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March 15, 1983
IPN-83-22

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation

Subject: Indian Point 3 Nuclear Power Plant
Docket No. 50-286
Inadequate Core Cooling Instrumentation

Dear Sir:

Enclosed as Attachments 1 and 2 to this letter is the Authority's response to your Generic Letter 82-28 dated December 10, 1982 regarding instrumentation for inadequate core cooling.

Should you or your staff have any questions, please contact Mr. P. Kokolakis of my staff.

Very truly yours,

J. P. Bayne
Executive Vice President
Nuclear Generation

cc:attached

State of New York
County of Westchester

MITCHELL J. WEINSTEIN
Notary Public, State of New York
No. 30-4740329
Qualified in Nassau County
Commission Expires March 30, 1983

A001

Subscribed and sworn to before me this 15th day of March 1983.

Notary Public

8303180479 830315
PDR ADOCK 05000286
P PDR

cc: Resident Inspector's Office
Indian Point U-it 3
U. S. Nuclear Regulatory Commission
P. O. Box 66
Buchanan, New York 10511

ATTACHMENT 1

INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE COOLING

REQUIRED DOCUMENTATION FOR REACTOR COOLANT INVENTORY TRACKING SYSTEM.

NUREG-0737, ITEM II.F.2

ITEM 1: A description of the proposed final system including:

(a) Final design description of additional instrumentation and displays.

As stated in our letter dated September 11, 1982 the Indian Point 3 facility will utilize the Westinghouse 7300 series Reactor Vessel Level Instrumentation System (RVLIS) for tracking the coolant level in the reactor vessel. The RVLIS is planned to be installed during our 5/6 refueling outage (mid-1986). A generic description of the 7300 series RVLIS was submitted by Westinghouse for NRC review in December 1980. By letter dated January 2, 1982 the Authority provided additional information (both generic and plant-specific) for the NRC to complete its review of the RVLIS. The IP-3 system will not deviate from that described in the above referenced submittals. The NRC technical review of the Westinghouse generic RVLIS is presented in NUREG/CR-2628. No other additional instrumentation (e.g., SMM, T/C) is planned to be installed at this time.

ITEM 1: (b) A detail[illegible] description of existing [illegible]strumentation systems (e.g., subcooling meters and incore thermocouples), including parameter ranges and displays, which provide operating information pertinent to ICC considerations.

Subcooling Meter

There is one saturation recorder which is located on an instrument rack in the Central Control Room. The saturation recorder and alarm inform and warn the operator of saturation conditions in the Reactor Coolant System.

The system involves a calculating device to develop a saturation curve, an alarm duplex bistable, an isolating amplifier, a high selector, a low selector and a summing unit to form a difference signal between reactor coolant pressure and saturation pressure.

The RCS pressure is determined by the use of two pressure loops; the two signals from these loops are channeled into a low selector device. This device chooses the lower pressure signal and feeds it to a duplex bistable and a summing unit.

The programm[illegible] RCS saturation pressure [illegible] determined by the use of four RCS temperature loops taken from each of the four hot leg instruments loops. The four signals from these loops are channeled into a device which selects the highest temperature signal and feeds it to a characterizer where a corresponding saturation pressure signal is derived. This pressure signal is fed into a duplex bistable and summing unit. The duplex bistable alarms, when the difference in pressures (RCS vs. saturation) approaches saturation conditions.

Information on parameter ranges and displays:

a. Information displayed: $P - P_{sat}$ subcooled

b. Range of display: 0 - 1500 psi subcooled

c. Continuous indication (by recorder)

d. Alarms: Approach - 300 psi subcooled

Saturation - 0 psi subcooled

e. Range of temperature inputs: 0-700°F

f. Range of pressure inputs: 0-2500 psi (loop 1)

0-3000 psi (loop 4)

<u>Incore Thermocouples</u>

The thermocouple system utilizes 65 thermocouples, positioned to measure coolant outlet temperature at preselected core locations. The thermocouples are the chromel-alumel type and have an accuracy of $\pm$ 2°F.

The thermocouples are enclosed in stainless steel sheaths. These sheaths are routed in guide tubes which position the thermocouple end at the selected core location. The guide tubes extend the entire distance from the core location to the seal assemblies.

The guide tubes are routed to one of five instrument ports used for the thermocouples. The individual thermocouple guide tubes are enclosed in a thermocouple port column which protrudes through the reactor head instrument port. The individual thermocouple quide tubes are sealed to the thermocouple port column. The thermocouple sheath is sealed to the guide tube by means of a Swagelok seal.

The individual thermocouple wires are separated and routed to either of two reference junctions. The selection of the thermocouples to be connected to each reference junction was made to eliminate the possibility that a single failed reference junction would totally negate the value of the readings received from the thermocouple system. In the event a reference junction does fail, the thermocouples connected to the remaining reference junction have been chosen so as to provide a meaningful representation of the core temperatures. The reference junction boxes are located in the seal table room, and they are maintained at 160°F by an electric heater in the box.

