SNUPPS
Standardized Nuclear Unit
Power Plant System

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Executive Director

September 24, 1981

SLNRC 81-112 FILE: 0541
SUBJ: NUREG-0737 Item II.F.2

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Docket Nos. STN 50-482, STN 50-483, and STN 50-486

Reference: NRC (Youngblood) letter to UE (Bryan) and KGE (Koester), dated September 1, 1981, SNUPPS FSAR Request for Additional Information

Dear Mr. Denton:

The referenced letter requested additional information on the subject TMI review item. The enclosure to this letter provides the requested information and will be incorporated in a future revision to the SNUPPS FSAR.

Very truly yours,

N A Petrick

Nicholas A. Petrick

RLS/mtk

Enclosure

cc: J. K. Bryan UE
D. F. Schnell UE
G. L. Koester KGE
D. T. McPhee KCPL
W. A. Hansen NRC/CAL
T. E. Vandel NRC/WC

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SLNRC 81-112
Enclosure

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Q492.9 The staff has reviewed the applicants' response to the requirements of Item II.F.2 of NUREG-0737 and found that the applicants have not provided the documentation required by Item II.F.2. Therefore, the staff will require that the applicants provide the documentation required by Item II.F.2 of NUREG-0737.

RESPONSE See revised Section 18.2.13.

18.2.13 INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE COOLING (II.F.2)

18.2.13.1 NRC Guidance Per NUREG-0737

Position

Licensees shall provide a description of any additional instrumentation or controls (primary or backup) proposed for the plant to supplement existing instrumentation (including primary coolant saturation monitors) in order to provide an unambiguous, easy-to-interpret indication of inadequate core cooling (ICC). A description of the functional design requirements for the system shall also be included. A description of the procedures to be used with the proposed equipment, the analysis used in developing these procedures, and a schedule for installing the equipment shall be provided.

Clarification

(1) Design of new instrumentation should provide an unambiguous indication of ICC. This may require new measurements or a synthesis of existing measurements which meet design criteria (item 7).

(2) The evaluation is to include reactor-water-level indication.

(3) Licensees and applicants are required to provide the necessary design analysis to support the proposed final instrumentation system for inadequate core cooling and to evaluate the merits of various instruments to monitor water level and to monitor other parameters indicative of core-cooling conditions.

(4) The indication of ICC must be unambiguous in that it should have the following properties:

(a) It must indicate the existence of inadequate core cooling caused by various phenomena (i.e., high-void fraction-pumped flow as well as stagnant boil-off); and,

(b) It must not erroneously indicate ICC because of the presence of an unrelated phenomenon.

(5) The indication must give advanced warning of the approach of ICC.

(6) The indication must cover the full range from normal operation to complete core uncovery. For example, water-level instrumentation may be chosen to provide advanced warning of two-phase level drop to the top of the core and could be supplemented by other indicators such as incore and core-exit thermocouples provided that the indicated temperatures can be correlated to provide indication of the existence of ICC and to infer the extent of core uncovery. Alternatively, full-range level instrumentation to the bottom of the core may be employed in conjunction with other diverse indicators such as core-exit thermocouples to preclude misinterpretation due to any inherent deficiencies or inaccuracies in the measurement system selected.

(7) All instrumentation in the final ICC system must be evaluated for conformance to Appendix B (to NUREG-0737), "Design and Qualification Criteria for Accident Monitoring Instrumentation," as clarified or modified by the provisions of items 8 and 9 that follow. This is a new requirement.

(8) If a computer is provided to process liquid-level signals for display, seismic qualification is not required for the computer and associated hardware beyond the isolator or input buffer at a location accessible for maintenance following an accident. The single-failure criteria of item 2, Appendix B, need not apply to the channel beyond the isolation device if it is designed to provide 99 percent availability with respect to functional capability for liquid-level display. The display and associated hardware beyond the isolation device need not be Class 1E, but should be energized from a high-reliability power source which is battery backed. The quality assurance provisions cited in Appendix B, item 5, need not apply to this portion of the instrumentation system. This is a new requirement.

(9) Incore thermocouples located at the core exit or a discrete axial levels of the ICC monitoring system and which are part of the monitoring system should be evaluated for conformity with Attachment 1, "Design and Qualification Criteria for PWR Incore Thermocouples," which is a new requirement.

