MAINE YANKEE ATOMIC POWER COMPANY •

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April 29, 1983
MN-83-83

Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Darrel G. Eisenhut, Director
Division of Licensing

References: (a) License No. DPR-36 (Docket No. 50-309)
(b) MYAPCo Letter to USNRC dated June 24, 1982, MN-82-120
(c) MYAPCo Letter to USNRC dated August 12, 1982, MN-82-159
(d) MYAPCo Letter To USNRC dated October 18, 1982, MN-82-193
(e) MYAPCo Letter to USNRC dated October 19, 1982, MN-82-197
(f) USNRC Letter to All Licensees of Operating Westinghouse and CE PWRs dated December 10, 1982

Enclosures: (1) Reactor Coolant Inventory System Description
(2) Conformance Summary to NUREG-0737 - Item II.F.2
(3) Maine Yankee Schedule for ICC Implementation

Subject: Inadequate Core Cooling Instrumentation System (Generic Letter No. 82-28)

Dear Sir:

The attached enclosures respond to the three requests for information made in accordance with 10 CFR 50.54(f), Reference (f).

A description of Maine Yankee's design for a reactor coolant inventory system can be found at Enclosure (1). Enclosure (2) summarizes the status of inadequate core cooling conformance to NUREG-0737, Item II.F.2. The proposed schedule for final system implementation is provided at Enclosure (3) for NRC Project Manager review.

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United States Nuclear Regulatory Commission
Attention: Mr. Darrel G. Eisenhut, Director

We suggest that staff review of the material attached takes into consideration that the Maine Yankee plant is of an earlier design so it is not practical, in some cases, to implement backfits that conform completely to current design. We believe the modifications proposed meet the intent and purpose of the regulations.

However, if in the course of your review you identify any aspects of our design and approach that appear not to meet the intent of the requirements, please inform us so that we can identify and address the underlying safety concern.

We trust that this response is satisfactory. Should you require additional information, please feel free to contact us.

Very truly yours,

MAINE YANKEE ATOMIC POWER COMPANY

John B. Randazza
Vice President

JBR:pjp

Enclosures: Enclosure 1 - 7 pages
Enclosure 2 - 11 pages
Reference 1 - 7 pages
Reference 2 - 7 pages
Reference 3 - 19 pages
Enclosure 3 - 1 page

cc: Mr. James M. Allen
Mr. Robert A. Clark
Mr. Paul A. Swetland

STATE OF MAINE)
)ss
COUNTY OF KENNEBEC)

Then personally appeared before me, John B. Randazza, who being duly sworn did state that he is a Vice President of Maine Yankee Atomic Power Company, that he is duly authorized to execute and file the foregoing request in the name and on behalf of Maine Yankee Atomic Power Company, and that the statements therein are true to the best of his knowledge and belief.

S. Jeanette Hopkins
Notary Public

S. JEANETTE HOPKINS
NOTARY PUBLIC, STATE OF MAINE
MY COMMISSION EXPIRES
MAY 1, 1988

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ENCLOSURE 1
MN-83-83

REACTOR COOLANT INVENTORY SYSTEM DESCRIPTION

10 CFR 50.54(f) REQUEST 1

Within 90 days of the date of this letter, identify to the Director, Division of Licensing, the design for the reactor coolant inventory system selected and submit to the Director, Division of Licensing, detailed schedules for its engineering procurement and installation. References to generic design descriptions and to prior submittals containing the required information where applicable, are acceptable.

RESPONSE

Maine Yankee has chosen a reactor coolant inventory system based on the principles of differential pressure and temperature measurement. An important advantage of this concept is its relative simplicity. This system, used in conjunction with other components of the inadequate core cooling instrumentation system, will provide useful information during transient situations where sufficient response time is available for operator intervention, i.e, primarily small break loss of coolant accidents. An indication of the approach to core uncovery will facilitate an orderly handling of the problem.

In the case of a large break LOCA, the transient is so rapid that automatic protective features are relied upon for core protection since the operator would not have time to react. Following such a transient, core cooling instrumentation would be useful in aiding the operator in monitoring recovery.

The Maine Yankee reactor coolant inventory system is designated the Primary Inventory Trend System (PITS). This plant specific system is designed to comply with TMI Action Item II.F.2 and will provide level indication over the entire range of the system from the top of the pressurizer to the bottom of the reactor vessel.

The system consists of three inventory indications and five saturation deviation (Subsat) indications (both termed channels in this response) that will provide reactor coolant system inventory mass and distribution information on the main control board.

This design concept was chosen because it offered the following advantages:

1) It covers the full range of reactor coolant system inventory.

2) It provides redundant inventory information.

RESPONSE TO REQUEST 1 (Cont'd)

3) It utilizes proven components widely used in nuclear power plants; dp cells and temperature sensors.

4) It provides information regarding inventory distribution/heat sink capability that would be useful in assessing system conditions in a variety of accidents.

5) No components are added to the reactor internals that could break loose and cause damage, or that would become highly radioactive and difficult to maintain.

6) No additional radioactive components must be handled during refuelings.

7) With the plant shutdown, the inventory channels can be calibrated, tested or replaced without the necessity of a cooldown or breeching the primary boundary.

8) Much of the instrumentation is used in other operations gaining operator confidence in its reliability, e.g., I_Y monitors core dp during operation, I_X and I_Z are used to monitor water level during refuelings.

9) Instruments provide a readable indication during normal operation so that failure or excessive drift will be discernible.

The system will be benchmarked against operating conditions following the next refueling outage to determine actual system response to various level, flow and temperature parameters. This program will be used to benchmark an analysis which will predict system response during the accidents of interest.

Operations and other personnel responsible for nuclear safety will receive special training on system diognostics. In addition, system response will be factored into our site specific simulator scheduled for completion in late 1984.

PITS INVENTORY CHANNELS DESCRIPTION

The PITS inventory channels consist of three differential pressure transmitters as shown in the attached Figure 1 which will be calibrated to read in feet of plant elevation.

RESPONSE TO REQUEST 1 (Cont'd)

Although these transmitters are cold calibrated, the display will be adjusted to compensate for a nominal specific gravity difference of 0.8 between the static and variable sensing lines.

