Florida Power
CORPORATION

July 18, 1983
3F-0783-15

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

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
NUREG-0737, Item II.F.2
Instrumentation for Detection of Inadequate Core Cooling

Dear Mr. Denton:

Florida Power Corporation (FPC) hereby provides the conceptual design; overall schedule for engineering, procurement, and installation; and the Nuclear Regulatory Commission (NRC) checklist for compliance with NUREG-0737, Item II.F.2. The above is included in the attached "Response to NRC Order for Modification of License - Section III, and Appendix A". This is submitted as stated in our letters to you dated April 15, 1983 and April 25, 1983.

FPC has made significant progress in the development of a conceptual design and is able to submit to you the NRC checklist for compliance with NUREG-0737, Item II.F.2 at this time. FPC had previously stated it would be submitted by August 26, 1983.

FPC has 90% confidence that the system can be installed and operational by the end of our Refuel V, which is scheduled to start in February, 1985. FPC has 100% confidence that the system can be installed and

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operational by the end of our Refuel VI. FPC requires NRC approval of our conceptual design and NRC checklist by September 2, 1983 in order to proceed with our detailed design, procurement, and installation so that we can fulfill our commitment to the NRC.

As discussed with Mr. Ron Hernan, our Project Manager, ten (10) copies of the subject report are attached.

Sincerely,

G. R. Westafer

G. R. Westafer
Manager, Nuclear Licensing and Fuel Management

Attachments

Westafer(R01)C5-1

cc: Mr. J. P. O'Reilly, Regional Administrator
Office of Inspection & Enforcement, Region II
U. S. Nuclear Regulatory Commission
101 Marietta Street NW, Suite 2900
Atlanta, GA 30303

RESPONSE TO NRC ORDER FOR MODIFICATION OF LICENSE -
SECTION III, AND APPENDIX A

RE: NUREG 0737, TMI Item II.F.2, Inadequate Core Cooling (ICC)
Crystal River - Unit 3 Nuclear Generating Plant
Florida Power Corporation

July 1983

RESPONSE TO NRC ORDER FOR MODIFICATION OF LICENSE -
SECTION III, AND APPENDIX A

RE: NUREG 0737, TMI Item II.F.2, Inadequate Core Cooling (ICC)
Crystal River - Unit 3 Nuclear Generating Plant
Florida Power Corporation

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Inadequate Core Cooling System for Crystal River - Unit 3
Florida Power Corporation

The CR3 Inadequate Core Cooling (ICC) system consists of the following major elements:

1. A reactor coolant inventory tracking system (RCITS) which indicates reactor vessel and hot leg coolant level when RC pumps are tripped and coolant inventory trends when RC pumps are running.

2. Extended range core exit thermocouple (CET) temperature displays which indicate distribution of coolant temperature rise over all regions of the core.

3. A subcooling margin monitor (SMM) system which indicates the reactor coolant saturation and superheat temperatures.

4. Other instrumentation currently used by the operators to indicate core cooling conditions including T-hot, T-cold, T-average, RC pressure, pressurizer pressure and level, and secondary side parameters.

Response to Appendix A Checklist for Plant-Specific Review of Inadequate Core Cooling (ICC) Instrumentation System

1. Description of the proposed final system, including:

   a. A final design description of additional instrumentation and displays.

      Response:

      Additional equipment will include analog instrumentation to measure and display coolant level in the reactor and in each hot leg. Void fraction instrumentation and display equipment will be added.

      Core exit temperature currently is displayed by the plant computer. A Class 1E qualified CET backup display will be added to the main control board together with the coolant level and void fraction indicators.

      All hardwired indicators are backed up by independent displays in the plant computer. All safety-related signals will be electrically and physically isolated before transmission to nonsafety-related equipment.

      Detailed design descriptions are included in the enclosures, as referenced below.

   b. Detailed description of existing instrumentation systems.

      Response:

      Design details of existing instrumentation were provided to the NRC in FPC Letter No. 3F-0483-19 dated April 25, 1983. Enclosures 1A and 1B are copies of the technical descriptions of existing instrumentation.

   c. Description of completed or planned modifications.

      Response:

      Conceptual design details of planned modifications were submitted to the NRC in FPC Letter No. 3F-0483-11 dated April 15, 1983. Specific details of the RCITS design are described in Enclosure 2. A detailed description of the proposed CET display system is included in Enclosure 3.

      Modifications of the CET and SMM systems are noted in Item 4.

2. A design analysis and evaluation of inventory trend instrumentation and test data to support design in Item 1.

Response:

The RCITS uses DP instruments as a means of determining reactor coolant inventory (water level) when the coolant pumps are off.

DP instruments have been used to accurately infer liquid level for more than half a century. During that time, this relatively simple concept and its techniques have become well known. This extensive experience has rendered it a proven technology. DP sensing devices have earned the reputation of being highly reliable, rugged, and easy to maintain. In recent decades, they also have proven to be insensitive to radiation exposure. They have been and are being used routinely in water level measurement in light water reactors where they provide safety functions for SCRAM, containment isolation, emergency core cooling system initiation, automatic depressurization system initiation, recirculation pump shutoff, and main steam isolation valve closure. They also have been used to determine liquid level in the pressurizer in tests conducted in the loss of fluid test (LOFT) facility. A number of tests have been conducted at the Semiscale Test Facility to further test their performance.

A design analysis of inventory trending methods with RC pumps running is contained in Babcock & Wilcox (B&W) Document No. 77-1137950-00, Feasibility Study of Inventory Trending Methods With RC Pumps Operating, October 1982. We plan to use pump power to infer density.

3. Description of tests planned and results of tests completed for evaluation, qualification, and calibration of additional instrumentation.

Response:

For RCPs operating, using pump motor power: A description covering this question is contained in B&W Document No. 77-1137950-00, Feasibility Study of Inventory Trending Methods With RC Pumps Operating, October 1982.

For RCPs off, using DP instruments to indicate RC inventory: No tests have been planned or conducted. DP sensing instruments have been proven to be reliable, easy to maintain, and routinely used in water level measurement in the nuclear industry (refer to Response 2 above). No testing is considered necessary for evaluating or calibrating these instruments to support use in coolant inventory trending applications.

All environmental qualification tests and documentation of results will be in accordance with IEEE 323-1974, Sections 6.3 and 8.0. Tests for equipment evaluation will be described in the procurement specifications, and test calibration will be described in the plant surveillance procedures (SP series).

4. Provide a description covering the evaluation of conformance with NUREG 0737,II.F.2, Attachment 1 and Appendix B.

Response:

Enclosure 4 is a summary of requirements and an evaluation of conformance with NUREG 0737,II.F.2, Attachment 1, for the CETs and subcooling margin monitors. Enclosure 4 includes a checklist of deviations and proposed modifications. Enclosures 5 and 6 evaluate the conformance of the proposed RCITS and CETs to Appendix B.

All new Class 1E equipment required for the ICC instrumentation system will be qualified in accordance with NUREG 0737, Appendix B, as modified by II.F.2, Attachment 1.

Existing Class 1E equipment not presently qualified will be qualified in place or will be replaced with new qualified equipment.

5. Describe computer, software, and display functions associated with ICC monitoring in the plant.

Response:

The computer is equipped to display a core map, indicating the temperature of all CETs, and highlighting the single highest value in color. CETs may be digitally trended in operator-selected groups. Four CETs may be selected for trending on analog recorders. The computer will provide a backup calculation of void fraction. A digital trend display will be available on demand.

The system is redundant, that is, the central processor is backed up by a second processor for reliability. The computers are energized from a high reliability uninterruptible power source which is battery backed.

6. Provide a proposed schedule for installation, testing, and calibration and implementation of any proposed new instrumentation or information displays.

Response:

The proposed schedule for these items is provided in Enclosure 7.

7. Describe guidelines for use of reactor coolant inventory tracking system, and analyses used to develop procedures.

Response:

B&W will revise and update its Abnormal Transient Operating Guidelines (ATOG), Document No. 74-1126473-00. This document has been forwarded previously to the NRC for review. Enclosure 7 provides the schedule for revision. Emergency Operating Procedures are being developed from the ATOG.

8. Operator instructions in emergency operating procedures for ICC and how these procedures will be modified when final monitoring system is implemented.

Response:

Emergency Operating Procedures, including ICC, presently are being revised in accordance with the ATOG. Training in these new procedures for the operators will be conducted at the plant's training center. When the final monitoring system is approved, the ATOG and Emergency Operating Procedures will be revised to include the additions/modifications. Enclosure 7 provides the schedule for training of operators.

9. Provide a schedule for additional submittals required.

Response:

Neither the Combustion Engineering HJTC system nor the Westinghouse dp system is being considered. A detailed description of the proposed RCITS is provided in our response to Item 1c. No additional technical submittals are anticipated.