All of the control equipment for the Thermocouple System is located on a rack in the CCR. A multipoint precision indicator has been provided to indicate the temperature sensed by the thermocouples. Only one thermocouple at a time can be connected to the indicator. Switches have been provided on the front of and above the indicator to select that thermocouple desired to be read.

An additional selector switch located on the front of the panel allows either the low (100-400°F) or high (400-700°F) range measuring circuit to be used. Besides being directed to the indicator the thermocouple outputs are also supplied to the plant computer.

The plant computer prints out, on demand, current maps, hourly maps and history maps (24 hour maps) showing the thermocouple temperatures. The thermocouple temperature range in the computer is 0-1000°F.

ITEM 1 (c) <u>A description of any planned modifications to the instrumentation systems described in item 1.b above.</u>

The Authority will install a Qualified Safety Parameter Display System (QSPDS) and Critical Function Monitoring System (CFMS) which are being engineered and designed by Combustion Engineering. The CFMS and QSPDS

will satisfy the intent of NUREG-0737 Item II.F.2, Attachment 1, for primary and backup displays for the thermocouple temperatures. Additional information regarding the display features of the proposed QSPDS and CFMS is provided in Attachment 2 to this letter. Note that the input signals to the RVLIS, QSPDS and CFMS are from original plant equipment. An evaluation of this equipment will be performed during our Regulatory Guide 1.97 Rev. 2 plant review. A schedule of our plant review will be provided in the Authority's response to Supplement 1 of NUREG-0737.

ITEM 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.

An analysis of the Reactor Vessel Level Instrumentation System including an evaluation of the level monitoring instrumentation and test data supporting the system design is contained in the generic system description submitted by Westinghouse in December 1980 and reviewed by the NRC in NUREG/CR-2628. Some additional information is provided in the letter dated January 2, 1982 submitted by the Authority. In addition, Westinghouse has completed six semiscale tests at the Idaho test facility with the RVLIS installed. The semiscale tests simulated cold leg breaks and natural circulation in a PWR. The results of the tests demonstrate that the RVLIS provides a good indication of the vessel inventory.

ITEM 3: <u>A description of additional test programs to be conducted for evaluation, qualification, and calibration of additional instrumentation.</u>

A description of test programs to be conducted for evaluation, qualification and calibration of instrumentation is provided in the generic RVLIS description submitted by Westinghouse in December, 1980. Note that the input signals to the RVLIS, QSPDS and CFMS are from original plant equipment. An evaluation of this equipment will be performed during our Regulatory Guide 1.97 Rev. 2 plant review. A schedule of our plant review will be provided in the Authority's response to Supplement 1 of NUREG-0737.

ITEM 4: An evaluation, including proposed actions on the conformance of the ICC instrument system to this document, including NUREG-0737, Item II.F.2 Attachment 1 and Appendix B. Any deviations should be justified.

The Westinghouse 7300 Series Reactor Vessel Level Instrumentation System has already been evaluated by the NRC and found to be acceptable, as indicated in NUREG/CR-2628.

The present incore thermocouple temperature display does not fully meet the requirements of NUREG-0737, Item II.F.2, Attachment 1 and Appendix B. The Authority will install a Critical Function Monitoring System (CFMS) and Qualified Safety Parameter Display System (QSPDS) to meet the intent of II.F.2, Attachment 1 for primary and backup thermocouple temperature displays. The CFMS (primary display system) is a high performance 32-bit computer system providing display of thermocouple temperatures and other safety parameters in the Central Control Room. The QSPDS is a backup to the CFMS and is qualified to Class 1E standards (including seismic). The method of isolating non-1E inputs from the 1E QSPDS is summarized in the response to Item 6 of Attachment 2 to this letter. Attachment 2 to this letter provides specific information regarding the proposed upgraded incore thermocouple system.

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

The general description submitted by Westinghouse and the Authority's letter of January 2, 1982 provide sufficient information on the 7300 series inputs, outputs, displays and calculational features.

ITEM 6: A current schedule, including contingencies, for installation, testing and calibration, and implementation of any proposed new instrumentation or information displays.

As stated in our letter of December 30, 1981 the Authority plans to install the RVLIS by the end of the 5/6 refueling outage. System testing and calibrations will be performed during plant startup following the 5/6 refueling outage. Upon successful completion of the system testing and calibrations and NRC preimplementation review, the RVLIS will be placed in normal operation.

ITEM 7: Guidelines for use of the additional instrumentation, and analyses used to develop these procedures

Guidelines for use of inadequate core cooling instrumentation have been transmitted to the NRC via Westinghouse Owners Group Letter, OG-44, dated November 10, 1980. Analyses used to develop these guidelines are presented in the generic description submitted by Westinghouse in December, 1980. This item will be further addressed in our response to Supplement 1 to NUREG-0737.