These three inventory channels alone cannot provide the necessary information to evaluate core coolant inventory under all possible transient conditons so must be used in conjunction with the five saturation deviation (Subsat) channels described later. However, the inventory channels will provide a direct, dependable indication of reactor coolant inventory within and above the core, when the Subsat channels indicate that subcooling margin exists or when reactor coolant level has fallen below the top of the reactor coolant pipe. The top of the loop piping is approximately seven feet above the top of the core.

Transmitter I_Z will measure differential pressure across the entire primary system. It is connected to the top of the pressurizer on the static side and to an incore instrument tube located at the bottom of the reactor vessel on the variable side of the transmitter. It will cover the system from a full, cold pressurizer to a zero inventory condition above the core support plate.

Transmitter I_Y will measure differential pressure across the entire reactor vessel. It is connected to the reactor head vent line on the static side of the transmitter and the same incore instrument tube as I_Z on the variable side.

Transmitter I_X will measure differential pressure from the top of the vessel to the bottom of the hot leg. It is connected to the reactor head vent line on the static side and to the hot leg on the variable side.

All three transmitters are qualified to IEEE 323 1974 qualification standards. The two wide-range units (I_Y and I_Z) are located at approximately minus sixteen feet elevation in the incore access area. The I_X unit is located at plus two foot elevation in the outer annulus of the reactor containment. All three transmitter outputs will be displayed on a three-pen recorder located on the main control board. The recorder will be calibrated so that the differential pressure sensed by the three transmitters will represent system levels which will provide trend information to the operators.

The overlapping inventory and Subsat channels of the PIT system assures that plant operators will have sufficient information at all times to evaluate the trend and adequacy of reactor coolant system inventory.

PITS SUBSAT CHANNEL DESCRIPTION

The saturation deviation (Subsat) channels measure the subcooling margin existing at five key locations in the reactor coolant system where steam voiding would be most likely to occur under abnormal conditions. The five locations of interest are:

RESPONSE TO REQUEST 1 (Cont'd)

a. Beneath the reactor vessel head (Channel S_{rh})
b. Top of the core region (Channel S_{rx})
c. Each of the steam generators (3) (Channel S_{sg})

Conditions beneath the reactor vessel head are monitored by Subsat Channel S_{rh}. This channel uses dual-element RTD located in the fluid space just under the reactor vessel head. A reading of less than 0°($\pm$2°F) subcooling, would provide an indication of probable steam voiding under the head.

Four core exit thermocouples provide input to Subsat Channel S_{rx} which will give indication of conditions at the top of the core. A reading of less than 0°F ($\pm$2°F) subcooling, on any of these channels will indicate that bulk boiling is probably occurring within the reactor core.

Subsat Channel S_{sg} utilizes a temperature signal derived by processing existing secondary side pressure signals for each of the three steam generators. A separate S_{sg} channel is provided for each of the steam generators. A software program will be derived to calculate RCS temperature from steam generator pressure and calculate a margin to subcooling. A reading of less than 0°F ($\pm$2°F) subcooling on any channel provides an indication that steam voiding may exist in the U-tubes for that particular steam generator. This will enhance the operator's understanding of reactor coolant system conditions by providing early indication that heat transfer across the U-tubes was degrading to the point where natural circulation flow in that loop and ultimately core heat transfer could be jeopardized.

PITS DISPLAY DESCRIPTION

Two display units on the main control board will provide the necessary information to plant operators. The three inventory channels will be displayed on a three pen, two speed continuous strip chart recorder. The signals to the strip chart recorder will be processed to provide indication of level over the entire inventory range to provide better readability. The Subsat channels may be selected for display on the subcooled margin monitor.

TRANSIENT OPERATION

A description of how the system would be used by the operators during off normal conditions follows:

Full scale indication for PITs inventory Channel I_z equates to a hot, solid reactor coolant system. This channel should always be in range during normal operation and will be available at the start of an accident.

During normal operation the lowest of the two pressurizer pressure inputs and the highest of the four core exit thermocouple inputs are normally selected for the Subcooled Margin Monitor indication.

RESPONSE TO REQUEST 1 (Cont'd)

In the event of a loss of coolant accident (LOCA), pressurizer level will fall until low system pressure initiates high pressure safety injection. The operator has three normal pressurizer level channels available to him during this portion of the transient.

Following reactor scram and safety injection, the operator trips reactor coolant pumps as required by procedure. At this point, PITS inventory channel I_Z will also be tracking the changing pressurizer level indications.

As the level decreases further (as monitored on Channel I_Z), all normal pressurizer level channels will bottom out and PIT's Channel I_X and I_Y will come within range. The operators would begin verification of inventory distribution at this point by monitoring the five Subsat channels to check for subcooling under the reactor vessel head, at the top of the core and in each of the steam generator U-tube regions.

As reactor coolant pressure approaches saturation, as indicated by S_{rx}, steam will begin to accumulate under the reactor head as bulk boiling occurs in the core.

Procedures will be developed to aid the operator in interpreting the various combinations of inventory and Subsat channel indications. For example, when Subsat Channel S_{rh} indicates a possible steam void under the head, the procedures would inform the operator that inventory channels reading in excess of 15 feet must be discounted due to the possible effect of the steam void and the inventory assumed to be 15 feet.

A continued decrease in water level below the top of the reactor coolant loop (15 feet) will connect all possible steam void locations within the system. In this range (0 feet to 15 feet) the inventory channels will provide the most reliable indication of coolant inventory.

Channel I_X will bottom out as the level drops below the bottom of the reactor coolant pipe (13 feet). Any further decrease in water level below 13 feet and within the core region can be monitored by inventory channels I_Y and I_Z.