ENCLOSURE 1A

TECHNICAL DESCRIPTION OF EXISTING CORE EXIT THERMOCOUPLES' DESIGN AS ADDRESSED IN TMI ITEM II.F.2, ATTACHMENT 1, IN APPENDIX A TO THE ORDER FOR MODIFICATION CRYSTAL RIVER 3 FLORIDA POWER CORPORATION

WPC/6-4B/9834

1. DIAGRAM OF CORE EXIT THERMOCOUPLE LOCATION

A diagram of the incore monitoring assembly locations is presented on Drawing No. 86522B. These assemblies each contain one core exit thermocouple (CET). A total of 52 CETs are distributed throughout the core.

2. DESCRIPTION OF PRIMARY OPERATOR DISPLAYS

The primary operator display of CETs is provided by a core map diagram on the plant computer CRT monitor. The diagram includes all 52 CET temperature readings over a range of 0° to 900°F. Any temperature exceeding a high alarm limit (700°F) is alarmed and the hottest temperature is highlighted in color. Alarmed values flash in red until acknowledged by the operator. A printed hard copy of the core map may be requested by the operator.

All alarmed values are printed on the alarm typer.

Any CET or a group of CETs may be digitally trended on a line printer. Any single CET may be time trended in analog format on the CRT display. Up to four CETs may be time trended on analog strip chart recorders.

An independent and separate recording system provides alarming capability for all 52 CETs. A printed record of all CET temperatures over a range of -35° to 2,490°F is available on demand.

3. IMPLEMENTATION OF THE BACKUP DISPLAY

Two subcooling margin monitor (SMM) digital displays are located on the main control board. These instruments acquire the hot leg (T_h) and cold leg (T_c) temperatures and the reactor pressure at each loop to calculate the corresponding saturation temperature (Tsat). Each monitor displays the degrees of subcooling of one loop continuously and the degrees of subcooling of the other loop on demand.

In addition to T_h and T_c, the hottest CET selected from a group of six is connected to each SMM. These 12 CETs have been selected to provide representative temperatures from each core quadrant and the central region. The location of these CETs is identified on the enclosed marked-up copy of Drawing No. 86522B. The hottest CET temperature over a range of 0° to 1,023°F is displayed on demand. Tsat corresponding to the hottest CET also is displayed on demand.

The instruments include a low margin to saturation alarm indicator and an alarm signal to the plant annunciator and event recorder.

Verification of SMM meter operability is performed semiannually by performing a calibration procedure using Surveillance Procedure SP-122.

4. USE OF THE PRIMARY AND BACKUP DISPLAYS

Refer to Enclosure 3.

5. NUREG 0737 CRITERIA

Refer to Enclosure 6.

6. PARTS OF SYSTEM POWERED FROM CLASS 1E POWER SOURCES

Thermocouple transmitters for the 12 CETs used by the subcooling margin monitors are powered from the same vital power sources as the respective SMMs. The CRT displays are powered from the battery-backed plant computer uninterruptible power supply. CETs connected only to the plant computer are not isolated.

7. ENVIRONMENTAL QUALIFICATION CRITERIA

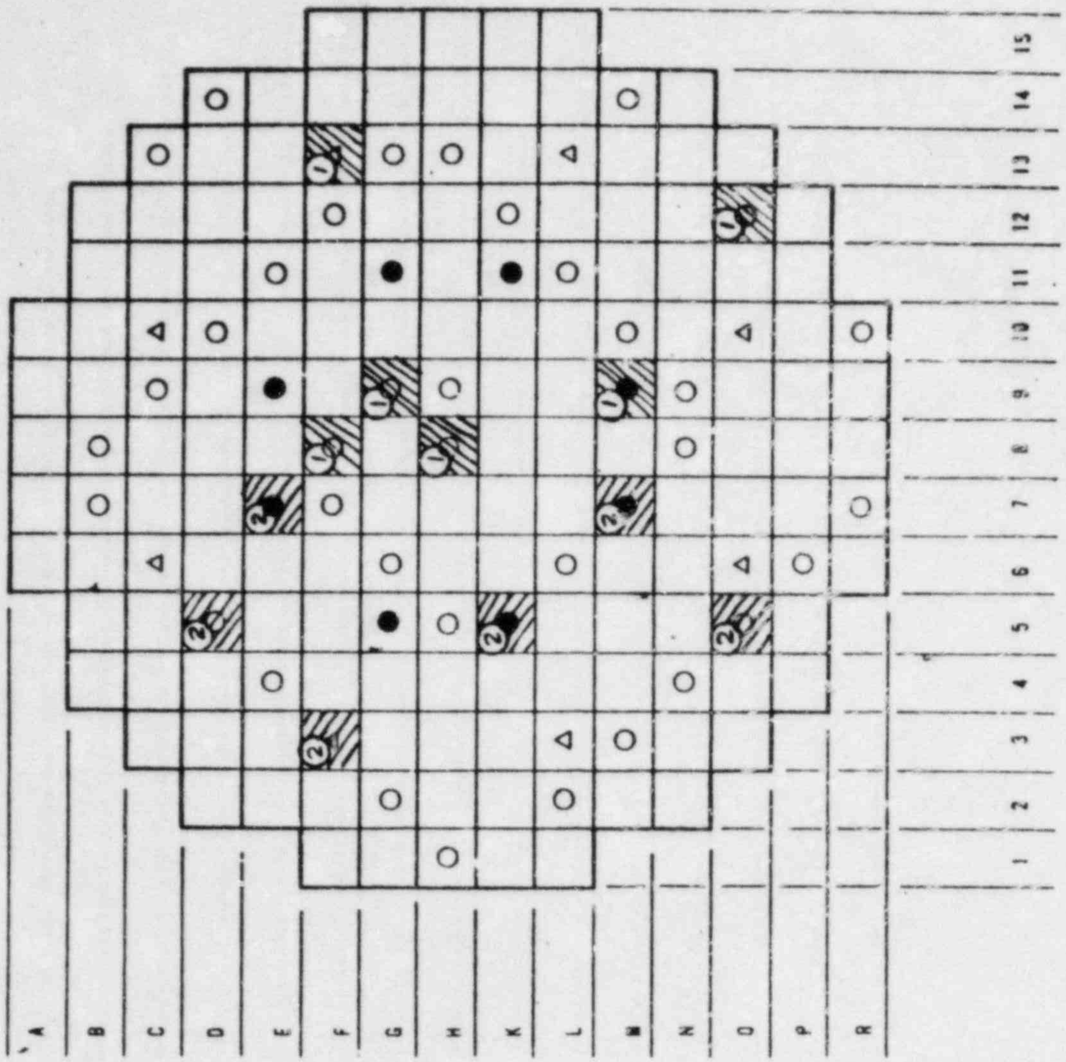
Refer to Enclosure 3.

THE BABCOCK & WILCOX COMPANY
POWER GENERATION DIVISION

REVISIONS			MICROFILM
SIZE NO.	LTR	DESCRIPTION	ORIGINAL

4203-75-034-0

INCORE MONITORING ASSEMBLY LAYOUT



SMM INSTRUMENT NO. 1
SMM INSTRUMENT NO. 2
INCORE ASSEMBLY LOCATION
INCORE ASSEMBLY SYMMETRY LOCATION
INCORE ASSEMBLY SYMMETRY LOCATION

THIS DRAWING IS FOR
GENERAL INFORMATION
AND REFERENCE ONLY
and has not been returned to the manufacturer with GAI APPROVAL or COMMENTS
ONLY FOR INCORE INSTRUMENTATION
[illegible] POWER CORP.
CRYSTAL RIVER STATION - UNIT 3
SIGNED D E [illegible] ENGINEER
DATE SEP [illegible]

GILBERT
[illegible] INC. W.O.[illegible]
SEP [illegible] '71 4203

MARKED UP TO SHOW
CETS SELECTED FOR
INPUT TO SUBCOOLING
MARGIN MONITORS. 4/14/83 H.A. FINK
620-0007-24-00

DWN BY L.W. DATE 8/10/71 | CHKD [illegible]
INCORE MONITORING ASS'Y LAYOUT
36522 B-0

8652223

ENCLOSURE 1B

TECHNICAL DESCRIPTION OF EXISTING SUBCOOLING MARGIN MONITORS AS ADDRESSED IN TMI ITEM II.F.2 AND NUREG 0737, APPENDIX B, TO THE ORDER FOR MODIFICATION CRYSTAL RIVER - UNIT 3 FLORIDA POWER CORPORATION

WPC6-4B/7567

1.0 ENVIRONMENTAL QUALIFICATION

The subcooling margin monitors (SMMs) were tested by Babcock & Wilcox (B&W) for seismic and environmental qualification. The devices meet the requirements for installation in an electronic equipment room and the control room.

