefore, approximately zero. In the absence of liquid, the heated and unheated thermocouple temperatures and output voltages become unequal, causing $V_{(A-C)}$ to rise.



V (A - B) = ABSOLUTE TEMPERATURE, UNHEATED JUNCTION
V (C - B) = ABSOLUTE TEMPERATURE, HEATED JUNCTION
V (A - C) = DIFFERENTIAL TEMPERATURE

POWER SYSTEMS COMBUSTION ENGINEERING, INC.	ELECTRICAL DIAGRAM OF HJTC	Figure 4

The voltage output for each HJTC is processed by a microprocessor based system performing the following signal processing, surveillance, and heater power control functions:

- Provides indication of the collapsed liquid level above the core alignment plate.
- Provides a level output signal for trend recording to the operator via the SPDS (or pen recorder if desired).
- Provides temperature indications of coolant in the upper plenum.
- Provides test features for performing HJTCS operability and diagnostics.
- Provides on-line surveillance of HJTCS to access operability.
- Provides control of heater voltage to minimize HJTC internal heating after uncovery.

c. Operator Interface

The HJTCS operator interface consists of an output indicator mounted on the cabinet, one 2 channel MCB vessel mimic, an output to a trend recorder, and an alarm output to the plant annunciator system. The level indication consists of a panel insert for a digital panel meter and an LED mimic that is capable of displaying the percent level of the steam-water interface above the upper core alignment plate as indicated by the HJTC Probe assembly. The plant annunciator system alerts the operator that an ICC instrumentation channel has failed. Fiber-optic data links are also provided for transmission of HJTCS data to the SPDS.

C. RCITS Hardware Description

A diagram showing the HJTCS hardware configuration for two channels is provided in Figure 1. Additionally, a functional block diagram for the HJTCS is shown in Figure 5. The hardware consists of the following major components: (1) sensing equipment, (2) signal processing equipment, (3) heater power controllers, (4) indicators and controllers, (5) serial fiber-optic data links, and (6) in-containment cable.

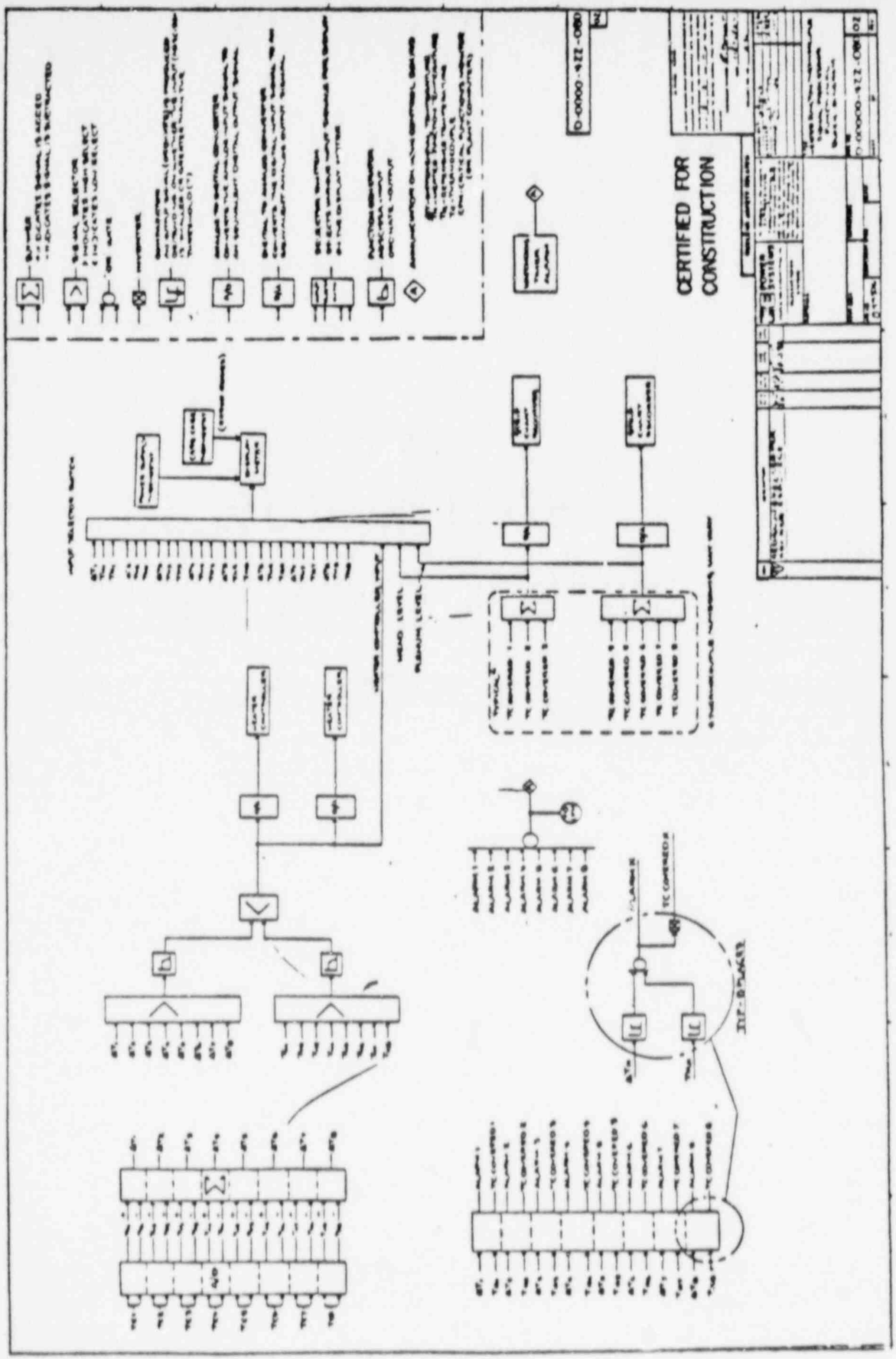
1. Sensing Equipment

The HJTCS is composed of two channels of HJTC instruments. Each HJTC instrument channel is manufactured into a probe assembly consisting of eight (8) HJTC sensors, a seal plug, and electrical connectors (Figure 6). The eight (8) HJTC sensors are physically independent. They are located at eight levels extending from the reactor vessel head to the upper core alignment plate. The probe pressure retaining parts are designed using ASME Boiler and Pressure Vessel Code (BPVC) techniques. However, the probe is not a Code stamped item since the code excludes instruments and small diameter fittings from the rules of the Code.

The probe assembly is housed in a stainless steel probe holder support tube that protects the sensors from flow loads and serves as the guide path for the sensors.

2. Signal Processing Equipment

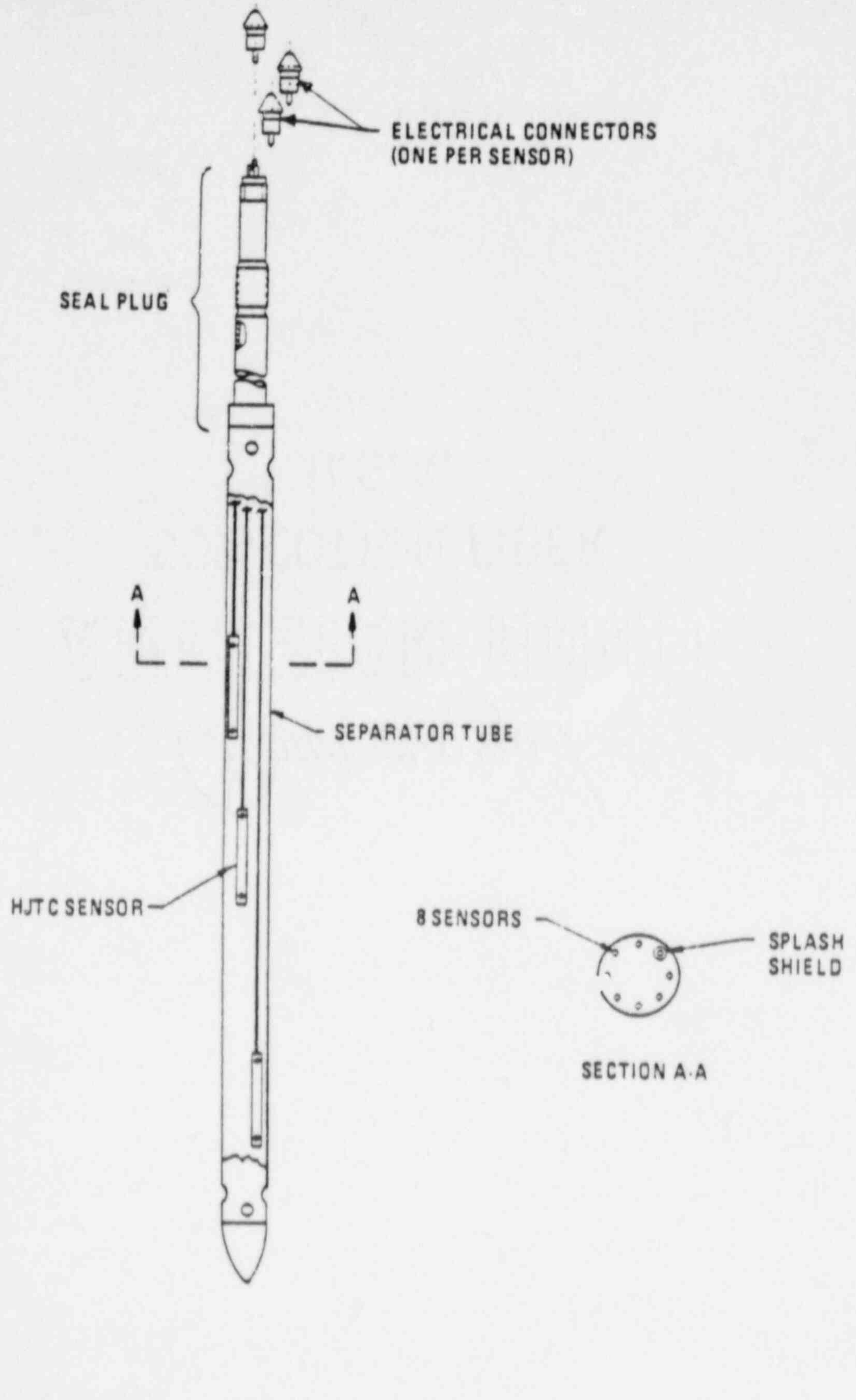
Signal processing is performed by a microprocessor system. The system also controls heater power and performs on-line surveillance to determine open thermocouples and heater operability. The signal processor receives millivolt inputs from each of the eight (8) HJTC sensors. The device then processes these inputs and



POWER SYSTEMS
COMBUSTION ENGINEERING INC

HJTC SIGNAL PROCESSOR
FUNCTIONAL BLOCK DIAGRAM

Figure 5



POWER SYSTEMS COMBUSTION ENGINEERING INC	HEATED JUNCTION THERMOCOUPLE PROBE ASSEMBLY	Figure 6

provides the following outputs: (a) level and temperature signals to the panel insert (display), (b) a level signal output for trend recording via the SPDS, (c) a signal to the plant annunciator system, (d) a signal to the heater controllers to modulate heater voltage after uncovery, and (e) output signals to APCo's SPDS via fiber-optic data links (Described in Paragraph 5 below).

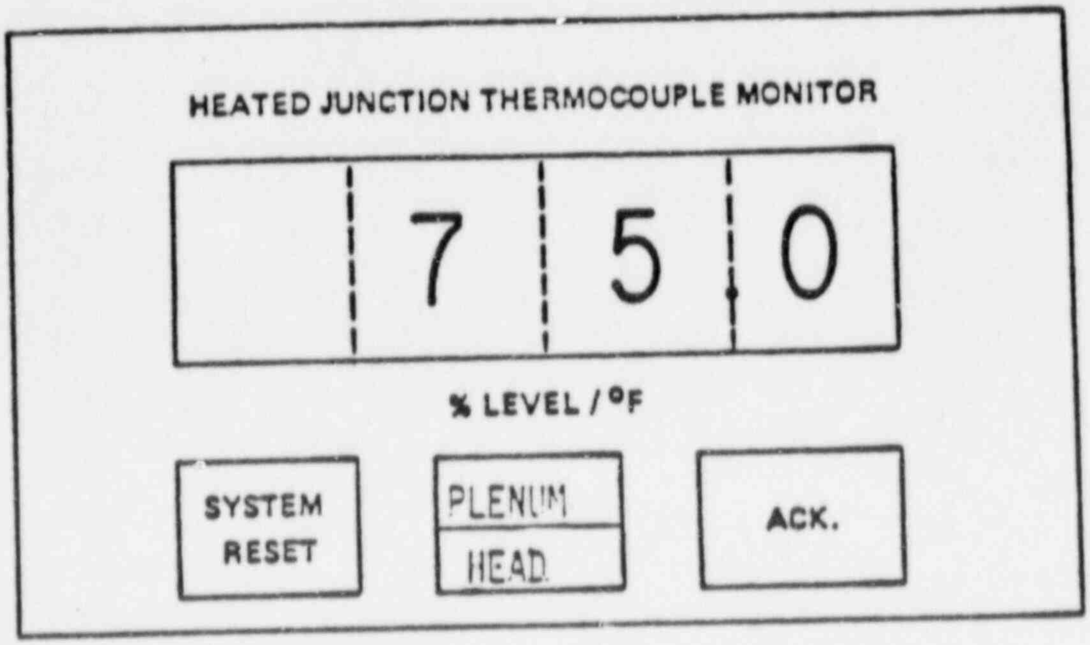
The signal processing equipment is qualified to mild environment conditions and is installed in the control room.