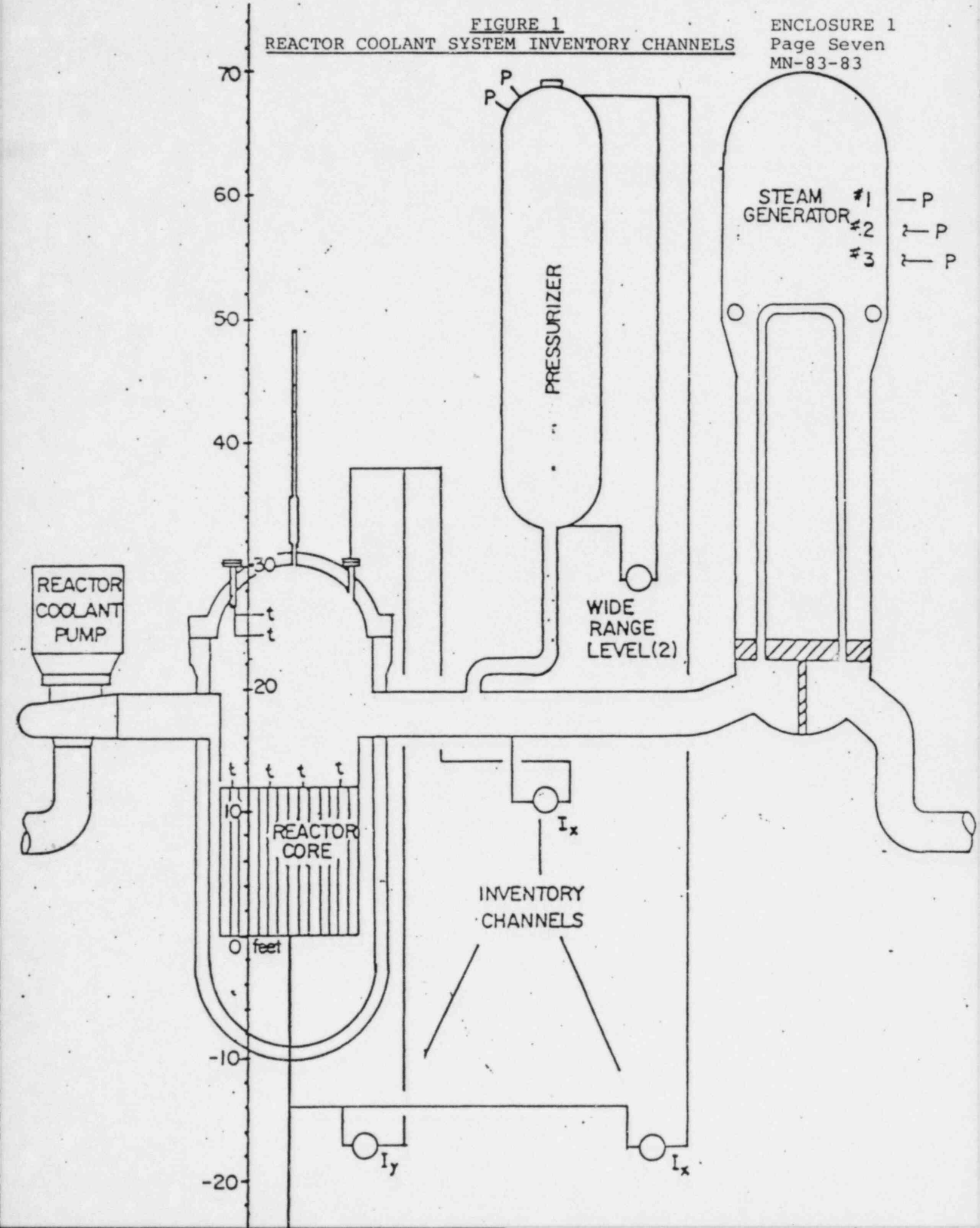
ENGINEERING, PROCUREMENT, AND INSTALLATION SCHEDULES

The three delta pressure transmitters are currently installed. The thermocouple inputs for the subsat channels are currently installed and available. Specific information regarding these instruments is found at References (b), (c), and (d).

RESPONSE TO REQUEST 1 (Cont'd)

The strip chart recorder is currently on-site awaiting installation. Installation is scheduled to be completed by May 30, 1983. Following installation, the Primary Inventory Trend System will enter a system acceptance testing period. Data recording will continue through the shutdown and subsequent startup from the 1984 refueling outage. This data will be used to benchmark an analysis which will be used to predict system response during accident conditions. The results of the analysis will then be factored into procedures and into operator training and site specific simulator response. It is anticipated that this sytem will be completely operational for use by the operators following the 1985 refueling outage.

FIGURE 1
REACTOR COOLANT SYSTEM INVENTORY CHANNELS



ENCLOSURE 2
MN-83-83

CONFORMANCE SUMMARY TO NUREG-0737 - TIEM II.F.2

10 CFR 50.54(f) REQUEST 2

Within 90 days of the date of this letter, review the status of conformance of all components of the ICC instrumentation system, including subcooling margin monitors, core-exit thermocouples, and the reactor coolant inventory tracking systems, with NUREG-0773, Item II.F.2 and submit a report on the status of such conformance.

Item (1)

A description of the proposed final system including:

Item 1(a)

A final design description of additional instrumentation and displays;

RESPONSE

Additional instrumentation being added to the plant as part of the ICC system includes the following:

1.	Primary Inventory Trend System Strip Chart Recorder (3 Pen-Recorder)	3 channels of level indication, see Figure 1 of Enclosure 1
2.	Core Exit Thermocouple Backup Displays	8; 2 per Quadrant

Item 1(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 considerations; and

RESPONSE

The Maine Yankee Inadequate Core Cooling Instrumentation System consists of the following instrumentation which will be utilized by Maine Yankee operators to make assessments as to whether or not a condition of inadequate core cooling exists. The use of the available data will provide the operators with the necessary information to determine that sufficient core cooling is being provided:

RESPONSE TO ITEM 1(b)(Con'td)

		Indication	Range	Method of Display*
1.	Primary Inventory Trend System	3 dp	0 to 64.5'	MCB/R
			-57.7 to +57.7'	MCB/R
			0 to 16.1'	MCB/R
		5-Sat	1-Srh 0-150°F	MCB/M
			1-Ssx 0-150°F	MCB/M
			3-Ssg 0-150°F	MCB/M
2.	Core Exit Thermocouples	8-Temp	200-2250°F	New Display Computer
3.	Subcooled Margin Monitor	T-SAT	3 RDT's 0-750°F	MCB/M
			4 CETs 0-750°F	MCB/M
		P-SAT	2 PZR Press 0-3250 psig	MCB/M

- The following instrumentation, although not specifically part of the ICCI System, also provides backup information to aid the operators in diagnosing potential problems which could result in degrading the adequacy of core cooling. Some of this equipment has been qualified while others have not.