ITEM 8: A summary of [redacted]y operator action instruc[redacted]ons in the current emergency procedures for ICC and a description of how these procedures will be modified when the final monitoring system is implemented.

Current procedures call for monitoring of the core exit T/C's, RCS wide-range temperature and pressure, and the subcooling margin monitor (SMM).

The WOG Emergency Response guidelines provide guidance as to the use of the RVLIS, the core exit T/C's and the SMM under ICC conditions. Incorporation of additional guidance for the use of these systems into plant specific procedures will be performed as part of the efforts related to Supplement 1 to NUREG-0737, and will be coordinated with physical implementation of the systems.

Instructions for the use of the core exit T/Cs and the SMM are contained in existing plant procedures, which are available on site.

ITEM 9: Schedule for additional submittals

The only open items, involve the integration of the use of ICC equipment into the emergency procedures and compliance with Regulatory Guide 1.97, Rev. 2. These issues will be addressed as part of our response to Supplement 1 to NUREG-0737.

Westinghouse Differential Pressure System Additional Information

(a) Describe effect of instrument uncertainties on measurement of level

The effects of uncertainties in the temperature and pressure signals are discussed in the Authority's letter to the NRC dated 2/2/82.

(b) Are differential pressure transducers located outside containment?

The differential pressure transmitters are located outside containment.

(c) Are hydraulic isolators and sensors included in the impulse lines?

Hydraulic isolators and sensors are included in the impulse lines.

ATTACHMENT 2

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

DESIGN AND QUALIFICATION CRITERIA FOR

PRESSURIZED WATER REACTOR INCORE THERMOCOUPLES

ITEM 1. Provide diagram of core exit thermocouple locations or reference the generic description if appropriate.

A spatially oriented core map showing the core exit thermocouple locations is presented in Figure 1.

The T/C's are of sufficient number to provide indication of radial distribution of the coolant enthalpy.

ITEM 2: Provide a description of the primary operator displays.

The proposed primary operator displays will be part of the Critical Function Monitoring System (CFMS). The CFMS is a high performance 32-bit computer system which will provide displays of safety parameters in the Central Control Room (CCR). The display system in the CCR will consist of 4 multi-colored CRT display stations with alpha-numeric keyboards. In addition, there will be two video hardcopy units and two matrix printers in the CCR. Each display station will be capable of providing any one of the fixed format graphic displays.

ITEM 2: (a) A diagram of the display panel layout for the core map and description of how it is implemented.

The proposed display panel layout for the primary operator displays is shown in Figure 2. A core map with the thermocouple locations and temperatures will be one of the graphic displays shown on the CFMS CRT's.

ITEM 2: (b) The range of the readouts

The range of the thermocouple temperature readouts will be 160°F - 2300°F. A selective reading of core exit T/C's will be provided by the computer

for all thermocouples, including a hard copy of actual readouts. The computer has a trend capability which can be displayed on command.

ITEM 2: (c) Description of the alarm system

Specific information on the primary display alarms for the in-core thermocouples is not yet available. However, generally speaking, the CFMS software features include six levels of alarm indications: high, high-high, fail-high, low, low-low, and fail-low. The alarms are displayed graphically by changes in colors and/or flashing indicators. In addition, there is a current alarm list which can be displayed upon demand and which provides a chronologically ordered list of the alarm status of all monitored parameters.

NOTE: The graphic displays are arranged in a hierarchical structure. The hierarchy is arranged in three levels. This type of arrangement automatically cues the operator on the occurrence of a pre-selected alarm and allows the operator to follow a structured fault diagnosis path.

ITEM 2 (d) Description of how the ICC instrumentation readouts are arranged with respect to each other.

The ICC instrumentation readouts (reactor vessel level, in-core thermocouple temperatures and saturation margins) are displayed on the CFMS CRT's. Since the graphic displays are arranged in a hierarchical structure, the operator can rapidly access the ICC instrumentation readouts. The human factors review of operator display interface will be done as part of our response to Supplement 1 to NUREG-0737.

ITEM 3: Describe the implementation of the back-up display (including the subcooling margin monitors), how the thermocouples are selected, how they are checked for operability, and the range of the display.

The Qualified Safety Parameter Display System (QSPDS) will provide the backup displays for the in-core thermocouple temperatures and saturation margins. The QSPDS utilizes two (2) Plasma Display Units for displaying the in-core thermocouple temperatures and saturation margins as well as other safety parameters. Each Plasma Display Unit is a plasma dot matrix having the characteristics listed in Table 1. There is one display which provides information regarding the margin of subcooling in the core (see Figure 3).

There are two displays which provide information regarding the in-core thermocouple temperatures. One display provides a representative thermocouple temperature as well as the highest and next highest thermocouple temperatures for each quadrant in the core (see Figure 4). The other display provides a core map with 16 spatially oriented thermocouples (4 thermocouples in each quadrant). The temperatures of the 16 thermocouples are also provided on this display (see Figure 5).