3. Heater Power Control

In each channel, two heater controllers supply power to the HJTC heaters. Each heater controller serves a series group of four heaters.

4. Indicators and Recorders

The output of the signal processor is sent to a Class 1E seismically qualified panel mounted insert and MCB mimic. A signal processor output is provided for trend recording via the SPDS. The panel mounted insert (Figure 7) will display percent level (above the core), provide for alarm indication, and, upon operator request, can display the temperatures of each individual thermocouple. The digital display will be mounted on the microprocessor cabinet. A mimic display (LED lights) is provided on the control board that indicates the status of each of the eight HJTC sensors in each channel (i.e., covered with liquid or uncovered). Figure 8 provides a schematic of the mimic display. The mimic display dimensions are 7 1/2" x 10".



CE POWER SYSTEMS
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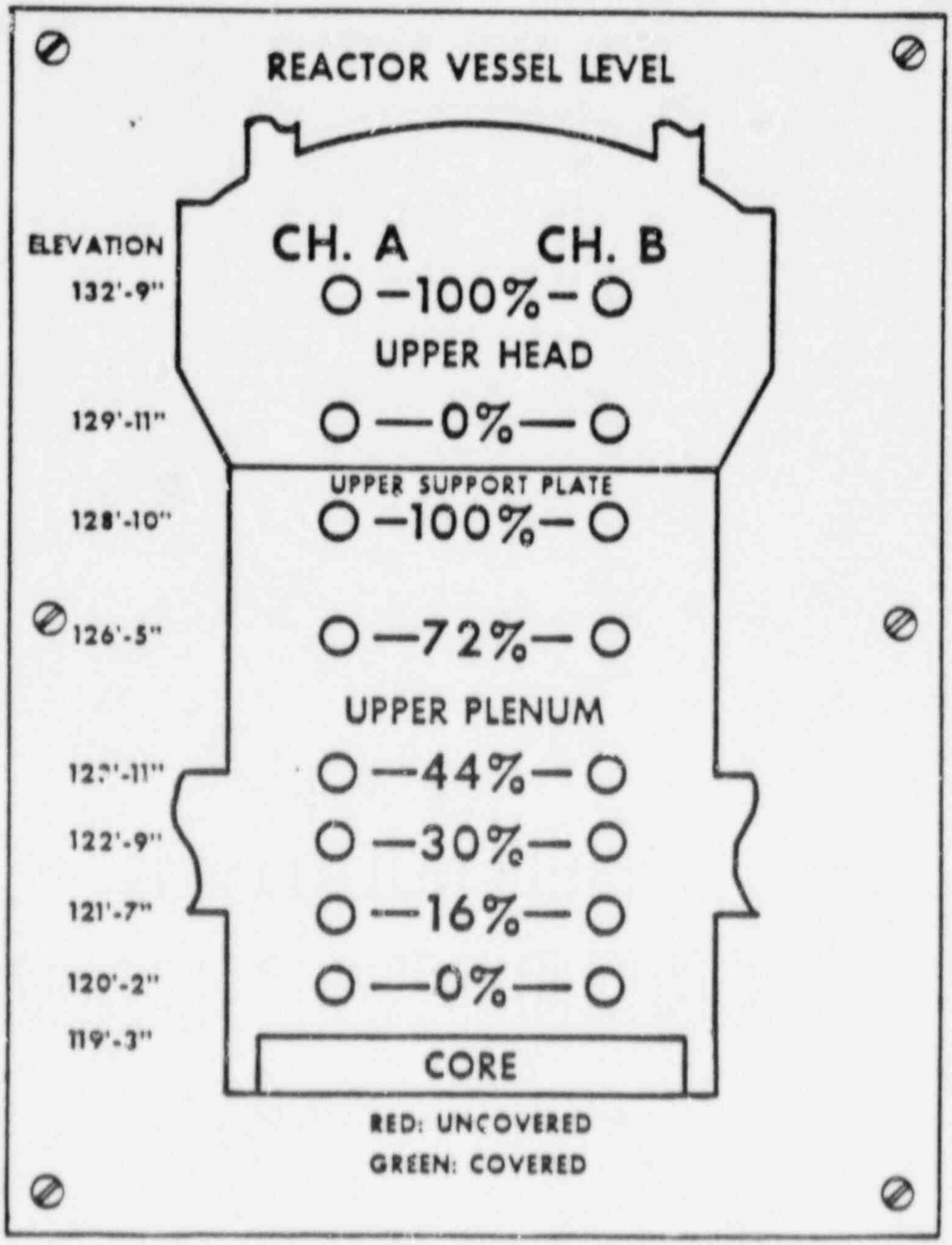
HJTC PANEL DISPLAY

Figure 7



CE POWER SYSTEMS COMBUSTION ENGINEERING INC	REACTOR VESSEL LEVEL LED MIMIC DISPLAY	Figure 8

5. Serial Data Link to the SPDS Computer System

The HJTC includes a serial, asynchronous data link to the SPDS computer. The transmission between the HJTC and the receiving computer will be via fiber-optic cable which provides qualified Class 1E isolation. Interface between the data link and the receiving computer will be via a standard RS-232 modem.

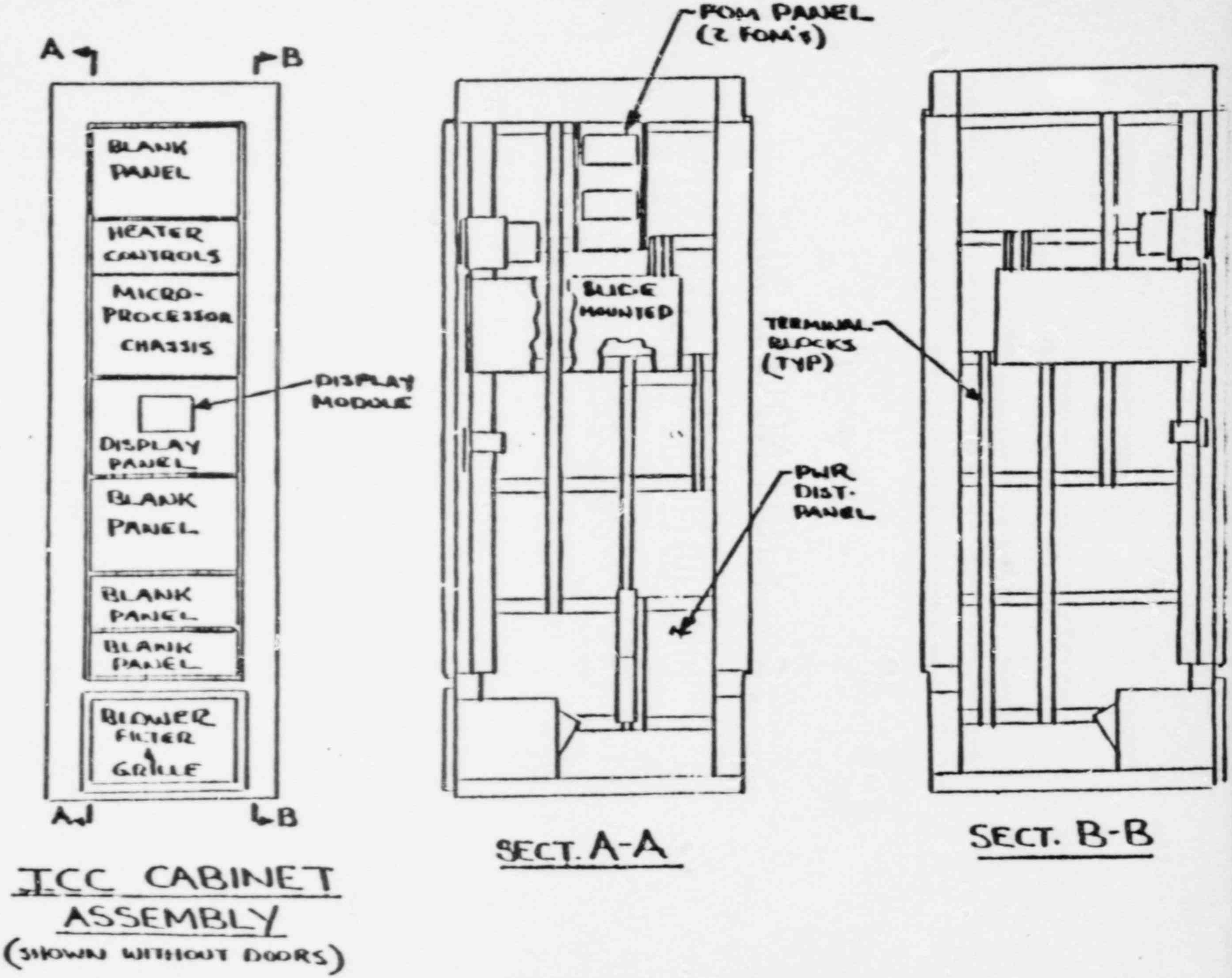
The HJTC software can transmit the following data: heated, unheated, and differential temperatures; reactor vessel levels; representative upper head temperatures; heater control signals; and the status of the reactor vessel level at each level.

6. ICC Monitoring System Cabinet Assembly

Two (2) pre-wired, single bay cabinets (one for each channel) are provided for the ICC Monitoring system to house the signal processing equipment, heater power controllers, and serial data links. Each cabinet is 30" wide by 36" deep by 90" high. The cabinets are designed for both top (removable top coverplates) and bottom cable entry. The cabinet front doors permit viewing of the cabinet mounted HJTC display module when closed. Figure 9 shows the ICC cabinet configuration. The cabinets contain the processing hardware and signal terminations for SMM and CET functions. The ICCMS power requirements are 115 VAC ± 10%, 60 Hz ± 10%, 12 amps maximum, and 6 amps nominal. The ICCS heat load is 7,000 BTU/HR.

7. HJTC Probe Holder Support Tube

The probe holder support tubes provide the guidance and support for the HJTC probe assemblies. They are located in two (2) guide path shrouds. The location of the guide path shroud is in a spare Rod cluster control guide tube position. The probe holder support tubes