(10) 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.

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

ATTACHMENT 1, DESIGN AND QUALIFICATION CRITERIA FOR PRESSURIZED-WATER REACTOR INCORE THERMOCOUPLES

(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.

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

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

(b) A selective reading of core 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 <u>all</u> 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.

(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).

(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.

(5) The instrumentation must be evaluated for conformance to Appendix B (to NUREG-0737), "Design and Qualification Criteria for Accident Monitoring Instrumentation," as modified by the provisions of items 6 through 9 which follow.

(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.

(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 isolater/input buffer at a location accessible for maintenance following an accident.

(8) The primary and backup display channels should be designed to provide 99 percent 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.

(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.

18.2.13.2 SNUPPS Response

INSERT

INSERT

Item II.F.2 of NUREG-0737 specifies the following as required documentation concerning instrumentation for detection of inadequate core cooling (ICC):

(1) A description of the proposed final system including:

   (a) a final design description of additional instrumentation and displays;

   (b) a detailed description of existing instrumentation systems (e.g., subcooling meters and incore thermocouples), including parameter ranges and displays, which provide operating information pertinent to ICC consideration; and

   (c) a description of any planned modifications to the instrumentation systems described in item 1.b above.

(2) The necessary design analysis, including evaluation of various instruments to monitor water level, and available test data to support the design described in item 1 above.

(3) A description of additional test programs to be conducted for evaluation, qualification, and calibration of additional instrumentation.

(4) An evaluation, including proposed actions, on the conformance of the ICC instrument system to this document, including Attachment 1 and Appendix B. Any deviations should be justified.

(5) A description of the computer functions associated with ICC monitoring and functional specifications for relevant software in the process computer and other pertinent calculators. The reliability of nonredundant computers used in the system should be addressed.

(6) A current schedule, including contingencies, for installation, testing and calibration, and implementation of any proposed new instrumentation or informative displays.

(7) Guidelines for use of the additional instrumentation, and analyses used to develop these procedures.

(8) A summary of key operator action instructions in the current emergency procedures for ICC and a description of how these procedures will be modified when the final monitoring system is implemented.

(9) A description and schedule commitment for any additional submittals which are needed to support the acceptability of the proposed final instrumentation system and emergency procedures for ICC.

The following is a discussion of each of the above items as they relate to the SNUPPS instrumentation for detection of ICC:

(1) The final system to be used at the SNUPPS units to detect ICC consists of a reactor vessel level instrumentation system and a thermocouple/core cooling monitor system.

Reactor Vessel Level Instrumentation System

The SNUPPS design provides redundant safety-grade (Class IE) reactor vessel water level instrumentation. The reactor vessel level instrumentation system (Figure 18.2-2) utilizes two sets of two d/p cells. These cells measure the pressure differential between the bottom of the reactor vessel and the top of the vessel. This d/p measuring system utilizes cells of differing ranges to cover different flow behavior with and without pump operation as discussed below:

(a) Reactor Vessel - Narrow Range (ΔP_b) This measurement provides an indication of reactor vessel level from the bottom of the reactor vessel to the top of the reactor during natural circulation conditions.

(b) Reactor Vessel - Wide Range (ΔP_c)

This instrument provides an indication of reactor core and internals pressure drop for any combination of operating RCPs. Comparison of the measured pressure drop with the normal, single-phase pressure drop will provide an approximate indication of the relative void content or density of the circulating fluid. The indication of coolant density is significant only when the subcooling is near zero. This instrument will monitor coolant conditions on a continuing basis during forced flow conditions.

To provide the required accuracy for level measurement, temperature measurements of the impulse lines are provided. These measurements, together with existing reactor coolant temperature measurements and wide range RCS pressure, are employed to compensate the d/p transmitter outputs for differences in system density and reference leg density, particularly during the change in the environment inside the containment structure following an accident.

Additional information (i.e., analyses, evaluations) concerning the Westinghouse generic reactor vessel level instrumentation system has been submitted to the NRC via Reference 7. The specific hardware for SNUPPS is not exactly as documented in Reference 7, since the SNUPPS design does not include a measurement of reactor vessel level above the hot legs. However, the analyses, evaluations, and conclusions contained in Reference 7 are applicable to SNUPPS, since they are not sensitive to the above mentioned design difference.