		Indication	Range	Method of Display*
1.	Core Exit Thermocouples	19 Additional-Temp	200-2250°F	Computer
2.	Hot Leg RTD's	4/loop NR	515-665°F	MCB/M
		1/loop NR	515-615°F	MCB/M, Computer
		1/loop WR	0-600°F	MCB/M
3.	Cold Leg RTD's	4/loop NR	465-615°F	MCB/M
		1/loop NR	515-615°F	MCB/M, Computer
		1/loop WR	0-600°F	MCB/M
4.	Computer Saturation Monitor	1-Press.	NA	Computer

*Method of Display:
MCB/M - Main Control Board Meter Indication
MCB/R - Main Control Board Recorder Indication
Computer - Operator selection of computer output displays including digital voltmeter, strip chart, group or point typewritter trending or special programs (i.e., core exit thermocouple maps).

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RESPONSE 1(b) Cont'd)

		Indication	Range	Method of Display*
5.	Pressurizer Pressure	4-Press.	1200-2400 psig	MCB/M
		2-Press.	1500-2500 psig	MCB/M MCB/R, Computer
		2-Press.	0-1600 psig	MCB/M, Computer
		1-Press.	0-3250 psig	MCB/R
6.	Pressurizer Level	2-Press.	0-100%	MCB/M, MCB/R, Computer
		1-Level (cold cal.)	0-100%	MCB/M
7.	S. G. Level	4/SG NR	0-100%	MCB/M
		1/SG NR	0-100%	MCB/M, MCB/R
		1/SG WR	0-475"	MCB/M, Computer
8.	S. G. Pressure	4/SG	0-1000 psig	MCB/M, Computer

*Method of Display
MCB/M - Main Control Board meter indication
MCB/R - Main Control Board recorder indication
Computer - Operator selection of computer output displays including digital voltmeter, strip chart, group or point typewriter trending or special programs (i.e., core exit thermocouple maps)

Item 1(c)

A description of any planned modifications to the instrumentation systems described in item 1.b above.

RESPONSE

Previous Maine Yankee commitments regarding upgrades to the subcooled margin monitor can be found at MYAPCo Letter to USRNC dated October 19, 1982, MN-82-197.

RESPONSE TO Item 1(c) (Cont'd)

Other modifications include the installation of the backup core exit thermocouple display and the Primary Inventory Trend System recorder.

The subcooled margin monitor (SMM) is scheduled for further upgrading during the 1984 refueling outage. This upgrade will add a reactor vessel head subsat channel (S_{rh}) and three steam generator subsat channels (S_{sg}) while deleting the hot leg RTD inputs. This will complete our efforts to provide all qualified inputs to the SMM. Additionally, two selector switches will be added. One will enable the operator to select between the two pressurizer pressure inputs. The other will allow the operator to switch between the 4 CETs, two RTD elements and the three loop temperatures derived from steam generator pressure.

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.

RESPONSE

The following references provide information which supports the information used in the design of Maine Yankee's inadequate core cooling instrumentation system:

(a) CEN-117 - Inadequate Core Cooling - A response to NRC I.E. Bulletin No. 79-06c, Item 5, for Combustion Engineering Nuclear Steam Supply Systems.

(b) CEN-158-P - Evaluation of Instrumentation for Detection of Inadequate Core Cooling in Combustion Engineering Nuclear Steam Supply Systems, May, 1981.

(c) CE NPSD-171 - Comparison of Bottom-Mounted Core Exit and In-Core Thermocouples to Detect Inadequate Core Cooling, December, 1982.

(d) NUREG/CR-2628 - Inadequate Core Cooling Instrumentation Using Differential Pressure for Reactor Vessel Level Measurement.

(e) EPRI NP-2727-SR - A Review of Proposed Instrumentation for Measurement of Water Level as a Means of Detecting Inadequate Core Cooling in Pressurized Water Reactors.

(f) MYAPCo Letter to USNRC dated October 18, 1982, MN-82-193, - Incore Thermocouple Equipment Qualification.

Item (3)

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

RESPONSE

The Primary Inventory Trend System will be undergoing an acceptance data recording phase which will extend through the startup from the 1984 refueling outage. This data will be used to benchmark an analysis which will be developed to predict the response of the Inadequate Core Cooling Instrumentation System during various accident scenarios of interest. The results of this analysis will then be used as an input to the Maine Yankee plant specific simulator currently scheduled to be operational in late 1984. This added capability will allow the operators to gain valuable experience in using the ICCI System to diagnose and make decisions regarding the adequacy of core cooling during simulator training.

Item (4)

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

RESPONSE

Conformance to Attachment I "Design and Qualification Criteria for Pressurized Water Reactor Incore Thermocouples" and Appendix B, "Design and Qualification Criteria for Accident Monitoring Instrumentation" is submitted as Reference 1 and Reference 2 of this enclosure.

Item (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.

RESPONSE

The plant process computer system function associated with ICC monitoring for the parameters of interest is characterized by three distinct categories which include ICCI system information and backup information. The first functional area includes the parameters of core exit thermocouples, loop hot and cold leg RTDs, pressurizer pressure and level and steam generator pressure and level. Summary information on these parameters is included in Table I. All of these parameters have the capability of generating high alarms, low alarms or both. The alarm functions may be individually selected or altered by the control room operators. Presently, most computer alarm levels are set so that the computer alarm will be activated before the main control board alarm if both are available for a particular parameter. As can be seen from Table I, the update frequency of these parameters is once per minute.

The second functional area includes the plant process computer calculation of the margin to saturation (expressed as temperature in degrees F). This function provides backup information only. The calculation philosophy will be more fully described in the section "Functional Specification for Relevent Software", with the major differences between this parameter and those described above being its calculation frequency of once every five minutes as opposed to once each minute and the fact that this point does not support alarm annunciation.