POWER SYSTEMS
COMBUSTION ENGINEERING INC

ICC CABINET CONFIGURATION

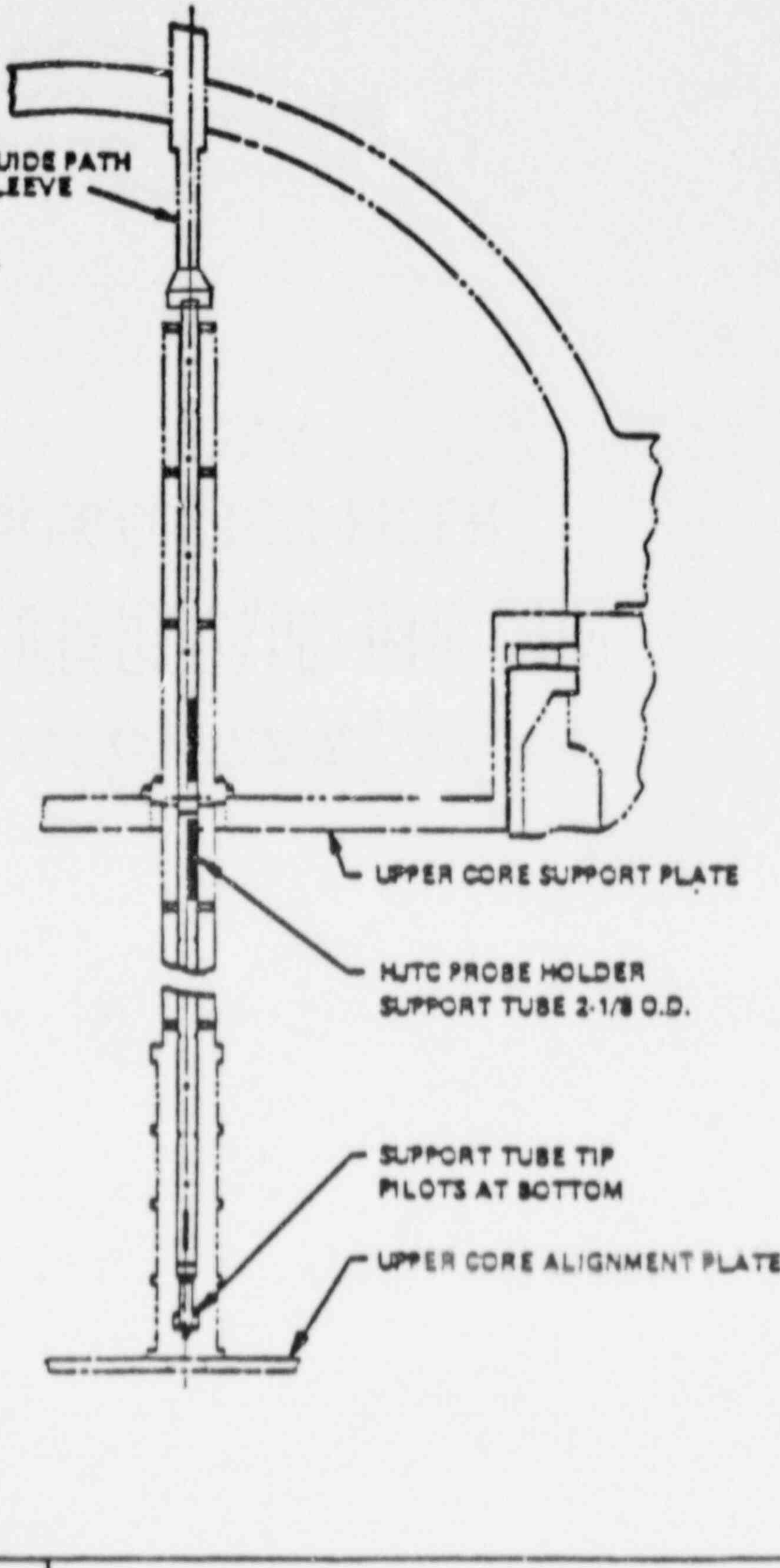
Figure 9

are attached to the interior of the guide path shroud structure that is conceptually identical to an existing rod cluster control guide tube. The probe holder assembly (see Figure 10), consisting of the guide path shroud and the probe holder support tube, is installed in the upper core support structure by removing a cover plate from the upper core support plate and the currently installed rod control cluster guide tube from the upper core support structure and then installing the probe holder assembly in the position newly made available. The installed probe holder assembly is held in place utilizing the bolting and locking arrangement employed in the original design of the upper core support structure. The probe holder assembly, in essence, simply replaces the rod cluster control guide tube and rod cluster control drive shaft.

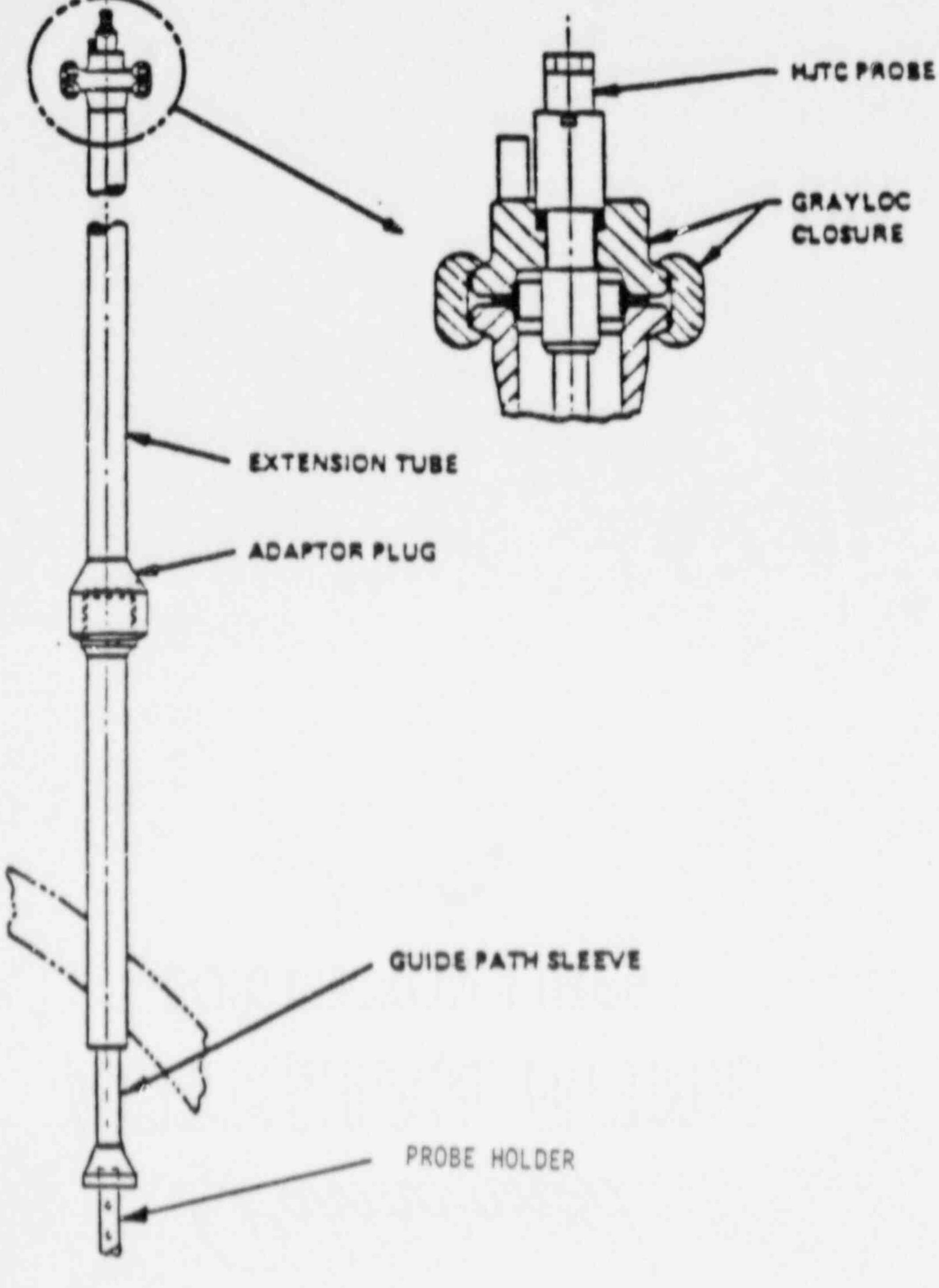
The probe holder assemblies have been judiciously located in positions such that the normal and postulated accident loadings on the probe holder are acceptable. The probe holder assembly is defined as an internal structure in accordance with ASME Boiler and Pressure Vessel Code Subsection NG requirements and was fabricated to these requirements. The structural analysis to verify conformance to the stress and deflection criteria was completed for the vessel and head modifications and probe installation.

8. Reactor Pressure Boundary Modifications

Modification of the reactor vessel head pressure boundary at two spare control element drive mechanism locations was required to form a penetration for each of the two HJTC probe assemblies. Figure 11 shows the required configuration.



POWER SYSTEMS COMBUSTION ENGINEERING, INC	HJTC PROBE HOLDER SUPPORT TUBE INSTALLATION	Figure 10



POWER SYSTEMS COMBUSTION ENGINEERING INC	HJTC PROBE PRESSURE BOUNDARY INSTALLATION	Figure 11

The Farley Units 1 and 2 HJTC nozzles are located near the periphery of the array of head nozzles and are therefore accessible at a low elevation. A capped latch housing extension, that mates to the reactor head nozzle in the same fashion as the existing closure and that extends upward, was welded to the quick disconnect Grayloc closure assembly. The quick disconnect Grayloc closure was welded to the capped latch housing extension to form the HJTC pressure boundary assembly. The blind hub of the flange set is configured to accept the HJTC probe seal plug and packing rings. It also contains a vent plug to ensure proper venting of the nozzle. The thermal sleeve extends downward into the head area and overlaps the upper section of the probe holder, thereby shadowing the probe from direct cross flow.

The design of the Grayloc flange is such that the HJTC probe assemblies can be removed or installed through the penetration without removing the reactor vessel head.

9. HJTC Handling Hardware

The length of the HJTC probes is approximately twenty-five feet. As a result, outages in which the reactor vessel head is removed will require that the probe be separated from the head. This is accomplished by separating the Grayloc flange and by disconnecting the probe from the Grayloc blind hub. The probe electrical connectors are then covered with a leaktight bullet nose and the probes are left in the upper internals package during outages. Special handling equipment, other than the watertight bullet noses, is not required for the Farley Units because the probe assemblies are short enough to be left in the upper internals package.

10. Accuracy

The accuracy of the indicated temperature for the HJTCS is ± 7.6°F (RSS method) from 70°F to 530°F and ± 15°F at 1800°F. The accuracy between 530°F and 1800°F is a linear ramp between the accuracies defined above for these two temperatures. During and after design basis event conditions, the temperature indication accuracy is ± 23°F from 70°F to 530°F and ± 26.3°F at 1800°F.

The measurement accuracy described above accounts for all uncertainties within the instrument loop (i.e., the thermocouple and its accuracy, HJTCS cabling, signal processing, and display uncertainties).

D. RCITS In-Containment MI Cable Description

The cable provided was designed to meet the criteria specified and tests imposed by IEEE Standards 323-1974, 383-1974, and 344-1975 and 10CFR50.49.

Mineral Insulated Cable (MI Cable) is a 1/4 inch, stainless steel sheathed multi-conductor cable that is fully qualified to the post-accident environment at Farley Nuclear Plant. Copper wire is 18 gauge and Chromel-Alumel wire is 28 gauge. It is hermetically sealed through an all-welded construction technique and this, together with the inorganic materials used, provides a very high tolerance for abnormal temperatures and pressures and has minimal susceptibility to radiation damage. The cable has an inner copper liner used to reduce electromagnetic interference and is factory terminated with qualified, quick-disconnect type multipin connectors. The outer jacket consists of fully annealed stainless steel that may be formed into bends as tight as a 2" bend radius to facilitate installation. Mounting of the cable utilizes means identical to those used in instrument sensing lines.

1. Reactor Cavity Cable

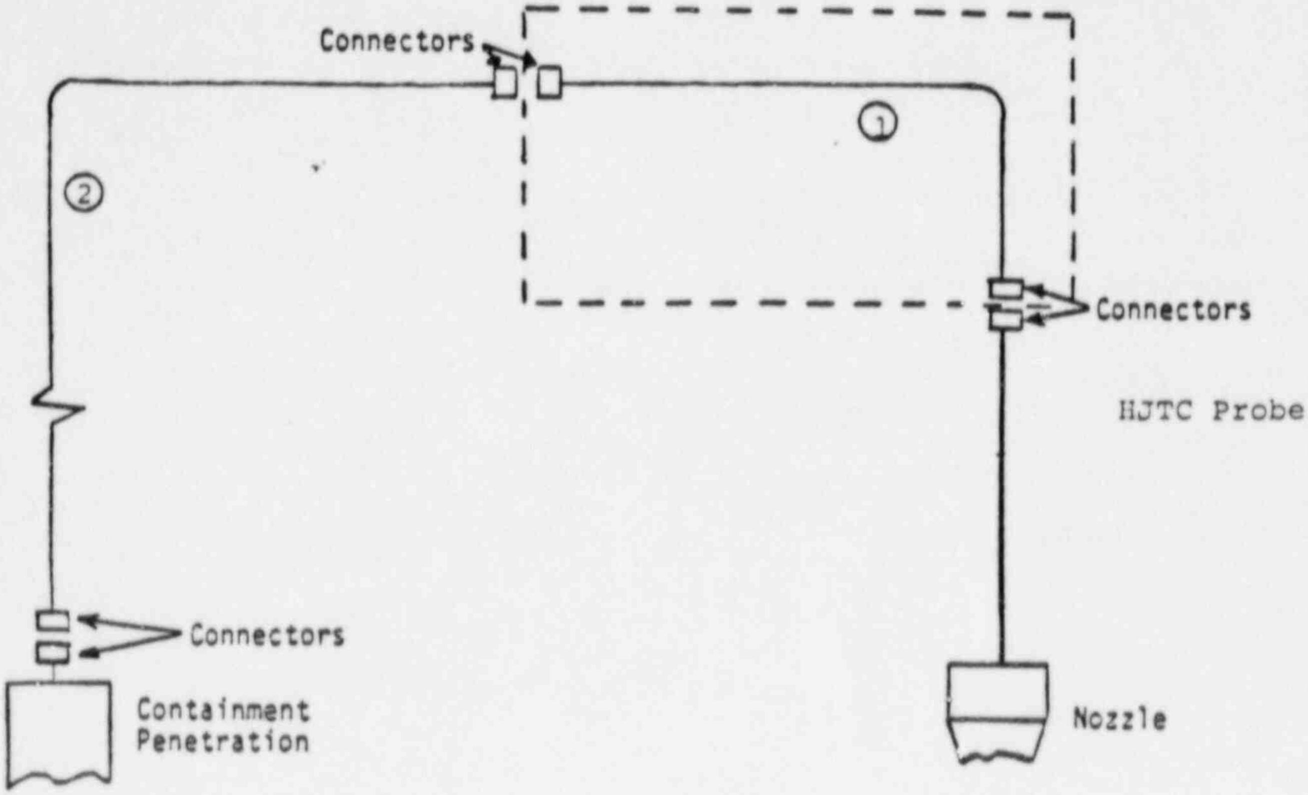
Each HJTC cable set is compriced of one cable section from the HJTC probe to the poolside disconnect panel. This set consists of sixteen (16) cables, one for each sensor in two (2) HJTC probes (See cable 1 of Figure 12). The cable is required to be supported every five (5) feet except at the connectors where a support within three (3) feet is required. For ease in routing the cable, all eight (8) cables of one train can be bundled together and routed as one group.