Thermocouple/Core Cooling Monitor System

The core cooling monitor system is a core exit thermocouple/core cooling detection system which provides presentation and display of the status of the core heat removal capability to both the plant operators and the technical support center. The system consists of redundant channels and output trains of thermocouple measurements, wide range hot and cold leg RTD temperatures and reactor pressure signals. These parameters are used by the system to display thermocouple temperatures and to calculate saturation temperatures and margin of saturation (Tsat margin) which is often referred to as subcooling. The calculations are performed by the system which is based on microprocessor and data handling devices.

Thermocouple Monitor

The core exit thermocouple portion of the ICC system is arranged as follows:

(a) Primary system

The primary system measures all the thermocouples via isolators located in the qualified back-up system cabinet.

(b) Back-up system

The back-up system consists of two channels each monitoring half of the 50 core outlet thermocouples. The system has separation and redundancy as well as qualification to comply with Appendix B of NUREG-0737 (see the discussion of item (4) below).

Core Cooling Monitor

The core cooling monitor portion of ICC system compares core outlet thermocouple temperatures, hot and cold leg RTD temperatures with the saturation temperature based on the lowest of three pressure signals. This system has separation and redundancy as well as qualification to comply with Appendix B of NUREG-0737 (see the discussion of item (4) below).

The thermocouple/core cooling monitor is designed to give an early warning to the plant personnel that core conditions are approaching a saturation condition.

The thermocouple/core cooling monitor combines the functions of monitoring for excessive core exit thermocouple temperatures and monitoring both core exit thermocouple temperatures and hot and cold leg RTD temperatures for saturation margin (Tsat meter).

The system consists of two redundant channels each monitoring half of the core outlet thermocouples, and four hot and cold leg RTDs. Three reactor pressure input signals are used with the auctioneered low pressure used by the microprocessor to perform the Tsat margin function. The thermocouple temperatures are corrected for reference junction temperature with three reference junction temperature signals input to each channel. (All of the thermocouples connected to one channel are from one reference junction unit).

The systems two redundant trains utilize the following safety-grade equipment:

(a) Thermocouples

(b) Reference junction boxes

(c) RTDs

(d) Termination board assemblies

(e) Microprocessor assemblies

(f) Remote displays

(g) Analog meters

(h) Recorders

(i) Power supplies

(j) Connections and cabling

The equipment listed above and shown in Figure 18.2-3 has been designed to satisfy the requirements of IEEE Standard 279. This safety-grade system is isolated from the non-Class 1E plant computer, technical support center, and data links by qualified isolation devices.

The system can display individual thermocouple temperatures and provides two levels of alarm when preset temperatures are exceeded. The display is a alphanumeric panel digital display with eight lines of thirty-two characters each located at the processing cabinets, behind the main control board.

The thermocouple monitor can calculate and display core outlet temperature quadrant tilts based on thermocouple temperatures. The tilts calculated by each unit are based on half the total number of core thermocouples. This information is also available to the operator at the main control board via the plant computer.

The core cooling monitor compares core outlet thermocouple temperatures, hot leg, and cold leg RTD temperatures with the saturation temperature based on the lowest of three pressure signals. Two levels of alarm are provided for the core cooling (Tsat) monitor function. The margin to saturation is displayed on two redundant analog meters on the vertical section of the main control board and are visible to an operator at the control console.

The thermocouple/core cooling monitor provides information to the operator that assists in the performance of the required manual safety functions following a Condition II, III or IV event. This includes information relative to maintaining the plant in a safe shutdown condition or to proceed to a cold shutdown condition consistent with the Technical Specification limits.

Additional information concerning the thermocouple/core cooling monitor system is provided in Table 18.2-3.

(2) Reference 7 provides a design analysis and evaluation of the instrumentation for detection of inadequate core cooling (ICC).

(3) Additional testing of the equipment described above is currently in progress in order to establish and upgrade qualification of the equipment to comply with NUREG-0737.

The test programs are:

(a) Qualification tests of core exit thermocouples

(b) Qualification tests of temperature compensati[illegible] function boxes

(c) Qualification tests of electronics to add t[illegible] system computer and technical support center isola[illegible]s a[illegible] [illegible]processors

(d) Any analysis and/or tests needed to justify qualification of modified equipment (such as seismic analysis of cabinets used to house electronics).

