

AUG 26 1981

Docket Nos: 50-460, 513

APPLICANT: Washington Public Power Supply System  
FACILITY: WNP-1/4  
SUBJECT: Summary of Meeting with Washington Public Power Supply System and Babcock and Wilcox to Discuss Inadequate Core Cooling Instrumentation - July 29, 1981

Background

NUREG-0737 was issued in November 1980 and represents an NRC staff clarification of TMI-2 approved action plan requirements. On May 13, 1981 a proposed rule was published in the Federal Register to codify that portion of the NUREG-0737 applicable to operating license applications into the Commission's regulations (i.e. 10CFR 50). This proposed rule is presently being reviewed prior to becoming a final rule. Section 50.34(f) (2)(VII) of the proposed rule (i.e. item II.F.2 of NUREG-0737) will require instrumentation to detect inadequate core cooling. At the request of the Washington Public Power Supply System (WPPSS) a meeting was held at the NRC's Bethesda, Maryland offices for the purpose of allowing WPPSS and the NSSS supplier for the WNP-1 and WNP-4 projects (Babcock and Wilcox) to present the conceptual design intended for use at these projects to meet the requirements of NUREG-0737 Item II.F.2. This meeting was held on July 29, 1981.

Enclosure 1 lists the meeting attendees.

The agenda and visual aids used in the meeting are enclosed as Enclosure 2.

Discussion

The representatives of WPPSS (hereafter called the Supply System) included in the opening statements the fact that the design discussed at the meeting applied only to the WNP-1/4 projects and did not represent a Babcock and Wilcox (B&W) generic design to be applied to other plants of B&W design. The Supply System also stated that the anticipated outcome of the meeting was NRC staff concurrence with the basic design and approach as a prelude to dedicating additional resources to detailed development of the design.

Babcock and Wilcox (Schieck) summarized what B&W and the Supply System understand to be the requirements/comments of Item II.F.2. (see pages 2 through 5 of Enclosure 2). By defining inadequate core cooling (ICC) as "insufficient reactor core heat removal to preclude continuing fuel clad temperature increase to the point of substantial fuel damage", B&W took the position that the most reliable indications of the approach or onset of ICC are the core thermocouple

OFFICE							
SURF	B109020004	B10826					
L	A	PDR	ADOCK	05000460	PDR		

readings. Consequently, one important feature that was emphasized is qualification of all incore thermocouples as safety-related equipment. The Supply System intends to qualify all incore thermocouples as required and to designate four thermocouples in each core quadrant to readout in a backup display. These requirements are detailed in attachment I to Item II.F.2.

The next portion of the presentation dealt with the applicability of various core parameters and corresponding instrumentation to the various core conditions from normal operation to complete core uncover. This is shown in page 7 of Enclosure 2. A summary of RCS level vs volume demonstrated that by the time water level has dropped to a level corresponding to the bottom of the hot leg nozzles, 80% of the RCS inventory has been lost (assuming the pressurizer has drained). By comparison, with water level at 10 feet below the top of the hot leg piping (the top of the hot leg being the high point in the RCS) only 14% of the RCS has been lost assuming the pressurizer is empty (3%, with the pressurizer not empty). On this basis, the Supply System proposed use of differential pressure type level indicators on the hot leg piping as an alternative to monitoring actual reactor vessel level. Item II.F.2 states that "the evaluation is to include reactor water level indication." The design proposed by the Supply System would therefore cover a range encompassing 80% of the inventory of the RCS but would not show levels below the hot leg nozzle. The point at which fuel begins to be uncovered corresponds to an 84% loss of RCS inventory at which time incore thermocouples would clearly indicate inadequate core cooling. Therefore only a "dead band" of 4% RCS inventory would exist between the low range of hot leg level indication and commencement of core uncover. (See pages 8 and 9 of Enclosure 2).

A "margin-to-saturation" meter, display and alarm was proposed as part of the planned ICC instrument package and would have a range of between 200 F subcooled to 35 F superheated. An alarm would be provided at an appropriate setpoint to give advance warning of the approach to ICC.

Details of the various instruments comprising the ICC package were discussed including the inputs, outputs, number of channels, ranges and power supplies (page 10 through 14 of Enclosure 2). A tentative schedule of key steps in the development of the ICC package and a summary of the features of the proposed system and steps required for final acceptance were also discussed.

The staff raised the question of what system testing and qualification steps were planned in addition to environmental qualification of the individual components. The Supply System stated that only environmental testing/qualification was planned. The staff requested an evaluation be made to determine what type of testing should be performed to verify performance of the system design. As an example, it was pointed out that the Westinghouse reactor vessel level instrumentation system developed for this purpose is being tested as a system both at the vendor's facility and at the Semiscale Test Facility in Idaho (INEL). The staff offered to pursue the availability of Semiscale for testing of the system proposed for WPPSS, if necessary.

OFFICE ▶	.....	.....	.....	.....	.....	.....	.....
SURNAME ▶	.....	.....	.....	.....	.....	.....	.....
DATE ▶	.....	.....	.....	.....	.....	.....	.....