2. Containment Cable

Each cable is comprised of one section from the poolside disconnect panel to the containment penetration (refer to cable 2 of Figure 12). Routing and handling is the same as the reactor cavity cable described above. Mating half connectors that can be installed in penetration assemblies for containment penetrations are also included.

E. RCITS Software Description

The level logic is performed on each of the sensor reference junction and differential temperature signals in the channel. When the magnitude of both the sensor's differential output and reference junction output is less than their respective setpoints, the output from the level logic will indicate the presence of liquid at the respective sensor. If the magnitude of a sensor's differential output or reference junction output reaches or exceeds a high preset value, then the output signal from the level logic will indicate that the liquid level has dropped to a level lower than the respective sensor.



CABLE SECTION IDENTIFICATION

1. Cable to Pool-Side Disconnect
2. Cable to Penetration

Notes:

Each cable section consists of 5 wire cabling

------------ Refueling Disconnect Points

POWER SYSTEMS COMBUSTION ENGINEERING INC	HJTC MI CABLE LAYOUT	Figure 12

III. Description of CET System

A. Design Features of CET

The Core Exit Thermocouple (CET) System provides the transmission of thermocouple signals, signal processing and display to allow the operator to monitor core exit temperature. The cabling used to transmit signals is similar to RCITS cabling and may be routed with RCITS cabling. The signal processing is performed in the processor cabinet that also does the signal processing for RCITS. The digital display module is similar to that provided for RCITS.

B. Functional Description of CET

The CET data is provided to indicate and trend the core heatup in the event of a core uncovery and to indicate and trend the cooldown during subsequent core recovery. Fuel clad temperature is representative of core temperature. Due to thermal coupling between the cladding and liquid or steam temperature, it is sufficient to measure the temperature at the exit of the core to provide an indication of core temperature. The CET system uses the existing thermocouples located in the upper guide structure just above the core.

CET inputs are divided between the two channels so that each channel sees a representative distribution of CET temperatures.
Out-of-range thermocouple values can be manually defeated by the operator. From among the valid CET temperature indications, the highest CET temperature is calculated for display and for input to the SMM calculation. All CET temperatures are available for display on command. All CET temperatures will be data linked to the SPDS computer.

C. CET Hardware Description

The existing connectors of the individual thermocouples will be replaced with qualified hermetic connectors for mating with the mineral insulated cable connectors. This CET connector upgrade consists of removing the existing thermo-electric connectors and installing C-E's qualified twin pin connector. MI cable is used to carry the T/C signals from the reactor vessel head to the cont 'nment penetration.

Each CET cable set is comprised of 3 cable sections. The first cable section consists of a short transition cable which provides connectors for mating with the individual thermocouples. The leads from these connectors are combined into a single multi-connector cable, terminated at the top in a multipin connector (refer to cable 1 Figure 13). This cable section is designed to fit under the refueling bullet noses for the CET's so that during refueling operations only the multipin connector is disassembled leaving the twin pin CET connectors untouched. This results in reduced refueling time and man-rem exposure since only the multipin connectors need be disconnected instead of each CET twin pin connector. It also further reduces the potential of damage to the individual CET connectors. The second cable section is routed within the head area cable support structure and interfaces with the transmission cable and containment cable (refer to cable 2, Figure 13). This section is disconnected at both ends and removed from the head area cable support structure during refueling. A third, permanently installed, cable section will be provided to run from the poolside disconnect to the containment penetration. (Refer to cable 3, Figure 13).

The CET Processor is comprised of two independent and redundant channels (A and B) which meet the isolation and qualification standard for a Class 1E system. Each channel contains microcomputer-based electronics to process and display CET temperatures. The CET processor meets the seismic and environmental qualification criteria set forth in IEEE Standard 323-1974, IEEE Standard 344-1975, and 10CFR50.49. The system employs both a continuous, on-line diagnostic routine and on-demand calibration logic to ensure software reliability and hardware maintainability. The data link shall provide the SPDS with all CET values in a timeframe compatible with SPDS operation. The following describes the major instrumentation comprising the CET Processor.

1. Microprocessor chassis for processing all the Inputs/Outputs of the CET System, along with thermocouple reference junction temperatures for thermocouple compensation.

2. Fiber-optic RS232C data links (with fiber optic modems) for communications between the CET Processor and the SPDS. These data links meet the isolation requirements of IEEE-279.

3. Individual, dedicated digital panel meters, located on the main control board, are used for displaying CET parameters conveniently to the operator.

4. Class 1E contact alarm outputs and Class 1E analog trend recorder outputs for alarming and recording the highest valid CET temperature. (Analog outputs are not utilized since trending and alarms are indicated on the SPDS display.)

D. CET In-Containment MI Cable Description

1. Reactor Cavity Cable

Mineral Insulated (MI) Cable for the CET signals which is similar in construction to MI cable for the RCITS will be utilized.

Each CET cable set will carry signals from the thermocouples in sufficient quantity to monitor the number of core exit thermocouples as indicated below:

No. of Instrument Ports	4
No. of Thermocouples Per Port	12 & 13
Total No. of Thermocouples	51
Type of Cables	8 & 10 wire

Each reactor cavity CET cable set is comprised of 2 cable sections. Copper wire is 18 gauge and Chromel-Alumel wire is 28 gauge. The first cable section consists of a short section which provides connectors for mating with the individual thermocouple connectors. The leads from these connectors are combined into a single multi-connector cable, terminated at the top in a multipin connector (refer to cable 1 Figure 13). This cable section is designed to fit under the refueling CET bullet noses so that during refueling operations only the multipin connector is disassembled leaving the twin-pin CET connectors untouched. Bullet nose assemblies used to protect the CET connectors during refueling will be lengthened to accommodate the short first MI cable section. The second cable section provides the transition from the refueling bullet nose disconnect along the reactor cavity to the poolside disconnect (refer to cable 2 Figure 13). This section is disconnected at both ends during refueling and remains with the cable support structure.

Since the cable is semi-rigid, no external cable support structure is required for the short segment of this cable section which traverses the refueling cavity. A third section (beyond the reactor cavity) runs from the poolside disconnect to the containment penetration.

The existing connectors of the individual thermocouples will be replaced with qualified hermetic connectors for mating with the mineral insulated cable connectors. This CET connector upgrade consists of removing the existing Thermo-Electric type connectors and installing C-E's qualified twin-pin connectors that have been tested to meet the applicable post-accident containment environments.

2. Containment Cable

Each Mineral Insulated cable is comprised of one section from the poolside disconnect panel to the containment penetrations (refer to cable 3 of Figure 13). Routing and mounting is the same as for the HJTC containment cables.

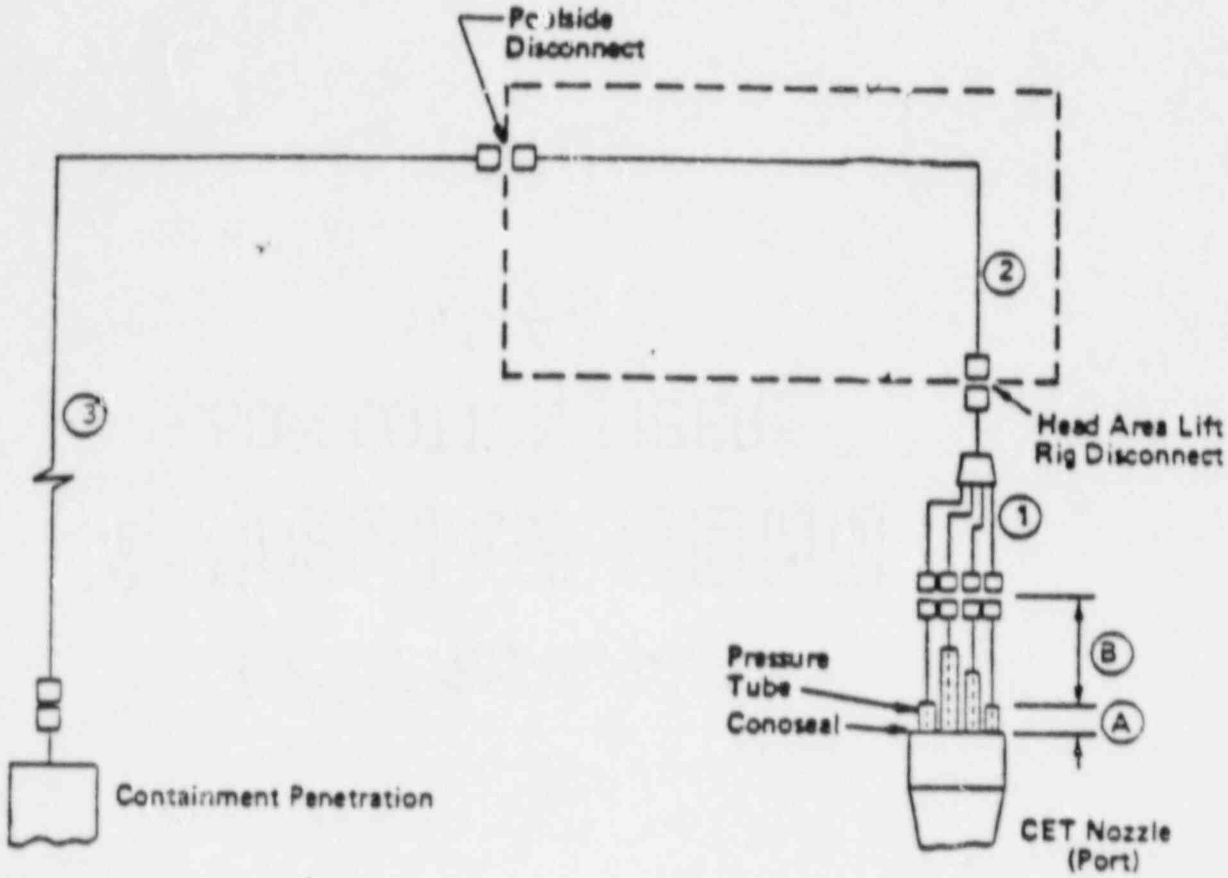
E. CET Software Description

The CET software consists of calculating the highest and next highest CET temperatures per quadrant and the highest CET temperature overall.

IV. Description of SMM

A. Design Features of SMM

The Subcooled Margin Monitor (SMM) is an on-line microcomputer based system which uses reactor coolant process signals to provide a continuous indication of the margin from saturation conditions. The



CABLE SECTION IDENTIFICATION

① Head Area Transition Cable

② Head Area Cable

③ Containment Cable

THERMOCOUPLE LEAD IDENTIFICATION

Ⓐ Pressure Tube

Ⓑ Exposed T/C Lead

NOTES:

CABLE ① GATHERS T/C LEADS FROM FOUR OR FIVE INDIVIDUAL CET ASSEMBLIES

EACH CABLE SECTION CONSISTS OF THE APPROPRIATE NUMBER OF 8 WIRE AND 10 WIRE CABLING

—— REFUELING DISCONNECT POINTS

POWER SYSTEMS COMBUSTION ENGINEERING INC	CET MI CABLE LAYOUT	Figure 13

SMM provides information for the operator to determine the loss of subcooled margin which is the first phase of an Inadequate Core Cooling scenario. In addition, active fuel uncovery is confirmed by the indication of superheated steam temperatures. The operator is provided continuous indication of either the pressure or temperature margin from saturation. The data-link will transfer all RCS pressures used in the algorithm to the SPDS.