2.0 SINGLE-FAILURE ANALYSIS

Two independent SMMs are provided for redundancy. Sensors and instrumentation also are independent and redundant.

The design of the SMM considered the most likely cause of failure is loss of the internal clock. A circuit is incorporated that will detect the loss of the clock at the display and will blank the display.

3.0 CLASS 1E POWER SOURCE

The SMMs, sensors, and instrumentation are powered from separate vital (Station Class 1E) power sources.

4.0 AVAILABILITY PRIOR TO AN ACCIDENT

Each SMM is capable of being manually switched to either loop. Because the SMMs are redundant, they are designed to provide 99-percent availability for each channel.

5.0 QUALITY ASSURANCE

B&W considers the SMM to be a commercial-grade item, not a basic component as defined in 10CFR21. B&W has certified that the SMMs conform to its quality assurance plan.

6.0 CONTINUOUS INDICATION

The SMMs can be selected either to provide continuous indication of the degrees of subcooling or to provide other system parameters.

An additional microprocessor-driven CRT display of saturation curves (both loops) is located in the control room. There are no plant operator controls for this display.

7.0 RECORDING INSTRUMENT OUTPUTS

The SMMs provide no outputs for recording.

8.0 IDENTIFYING INSTRUMENTS

The SMMs are located in the main control board and are suitably identified.

9.0 ISOLATION

Sensors and instrumentation supplying signals to SMMs are part of the existing NNI instrumentation. Buffering between NNI and SMMs is provided by instrument transmitters.

ENCLOSURE 2

TECHNICAL DESCRIPTION
REACTOR COOLANT INVENTORY TRACKING SYSTEM (RCITS)

CRYSTAL RIVER - UNIT 3
FLORIDA POWER CORPORATION

SUMMARY

The Reactor Coolant Inventory Tracking System is intended to provide a continuous unambiguous control room indication of reactor vessel head and hot leg coolant inventory trending with reactor coolant pumps (RCPs) either running or tripped. The system is being designed to meet the parameters specified in NUREG-0737, item II.F.2.

The design encompasses the use of differential pressure (DP) measurements across vertical elevations of the hot leg and the reactor vessel to infer coolant level when the RCPs are tripped, plus the use of RCP motor power measurements and pump inlet temperatures to infer coolant inventory trends when the RCPs are running. The design also includes density compensation for DP measurements due to temperature effects on reference leg and process liquid density.

DP measurements cover a wide range measurement from the top to the bottom of the hot leg, plus a narrow range measurement from the top of the reactor vessel (RV) head to the bottom of the hot leg. A total of four DP transmitters will be used to provide redundancy. Each pair of wide and narrow range transmitters will be powered independently by Class 1E instrumentation power. They will be mounted within the containment area. Seal chambers will be located at the high point of each reference leg to keep the legs full of water.

The design includes removal of the center control rod drive mechanism to provide a penetration in the RV head for location of the top RV pressure tap. The top hot leg pressure taps will be located off the hot leg high point vents. Florida Power Corporation (FPC) already has processed and has installed the lower pressure tap on the decay heat suction line during the 1983 refueling outage.

Class 1E qualified electronic analog equipment racks will be used to power the DP transmitters and process their outputs, with the reference leg and process temperature outputs, to compute the equivalent water level. The racks will provide outputs to indicating recorders in the control room, and to the computer.

A non-1E electronic analog equipment rack will be used to process the RCP inlet temperature and motor power inputs, and to compute the void fraction. The rack will provide outputs to a control room indicator recorder, and to the computer.

Sketches of the system are shown in Figures 1 and 2. Individual parts of the system are described in the following paragraphs.

1. TOP HOT LEG PRESSURE TAP

The top hot leg pressure tap will be located off the hot leg high point vent. Double isolation valves will be installed at the process connection.

2. TOP REACTOR VESSEL PRESSURE TAP

The top reactor vessel pressure tap will be made to a penetration in the reactor vessel head presently occupied by the center control rod drive mechanism. Double isolation valves will be installed.

3. SEAL CHAMBERS

A seal chamber will be installed at the high point of each reference leg to ensure that the reference leg to each DP transmitter remains full of water. The seal chambers will be water reservoirs only and will not contain a bellows or diaphragm. There will be three connections in the seal chambers. One will be at the top for connection to a vent valve, one at the bottom for connection to the reference leg of the transmitter, and the third at the center line on one end for connection to the pressure tap.

4. REMOVABLE SECTION OF RV HEAD REFERENCE LEG

A removable section of stainless steel tubing will be installed between the reactor vessel top tap and the refueling cavity wall for removal during refueling. Tubing configuration will be such as to allow for thermal expansion and movement of the reactor vessel head.

5. SUPPORT FOR REMOVABLE SECTION OF RV HEAD REFERENCE LEG

A removable support for the removable section of tubing between the RV head and the refueling cavity wall will be installed on the cavity wall to provide seismic support for the tubing.

6. BOTTOM HOT LEG PRESSURE TAP

The bottom hot leg pressure tap is located off the decay heat suction line at el 115 ft 0 in., with double isolation valves.

7. DIFFERENTIAL PRESSURE TRANSMITTERS

Differential pressure transmitters manufactured by Rosemount, Inc., are qualified in accordance with IEEE 323-1974, and will be used as the primary sensors in the system to monitor coolant levels with RCPs tripped.

Four transmitters will be installed, two narrow range and two wide range to provide redundancy. Each will have provisions for zero suppression and elevation. Each pair of narrow- and wide-range transmitters will be powered independently from a separate Class 1E electrical power source.

The DP transmitters will be mounted on the outside of the D-ring approximately at el 100 ft 0 in.

The narrow-range transmitters will be calibrated for approximately 12 ft of water which, when compensated for system temperature variations, will be equivalent to the level of the coolant in the reactor vessel, above the bottom of the hot leg, when the RCPs are tripped. See Loop Diagram No. 14235.13-SK-17, attached.

The wide-range transmitters will be calibrated for approximately 50 ft of water which, when compensated for system temperature variations, will be equivalent to the level of coolant within the hot leg when the RCPs are tripped. See Loop Diagram No. 14235.13-SK-16, attached.

The DP measurement system will not be functional when the RCPs are running or during venting operations. It will, however, be designed to withstand the conditions that will exist at those times without damage, and be fully recoverable afterwards.

8. REFERENCE LEG TEMPERATURE MEASUREMENT

The system design will include the use of Class 1E qualified strap-on RTDs on the longest vertical portions of the water-filled reference legs to provide the temperature input required to convert the DP measurement to the equivalent coolant level. The RTDs will be insulated where exposed to ambient conditions so they will sense only the temperature of the reference leg.

9. HOT LEG TERMPERATURE MEASUREMENT

RTDs already installed in the hot legs will provide the process water temperature input required by the DP measurement system.

10. ANALOG EQUIPMENT RACKS - COOLANT LEVEL WITH RCPs TRIPPED

Class 1E Qualified electronic analog equipment racks will be used to power the differential pressure transmitters and process the outputs to compute coolant level. The racks will contain interconnected plug-in modules which perform the functions of current to voltage conversion, summation, function generation, division, and isolation.

Two independently powered racks will be used to provide redundancy. Each rack will process one narrow-range and one wide-range channel. Outputs of the racks will be sent to analog indicating recorders located in the control room, and to the computer, where the level indication will be available upon demand as backup.

The racks will be located outside of containment for accessibility and input and output terminals on the modules will be available for monitoring from the front. In addition, each of the input modules will have provision for insertion of a test jack, which will disconnect the normal transmitter input and connect a test input. This will be used for calibration and troubleshooting.

11. COOLANT INVENTORY TRENDING WITH RCPs RUNNING

The system provides a design to monitor the void trend in the reactor coolant system with RCPs running. Measurements of RCP motor power and RCP inlet temperatures are taken. The RCP motor power input is used to infer the average density of the fluid in the state (liquid or two-phase liquid/vapor) in which it passes through the pump. Coolant temperature at the inlet of the pump is used to infer the density of each individual phase of the fluid in the state in which it passes through the pump. A calculation of void fraction is performed based on the inferred densities using an empirical correlation. Refer to Babcock & Wilcox Document No. 77-1137950-00, October 1982, entitled Feasibility Study of Inventory Trending Methods With RC Pumps Operating.

The calculation of void fraction using the pumps as density transducers cannot be made with the same certainty as direct measurement. However, direct measurement is not feasible. The accuracy of the calculated void fraction may vary to the extent that the pump operating conditions (pump motor efficiency, pump speed, and pump hydraulic torque) vary from time to time.