(4) An evaluation of the conformance of the reactor vessel level instrumentation system to NUREG-0737 is provided in Reference 7.

An evaluation of the conformance of the thermocouple/core cooling monitor system to NUREG-0737 (Attachment 1 and Appendix B) is as follows:

(a) Attachment 1, Item (1)

The core exit thermocouples are being qualified so as to comply with the recommendations of Regulatory Guides 1.89 and 1.100. The thermocouples are located at the core exit and in an arrangement

such that each of the redundant microprocessor systems has core exit temperatures distributed over the entire core, in sufficient number to determine the radial power distribution and so located as to verify power distribution symmetry among core quadrants.

(b) Attachment 1, Item (2)

The primary operator display is a computer based display and calculation system. It provides information as required by subitems (a) through (f).

(c) Attachment 1, Item (3)

The back-up system to display thermocouple readings is located in a cabinet which also houses the core cooling monitor. This system has a 40-character (alphanumeric) display line located on the front of each of the microprocessor drawers. This back-up system can display all of the 50 individual thermocouple temperatures within 6 minutes. The range extends from less than 200^{0} to 2300^{0}F.

(d) Attachment 1, Item (4)

Human-factors consideration of the types and locations of displays and alarms is discussed in Sections 18.1.16 and 18.3.2. The ICC instrumentation will be considered in the overall human factors evaluation.

(e) Attachment 1, Item (5)

Conformance to the specific items of Appendix B to NUREG-0737 is as follows:

(1) Appendix B, Item (1)

The thermocouple/core cooling monitor instrumentation is currently being tested to establish environmental qualification in accordance with Regulatory Guide 1.89 (NUREG-0588). This qualification requirement applies to the complete instrumentation channel from thermocouple to display where display indicates the remote display, analog meter, and recorder. Qualified channel isolation devices isolate this qualified instrumentation from the data links, technical support center display, and plant computer display.

The seismic portion of the environmental qualification testing is being performed to comply with Regulatory Guide 1.100. This seismic qualification will provide assurance that the instrumentation will continue to read within the required accuracy following, but not necessarily during, a safe shutdown earthquake.

Instrumentation, whose ranges are required to extend beyond those ranges calculated in the most severe design basis accident event for a given variable, will be qualified using the following criteria.

The qualification environment will be based on the design basis accident events, except the assumed maximum of the value of the monitored variable will be the value equal to the maximum range for the variable. The monitored variable will be assumed to approach this peak by extrapolating the most severe initial ramp associated with the design basis accident events. The decay for this variable will be considered proportional to the decay for this variable associated with the design basis accident events. No additional qualification margin needs to be added to the extended range variable. All environmental envelopes except that pertaining to the variable measured by the information display channel will be those associated with the design basis accident events.

The above environmental qualification requirement does not account for steady-state elevated levels that may occur in other environmental parameters associated with the extended range variables. For example, a sensor measuring containment pressure must be qualified for the measured process variable range, but the corresponding ambient temperature is not mechanistically linked to that pressure. Rather, the ambient temperature value is the bounding value for design basis accident events analyzed in Chapter 15.0. The extended range requirement is to ensure that the equipment will continue to provide information should conditions degrade beyond those postulated in the safety analysis. Since variable ranges are nonmechanistically determined, extension of associated parameter levels is not justifiable and has, therefore, not been required.

(2) Appendix B, Item (2)

The purpose for qualifying the thermocouple/core cooling monitoring system is to generate evidence that the equipment will maintain and perform its functions during a design basis event. It is of special concern during the qualification effort to uncover common mode failures.

The single-failure criteria for the computer and information beyond the isolator does not apply to this data based information device as referred to in NUREG-0737 (clarification item (8)). In relation to diversification, the use of reactor vessel level instrumentation adds diversification to the ICC instrumentation. Inclusion of the core cooling (Tsat margin) monitoring functions enhances even further the capability of the SNUPPS ICC instrumentation.

(3) Appendix B, Item (3)

The instrumentation is energized from Class 1E power sources.

(4) Appendix B, Item (4)

All of the ICC instrumentation complies with IEEE Standard 279. The systems utilize two trains, therefore, the "Exemption" as defined in Paragraph 4.11 of IEEE Standard 279 is applicable here.