The third functional area of process computer inputs also deals with only a singular parameter from the supplied list, but that point does have some unique attributes. This point is the input from the C-E subcooled margin monitor, and the discussion here will not deal with the operation of the subcooled margin monitor itself, but rather with the plant process computer functions associated with that device. The plant process computer receives an input from the subcooled margin monitor which is proportional to the margin to saturation temperature as calculated by that device. As a process (voltage) input this signal is essentially the same as those inputs of the first type, but the alarming capability is not presently used because the subcooled margin monitor has several dedicated PAN alarms which are annunciated directly by the monitor.

RESPONSE TO Item (5) (Cont'd)

The functional specification for the process software must also be separated into functionally different areas. Those areas are 1) inputs which are received in analog (voltage) form (which includes or at least could include all of the parameters of interest with the exception of the process computer calculated margin to saturation), and 2) parameters which are computed from combinations of other parameters which may be physical inputs and/or formulas.

The first computational path can be functionally described as follows:

> A physical phenomenon, whether it be pressure, temperature or others, is first sensed and converted to an analog electrical signal by an appropriate transmitter. This analog (voltage) signal is physically connected to a capacitive circuit on an input relay card. The incoming voltage charges a capacitor to a steady state value. A computer control program activates a multiplexer circuit on a periodic basis (once each ten seconds on our present system). The multiplexer circuit accesses physical inputs sequentially and causes the physical input to be momentarily disconnected from the capacitor it had been charging and then the charge of this first capacitor is used to charge a second capacitor.
>
> The two capacitors are then electrically disconnected and the input signal is again connected to the first capacitor. The charge which has been imparted on the second capacitor is fed through an amplification circuit and the amplified signal is then fed to an analog to digital converter (ADC).
>
> The function of the ADC is to produce a computer compatable (digital) value which is proportional to the measured sensor potential relative to the range of the input signal. It is at this point that the converted value is compared to alarm limits if any have been entered.
>
> The ADC output is accumulated and once each minute an average value is converted to the appropriate engineering units based upon the type and range of the sensor and point specific conversion coefficients. These engineering units data can then be displayed or trended if so selected by the control room operators.

The functional specification for the relevant software for parameters which are computed from other inputs or from formulas is significantly different from the process described above. Each computed point is uniquely defined in terms of an algorithmic structure which can represent an almost unlimited amount of computational manupulation. Once every five minutes a series of software routines are executed which perform these computations.

RESPONSE TO Item (5) (Cont'd

In the case of the process computer calculated margin to saturation the algorithm is quite straight forward. All of the core exit thermocouples are compared and the highest is chosen for further processing. One channel of pressurizer pressure (the program allows either but presently does not auctioneer for the lowest) and the highest core exit temperature are then input to an interpolative routine based on the "Steam Tables" to arrive at a saturation temperature. The highest core exit temperature is subtracted from this value to obtain the margin to saturation.

Parameters of this type can also be selected for display or for trending by the control room operators, and in that sense computed points are the same as analog input points, however, they do not support alarming functions associated with analog inputs.

The present plant process computer system at Maine Yankee is non-redundant and the recent operating history suggests that system availability is about 97%. The estimate does not include hours of system unavailability which are planned such as scheduled preventative maintenance and system backups.

Maine Yankee is presently in the process of converting to a new, redundant plant process computer system which should increase total system avaibility to greater than 99%. This conversion will also allow the generation of computed points at the same frequency as scanned inputs as well as supporting full alarming capability for computed points. The conversion process is scheduled for completion prior to returning to power from the next refueling outage.

RESPONSE TO Item (5) (Cont'd)

TABLE I
ICCI/COMPUTER SYSTEM PARAMETERS

Point Description	Range	Update Frequency
Core Exit T/C	200-2250 Deg F	1/Min
Loop 1-2-3 TH (NR)	515- 615 Deg F	1/Min
Loop 1-2-3 TC (NR)	515- 615 Deg F	1/Min
Loop 1-2-3 TC (WR)	0- 600 Deg F	1/Min
Loop 2 TH (WR)	0- 600 Deg F	1/Min
Pzr Pres. Ch X+Y (NR)	1500-2500 PSIG	1/Min
Pzr Pres. (WR)	0-1600 PSIG	1/Min
Pzr Lvl Ch X+Y	0- 100 %	1/Min
S.G. Stm Pres. 1-2-3	0-1000 PSIG	1/Min
S.G. Lvl 1-2-3 (WR)	0- 39.6 FEET	1/Min

Item (6)

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

RESPONSE

The schedule associated with installation, testing and calibration and implementation of new instrumentation displays is discussed in Enclosure 3 to this letter.

Item (7)

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

RESPONSE

As previously discussed in this enclosure, guidelines for use of the ICCI system will be developed from the analysis which will be performed to predict the PIT system response. This analysis will be conducted following the startup from the 1984 refueling outage, and is expected to be completed by one year thereafter. These operator guidelines will be incorporated into the appropriate emergency operating procedure and refined further through use at the Maine Yankee simulator.

Item (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.

RESPONSE

Maine Yankee's Emergency Operating Procedures have been revised in accordance with TMI Item I.C.1. Operator instructions to mitigate an inadequate core cooling situation are contained in EOP 2-70-0, "Emergency Shutdown from Power," Section 4.0 RCS INVENTORY CONTROL, 5.0 RCS PRESSURE CONTROL and 6.0 HEAT REMOVAL and contain aspects of dealing with inadequate core cooling. The technical basis for this emergency operating procedure is attached as Reference 3 to this enclosure.

1) Following installation, testing, and final analysis of the integrated Inadequate Core Cooling Instrumentation System, additional revisions will be made to this technical basis and to EOP-2-70-0 to reflect the use of the instruments available to evaluate the adequacy of core cooling during off-normal situations.

Item (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.

RESPONSE

The acceptability of the Primary Inventory Trend System (PITS) will be demonstrated in a plant specific analysis which predicts its operation during various accident scenarios of interest. This analysis will commence following the startup from the 1984 refueling outage and is predicted to be completed one year thereafter. The PIT system is currently undergoing a data recording phase which will conclude when power operation is reached following the 1984 refueling outage.

REFERENCE 1
MN-83-83

TMI ITEM II.F.2
DESIGN AND QUALIFICATION CRITERIA FOR PRESSURIZED WATER REACTOR INCORE THERMOCOUPLES

Item II.F.2-Part 1

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

RESPONSE

Maine Yankee has eleven qualified core exit thermocouples. At least one is located in each quadrant.