However, in the use of void fraction calculations as a coolant inventory trending indication, the accuracy of the void fraction calculation is not as important as the need to establish a trend of void fraction with respect to time. The test data of the scale model pumps indicate that the pump power decreases with an increase in void fraction in a manner which can provide a reliable trending signal to the operator. The data indicates that the usable range of the signal can be limited to between 15 and 40 percent void fraction at the pump suction.

The RCPs are powered from non-Class 1E sources of electrical power. Therefore, void fraction calculations will be performed using a non-Class 1E electronic analog instrumentation cabinet which will be the primary device for void fraction calculations. The calculations will be performed independently for each RC loop, and the average of each of the two loops will be displayed in the control room on a trend recorder. Independent calculations also will be performed by the plant computer as a backup, and the trending indication will be available on demand.

The results of the void fraction calculations performed by the primary and backup devices may differ slightly in their absolute values. It is anticipated, however, that any variation in the trend of void fraction with respect to time indicated by the two devices will be insignificant.

The instrumentation required for void trending indication is shown on Sketch Nos. 14235.13-SK-23 and 14235.13-SK-44.

1. RC Pump Inlet Temperature Measurement

   Wide-range RTDs already installed in the cold leg will provide the water temperature input required for the void fraction calculations. Isolation will be provided between these sensors and the non-Class 1E algorithm cabinet.

2. RC Pump Power

   AC watt transducers manufactured by General Electric Company will be installed in the RC pump switchgear to provide the power input signal required for the void fraction calculations.

3. Void Fraction Algorithm Cabinet

   A non-Class 1E electronic analog equipment rack will contain the equipment to compute the void fraction. The rack will contain interconnected plug-in modules which will perform the functions of current-to-voltage conversion, summation, function generation, multiplication, and division. Outputs of the rack will be sent to an analog trend indicator recorder in the control room, and to the computer.

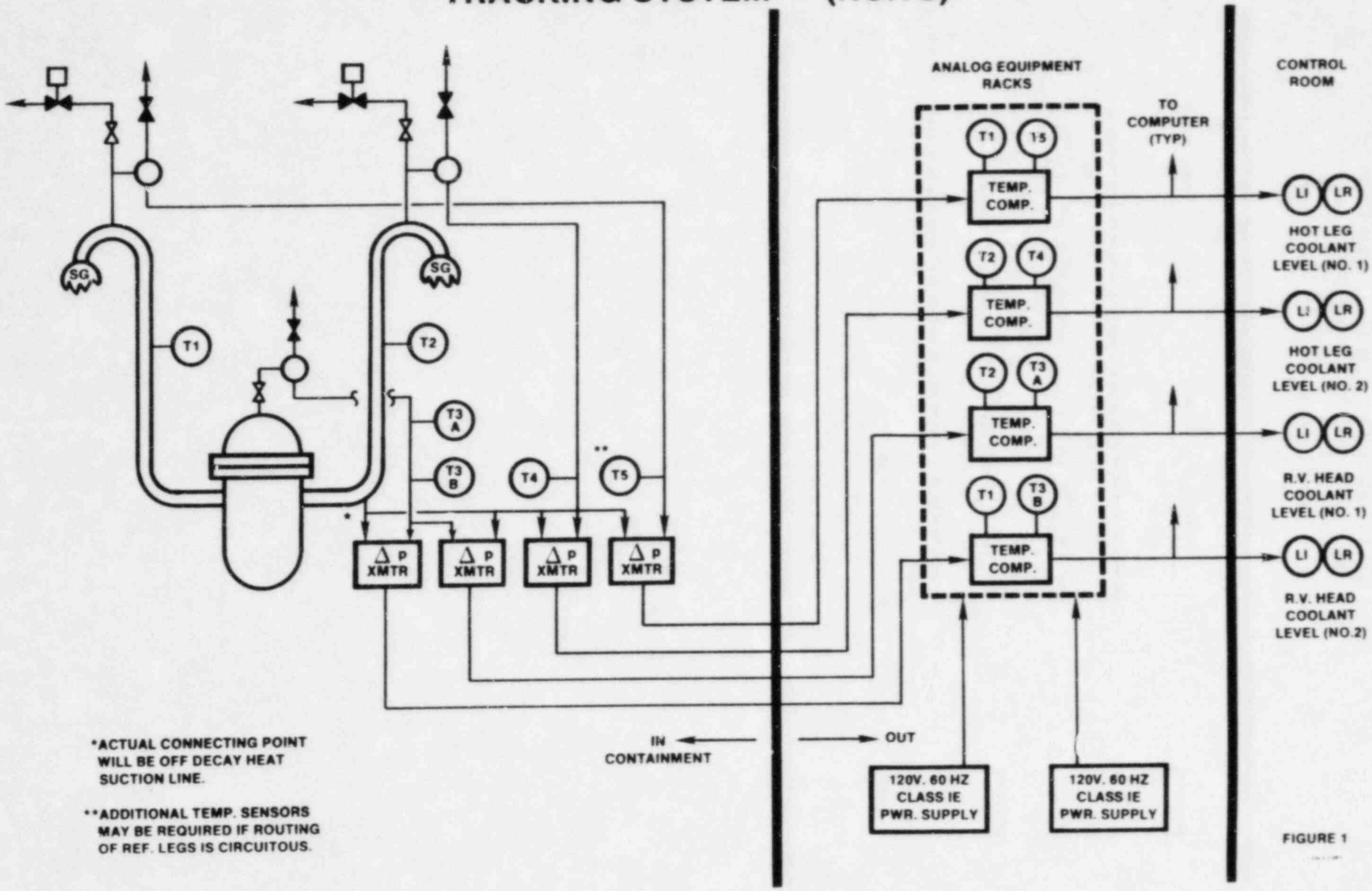
12. CONTROL ROOM INDICATION

Analog coolant level indicating recorders will be mounted on a panel in the control room in close proximity with the void fraction indicator recorder.

During normal operation with the RCPs running, or during the venting operation, the data provided by the void fraction indicator recorder will permit the operator to track the reactor coolant inventory. The coolant level indicators will read off scale high. Operational procedures will provide instructions to the operator that level indications are invalid under these conditions.

If the reactor coolant pumps are turned off and the system is not being vented, the coolant level indicators will provide a true indication of reactor coolant inventory in both the reactor and the hot legs.

REACTOR COOLANT INVENTORY TRACKING SYSTEM — (RCITS)



*ACTUAL CONNECTING POINT WILL BE OFF DECAY HEAT SUCTION LINE.