The selection of the sixteen thermocouples (four from each quadrant) was based on providing indication of the radial distribution of the coolant temperature rise across representative regions of the core. Considerations were also given to power distribution symmetry for diagnosis of localized core problems.

The backup display software includes a sensor reasonability algorithm which compares various thermocouples temperatures against a statistical average for checking the reasonability of thermocouple readings.

The display range of the thermocouples is 160°F to 2300°F.

ITEM 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.

The primary display system will be utilized during normal and accident plant operating conditions. If, however, the primary display system is not operable during accident conditions, the backup display system will be utilized to obtain the essential plant parameters which include the saturation margins and thermocouple temperatures. The operators will be trained in sufficient detail to enable them to perform all functions associated with the primary and backup display systems. The training will also enable the operators to recognize system malfunctions.

The operators will be fully knowledgeable of normal and emergency operating procedures. However, normal and emergency operating procedures have not yet been written for use of the CFMS, QSPDS and RVLIS for determining the approach to, existence of, and recovery from inadequate core cooling.

NOTE: Westinghouse has submitted guidelines for use of inadequate core cooling instrumentation to the NRC via Westinghouse Owners Group Letter, OG-44 dated November 10, 1980. These guidelines will be used for preparing plant specific operating procedures prior to the implementation of RVLIS and will be further covered in our response to Supplement 1 to NUREG-0737.

ITEM 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.

Human factors engineering and man-machine interface considerations are integrated into the design of the QSPDS and CFMS. A control room design review which will include a review of the ICC instrumentation will be performed in accordance with NUREG-0737, Supplement 1. A schedule for implementation of a control room design review will be provided in the Authority's response to Supplement 1 of NUREG-0737.

The Authority's response to items 1 through 7 in this Attachment support the conclusion that the proposed primary and backup displays and signal processing equipment for the in-core thermocouple temperatures and saturation margins meet the intent of NUREG-0737, Item II.F.2, Attachment 1. Note, however, that the sensors (i.e., thermocouples, hot leg RTD's and pressure transmitters) and associated wiring are original plant equipment. This equipment will be evaluated for compliance to NUREG-0737, Appendix B during our Regulatory Guide 1.97, Rev. 2 review of the plant. A schedule for a review of the plant's conformance to this guide will be provided in the Authority's response to Supplement 1 of NUREG-0737.

ITEM 6: Describe what parts of the systems are powered from the 1E power sources used, and how isolation from the 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.

Power Supplies for Primary Displays:

The primary displays for the thermocouple temperatures (T/C) and saturation margins (SM) are part of the Critical Function Monitoring System (CFMS). The CFMS will receive its power from a new 480v/3Ø/3 wire Motor Control Center (MCC) which will be used exclusively for the CFMS. As previously stated in our June 1, 1981 letter concerning the "Conceptual Design for Upgrading Emergency Support Facilities", a new 480v unit substation will furnish power to the new MCC bus. In the event of a unit substation power failure, an automatic transfer switch will transfer the normal MCC supply from the unit substation to a new standby emergency diesel generator set which will start-up automatically upon sensing the normal power supply failure. In addition, the CFMS will be supplied from the MCC through an isolation transformer and an uninterruptible power supply (UPS) designed to eliminate normal line transients and transients associated with the starting of the diesel generator. All power supplies for the primary displays are non-1E.

Power Supplies for Backup Displays:

The backup T/C's and SM displays are part of the Qualified Safety Parameter Display System (QSDPS). As previously stated, the QSPDS is qualified to Class 1E standards (including seismic). The power supplies to the two channels of the QSPDS are physically separated and energized from independent station safety related power sources.

Class 1E/Non-1E Isolation:

The Qualified Safety Parameter Display System is configured entirely of Class 1E seismically qualified components, specifically, the data acquisition equipment, central processing unit, and data display equipment. All of these components are powered from safety related power sources. Isolation from non-1E equipment is achieved with fiber optic links. All QSPDS hardware is classified as 1E up the the fiber optics isolation. Non-1E inputs into the QSPDS are isolated using the "N" channel processor for digitization and input into the QSPDS processor. The Critical Function Monitoring System is entirely non-1E and is electrically isolated from directly inputed 1E signals and signals transferred through the QSPDS.

ITEM 7: Confirm the environmental qualification of the core exit thermocouple instrumentation up to the isolation device.

The backup display system including the signal processing equipment up to the "N" channel isolation cabinet is environmentally qualified, as described in NUREG-0737, Appendix B, Item 1. The portion of the thermocouple instrumentation from the sensors to the "N" channel isolation cabinet is original plant equipment and will be evaluated during our Regulatory Guide 1.97 Rev. 2 review of the plant in response to Supplement 1 to NUREG-0737.

DESIGN AND QUALIFICATION CRITERIA FOR

ACCIDENT MONITORING INSTRUMENTATION

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.