B. Functional Description of SMM

The saturation temperature margin is the difference between the measured temperature of the reactor coolant and the saturation temperature. The saturation temperature is calculated from the minimum primary system pressure input. A maximum or representative temperature input is used for the measured value.

Temperature saturation margin calculations are performed for two major locations: 1) the highest primary loop RTD temperature and 2) a core exit temperature.

The operator can select (via a pushbutton) either RTD or CET saturation temperature margins for display at the operators display panel. All input temperatures and pressures will be available on operator command.

C. SMM Hardware Description

The Subcooled Margin Monitor consists of a digital display module, a microprocessor, plus the interconnecting cabling between the digital display and microprocessor. The panel display module face measures five inches wide by four and one quarter inches high. The microprocessor function is integrated into the ICCMS microprocessor.

The SMM provides outputs to alarms and trend recorders as well as data links to the SPDS. (Analog outputs are not utilized since trending and alarms are indicated on the SPDS display.)

V. Integration of RCITS, CET and SMM into a Total ICCM System

A. Introduction

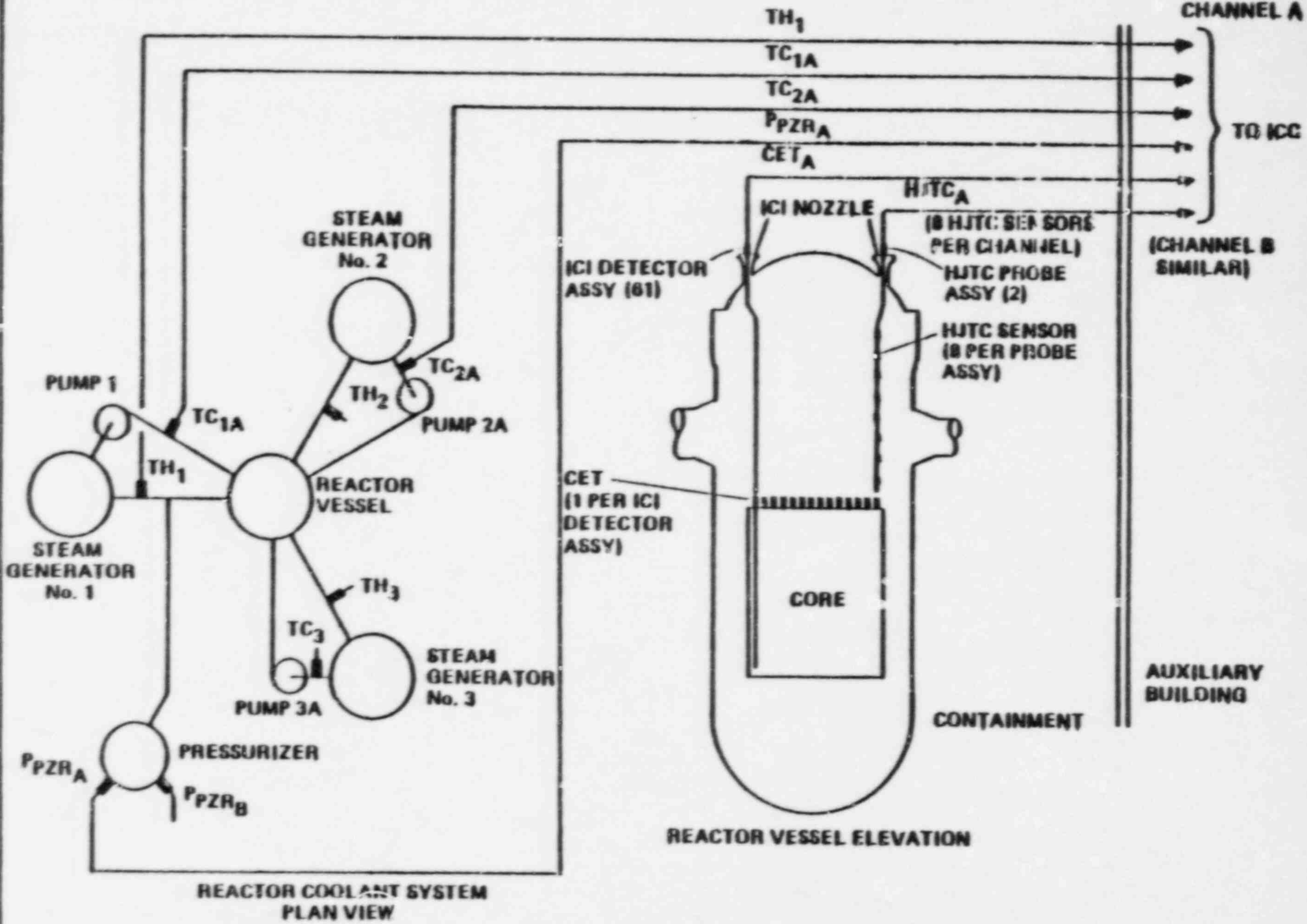
Inadequate Core Cooling (ICC) Monitoring System is a safety grade processing and display system which is qualified to Class 1E standards. The ICC Monitoring System addresses the NUREG-0737 ICC instrumentation processing and display requirements. The ICC Monitoring System design has been verified and tested to Class 1E criteria to ensure that the required standards of hardware and software reliability are achieved.

The main objectives of the ICC Monitoring System include:

- Class 1E inadequate reactor core cooling instrumentation signal processing
- Class 1E display of inadequate reactor core cooling instrument signals
- Isolation and data linking of Class 1E signals to Alabama Power Company's SPDS computers

The ICC Monitoring System processes Class 1E signals including those from: the SMM, the HJTCS, and CET's. The ICC Monitoring System will accommodate the types of thermocouple and RTD instrumentation used at Farley Nuclear Plant for ICC monitoring.

The ICC Monitoring System integrates the subcooled/superheat margin, reactor coolant inventory, and core exit temperature processing and display into one system. Figure 14 depicts the locations of the ICC sensor locations. Additionally, Table 1 provides the function, range, number of channels, and outputs for each ICC sensor.



CE POWER SYSTEMS
COMBUSTION ENGINEERING, INC.

SAMPLE LOCATIONS OF ICC SENSORS

Figure 14

TABLE 1

INADEQUATE CORE COOLING MONITORING SYSTEM PROCESSING AND DISPLAY

FUNCTION	SENSORS	PROCESSING RANGE	#/CHANNEL	OUTPUTS
Maximum HJTC Temperature	HJTC Unheated Junction Temperature	CRJ*-2300°F	1	1) Maximum Temperature.
Maximum CET Temperature	Individual CET Temperatures	CRJ*-2300°F	1	1) Maximum Temperature
Reactor Vessel Liquid Level (Top of core to top of head)	HJTC Probe Including: Heated Junction T/C Temp., Unheated Junction T/C Temperature; Differential Temp. (Level)	CRJ*-2300°F	16	1) Liquid level (Top of core to top of head) 2) HJTC Sensor Temperature 3) Maximum HJTC unheated junction temperature.
Core Exit Temperatures	Core Exit Thermocouples (CETC) Temperatures	CRJ*-2300°F	32 (maximum)	1) Individual CETC Temperatures 2) Maximum CETC Temperature
Saturation Margin	Hot Leg RTD Temp.	0-750 °F	3	1) RCS Loop Temperature margin (subcooled to superheat)
	Cold Leg RTD Temp.	0-750 °F	3	
	Max HJTC Unheated Junct. Temp.	CRJ*-2300°F	1	
	Maximum CET Temp.	CRJ*-2300°F	1	2) Core Exit Temperature Margin
	Pressurizer Pressure	1700-2500 psig	1	
	RCS Pressure	0-3000 psig	2	3) RCS Pressures (data link only)

*CRJ - Cold Reference Junction Thermocouple (Ambient Room Temperature of the Cabinet)

ENCLOSURE 2

Emergency Response Guidelines and Procedure Setpoints

for the Heated Junction Thermocouple System

at Farley Nuclear Plant

1. Try to Restart an RCP	
a. Check BOTH of the following HJTCS indications:	a. Perform the following:
1. Upper Head - (8)%	1. Increase PRZR level to (1)% using charging and letdown
2. Upper Plenum - (9)%	2. Establish subcooling greater than (2)°F using steam dump
5. Check HJTCS Upper Plenum Indication - GREATER THAN (5)%	Repressurize RCS to maintain HJTCS upper plenum indication greater than (5)%. Return to Step 3.
11. Continue Cooldown of Inactive Portion of RCS	
a. __________	
b. __________	
c. BOTH of the following HJTCS indications:	
1. Upper Head - (8)%	
2. Upper Plenum - (9)%	

35. Check RCP Status:

a. RCPs - AT LEAST ONE RUNNING	a. Try to start one RCP:
	1. IF ANY one of the following HJTCS indications is observed:
	o Upper Head - LESS THAN (26)%
	o Upper Plenum - LESS THAN (32)%
	THEN perform the following:

13. Verify Adequate SI Flow:

a. HJTCS upper plenum indication - GREATER THAN (10)%	a. Increase SI flow to maintain HJTCS upper plenum indication greater than (10)%

18. Depressurize all Intact SGs to Inject Accumulators as Necessary:

a. Dump steam to condenser as necessary to maintain HJTCS upper plenum indication at (10)%	a. Manually or locally dump steam from intact SG(s) as necessary to maintain HJTCS upper plenum indication at (10)%: o Use PORV - or - o [Enter plant specific means]

16. Control Charging Flow to Maintain Reactor Coolant Inventory by Maintaining HJTCS Upper Plenum Indication:

- o One RCP running - GREATER THAN (32)%
- o No RCPs running - GREATER THAN (33)%

20. Verify SI Flow Not Required

a. ________ a. ________

b. Check HJTCS upper plenum indication: b. ________

- o One RCP running - GREATER THAN (32)%
- o No RCPs running - GREATER THAN (33)%

Foldout for Guideline ECA-3.2

1. SI REINITIATION CRITERIA

Manually operate SI pumps as necessary if EITHER condition listed below occurs:

- o Core exit TCs - INCREASING
- o HJTCS upper plenum indication:
  - o One RCP running - GREATER THAN (32)%
  - o No RCPs running - GREATER THAN (33)%