(5) Appendix B, Item (5)

The ICC equipment falls under the quality assurance requirements applicable to Class IE equipment. Refer to Appendix 3A for a discussion of the quality assurance regulatory guides.

(6) Appendix B, Item (6)

A digital (40-character) line display is provided for the thermocouple readings in the back-up system. The computer based (primary) thermocouple indication system has continuous (recording) displays.

(7) Appendix B, Item (7)

The back-up Class IE system (which is on demand) includes redundant recorders. The computer based (primary) indication system has continuous (recording) displays.

(8) Appendix B, Item (8)

The instruments are specifically identified on the control panels so that the operator can easily discern that they are intended for use under accident conditions.

(9) Appendix B, Item (9)

The SNUPPS ICC instrumentation complies with isolation requirements.

(10) Appendix B, Item (10)

The SNUPPS ICC instrumentation is testable as required.

(11) Appendix B, Item (11)

Servicing, testing, and calibrating programs are specified to maintain the capability of the monitoring instrumentation.

(12) Appendix B, Item (12)

The access to the thermocouple/core cooling monitor permits removing channels for service (location is a main control room). The testing and/or maintenance is facilitated by this system location.

(13) Appendix B, Item (13)

The design facilitates administrative control of the access to all setpoint adjustments, module calibration adjustments, and test points.

(14) Appendix B, Item (14)

The monitoring instrumentation design, minimizes the development of conditions that would cause meters, annunciators, recorders, alarms, etc., to give anomalous indications potentially confusing to the operator.

(15) Appendix B, Item (15)

The instrumentation is designed to facilitate the recognition, location, replacement, repair, or adjustment of malfunctioning components or modules.

(16) Appendix B, Item (16)

The instrumentation used in both the reactor vessel level instrumentation system and thermocouple monitoring receives input signals directly from the sensors that measure the parameters. The core cooling monitor also derives most of the signals directly from the sensors except in the case where Tsat, pressures and others are obtained from the protection set.

(17) Appendix B, Item (17)

The instruments used for ICC instrumentation are also used, with the exception of the reactor vessel level indication, for monitoring normal operation of the plant to the extent that it is practical. No loss of sensitivity is expected due to this use.

(18) Appendix B, Item (18)

Periodic testing is in accordance with the applicable portions of Regulatory Guide 1.118.

(f) Attachment 1, Item (6)

The instrumentation system power supplies, separation, etc., are in conformance with this requirement.

(g) Attachment 1, Item (7)

The instrumentation qualification is discussed in item (4). e.1 above.

(h) Attachment 1, Item (8)

The instrumentation system is in conformance with this requirement.

(i) Attachment 1, Item (9)

Quality assurance is discussed in item (4).e.5 above.

(5) The ICC instrumentation can perform its functions independent of the plant computer.

(6) The ICC instrumentation will be installed by fuel load.

(7) and (8) The Westinghouse Owners Group has developed ICC operating guidelines. These guidelines were developed using the generic ICC analyses discussed in Section 18.1.8. These generic guidelines will be considered, as appropriate, by the SNUPPS utilities in developing plant specific operating procedures.

(9) No additional submittals are required with the exception of emergency operating procedures discussed in Sections 18.1.8 and 18.1.15.

Add to Reference section

7. Letter NS-TMA-2357, dated December 23, 1980, T. M. Anderson (Westinghouse) to D. G. Eisenhut (NRC).

TABLE 18.2-3

DETAILS FOR THE THERMOCOUPLE/CORE COOLING MONITOR SYSTEM

<u>Display</u>	
Information Displayed (T-Tsat, Tsat, Press, etc.)	P-Psat subcooled- $T-T_{sat}$ - superheated
Display Type (analog, digital, CRT)	Analog (control board) and digital (electronics package)
Continuous or on Demand	Continuous (control board) and on demand (electronics package)
Single or Redundant Display	Redundant
Location of Display	Control board and control room
Alarms (include set points)	Caution: 25 F subcooled for RTD; 15 F subcooled for T/C Alarm: of subcooled for RTD and T/C
Overall uncertainty (F, psi)	Digital: 4 F for T/C, 3 F for RTD Analog: 5 F for T/C, 5 F for RTD
Range of Display	Calibrated: 1000 psi subcooled to 2000 F superheat Overall: Never off scale
Qualifications (seismic, environmental, IEEE 323)	Seismic and environmental
<u>Calculator</u>	
Type (process computer, dedicated digital or analog calc.)	Dedicated digital
If process computer is used specify availability (percent of time)	NA
Single or redundant calculators	Redundant