**ADDITIONAL TEMP. SENSORS MAY BE REQUIRED IF ROUTING OF REF. LEGS IS CIRCUITOUS.

FIGURE 1

COOLANT INVENTORY TRENDING WITH RCPs RUNNING

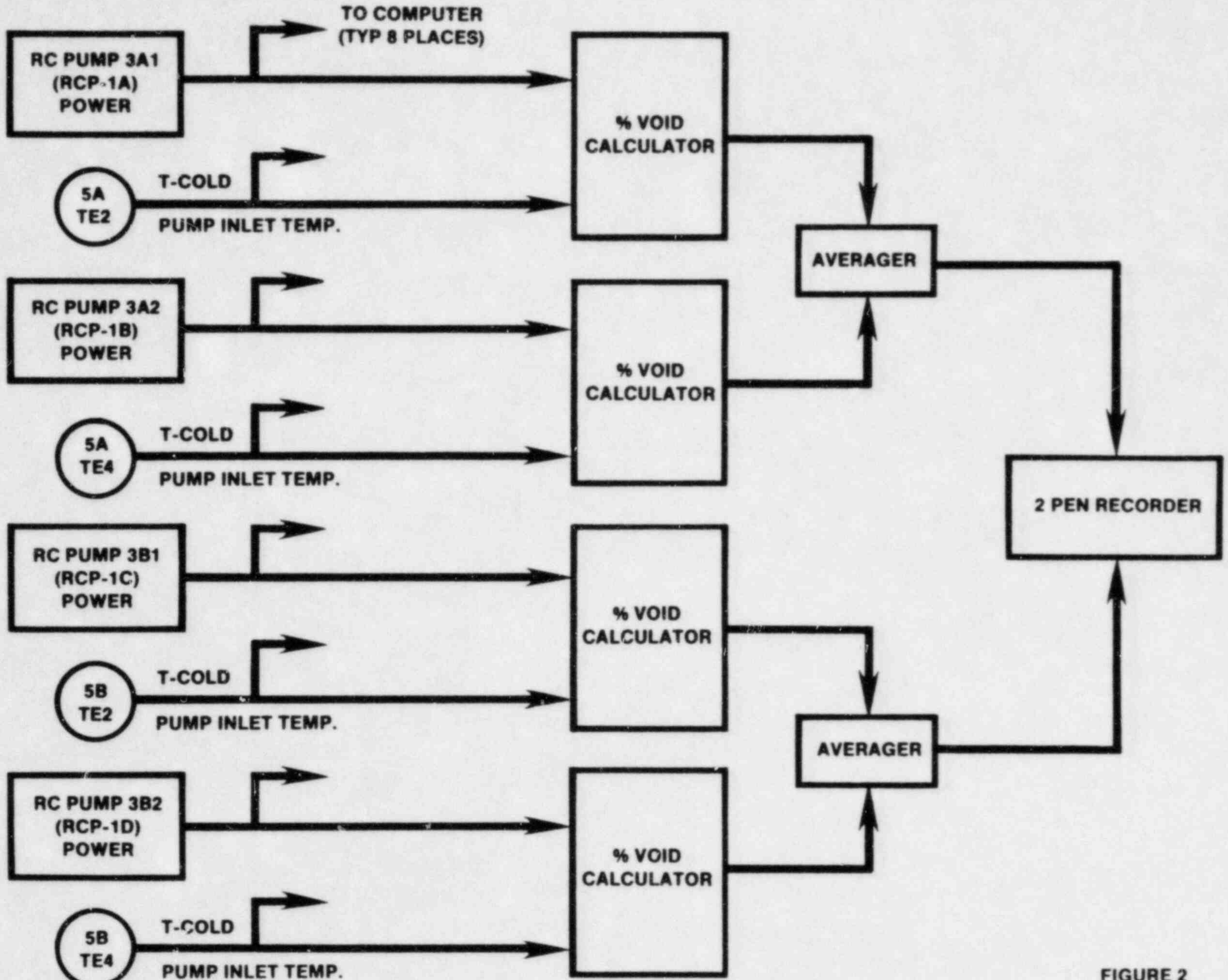
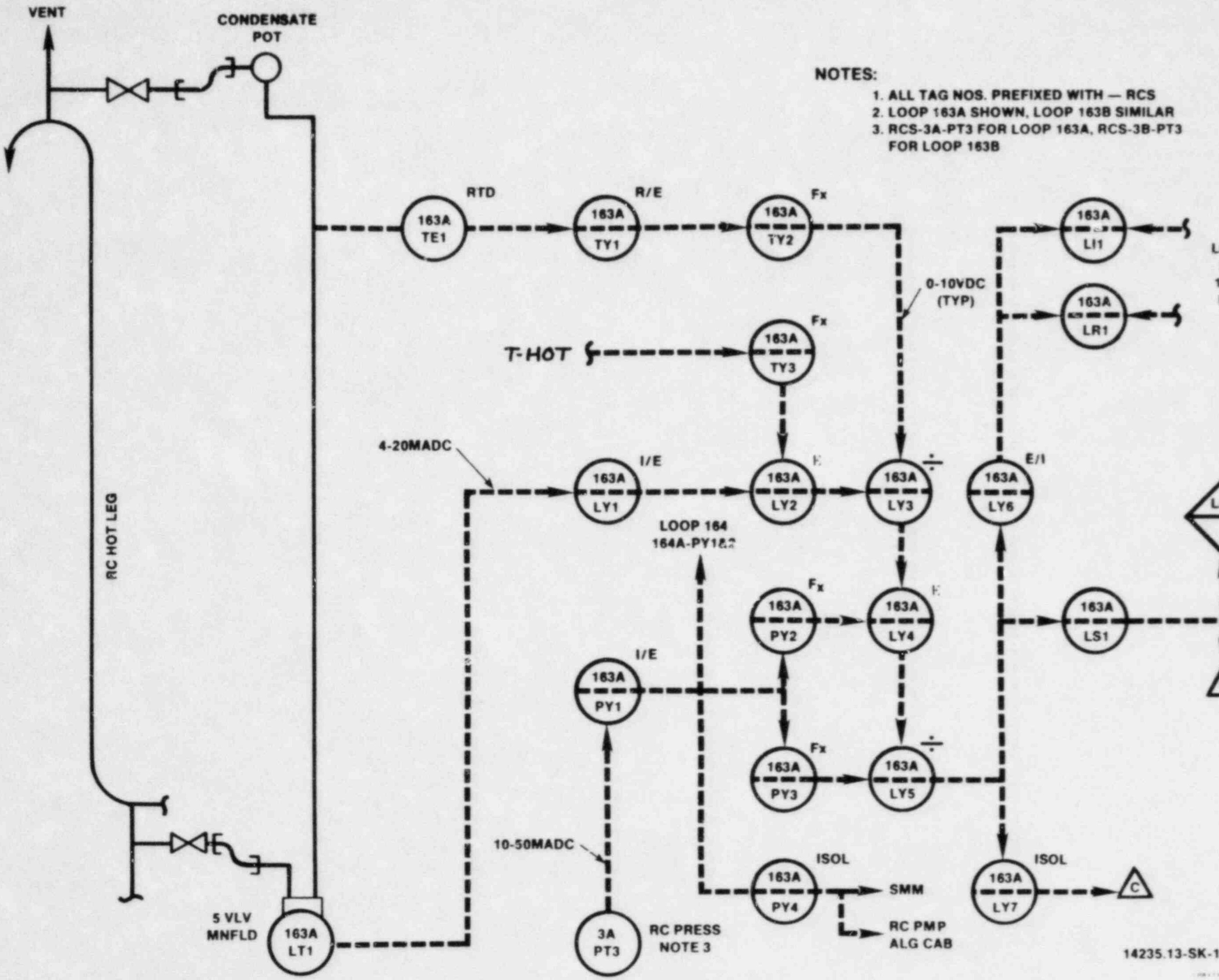


FIGURE 2

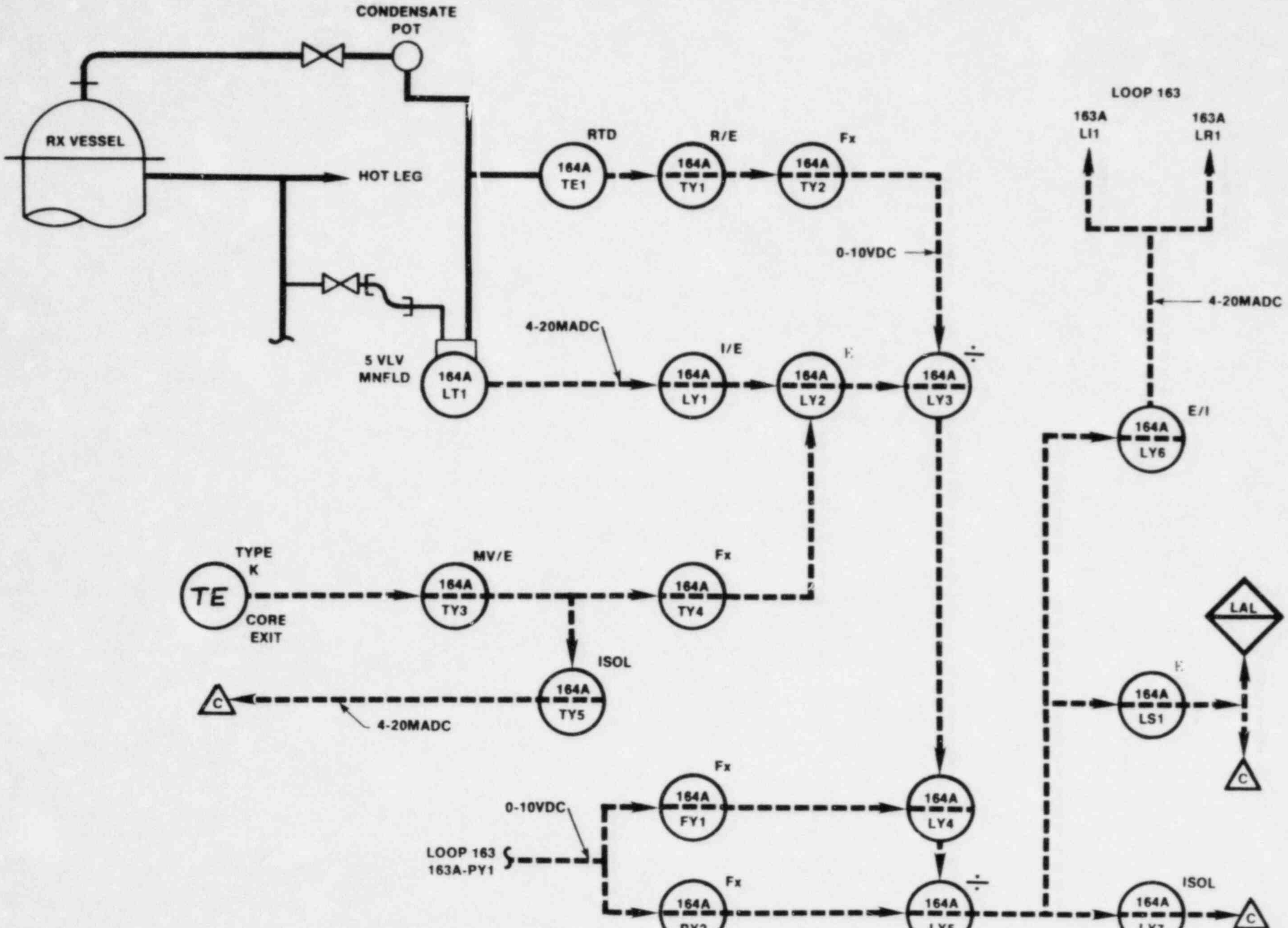
RCITS HOT LEG LEVEL LOOP 163



NOTES:
1. ALL TAG NOS. PREFIXED WITH — RCS
2. LOOP 163A SHOWN, LOOP 163B SIMILAR
3. RCS-3A-PT3 FOR LOOP 163A, RCS-3B-PT3 FOR LOOP 163B