The conformance of the RVLIS and Core Exit Thermocouples and Saturation Margin Displays (QSPDS and CFMS) to the Appendix B items listed in the Generic Letter No. 82-28 is shown in Tables 2 and 3.

Note that the input signals to the RVLIS, QSPDS and CFMS are from original plant equipment. An evaluation of this equipment will be performed during our Regulatory Guide 1.97 Rev. 2 plant review. A schedule of our review will be provided in the Authority's response to Supplement 1 of NUREG-0737.

TABLE 1
DISPLAY CHARACTERISTICS

Size:	8.5 x 8.5 inches
Addressable Points:	512 x 512 = 262,144
Resolution:	60 dots per inch
Color:	Neon orange
Alphanumerics:	
Character Sets:	7 x 10 U.C. letters, numerals, punctuation, and special characters in 8 x 16 dot matrix. Height = 0.167 in (0.423 cm). 8 x 16 U.C. letters and numerals in 8 x 16 dot matrix. Height = 0.267 in (0.677 cm).
Locating:	any point
Modes:	write (pattern dots on, background dots off) erase (pattern dots off, background dots unchanged) overstrike (pattern dots on, background dots unchanged) inverse (pattern dots off, background dots on) blink (alternating write and inverse modes)
Screen Capacity:	64 characters per line x 32 lines
Rate:	Up to 270 characters per second
Graphics:	
Vector Plotting:	any length from/to any point
Modes:	write, erase
Rate:	up to 80 vectors per second

TABLE 2

Reactor Vessel Level Instrumentation System

Compliance with Appendix B of NUREG-0737

"Design and Qualification Criteria for Accident

Monitoring Instrumentation"

Appendix B Item	Status of Compliance
1. Environmental qualification	Complies with NUREG-0588.
2. Single failure analysis	Complies.
3. Class 1E power source	See note (1).
4. Availability prior to an accident	Complies.
5. Quality assurance	QA program for design and manufacture of RVLIS conforms to 10 CFR 50 Appendix B.
6. Continuous indications	Complies.
7. Recording of instrument outputs	Complies.
8. Identification of instruments	Complies.
9. Isolation	Complies.

(1) Power is supplied from original plant safety-related electrical equipment which was designed in accordance with GDCs 2, 24 and 39 (July 11, 1967)

TABLE 3

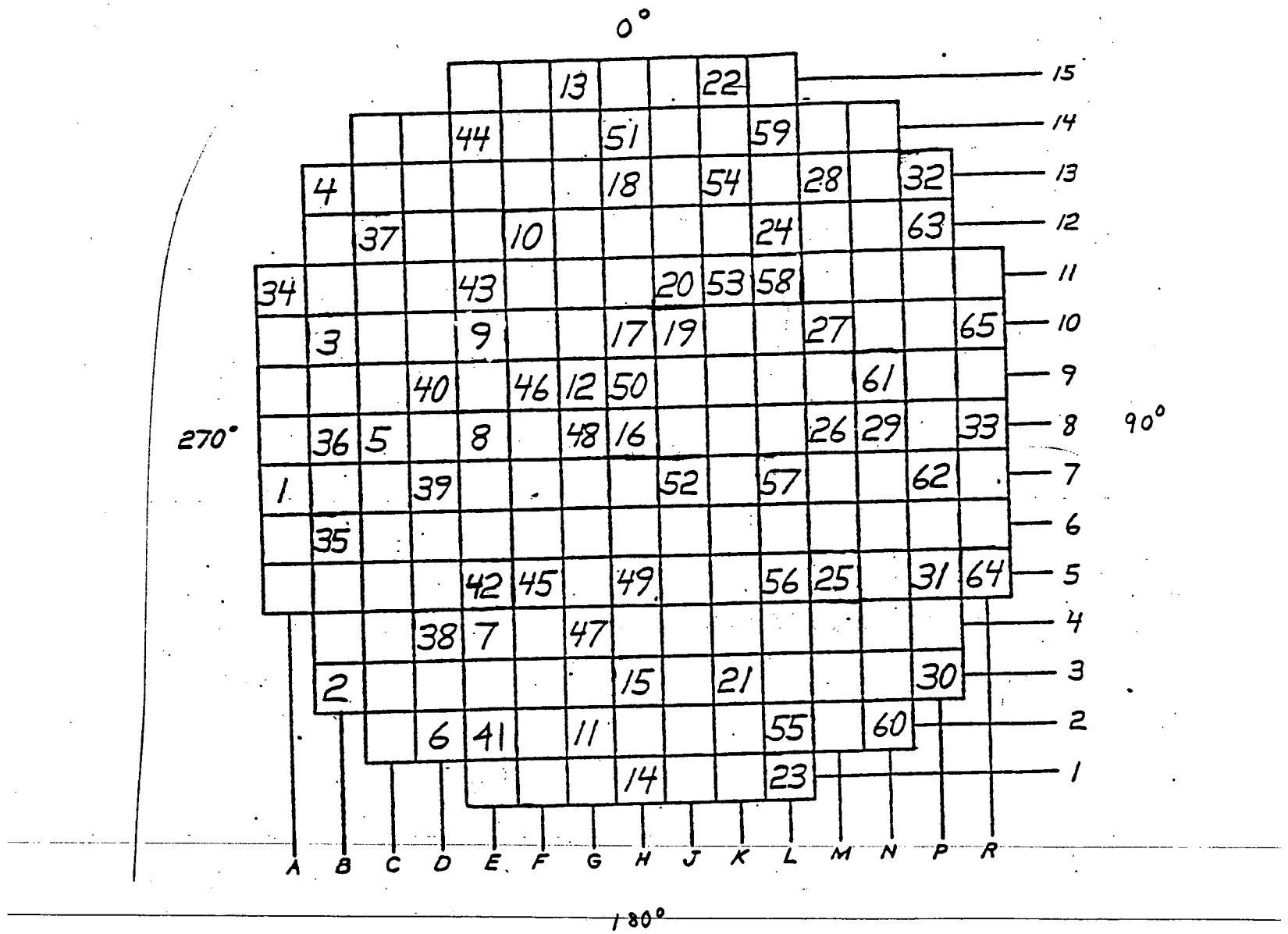
Thermocouple and Saturation Margin Displays