7. Check If SI Can Be Terminated

a. ________ a. ________

b. ________ b. ________

c. HJTCS upper plenum indication - GREATER THAN (12)% c. ________

d. ________ d. ________

11. Verify SI Flow Not Required ____________

o ________

o HJTCS upper plenum indication - GREATER THAN (12)%

Foldout For Guideline ECA-3.3

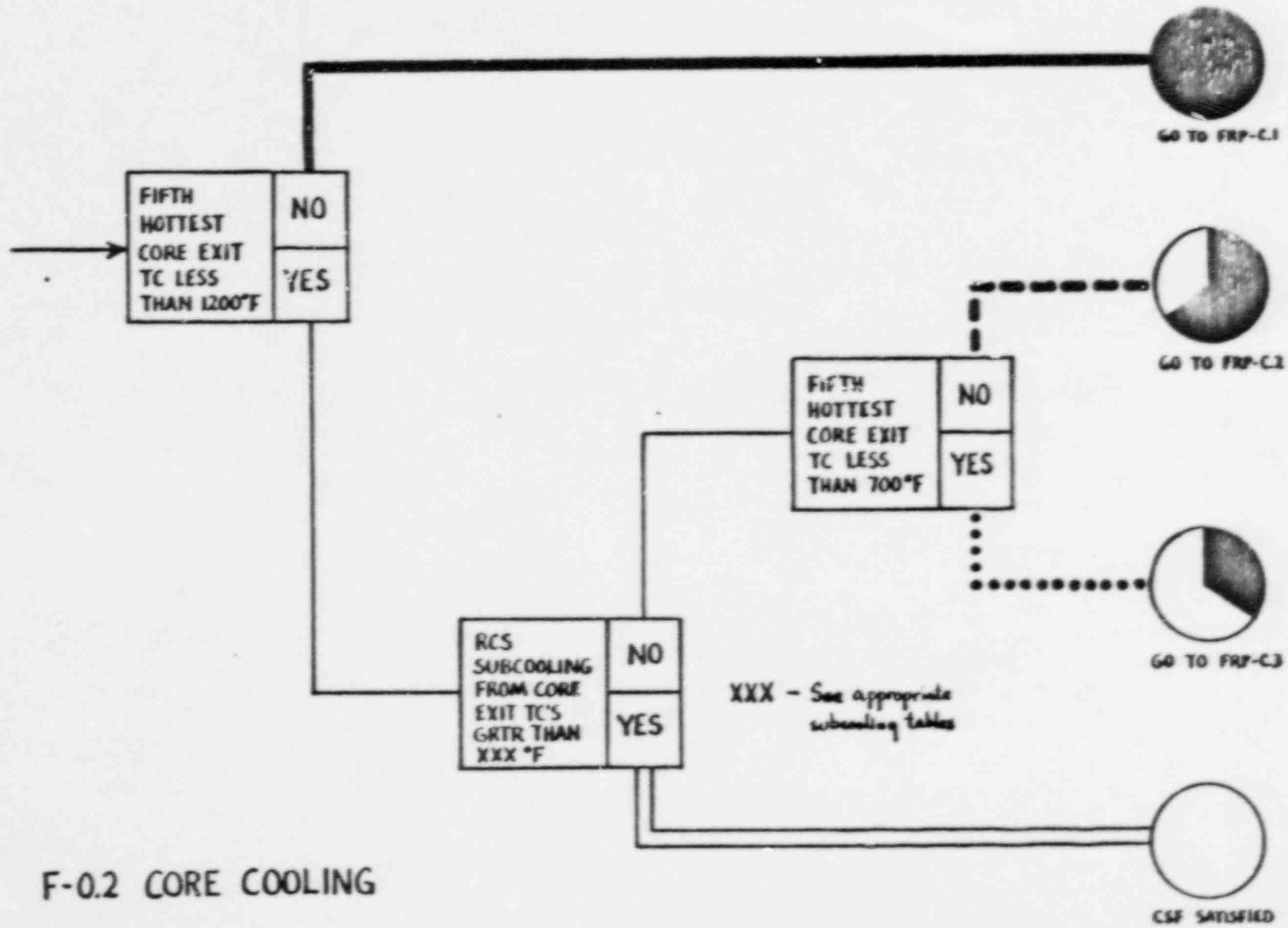
1. SI REINITIATION CRITERIA

Manually operate SI pumps as necessary if EITHER condition listed below occurs:

- o RCS subcooling based on core exit TCs - LESS THAN (10)°F [(11)°F FOR ADVERSE CONTAINMENT]

- o HJTCS upper plenum indication - LESS THAN (12)%

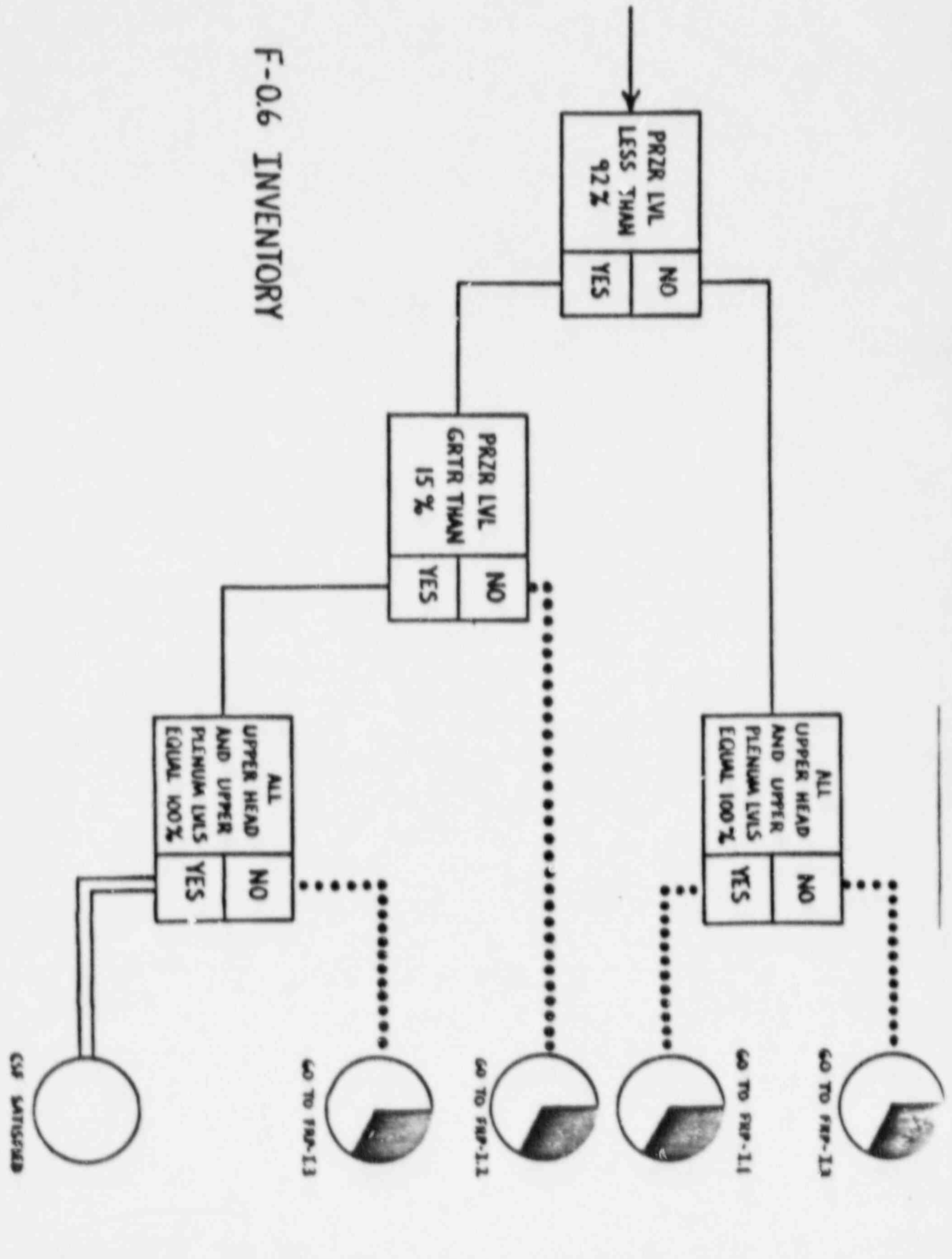
F-0.2 CORE COOLING STATUS TREE



F-0.2 CORE COOLING

Red Path Summary for E-0, E-1, E-3, ECA-2.1, ECA-3.1, ECA-3.2, and ECA-3.3 Foldouts

Under part b, CORE COOLING of Section 2, RED PATH SUMMARY for all guidelines above, delete reference to RVLIS/HJTCS.


F-0.6 INVENTORY
PRZR LVL LESS THAN 92%
NO
YES
PRZR LVL GRTR THAN 15%
NO
YES
ALL UPPER HEAD AND UPPER PLENUM LVLS EQUAL 100%
NO
YES
ALL UPPER HEAD AND UPPER PLENUM LVLS EQUAL 100%
NO
YES
GO TO FRP-I.3
GO TO FRP-I.1
GO TO FRP-I.2
GO TO FRP-I.3
CSF SATISFIED

6. Check HJTCS Upper Plenum Indication

   a. Indication - GREATER THAN (3)%   a. __________

   b. __________

16. Check Core Cooling

   a. __________   a. __________

   b. __________   b. __________

   c. HJTCS upper plenum indication - GREATER THAN (9)%

23. Check Core Cooling   __________

   o HJTCS upper plenum indication - GREATER THAN (9)%

   o __________

5. This step should be deleted.

7. Check Core Cooling

a. HJTCS upper head indication - GREATER THAN (9)%	a. ________
b. ________	b. ________
c. ________	

18. Check Core Cooling __________

- HJTCS upper head indication - GREATER THAN (15)%
- ________

5. Check If SI Can Be Terminated ____________

   o ________

   o HJTCS upper plenum indication - GREATER THAN (8)%

12. Verify SI Flow Not Required: ____________

   o ________

   o HJTCS upper plenum indication - GREATER THAN (8)%

8. Check RVLIS Upper Range Indication

a. Indication: — a. Return to Step 6

- o Upper Head - (6)%
- o Upper plenum - (17)%

b. Turn off PRZR heaters as necessary to stabilize RCS pressure

c. Return to guideline and step in effect.

10. Check HJTCS:

- o Upper head - (6)%
- o Upper plenum - (17)%

18. Review Reactor Vessel Venting Termination Criteria

- o __________

  \- or -

- o __________

  \- or -

- o __________

  \- or -

- o __________

  \- or -

- o HJTCS - INDICATES
  - o Upper head - (6)%
  - o Upper plenum - (17)%

20. Check HJTCS:

- o Upper head - (6)%
- o Upper plenum - (17)%

HJTCS LEVEL VALUES

HJTCS Upper Head Values

1. Value indicating upper head region full: 100%; corresponds to RVLIS Upper Range Value for indicating upper head full.

HJTCS Upper Plenum Values

1. Value indicating upper plenum region full: 100%; corresponds to RVLIS Upper Range Value for indicating upper head full.

2. Value which ensures that RCS void fraction is less than 25% with 1 RCP running: 72%; corresponds to RVLIS Dynamic Range Value for indicating level of top of hot legs with RCP(s) running.

3. Value which is top of hot legs, plus uncertainties: 44%; corresponds to RVLIS Full Range Value for indicating top of hot legs during natural circulation.

4. Value which is top of core, plus uncertainties: 0%; corresponds to RVLIS Full Range Value for indicating top of core.

5. Value which corresponds to 3.5 feet above bottom of active fuel in core with zero void fraction plus uncertainties: 0%; corresponds to RVLIS Full Range Value for level 3.5 feet above active fuel region (for use in FR-C.1 and FR-C.2 only).

6. Value which is above the top of active fuel in core with zero void fraction plus uncertainties: 0%; corresponds to RVLIS Full Range Value for top of active fuel on core with zero void fraction plus uncertainties.

ENCLOSURE 3

RESPONSE TO NUREG-0737, ITEM II.F.2, ATTACHMENT 1

1. **NRC Request**

Provide diagram of core-exit thermocouple locations or reference the generic description if appropriate.

APCo Response

The actual core-exit thermocouples have not been replaced. The thermocouples are the same type, have the same functional characteristics, and are in place at the same core locations as previously described to the NRC in Alabama Power Company letter dated July 17, 1980. The inside containment cabling, electrical penetrations, outside containment cabling, processor, and displays have all been upgraded. The transition cables which connect the thermocouple leads to the new qualified inside containment cabling were installed during the Unit 2 fifth and Unit 1 eighth refueling outages.

2. **NRC Request**

Provide a description of the primary operator displays including:

a. A diagram of the display panel layout for the core map and a description of how it is implemented, e.g., hardware or CRT display.

b. Provide the range of the readouts.

c. Describe the alarm system.

d. Describe how the ICC intrumentation readouts are arranged with respect to each other.

APCo Response

The core-exit thermocouple primary display is a CRT based display that consists of a two dimensional core map that presents thermocouples in their positions relative to core quadrants and core coordinates (see Figure 1). The range of thermocouple readouts is from ambient temperature (reference junction temperature) to 2300°F. The core-exit thermocouple values are displayed on the core map in cyan for good quality values less than 700°F, orange for good quality values greater than or equal to 700°F but less than 1200°F, and red for good quality values greater than or equal to 1200°F. Bad thermocouples have a value of "XXXX" displayed with a designator for bad quality. When at least five thermocouples display a value of greater than or equal to 1200°F the SPDS status tree for Core Cooling outputs a "JEOPARDY" or red path visual alarm. When there are at least five thermocouples greater than or equal to 700°F but less than five thermocouples greater than or equal to 1200°F the SPDS status tree for Core Cooling outputs a "SEVERE CHALLENGE" or orange path visual alarm when inadequate subcooling margin exists. When inadequate subcooling margin exists but there are not five or more thermocouples greater than or equal to 700°F a "NOT SATISFIED" or yellow path visual alarm occurs. No audible alarm exists for the CRT based displays.

In addition to the core map previously described, dislays exist that list all thermocouples on a per quadrant basis and also present their associated core map coordinates. Hard copy and trend capability exists for the primary display. There also exists a two page point detail display for each thermocouple that contains information intended principally for instrumentation maintenance purposes (e.g., calibration).

3. **NRC Request**

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.

APCo Response

The core-exit temperature backup displays are two (one per channel) four digit displays mounted on the main control board. The displays contain three push button switches which are used to 1) display the highest core-exit temperature value, 2) enter submodes to query the system, and 3) acknowledge alarms. The range for the core-exit temperature display is from ambient temperature (reference junction temperature) to 2300°F. The processor will signal an alarm on the display if the highest CET value exceeds 700°F. The response time for displaying a selected CET value is no greater than two seconds. The subcooling margin monitor displays are also located on the main control board and exist on CRT based displays as well. There are two (one per channel) four digit digital displays that can display subcooling margin based on CET's or loop wide-range RTD's.