14235.13-SK-16

RCITS RX HEAD LEVEL LOOP 164

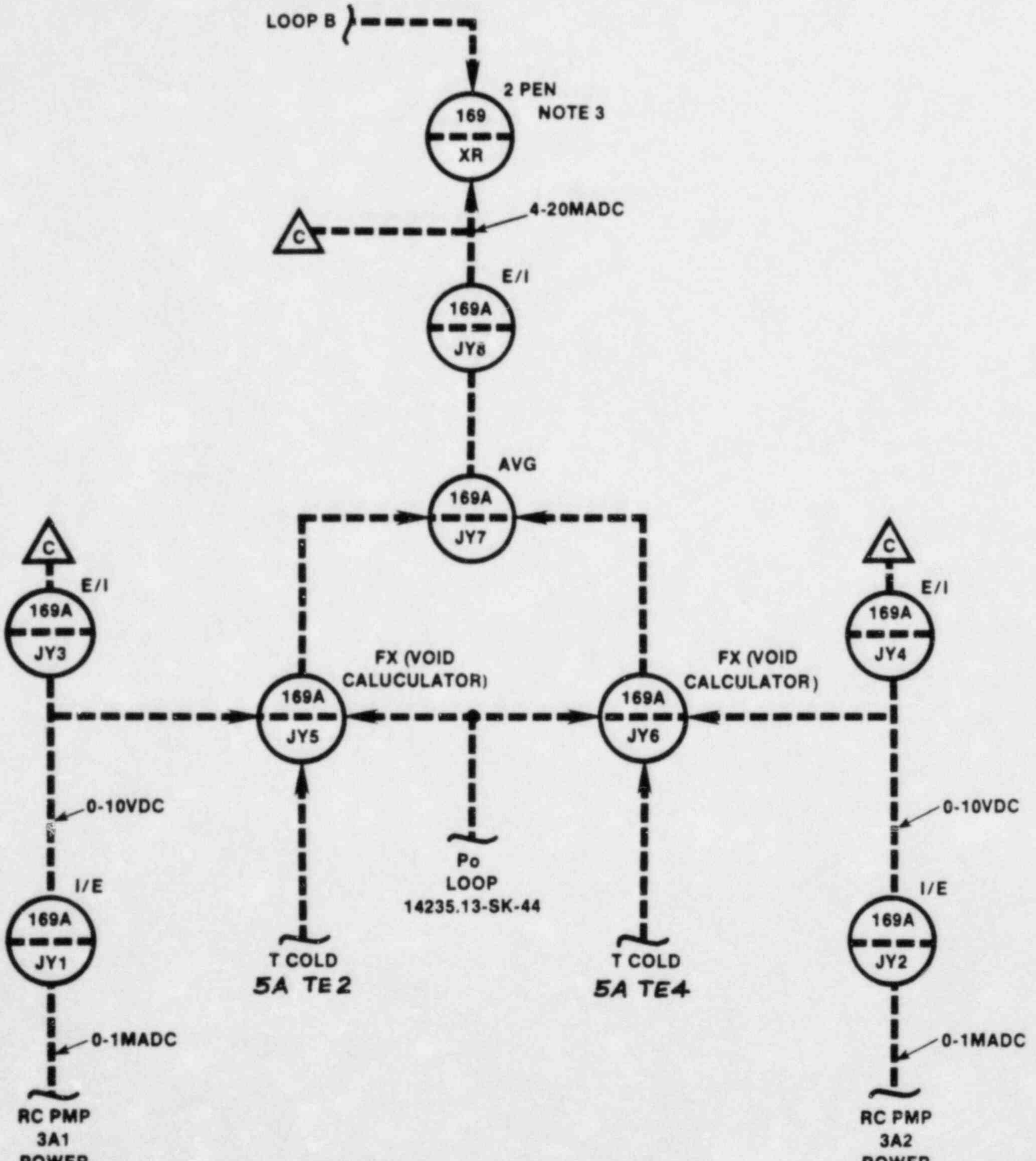


NOTES:

1. ALL TAG NOS. PREFIXED WITH — RCS
2. LOOP 164A SHOWN, LOOP 164B SIMILAR

14235.13-SK-17

VOID FRACTION ALGORITHM WITH RC PMP POWER



NOTES: 1. AL TAG NOS. PREFIXED WITH "RCS"
2. LOOP A SHOWN, LOOP B SIMILAR
3. XR COMMON TO BOTH LOOPS A&B

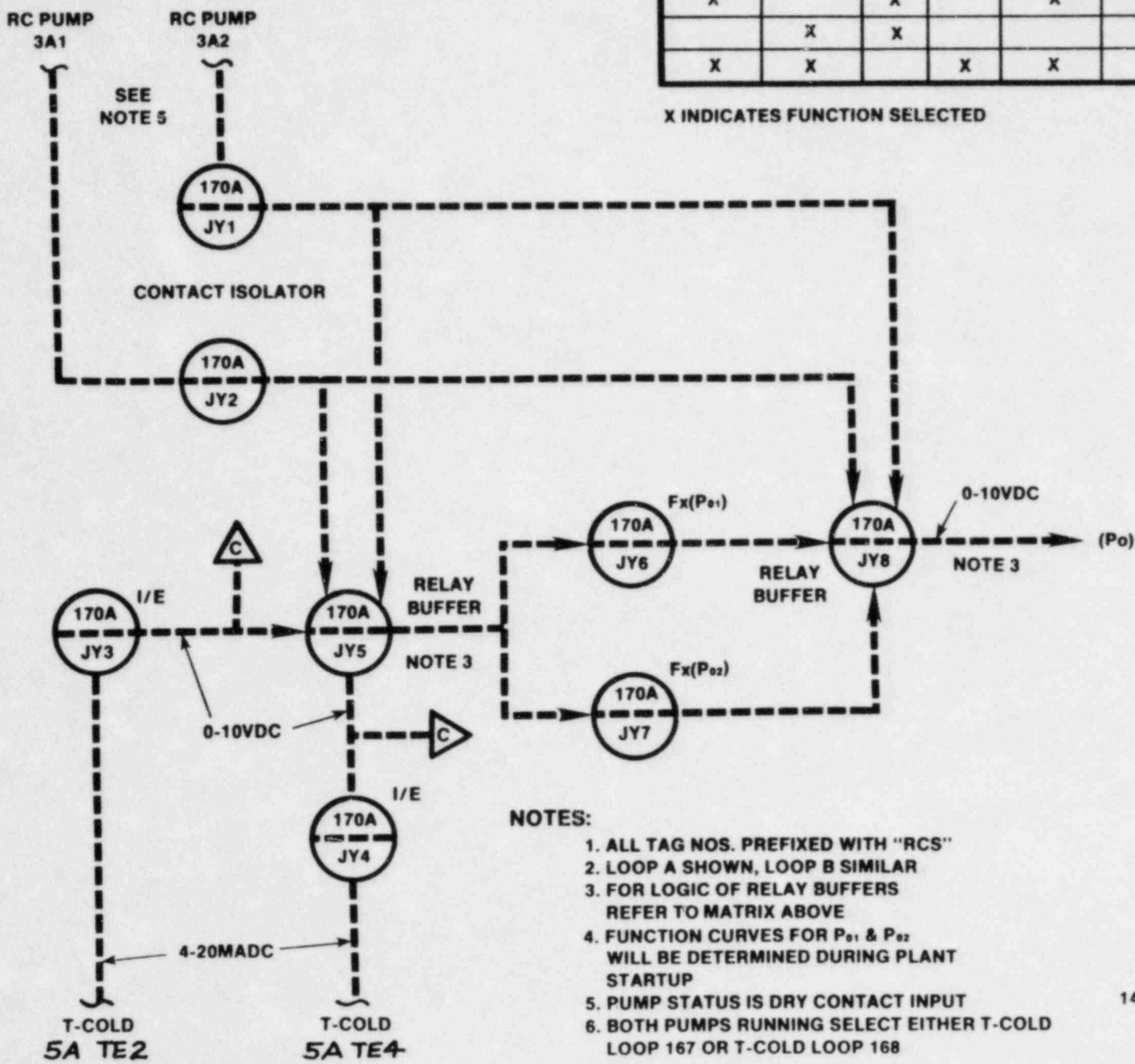
14235.13-SK-23

RC PUMPS REFERENCE PUMP POWER

MATRIX FOR FUNCTION SELECTION

RC PUMP 3A1	RC PUMP 3A2	P_{01}	P_{02}	T-COLD LOOP 167	T-COLD LOOP 168	REMARKS
X		X		X		
	X	X			X	
X	X		X	X	X	NOTE 6

X INDICATES FUNCTION SELECTED



NOTES:

1. ALL TAG NOS. PREFIXED WITH "RCS"
2. LOOP A SHOWN, LOOP B SIMILAR
3. FOR LOGIC OF RELAY BUFFERS REFER TO MATRIX ABOVE
4. FUNCTION CURVES FOR P_{01} & P_{02} WILL BE DETERMINED DURING PLANT STARTUP
5. PUMP STATUS IS DRY CONTACT INPUT
6. BOTH PUMPS RUNNING SELECT EITHER T-COLD LOOP 167 OR T-COLD LOOP 168

14235.13-SK-44

ENCLOSURE 3

TECHNICAL DESCRIPTION OF PROPOSED CORE EXIT THERMOCOUPLE SYSTEM DESIGN

RESPONSE TO II.F.2, ATTACHMENT 1

1. Diagram of Core Exit Thermocouple Location

A diagram of the in-core monitoring assembly locations is presented on Babcock and Wilcox (B&W) Drawing No. 86522B. These assemblies each contain one CET. A total of 52 CETs are distributed throughout the core as shown.

2. Description of Primary Operator Displays

a. The primary operator display of CETs is provided by a demandable core map diagram on the plant computer CRT monitor. The temperature at each of the 52 CET locations is displayed. Bad readings are identified.

b. The highest temperature of all operable thermocouples is highlighted in color and is updated continuously whenever the core map is displayed.

c. A hard copy of the core map is printed on demand by the computer line printer. The temperature of all CETs will be displayed over a range of 0°F to 2,500°F.

d. The computer provides a capability to display or to print a temperature-time digital trend history for any CET, singly or in groups, by operator selection. In addition, four analog strip chart recorders are driven by the computer. Each of these recorders can provide a trend record of any CET.

e. Any CET temperature exceeding a 700-°F alarm limit will be alarmed on the dedicated alarm monitor and alarm printer. If the core map diagram is requested, the alarmed CET will be displayed in color. This capability is consistent with CR3 operating procedures.

f. Human factor considerations were applied to the design of the display system. CET displays are consistent with all CR3 plant computer displays.

3. Description of Backup Displays

Three multipen analog temperature recorders will be provided on the main control board. A minimum of 16 CETs, 4 from each core quadrant, will be recorded continuously over a range of 0°F to 2,500°F. The recorders will have alarm capability, can automatically change chart speed on alarm, and will detect inoperable CETs.

Two subcooling margin monitors are located on the main control board. These instruments continuously display saturation temperature for each loop. In addition to displaying saturation temperature, each

instrument can display on demand the hottest CET selected from a group of six CETs. A total of 12 CETs have been selected to provide representative temperatures from each core quadrant and the control region. These instruments display temperatures over a range of 0°F to 1,023°F, well above saturation temperatures.

4. Use of Primary and Backup Displays

A human factors analysis will be conducted to determine the location and display of alarms.

a. During normal operations, the operator will have a continuous indication of the subcooling margin.

b. After an alarm condition by the SMM, the operator will be instructed in the emergency operating procedure to commence monitoring the CET primary display. The backup display on Channel B will be checked manually during the progress of the transient.

c. The operators will be trained in the revised abnormal transient operating guidelines and the revised emergency operating procedures prior to implementation of the new instrumentation and displays.

d. Other alarms occurring during the emergency will be prioritized in both the abnormal transient operating guidelines and the emergency operating procedures.

5. NUREG 0737 Criteria

The core exit thermocouples have been evaluated to the criteria of NUREG 0737, Appendix B. The results of this evaluation are described in Enclosure 6.

6. Power Sources

The primary and backup display channels will be electrically independent, energized from independent power sources, and physically separated in accordance with Regulatory Guide 1.75 up to and including the isolators. The primary display and computers are not Class 1E, but are energized from a battery backed high-reliability uninterruptible power supply.

The backup display and its power sources will be Class 1E.

CETs connected only to the plant computer will not be isolated, since they are unpowered and are not associated with safety systems. CETs connected to both safety and nonsafety systems will be isolated prior to the connection with nonsafety systems.

7. Environmental Qualification

There have been no problems with the existing in-core probe assemblies. One-half of them have been replaced during the 1983 refueling outage with similar units.

During the next refueling outage, all of the existing in-containment cable for the in-core probe assemblies will be replaced with qualified cable.

Also, during future outages, the in-core probe assemblies will be replaced with qualified units.

ENCLOSURE 4

SUMMARY OF REQUIREMENTS; CONFORMANCE WITH NUREG 0737, II.F.2, ATTACHMENT 1; AND PROPOSED MODIFICATIONS

1. CORE EXIT THERMOCOUPLES (CETs)

a. Requirements

A minimum of 4 CETs from each quadrant is required. They should be environmentally qualified. Their outputs should be electrically isolated and physically separated from nonsafety-related circuits.

The primary operator display of core exit temperature should be a core map available on demand. Temperature range should extend from 200°F to 1800°F minimum. A temperature-time trend history capability should be available on demand. The alarming capability should be consistent with operator procedures. The display must be human factor designed to provide rapid access to displays.

A backup CET display, qualified for Category 1E service, should be provided to display an additional 16 temperatures in 6 minutes. The temperature range should be 200°F to 2300°F. It should be powered from a separate 1E power source.

b. Conformance of Existing Equipment

The CETs, connectors, and cables are not environmentally qualified category 1E devices. Isolation and separation are not provided.

The temperature range for CETs in the plant computer (primary display) is 0°F to 900°F, which is less than the 1800°F required. An analog temperature-time trending display capability is not provided, but temperatures can be time recorded on computer output analog recorders. Access to operator displays should be improved.

A qualified backup display is not provided. An existing Esterline-Angus data logger does not meet the requirements.

c. Proposed Modifications

Existing thermocouple cables will be replaced by qualified cables as part of the ICC modifications. CETs will be replaced by environmentally qualified thermocouples as the in-core probe assemblies are replaced during future refueling outages.

The primary display need not be qualified for Category 1E service. However, separation in accordance with Regulatory Guide (RG) 1.75 will be provided between the primary and the backup. Isolators will be provided between the backup CETs and the computer. Seismically qualified racks and equipment, including type K thermocouple converters and analog isolators will be used to accomplish this.

A Category 1E qualified temperature display will be provided for backup. It will be located for rapid access by the operator and permit selective reading of 16 temperatures within 6 minutes. Qualified devices which meet the requirements are supplied by TI (Tigraph 200).

2. SUBCOOLING MARGIN MONITORS

a. Requirements

NUREG 0737, II.F.2 provides little guidance to the design criteria for subcooling margin instrumentation (also called saturation temperature meters, Tsat). RG 1.97, Revision 2, specifies a range of 200°F subcooling to 35°F superheat. It also places SMM in Category 2.

b. Conformance of Existing Equipment

Although there is no requirement for isolation and separation for Category 2 instrumentation, if it is determined that the input signals for the SMM are derived from safety systems, proper isolation and separation up to and including the isolators will be provided.

c. Proposed Modifications

FPC will verify the existing conditions and correst them, as required.