Compliance with Appendix B of NUREG-0737 "Design and Qualification Criteria for Accident Monitoring Instrumentation"

Appendix B Item	Status of Compliance
1. Environmental qualification	Backup displays support the latest qualification criteria set forth in IEEE std. 323-1974 and IEEE std. 344-1974.
2. Single failure analysis	Backup displays only.
3. Class 1E power source	See note (1).
4. Availability prior to an accident	Complies.
5. Quality assurance	Design and manufacturing criteria meet Combustion Engineering's Quality Assurance Program. (2)
6. Continuous indications	Complies
7. Recording of instrument outputs	Primary displays only.
8. Identification of instruments	Complies.
9. Isolation	Complies.

(1) For backup display, power is supplied from original plant safety-related electrical equipment which was designed in accordance with GDCs 2, 24, and 39 (July 11, 1967).

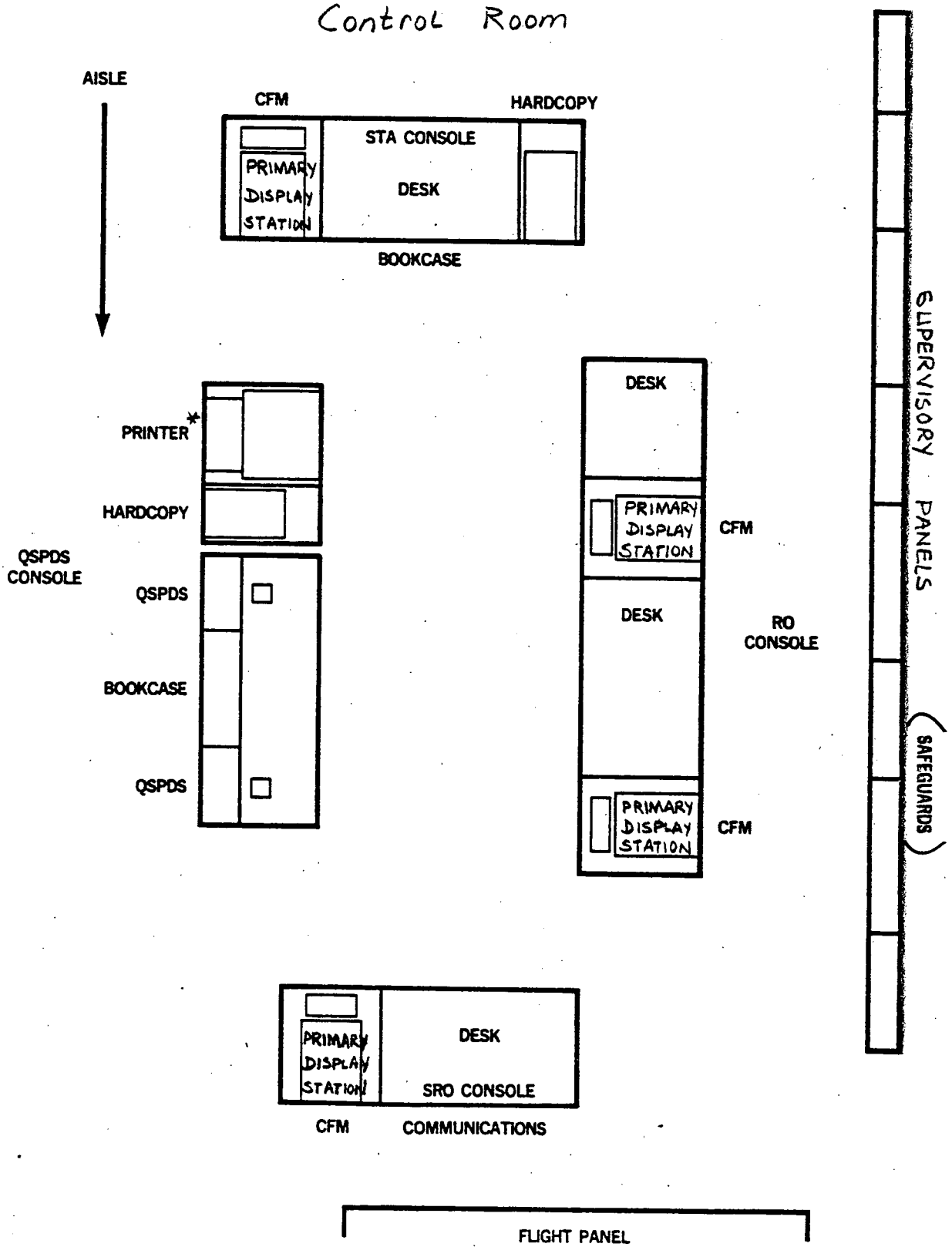
(2) See CE topical report CENTD-210 "Quality Assurance Program", November 16, 1977.