4. **NRC Request**

Describe the use of the primary and backup displays. What training will the operators have in 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.

APCo Response

The displays for core-exit temperature are used to verify the highest core-exit thermocouple value is: a) within a specified range, b) above or below a specified value, or c) trending in a certain direction. Operations personnel are instructed on the use of the upgraded core-exit temperature monitoring instrumentation during operator requalification training. The plant simulator has been modified to reflect the new system as well. The plant emergency operating procedure specifies to the operator when to monitor core-exit temperature.

5. **NRC Request**

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.

APCo Response

Alabama Power Company will complete the control room design review task analysis for the RCITS prior to implementing revised emergency operating procedures, which will be upon receipt of plant-specific approval from the NRC. The procedures and equipment will be validated using the plant simulator. The criteria of NUREG-0737, Attachment 1 and Appendix B, are satisfied. The specific responses to NUREG-0737, Attachment 1 and Appendix B, are included in Enclosures 4 and 5 of this letter, respectively.

6. **NRC Request**

Describe what parts of the system are powered from 1E power sources, and how isolation from non-1E equipment is provided. Describe the power supply for the primary display. Clearly delineate into two categories which hardware is included up to the isolation device and which is not.

APCo Response

The core-exit temperature instrumentation is powered by class 1E power sources. The cabling, processor, and backup displays are all class 1E. The primary display is not powered by a class 1E source. The isolation between the class 1E and non-class 1E supplied equipment is performed by a fiber-optic data link between the ICC instrumentation processor and the Safety Parameter Display System processor which generates the primary display. A description of the requirements met for isolation and class 1E power sources is provided in Enclosure 5.

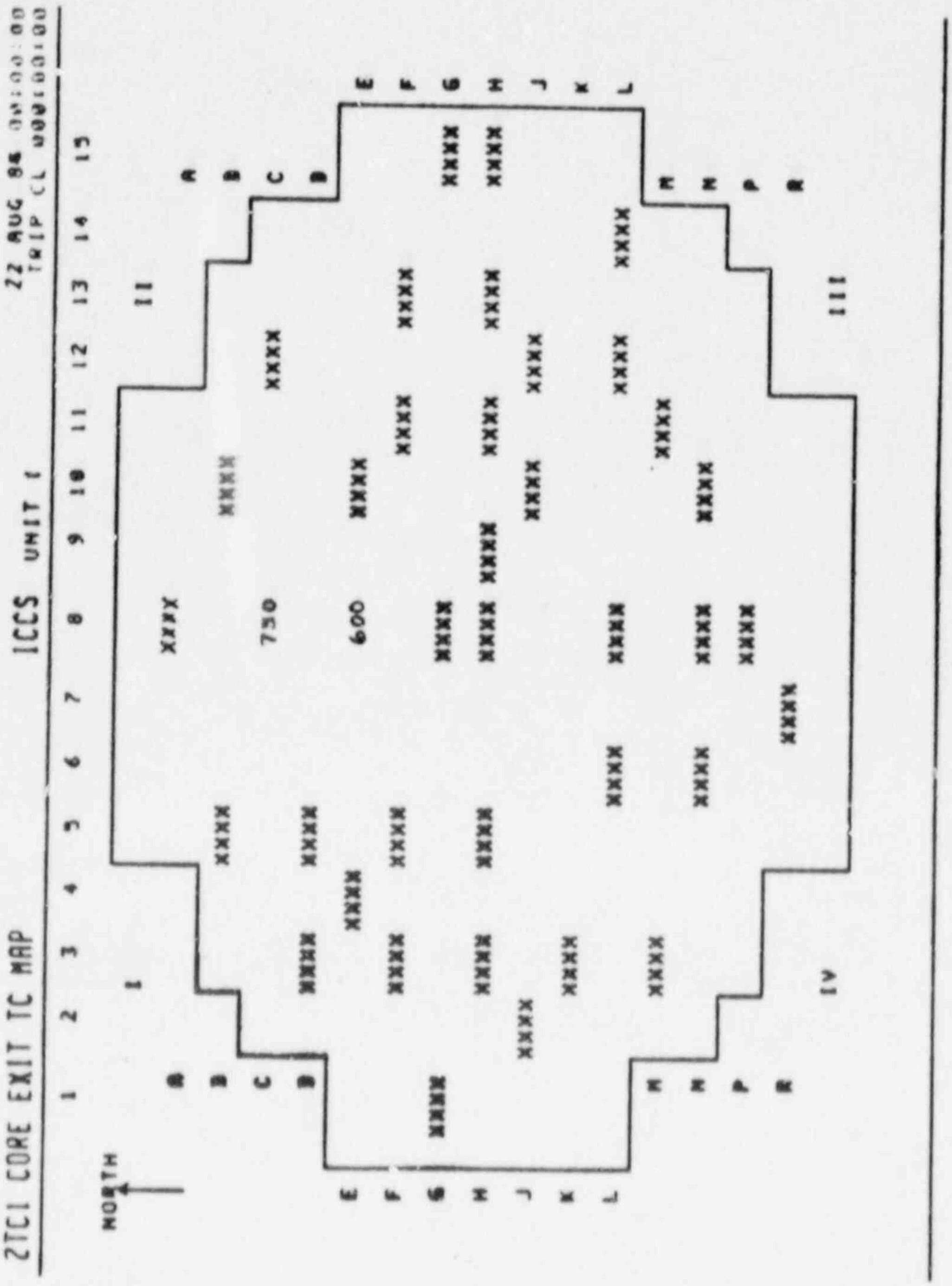
7. **NRC Request**

Confirm the environmental qualification of the core-exit thermocouple instrumentation up to the isolation device.

APCo Response

The upgraded core-exit temperature instrumentation is environmentally qualified from the transition cables that connect to the thermocouple leads at the reactor vessel instrument ports to the processor cabinet in the main control room. This system includes the cabling inside containment, the electrical penetrations, and the cabling from the electrical penetrations to the processor cabinet. A description of the environmental qualification requirements that were met is provided in Enclosure 5.

Figure 1



ENCLOSURE 4

The criteria of NUREG-0737, Attachment 1, are satisfied for the upgraded core-exit temperature instrumentation. The specific items of NUREG-0737, Attachment 1, are addressed below:

Item 1

Thermocouples located at the core exit for each core quadrant, in conjunction with core inlet temperature data, shall be of sufficient number to provide indication of radial distribution of the coolant enthalpy (temperature) rise across representative regions of the core. Power distribution symmetry should be considered when determining the specific number and location of thermocouples to be provided for diagnosis of local core problems.

Response

A thorough description of the core-exit thermocouples was provided by Alabama Power Company in letter dated July 17, 1980. The upgrades to the core-exit temperature instrumentation have no effect on the locations of the thermocouples. See the response to NRC Request No. 1 of Enclosure 3.

Item 2

There should be a primary operator display (or displays) having the capabilities which follow:

(a) A partially oriented core map available on demand indicating the temperature or temperature difference cross the core at each core exit thermocouple location.

(b) A selective reading of cor exit temperature, continuous on demand, which is consistent with parameters pertinent to operator actions in connecting with plant-specific inadequate core cooling procedures. For example, the action requirement and the displayed temperature might be either the highest of all operable thermocouples or the average of five highest thermocouples.

(c) Direct readout and hard-copy capability should be available for all thermocouple temperatures. The range should extend from 200°F (or less) to 1800°F (or more).

(d) Trend capability showing the temperature-time history of representative core exit temperature values should be available on demand.

(e) Appropriate alarm capability should be provided consistent with operator procedure requirements.

(f) The operator-display device interface shall be human-factor designed to provide rapid access to requested displays.

Response

See the response to NRC Request No. 2, 3, 4, and 5 of Enclosure 3 for a description of the primary operator display. See response to Item 4 below for description of human-factor design considerations.

Item 3

A backup display (or displays) should be provided with the capability for selective reading of a minimum of 16 operable thermocouples, 4 from each core quadrant, all within a time interval no greater than 6 minutes. The range should extend from 200°F (or less) to 2300°F (or more).

Response

See the response to NRC request No. 3 of Enclosure 3 for a description of the backup displays.

Item 4

The types and locations of displays and alarms should be determined by performing a human-factors analysis taking into consideration:

(a) the use of this information by an operator during both normal and abnormal plant conditions.

(b) integration into emergency procedures,

(c) integration into operator training, and

(d) other alarms during emergency and need for prioritization of alarms.

Response

The displays were designed with human-factors engineering practices applied. The NUTAC document for Control Room Design Review provided guidance for these practices. The design of the displays and alarms, as well as the physical arrangement on the main control board, was reviewed by Alabama Power Company's human-factors engineering consultant. The integration of the system into the emergency procedures will be validated by a task analysis of the system. Operator instruction will incorporate the new ICC instrumentation into requalification training for licensed reactor operators.

Item 5

The instrumentation must be evaluated for conformance to Appendix B, "Design and Qualification Criteria for Accident Monitoring Instrumentation", as modified by the provisions of items 6 though 9 which follow.

Response

The specific criteria of Appendix B to NUREG-0737, II.F.2, is addressed in Enclosure 5 to this letter.

Item 6

The primary and backup display channels should be electrically independent, energized from independent station class 1E power sources, and physically separated in accordance with Regulatory Guide 1.75 up to and including any isolation device. The primary display and associated hardware beyond the isolation device need not be class 1E, but should be energized from a high-reliability power source, battery-backed, where momentary interruption is not tolerable. The backup display and associated hardware should be class 1E.

Response

The two backup displays are electrically independent and physically separated from each other in accordance with Regulatory Guide 1.75. They are energized from class 1E power sources. The primary display is supplied by a highly reliable, battery-backed power supply and is completely independent from the backup displays.

Item 7

The instrumentation should be environmentally qualified as described in Appendix B, item 1, except that seismic qualification is not required for the primary display and associated hardware beyond the isolator/input buffer at a location accessible for maintenance following an accident.

Response

The ICC instrumentation is environmentally qualified as stated in response to NRC Request No. 7 of Enclosure 3. Further reference to environmental qualification will be made in Enclosure 5 (response to NUREG-0737, Appendix B). The ICC instrumentation system is seismically qualified except for the primary display and associated hardware beyond the isolator.

Item 8

The primary and backup display channels should be designed to provide 99% availability for each channel with respect to functional capability to display a minimum of four thermocouples per core quadrant. The availability shall be addressed in technical specifications.

Response

The ICC instrumentation primary and backup displays were designed for an availability factor of at least 99 percent.

Item 9

The quality assurance provisions cited in Appendix B, item 5, should be applied except for the primary display and associated hardware beyond the isolation device.

Response

The ICC instrumentation system was designed and fabricated under an approved quality assurance program. The specific reference will be provided in Enclosure 5.

ENCLOSURE 5

Listed below are the specific responses to NUREG-0737, II.F.2, Appendix B:

1. **Environmental Qualification**

   The ICC instrumentation system is environmentally qualified per the design requirements of R.G. 1.97 Category 1, IEEE-323-1974, R.G. 1.89, and 10CFR50.49. All equipment located inside containment or in areas of recirculated fluids is environmentally qualified for both normal and design basis accident conditions. There are no deviations from these requirements.

2. **Single Failure Analysis**

   Each of the two channels of the ICC instrumentation system constitutes a redundant division of this safety related system. Electrical independence of the two redundant divisions is achieved through several means: a) independent processor cabinets, b) independent power supplies, c) independent sensors and displays, and d) independent interconnecting cables, cable trays, and penetrations.

   The two channels are physically separated in accordance with the requirements of R.G. 1.75. Two separate routes which are protected from high energy line breaks are used from reactor to the processor cabinets. In addition, the ICC instrumentation system satisfies criteria set forth in NUREG-0696 regarding uninterrupted performance during and subsequent to events expected to occur during the life of the plant including earthquakes.

   Given the features of the design described above, it can be concluded that a single failure of any component (sensor, cable, penetration, cabinet, display) in one redundant channel will not prevent the other redundant channel from properly performing its intended function. Similarly, failure of the power supply associated with one redundant channel will not adversely impact the other channel.

   Each of the redundant ICC instrumentation system processors has a continuous on-line diagnostic routine that checks both hardware and software. The diagnostic system provides error and failure messages to the operators in the main control room. For example, a processor failure is annunciated by the plant annunciator. The on-line diagnostic allows the operator to deduce the actual plant conditions should a failure occur in one channel.