Qualified core exit thermocouples are located in the following core locations of Figure 2:

J5, D11, F11, G18, J11, L18, L2, N11, T16, T4, and Y8

The following summarizes the key attributes associated with these locations:

1. CETs are located in core locations which experience the indicated radial peaking factors (F_R). Higher radial peaking factors result in higher decay heat loads and are therefore more representative of core temperatures.

   Cycle 7

	F_r	No. of CETs		Figure 2 Locations
a.	F_R Ranges	0 - 0.8*	1	Y8
		0.8 - 1.0	3	F11, J5, T16
		1.0 - 1.3	7	D11, G18, J11, L18, L2, N11, T4
		F_R = Radial Peaking Factor		
b.	CETs with similar F_Rs	0.95	2	F11, J5
		1.10	2	L2, T4
		1.25	5	D11, J11, N11, G18, L18, L2, T4

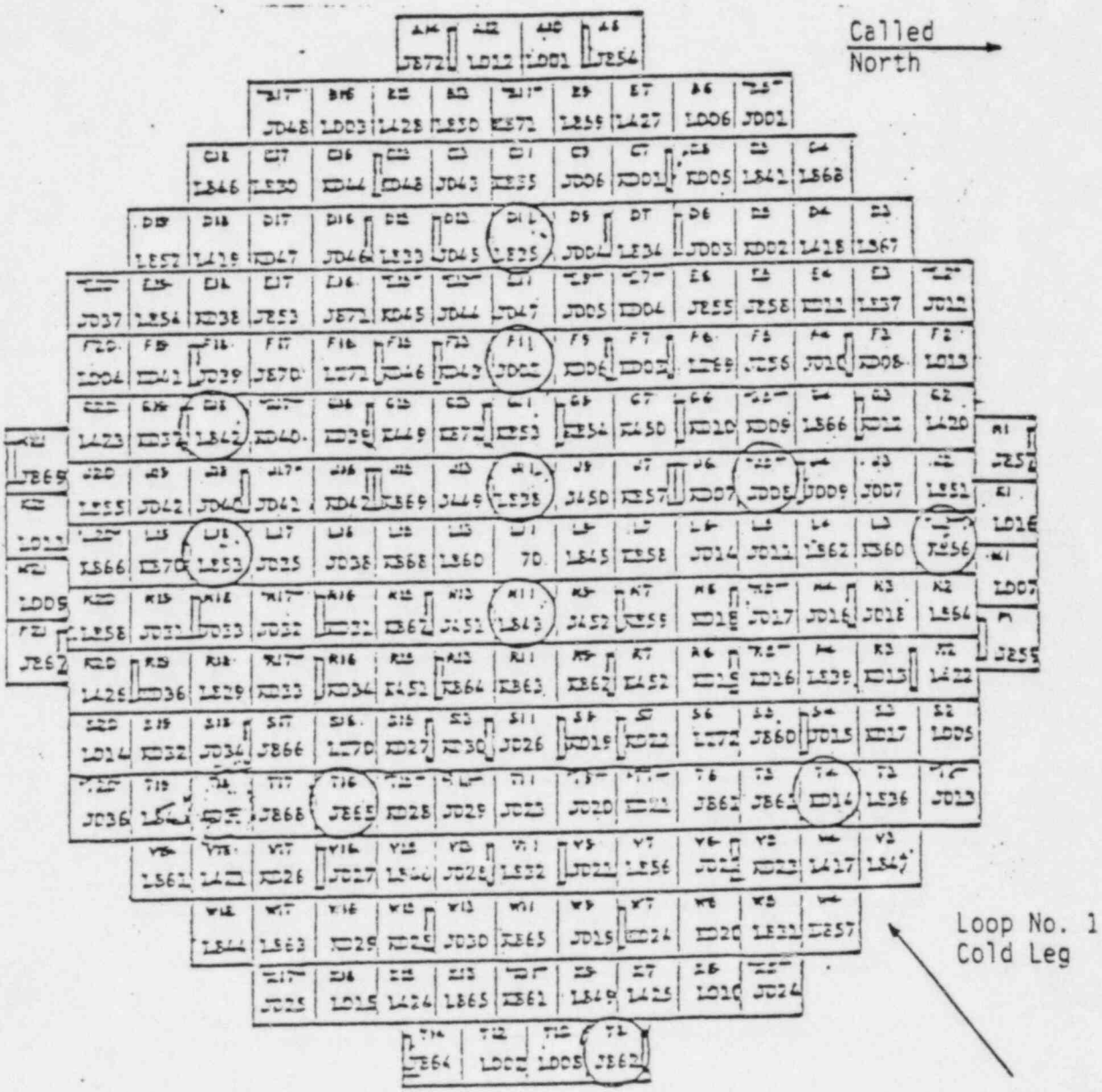
* A CET in an assembly with F_R less than 0.8 may not provide adequate indication of ICC.

FIGURE 2

QUALIFIED CET LOCATIONS

Fuel Assembly Serial Number vs. Core Position

Conditions: Core 7



RESPONSE TO Part 1 (Cont'd)

2. Two qualified core exit thermocouples (J11 and N11) satisfy 1/2 core symmetry.

3. The following eight CETs are located greater than two feet away from the edge of the core in the vicinity of the hot legs:

   J5, D11, F11, J11, L18, N11, T16, T4

4. The distribution of these CETs is considered to be adequate to provide early indication of the approach to an inadequate core cooling condition. The following core map depicts current qualified CET locations.

Item II.F.2 - Part 2

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

Part 2(a)

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

RESPONSE

Maine Yankee's primary operator display is generated by the main process computer. Maine Yankee has on demand a spatially oriented core map indicating the temperatures across the core at each operating core exit thermocouple location.

Part 2(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 inadquate 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.

RESPONSE

Maine Yankee has the capability of selective reading of core exit temperatures, continuous on demand on a CRT, which is consistent with parameters pertinent to operator actions.

Part 2(c)

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

RESPONSE

All thermocouples temperatures may be printed out for hard copy capability. Range at Maine Yankee is from 200°F to 2250°F.

Part 2(d)

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

RESPONSE

Trend capability showing the temperature-time history of core exit temperatures is available on demand via hard copy printouts.