INDIAN POINT UNIT NO. 3
CORE EXIT THERMOCOUPLE
LOCATIONS

FIGURE 1

CFMS Layout in Central Control Room



* There will be another matrix printer located in the Central Control Room.

FIGURE 2

SATURATION MARGIN

448 28

384 24

320 20

256 16

192 12

128 8

64 4

LOOP 4 SATURATION MARGIN

REACTOR COOLANT

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

CORE EXIT TEMP

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

LOOP 2 SATURATION MARGIN

REACTOR COOLANT

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

CORE EXIT TEMP

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

CORE SATURATION MARGIN

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

LOOP 3 SATURATION MARGIN

REACTOR COOLANT

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

CORE EXIT TEMP

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

LOOP 1 SATURATION MARGIN

REACTOR COOLANT

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 PSIG XXXXXXXXX

CORE EXIT TEMP

TSAT 0000 DEG F XXXXXXXXX
PSAT 0000 XXXXXXXXX

CORE 601

RCS 602

CNMT 603

RAD 604

SYSTEM ERR

XXXXXXXXX
XXXXXXXXX
XXXXXXXXX

FIGURE 3

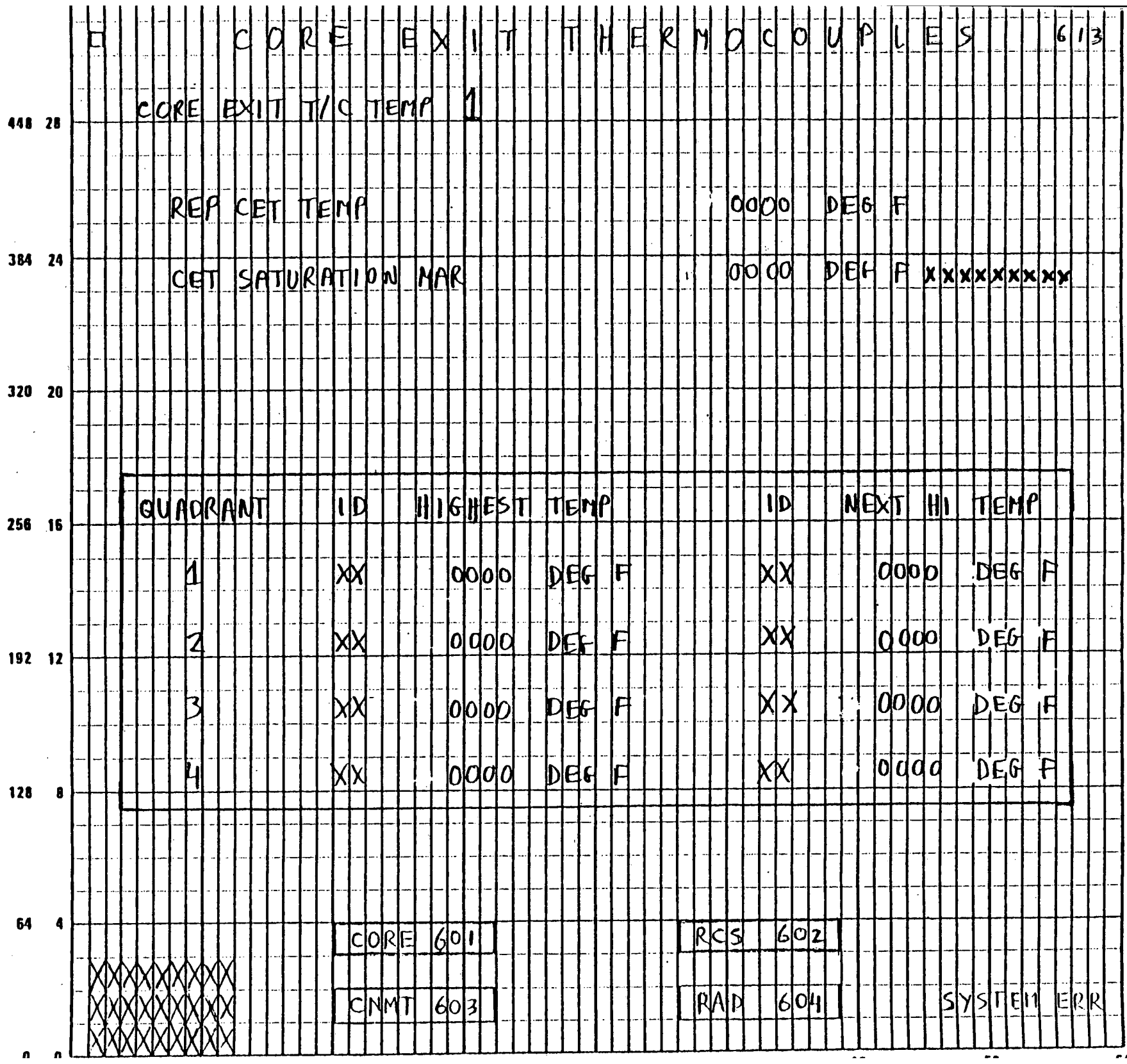


Figure 4

CORE EXIT THERMOCOUPLES 613

CORE EXIT T/C TEMP 1

REP CET TEMP 0000 DEG F

CET SATURATION MAR 0000 DEG F XXXXXXXXX

QUADRANT	ID	HIGHEST TEMP	ID	NEXT HI TEMP
1	XX	0000 DEG F	XX	0000 DEG F
2	XX	0000 DEG F	XX	0000 DEG F
3	XX	0000 DEG F	XX	0000 DEG F
4	XX	0000 DEG F	XX	0000 DEG F

CORE 601 RCS 602

CNMT 603 RAD 604 SYSTEM ERR

XXXXXXXXX
XXXXXXXXX
XXXXXXXXX

448 28
384 24
320 20
256 16
192 12
128 8
64 4
0 0

CORE MAP

631

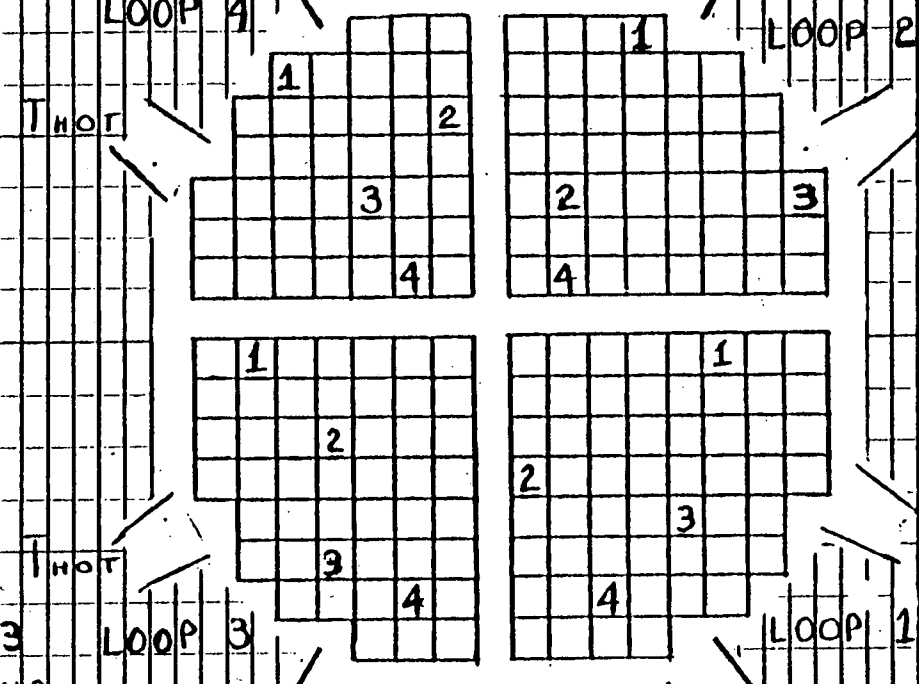
448 28
384 24
320 20
256 16
192 12
128 8
64 4

QUADRANT 4

	CET	TEMP
1	P13	0000
2	N09	0000
3	L11	0000
4	J10	0000

QUADRANT 2

	CET	TEMP
1	R05	0000
2	L07	0000
3	L0	0000
4	J07	0000



QUADRANT 3

	CET	TEMP
1	H14	0000
2	F12	0000
3	C12	0000
4	B10	0000

QUADRANT 1

	CET	TEMP
1	H03	0000
2	E08	0000
3	D04	0000
4	B06	0000

CORE 601

RCS 602

CNMT 603

RAD 604

Figure 5