II.F.2, ATTACHMENT 1 CHECKLIST
(FOR CORE EXIT THERMOCOUPLES)

Criteria	NonConformance	Proposed Modifications
1. Provide sufficient CETs with proper distribution.	-	-
2. Primary display:		
a. Core map	-	-
b. Continuous display	-	-
c. Range 200°F to 1,800°F	Insufficient range	Modify software.
Direct readout - hard copy	-	-
d. Trend capability	-	-
e. Alarm capability	-	-
f. Human factors design	No rapid access	1. Detailed analysis 2. Add keyboard function keys.
3. Backup display	Not qualified	Add qualified system.
4. Human factors analysis:		
a. Normal/abnormal use	Normal use not included	Modify procedures.
b. Emergency use	Insufficient detail	Modify procedures.
c. Training use	Not included	Modify procedures.
d. Prioritization	Not included	Modify procedures.
5. Conformance to Appendix B	See separate enclosure.	
6. Independent power sources	-	-
7. Instrument qualification	See Enclosure 3	See Enclosure 3
8. 99-percent availability	-	-
9. Quality Assurance	-	New equipment will meet Regulatory Guide QA requirements.

ENCLOSURE 5

RESPONSE TO APPENDIX B OF NUREG 0737, II.F.2

Design and Qualification of the Reactor Coolant Inventory Tracking System (RCITS)

1. Environmental/Seismic Qualification

The RCITS will be environmentally qualified in accordance with Regulatory Guide (RG) 1.89 (NUREG 0588), with the seismic portion of the qualification in accordance with RG 1.100, except as noted herein (see deviations).

2. Single Failure

The RCITS will be designed so that no single failure of the instruments or auxiliaries prevents the operator from determining the safety status of the unit. Redundancy is provided by dual instrument trains. The two differential pressure sensing trains do have taps in common at the penetrations in the reactor vessel head and the decay heat suction line; however, there is a very low probability of tap failure (see deviations).

3. Class 1E Power Sources

Each of the redundant differential pressure systems used to infer reactor coolant level with RCPs tripped will be electrically powered independently from separate Class 1E sources. The coolant inventory trending system used with RCPs running will be non-Class 1E (see deviations).

4. Availability Prior to an Accident

RCITS instrument channels will be available prior to an accident, except as provided in paragraph 4.11, Exemption, in IEEE Standard 279.

5. Quality Assurance Requirements

The QA requirements will be those imposed by the quality programs as stated in Section 1.7 of Crystal River - Unit 3 FSAR.

6. Continuous Indications

RCITS instrumentation will provide a continuous indication of reactor coolant inventory trending with RCPs running or tripped.

7. Recording Instrumentation

RCITS instrumentation will provide analog strip chart records of reactor coolant inventory trending with RCPs running or tripped.

8. Identification of Instruments

RCITS instruments mounted on the control panels will be specifically identified so that the operator can easily discern that they are for use under accident conditions.

9. Isolation

The transmission of signals from Class 1E sensors to any non-Class 1E instrument or device will be through isolation devices that are designated as part of the monitoring instrumentation.

10. Checking Operational Availability

The Class 1E qualified electronic analog equipment racks will be located outside of containment for accessibility. Input and output terminals on the racks will be located at the front. Each of the input modules will have provision for insertion of a test jack, which will disconnect the normal transmitter input and connect a test input. This will be used for calibration, troubleshooting, and checking the operational availability of each monitoring channel.

11. Servicing, Testing, and Calibration

Servicing, testing, and calibrating programs will be specified later in a technical specification change. See ICC Instrumentation Schedule for planned date of submittal.

A capability for testing during power operation will be provided for those instruments where the required interval between testing will be less than the normal time interval between generating station shutdowns. Refer to Item 10 for details.

12. Administrative Control of Removal from Service

Wherever means for removing channels from service are included in the design, the design will include locked cabinets and discreet distribution of keys to provide administrative control of the access to those removal means.

13. Administrative Control of Access to Adjustments

Administrative control of the access to all setpoint adjustments, module calibration adjustments, and test points also will be accomplished through the use of locked cabinets and discreet distribution of keys.

14. Minimizing Anomalous Indications

During normal operations with the RCPs running, or during the venting operation, anomalous indications will be minimized by the trending characteristics of the void fraction monitoring system. Only a continued trend towards an undesirable condition, not a transitory deviation from normal, will cause an anomalous indication.

When the RCPs are tripped, the coolant level indicators will provide real indication of coolant inventory; therefore, anomalous indications will be genuine indications of anomalous inventory conditions and should not be confusing to the operator.

15. Detecting, Locating, and Correcting Malfunctions

Instrument selection, location, and system design will be such as to facilitate the recognition, location, replacement, repair, or adjustment of malfunctioning components or modules. Refer to Items 10 and 11 for details.

16. Direct Measurement of Desired Variables

There is no practical means to directly measure all of the desired variables affecting the monitoring of coolant inventory. In the RCITS, measurement of the primary variables used to monitor coolant inventory are inferred from RCP motor power in normal operation and hydrostatic pressure when the RCPs are tripped. Measurements of the secondary variables of temperature and pressure used in the coolant inventory algorithms are made directly.

17. Normal/Accident Monitoring

RCITS instrumentation covers the full range of coolant inventory for normal and accident situations. Monitoring of void fraction trends with the RCPs running, and coolant level in the reactor vessel and hot legs when the RCPs are tripped provides adequate instrumentation sensitivity under both normal and accident conditions.

18. Periodic Testing

Same as Items 10 and 11.

RESPONSE TO APPENDIX B, NUREG 0737, II.F.2

DEVIATIONS

1. Environmental Qualification/Class 1E Power Source - RCITS with Reactor Coolant Pumps (RCPs) Running

RCP motors and their associated electrical circuits currently are powered from non-Class 1E sources and are not environmentally qualified in accordance with IEEE 323-1974. Since the RCITS is not a protection system, but a monitoring system with reliable backup from the core exit thermocouples and the saturation margin monitor, it is not intended that the RCP motors and their circuits be upgraded to meet the requirements of IEEE 323-1974. Rather, since the cost of such an upgrade would be exorbitant in terms of financial expenditure, downtime, and man/rem exposure, it is intended to make the computational and readout devices used with the RCP motor power inputs non-Class 1E also.

For maximum reliability in the RCITS with RCPs running, separate sets of analog computational devices will be used for each RCP loop and 100-percent computational backup will be provided by the computer, which will perform totally independent calculations and provide void trending indication upon demand.

2. Single-Failure Analysis - RCITS With RCPs Tripped

Single, rather than dual, pressure taps are provided in the reactor vessel head and in the decay heat suction line. Since the RCITS is a monitoring system, not a protection system, it is considered more important to safety and reliability to minimize the number of penetrations in the reactor coolant system than to increase them for the sake of redundancy. Instead, the taps will be designed in size, configuration, and selection of construction material to minimize the possibility of plugging or leaking. From these common taps, separate connections will be made to completely redundant instrumentation with totally independent electrical power sources so that no single failure of the instruments, auxiliaries, or power sources will prevent the operator from being presented with the information necessary for him to determine the safety status of the plant, to take corrective action, and to maintain a safe condition.

ENCLOSURE 6

RESPONSE TO APPENDIX B OF NUREG 0737, II.F.2

Design and Qualification of the Core Exit Thermocouple (CET) System

1. Environmental Qualification

The CET instrumentation will be environmentally qualified, except for the primary display and computers beyond the isolators.

2. Single-Failure Analysis

Redundancy will be provided by independent primary and backup systems. The primary system computer itself is redundant (see paragraph 5 in Response to Appendix A Checklist). Analog recorders will be provided for the backup system. The saturation meters, although not environmentally qualified, provide additional backup display consisting of the two highest CET temperatures selected from among 12 CETs, independent from the backup system.

3. Power Sources

The primary and secondary systems will be energized from separate vital buses. The primary system is energized from a battery-backed uninterruptible power supply.

4. Availability

Both channels will be available prior to an accident except as provided in paragraph 4.11, Exemption, as defined in IEEE Standard 279.

5. Quality Assurance (QA)

The QA requirements will be those imposed by the quality program, as stated in Section 1.7 of CR3 FSAR.

6. Continuous Indication

Continuous indication will be provided by the recorders in the backup system.

7. Recording

The backup system analog recorders will provide trend records. Hard copy of the computer display is available upon demand.

8. Identification

ICC instruments will be located together on the main control board. The CET recorders will be identified for use under accident conditions.

9. Isolation

Qualified isolators will be provided between Class 1E safety-related devices and nonsafety-related devices.

ENCLOSURE 7

ICC INSTRUMENTATION IMPLEMENTATION SCHEDULE

		Month/Year
o	Complete operator guidelines, including analysis used in developing procedures	12/84
o	Complete procurement of instrumentation	12/84
o	Commence installation of instrumentation	2/85
o	Complete operating and emergency procedure modifications	2/85
o	Submit technical specification	2/85
o	Commence training of RO/SRO	1/85
o	Complete installation	4/85
o	Complete testing and calibration	4/85
o	Complete training of RO/SRO	4/85
o	Commence operation	Dependent on date of NRC approval.