Part 2(e)

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

RESPONSE

This item is being reviewed for adequacy in conjunction with the Emergency Procedures through the Detailed Control Room Design Review (DCRDR) effort.

Part 2(f)

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

RESPONSE

This item is being reviewed for adequacy of the operator-display device interface through the DCRDR effort.

Item II.F.1 - Part 3

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

RESPONSE

A backup display will be provided with the capability for selective reading of a minimum of eight operable thermocouples, two per quadrant, all within a time interval no greater than six minutes. Thermocouple range extends from 200°F to 2250°F. Two thermocouples per quadrant are considered adequate. Combustion Engineering has determined that the functional requirement for the minimum number of CETs for ICC detection has been determined to be four thermocouples, one per quadrant. The adequacy of Maine Yankee's bottom-mounted core exit thermocouples is discussed in CE NPSD-171, "Comparison of Bottom-Mounted Core Exit and In-Core Thermocouples to Detect Inadequate Core Cooling."

Item II.F.2 - Part 4

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

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

(b) integration into emergency procedures,

(c) integration into operator training, and

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

RESPONSE

The types and locations of displays and alarms is being reviewed as part of the DCRDR Program for human factors considerations.

Item II.F.2 - Part 5

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

RESPONSE

See response to Reference 2 "Design and Qualification Criteria for Inadequate Core Cooling Instrumentation" of Enclosure 2.

Item II.F.2 - Part 6

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

RESPONSE

Isolation will be provided between any safety class hardware and non-safety class (NNS) hardware. The sensors, cabling, cold junction, backup display up to and including the isolation device will be Class 1E and powered from a Class 1E power source. Primary display and main process computer is NNS and is powered by a battery-backed highly reliable source.

Item II.F.2 - Part 7

The instrumentation should be environmentally qualified as described in Reference 2, "Design and Qualification Criteria for Inadequate Core Cooling Instrumentation" of Enclosure 2, 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.

RESPONSE

The Class 1E portions will be environmentally qualified as described in Reference 2, "Design and Qualification Criteria for Inadequate Core Cooling Instrumentation" of Enclosure 2, with the exception of seismic qualification which is not required for the primary display and associated hardware.

Item II.F.2 - Part 8

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

RESPONSE

The primary CET display is generated by the main process computer. Current computer reliability and reliability of the new main process computer, currently in acceptance testing, is discussed in the response to Item (5) of this enclosure. This CET display will have the capability of providing readout on all 27 thermocouples. The backup display channel is designed to provide 99% availability for each channel and will have functional capability to display a minimum of two thermocouples per core quadrant.

Consideration of technical specifications is deferred until completion of installation, testing, and analysis, and after receiving final NRC review and approval.

Item II.F.2 - Item 9

The quality assurance provisions cited in Reference 2, "Design and Qualification Criteria for Inadequate Core Cooling Instrumentation" of Enclosure 2, Part 5, should be applied except for the primary display and associated hardware beyond the isolation device.

RESPONSE

Quality Assurance will be applied through the use of Maine Yankee's Quality Assurance Program. See Reference 2, "Design and Qualification Criteria for Inadequate Core Cooling Instrumentation" of Enclosure 2, Part 5, generic response.

REFERENCE 2
MN-83-83

APPENDIX B OF NUREG-0737, II.F.2

DESIGN AND QUALIFICATION CRITERIA FOR INADEQUATE CORE COOLING INSTRUMENTATION

Listed below are the three component sets of the ICCI system. Conformance to the design and qualification criteria of Appendix B is described in this reference.

Generic responses to eleven of the eighteen criteria preceed the discussions of the three component sets. These responses are factored into the component discussions where applicable.

I. Core exit thermocouples (CETs)

II. Margin to saturation monitor

III. Primary Inventory Trend System (PITS)

GENERIC RESPONSES TO THE 18 CRITERIA OF APPENDIX B

1) Environmental Qualification

The instrumentation that was installed as original plant equipment was tested and installed to the seismic levels addressed in the Maine Yankee FSAR. The equipment that is being upgraded to Safety Class 1E, as required to meet NUREG-0737, has been tested to meet the requirements of IEEE 344-1971 when available. This equipment is installed to meet the mounting requirements of the vendor. The seismic levels used for this equipment meets the levels as defined by the Maine Yankee FSAR.

2) Separation and Redundancy

At this time, Maine Yankee does not meet all of the requirements of Regulatory Guide 1.75 or IEEE 384-1981. The separation of instrument trains in the plant follows the specification that the plant was originally designed to and is addressed in the FSAR.

4) Instrument Availability

Generally, all instrumentation channels that are provided for accident monitoring will be available for most modes of plant operation. Therefore, these channels will be available prior to an accident. However, it is necessary to perform maintenance and surveillance, and it is necessary to recognize the impact of refueling operations or other operations with the reactor disassembled.

5) Quality Assurance

The Regulatory Guides listed in Appendix B of NUREG-0737 are all related to Quality Assurance. These documents are all addressed in the Maine Yankee Atomic Power Company Operational Quality Assurance Program (MYOQAP). This program has taken certain exceptions to some of the requirements of these Regulatory Guides.

The MYOQAP is an approved document and is followed whenever any design changes are made to plant equipment. All equipment installed at Maine Yankee will meet or exceed the requirements of this program.

8) Instrument Identification

At the present time, Maine Yankee is conducting a Human Factors evaluation of its Main Control Board. During this evaluation program the location of some equipment may be changed. When the evaluation program is completed, a method for identifying the instruments to be used under accident conditions will be chosen and documented by that report.

11) Servicing, Testing, and Calibration Program

The calibration of accident monitoring instrumentation will be accomplished during each refueling shutdown. Since this equipment does not provide an additional safety function that would require verification during power operation, this interval should be adequate.

12) Bypass Administrative Controls

The design of existing plant systems meets the requirements of IEEE 279-1968, including Section 4.14 which addresses "Access to Means of Bypasses". These controls include key-locked panels, annunciation upon removal from service, and/or key-operated switches. Any new channels that are to be installed to meet the requirements of NUREG 0737 will be designed to meet or exceed these requirements.