   Reactor coolant system pressure and temperature inputs to the subcooling margin monitor portion of the ICC instrumentation system originate in the existing redundant class 1E process instrumentation cabinets (train A and B). In order to have the subcooling margin monitor of each train read the same, analog temperature and pressure data from both trains are provided as inputs to each train of the ICC instrumentation system. Opposite train inputs are isolated as described in item 9, such that a single failure will not prevent the ICC instrumentation system from performing its intended function.

3. **Class 1E Power Source**

The ICC instrumentation system is a class 1E processing and display system, designed to provide two independent and redundant channels (A and B) of safety grade display instrumentation.

A single bay cabinet is provided for each channel which houses the signal and power terminations for the processing equipment and heater controllers for the HJTC. The processing equipment provides power to the digital displays and the heater controllers. The heaters use the same power source as the processing equipment.

The main power supply to each of the two channelized ICC instrumentation system cabinets is provided from separate class 1E train oriented 120 VAC distribution panels (see Figures 2 and 3 attached). Each distribution panel is supplied power from a separate train oriented class 1E inverter. During normal operation the inverter power is derived from a class 1E AC source (600V class 1E MCC backed-up by a class 1E diesel generator). In the event of the source failing, a class 1E DC source (provided by a class 1E emergency battery) instantly feeds power to the inverter until the AC source returns, and as such, the inverter constitutes an uninterruptable source of AC power.

It should be noted that the inputs to the subcooling margin monitor are generated in the class 1E process control cabinets. Power supplies to these cabinets are provided by the channelized 120V class 1E vital AC distribution panels, which have class 1E battery and diesel back-up.

4. **Availability Prior To An Accident**

The ICC instrumentation system was designed to have a 99 percent availability factor. The system can be easily checked at power without affecting plant operation.

5. **Quality Assurance**

The Combustion Engineering quality assurance program incorporates the guidance endorsed by Regulatory Guide 1.97, Rev. 3.

6. **Continuous Indications**

The ICC instrumentation system includes two independent class 1E backup displays and one non-class 1E primary display. The processor continuously updates the information and generates a new display every three seconds.

7. **Recording of Instrument Outputs**

The primary display has the capability to maintain a historical log of values, and display them to the operator either on the CRT screen or a printed copy. The ICC system processor also has the capability to output to a trend recorder if needed.

8. **Identification of Instruments**

The ICC instrumentation system displays will be located on the reactor panel of the main control boards. Each display is clearly labeled by function.

9. **Isolation**

Signals that are transmitted from the ICC instrumentation system to non-class 1E equipment are isolated as follows:

1. Safety Parameter Display System (SPDS) Computer

   Isolation between the ICC instrumentation system and the SPDS computer is accomplished via a fiber-optic data cable.

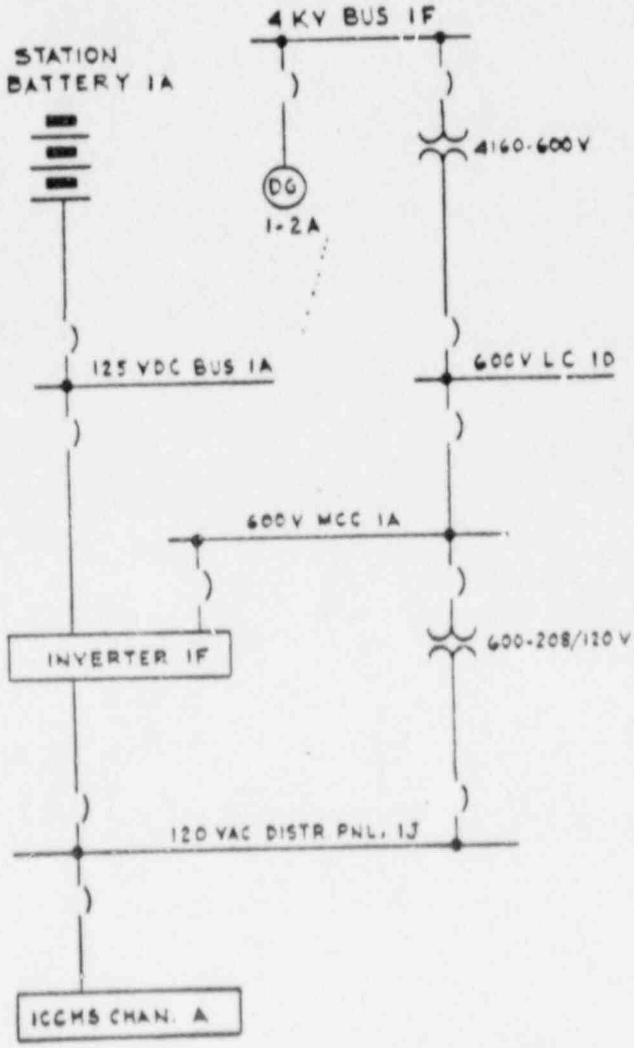
2. The Plant Annunciator

   Isolation between the ICC instrumentation system and the plant annunciator is accomplished by a class 1E relay (coil to contact isolation). The class 1E relay is located in the ICC instrumentation system cabinet.

In addition to the isolators discussed above, class 1E analog isolators are provided for the opposite train analog inputs provided to each train of the ICC instrumentation system. This isolation is accomplished as follows:

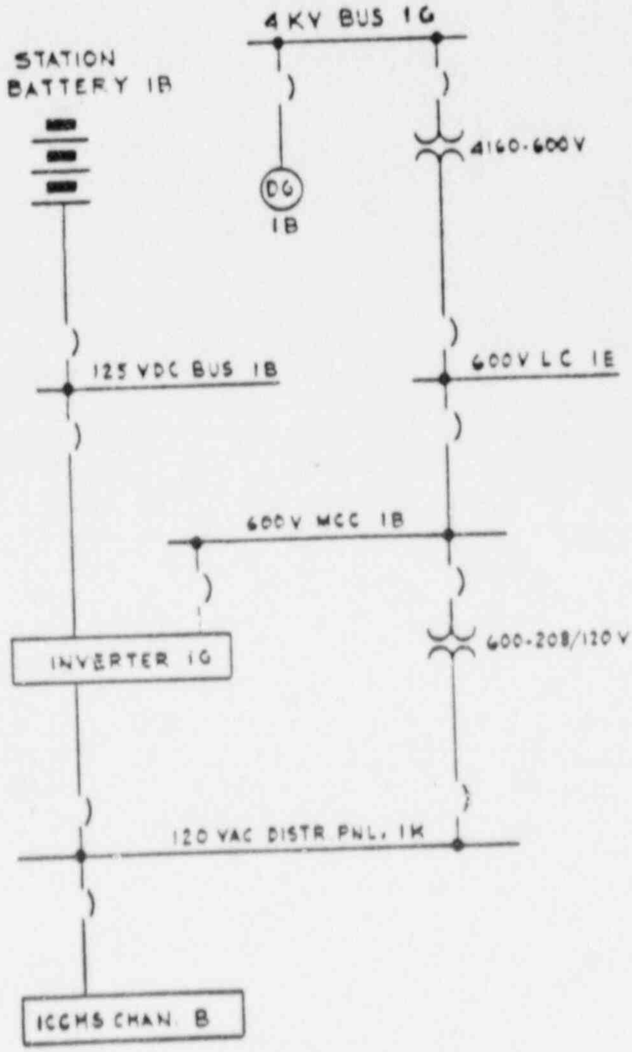
As indicated in response to item 2 above, reactor coolant system pressure and temperature data from both trains of process instrumentation are provided as inputs to each train of the ICC instrumentation system. The opposite train inputs are isolated by class 1E transformer modulation type isolators that are located in the process control cabinets. This isolation ensures that a fault in the process control cabinets cannot affect both trains of the ICC instrumentation system.

FIGURE 2



SINGLE LINE DIAG.
ICCMS POWER SOURCE
CHANNEL A

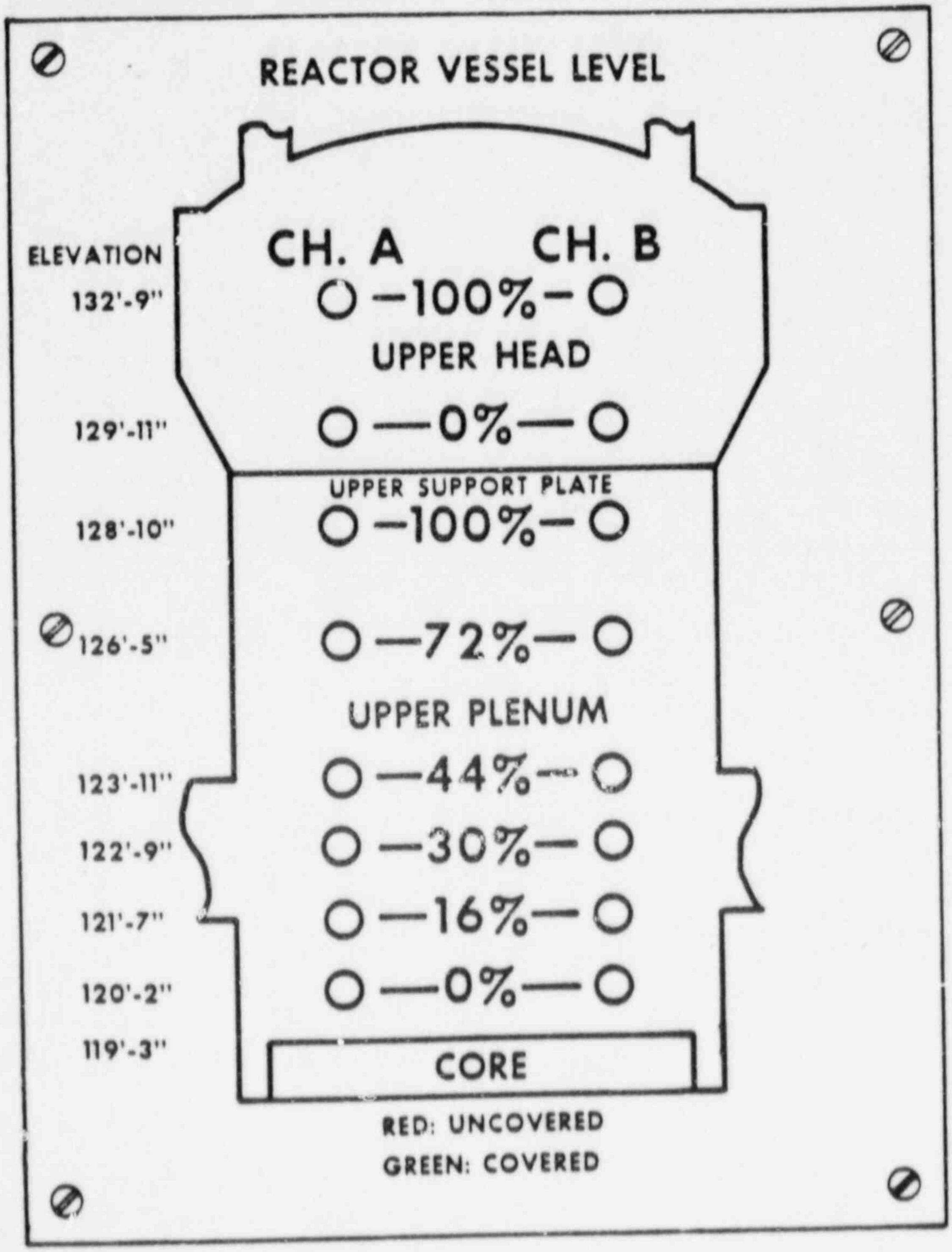
FIGURE 3



SINGLE LINE DIAG.
ICCMS POWER SOURCE
CHANNEL B

FIGURE 4

REACTOR VESSEL LEVEL MIMIC DISPLAY



ENCLOSURE 6

NRC Request

Discuss the spacing of the sensors from the core alignment plate to the top of the reactor vessel head. How would the decrease in resolution due to the loss of a single sensor affect the ability of the system to detect an approach to ICC?

APCo Response

The locations of the he ed junction thermocouple sensors were chosen to provide level indicat.on at important physical structures within the reactor vessel. The first sensor was located as close to the top of the vessel as possible in order to detect possible void formation in the head. The next two sensors were placed just above and just below the upper support plate in order to detect differences in draining rates between the upper head and upper plenum regions. The next sensor was placed midway between the upper support plate and the top of the hot leg. The next three sensors were located at the top, midplane, and bottom of the hot leg in order to detect possible void formation at the hot leg. The bottom sensor was placed as close as possible to the core. The loss of any one of these sensors would not diminish the operators ability to detect or trend water level since there are two independent channels of reactor vessel level available. See Figure 4 for a depiction of the sensor locations as displayed by the reactor vessel level mimic display.