TABLE 18.2-3 (Sheet 2)

Selection Logic (highest T., lowest press)	Auctioneered at high hot leg RTD or average incore thermocouple. Auctioneered low reactor coolant pressure
Qualifications (seismic, environmental, IEEE 323)	Seismic and environmental
Calculational Technical (steam tables, functional fit, ranges)	Functional fit - ambient to critical point
Input	
Temperature (RTDs or T/Cs)	RTDs, T/Cs, and Tref
Temperature (number of sensors and locations)	RTDs - 2 hot leg and 2 cold leg/channel T/Cs - 25 per channel
Range of temperature sensors	RTDs - 0-700 F T/Cs - 0-1650 F Calibration unit range - 0-2300 F
Uncertainty* of temperature sensors (F at 1)	See WCAP 8587
Qualifications (seismic, environ-- menta IEEE 323)	Seismic and environmental
Pressure (specify instrument used)	Barton DP Cell
Pressure (number of sensors and locations)	2 wide range - RCS loop 1 narrow range - pressurizer
Range of pressure sensors	Wide range 0-3000 psi narrow range 1700-2500 psi
Uncertainty* of pressure sensors (psi at 1)	See WCAP 8587
Qualifications (seismic, environmental, IEEE 323)	Seismic and environmental

*Uncertainties must address conditions of forced flow and natural circulation.