13) Adjustment Access Administrative Controls

Setpoint adjustments will be controlled by the use of key-locked switches, locked panels, or Control Room annunciation. All of the module calibrations are controlled by administrative procedures that require access by trained authorized technicians using controlled procedures after approval of the plant shift supervisor. This provides a redundant means of protecting against accidental adjustment of setpoint or calibration points.

14) Anomalous Indications

The monitoring instrumentation was designed to minimize the development of anomalous indications that could lead to an incorrect action on the part of an operator. Each of the instrument channels is independent of the other so the operator has a means to verify the indication. The redundant channels are located adjacent to each other for fast verification. Equipment is selected that will fail in a mode (high/low) that would cause the operator to question the indication and verify it prior to taking any action.

15) Malfunction Repair

The instrument loops have been designed, as far as practical, to facilitate the detection of a malfunction of a module or channel. The instruments are located in such a manner as to provide the operator with the ability to check the measurement against a redundant instrument channel. An annunciator is provided to indicate a loss of power for each vital bus. Indicators and recorders for each instrument loop will fail in either a high or low reading, not as is. Work is being conducted on qualifying an indicator/controller which will fail in the low position on loss of power. With the exception of the sensors, the instrumentation is located in the Main Control Room where it can be repaired or adjusted should the need arise.

18) Periodic Testing

At this time Maine Yankee does not meet all of the requirements addressed in Regulatory Guide 1.118. It is believed, however, that this plant does meet the intent of the requirement in this document. At each refueling outage, all safety Class 1E instrumentation is calibrated and tested.

Before each startup, following a refueling outage, each safety system is tested for its operability. Monthly surveillance is performed on equipment as required by Technical Specifications.

I. CORE EXIT THERMOCOUPLES

1-9) See response to Item II.F.2 - Part 2 of Reference 1 to this enclosure.

10) There are 27 thermocouples at the reactor core exit that can be used to verify temperature. Eleven CETs are currently qualified. By cross checking between the temperature indications, the operator can compare the measurement within an area of the core with a high degree confidence.

11) When the backup display is installed in the Control Room, a calibration program for these instruments will be initiated. At the present time, the thermocouple temperature indication is generated within the plant computer and calibration is not required.

12) See Generic Response #12.

13) See Generic Response #13.

14) See Generic Response #14.

15) See Generic Response #15.

16) The core exit thermocouples are a direct measurement of temperature.

17) The temperature indications that will be installed as the backup display and the temperature data generated within the plant computer are not used during normal plant operations. This information will be strictly used for post-accident monitoring.

18) See Generic Response #18.

II. MARGIN TO SATURATION MONITOR

1) At the present time, the sensors located in the reactor containment have been qualified as addressed within the Maine Yankee 79-01B report (YAEC-1229). The only exceptions are the three RTDs in the hot legs of the Reactor Coolant System. This equipment is currently not scheduled for upgrading to Safety Class 1E equipment. The design of the Primary Inventory Trend System does not use these RTDs in the saturation monitor. For further information, see Enclosure 1.

   The remaining equipment is Safety Class 1E with the exception of the plant computer and alarm systems. This equipment is located in a mild environment and has been environmentally qualified and has been seismically tested, as addressed in Generic Response #1.

   The plant computer and the alarm system are Non-Safety Class equipment. No environmental or seismic qualification has been performed on this equipment.

2) Although there are multiple inputs into the saturation monitor, there is only one channel of output information. In the event that the process computer for the saturation monitor fails, there are alternative ways for the operator to acquire the required information as addressed in the letter dated January 22, 1980, from Maine Yankee Atomic Power Company to USNRC. This letter stated, "Additionally, the margin to saturation will be computed in the main plant computer and displayed continuously on the Main Control Board CRT monitor. Procedures will also be available to the operators to provide guidance in the use of steam tables." Separation requirements are addressed in Generic Response #2.

3) This instrument train is energized from Vital Bus 1.

4) See Generic Response #4.

5) See Generic Response #5.

6) This instrument provides a continuous display on the Main Control Board.

7) The saturation monitor output is fed into the plant computer. The operator may call back any trend or transient information that is required.

8) See Generic Response #8.

9) The output from the saturation monitor to the plant computer has not been isolated, however, saturation monitor isolation is planned.

II. Margin to Saturation Monitor (Cont'd)

10) The information provided by the saturation monitor can be checked against the value given by the plant computer or it can be checked using steam tables and plant parameters indicated in the Main Control Room.

11) See Generic Response #11.

12) See Generic Response #12.

13) See Generic Response #13.

14) See Generic Response #14.

15) See Generic Response #15.

16) The margin to saturation is a calculated value based on direct measurements of both temperature and pressure. At this time, there is no method available to directly measure this value.

17) This instrument is the primary method for the operator to determine the distance the plant is from saturation and will be used for post-accident monitoring.

18) See Generic Response #18.

III. PRIMARY INVENTORY TREND SYSTEM (PITS)

1) The transmitters, cables and recorders are qualified to the guidelines provided in NRC Bulletin 79-01B. This will assure operation of the system during all anticipated transients.

2) The transmitters and their instrumentation loops were installed using current Maine Yankee separation criteria (Generic Response #2). The units are powered by a Class 1E vital bus. The PIT System will be used in conjunction with other indications as described in Enclosure 1 to this letter.

3) The PIT System is powered from a Class 1E power source.

4) See Generic Response #4.

5) See Generic Response #5.

6) The output of the PITS will be continuously indicated on a main control board recorder.

7) See 6 above.

8) See Generic Response #8.

9) The system is a dedicated system and will be used strictly for inventory trending, therefore, presently no isolation devices are needed.

10) All three transmitters will be indicated on a single three-pen recorder. Comparison of the three outputs will allow for interpretation of erroneous information. In addition, as described in Enclosure 1 to this letter, other systems will be used to interpret this data.

11) Present procedures will call for calibration and testing to occur each refueling outage. Operating history has shown these transmitters to be reliable and free from any appreciable drift, which we feel justifies this testing frequency.

12) See Generic Response #12.

13) See Generic Response #13.

14) See Generic Response #14.

15) See Generic Response #15.

16) See Enclosure 1 to this letter.

17) The PITS will be used during all phases of plant operations.

18) See Generic Response #18.