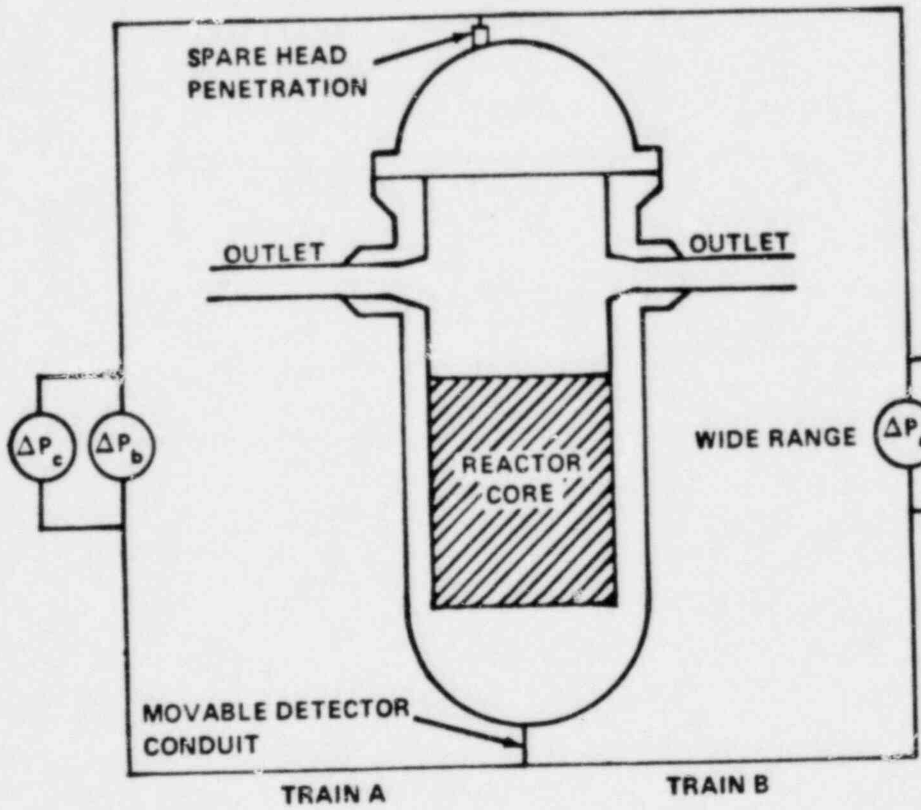

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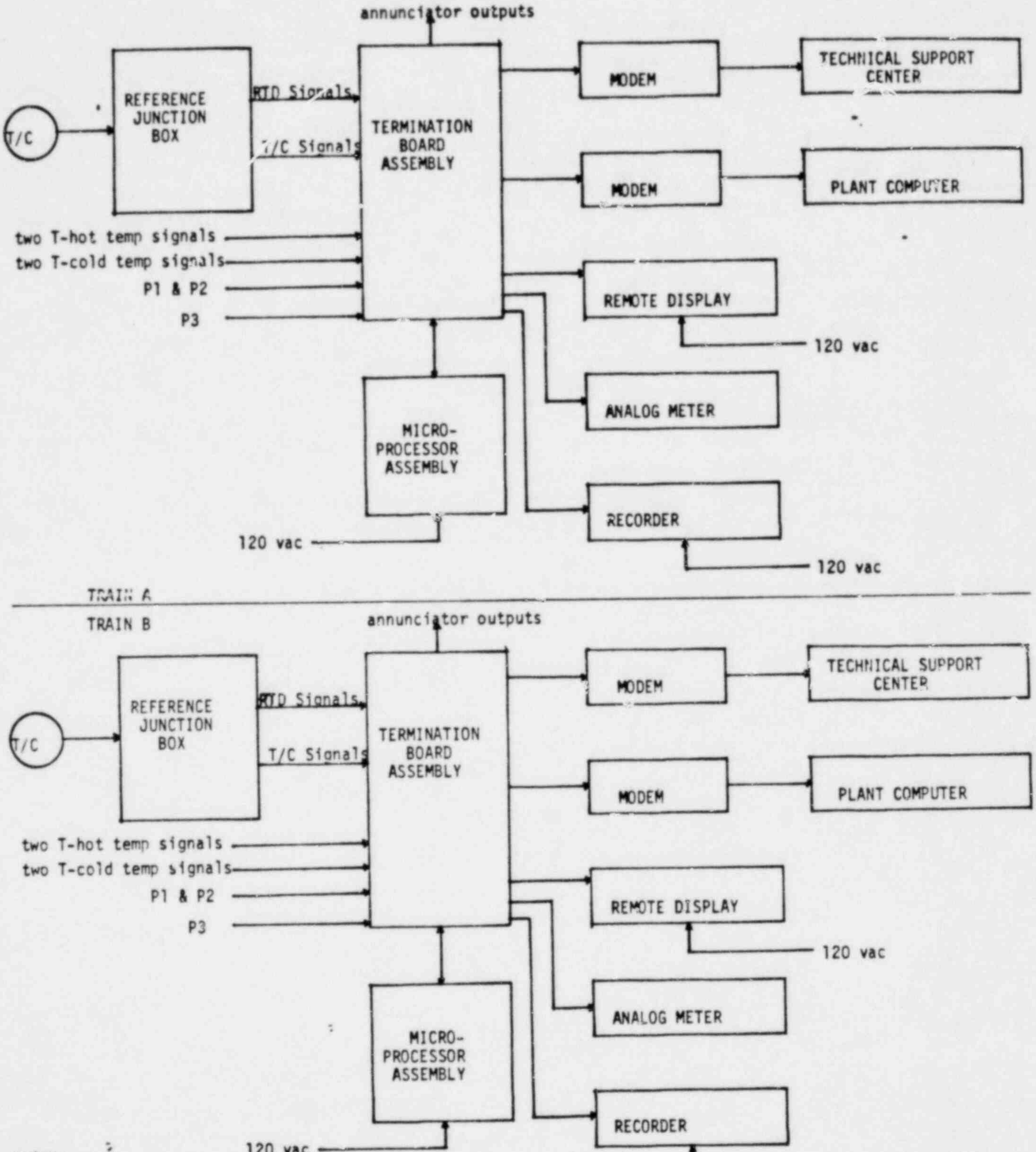
FIGURE 18.2-2
REACTOR VESSEL LEVEL
INSTRUMENTATION SYSTEM



notes:
1. P1 and P2 are wide range loop pressures
2. P3 is a narrow range pressurizer pressure
3. Material type for T/C is shown below. Type K extension wire size is 22 awg chromel/alumel wire.

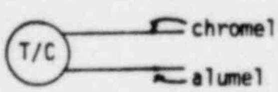


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FIGURE 18.2-3