A discussion on primary and backup displays relative to 99% computer availability ensued. The Supply System reiterated that they felt the proposal met those requirements of Item II.F.2.

Although the Supply System stated repeatedly that this proposal was unique only to the WNP-1 and WNP-4 units, the staff took a firm position with Babcock and Wilcox that the ICC instrumentation proposed at this meeting should be further developed into a generic solution to the extent possible for all B&W plants of similar design. Although this position was clearly stated and restated by the staff, no commitment was agreed to by Babcock and Wilcox.

Summary

Babcock and Wilcox proposed, on behalf of the Supply System, a combination of qualified incore thermocouples, margin-to-saturation instrumentation and hot leg/upper reactor vessel water level instrumentation to meet the ICC instrumentation requirements of Item II.F.2 in NUREG-0757 for WNP-1/4.

The staff responded that, with proper design, the level measurement concept proposed would probably be acceptable to the staff.

The Supply System was requested to evaluate additional testing and qualification of the proposed hot leg level indication system. It was also requested by the staff that this system be considered for submittal by B&W as a generic package to meet the ICC instrumentation requirements.

*RH*  
Ronald W. Hernan, Project Manager  
Licensing Branch #4  
Division of Licensing, NRR

Enclosures:  
As stated

cc: See next page

\*See previous white

OFFICE	DL:LB#4 <i>RH</i>	DL:LB#4	DL:LB#4	AD:CV/DL	AD:RSDSI	
SURNAME	*RHerran:eb	*MDuncan	EAdensam	RTedesco	LR Stein	
DATE	*8/6/81	*8/7/81	8/ /81	8/ /81	8/24/81	

A discussion ensued relative to primary and backup displays relative to 99% computer availability. The Supply System reiterated that they felt the proposal met those requirements of Item II.F.2.

Although the Supply System stated repeatedly that this proposal was unique only to the WNP-1 and WNP-4 units, the staff took a firm position with Babcock and Wilcox that the ICC instrumentation proposed at this meeting should be further developed into a generic solution to the extent possible for all B&W plants of similar design. Although this position was clearly stated and restated by the staff, no commitment was agreed to by Babcock and Wilcox.

Summary

Babcock and Wilcox proposed, on behalf of the Supply System, a combination of qualified incore thermocouples, margin-to-saturation instrumentation and hot leg/upper reactor vessel water level instrumentation to meet the ICC instrumentation requirements of Item II.F.2 in NUREG-0737 for WNP-1/4.

The staff responded with an evaluation that, with proper design, the level measurement concept proposed would probably be acceptable to the staff.

The Supply System was requested to evaluate additional testing and qualification of the proposed hot leg level indication system. It was also requested by the staff that this system be considered for submittal by B&W as a generic package to meet the ICC instrumentation requirements.

Ronald W. Hernan, Project Manager  
Licensing Branch #4  
Division of Licensing, NRR

Enclosures:  
As stated

cc: See next page

DISTRIBUTION

Docket File  
LB#4 r/f  
DEisenhut  
EAdensam  
RHernan  
MDuncan  
SHanauer  
RTedesco  
RVollmer  
TMurley  
RMattson  
RHartfield, MPA  
LRubenstein  
HSilver  
OELD

OIE (3)  
bcc: LPDR  
NRCPDR  
NSIC  
TIC  
TERA  
ACPS (16)

OFFICE	DL:LB#4 <i>rust</i>	DL:LB#4	DL:LE#4	AD:L/DL	<i>PA. S. / D.T.</i>	
SURNAME	RHernan:eb	MDuncan	EAdensam	RTedesco	<i>L. RUBENSTEIN</i>	
DATE	8/6/81	8/1/81	8/1/81	8/1/81	8/1/81	

WNP

Mr. R. L. Ferguson  
Managing Director  
Washington Public Power Supply System  
P.O. Box 968  
3000 George Washington Way  
Richland, Washington 99352

cc: Mr. V. Mani  
United Engineers & Constructors, Inc.  
30 South 17th Street  
Philadelphia, Pennsylvania 19101

Nicholas S. Reynolds, Esq.  
DeBevoise & Liberman  
1200 Seventeenth Street, N.W.  
Washington, D. C. 20036

Mr. E. G. Ward  
Senior Project Manager  
Babcock & Wilcox Company  
P.O. Box 1260  
Lynchburg, Virginia 23505

Resident Inspector/WPPSS NPS  
c/o U.S. Nuclear Regulatory  
Commission  
P.O. Box 69  
Richland, Washington 99352

MEETING ATTENDEES

July 29, 1981

WPPSS

R. Webring  
A. Hosler

NRC

L. Rubenstein, A/D, CCS  
L. Phillips, CPB  
T. Huang, CPB  
H. Li, ICSB  
R. Hernan, LPM/DL

BABCOCK AND WILCOX

R. Steinke  
G. Schieck  
R. Ganther  
C. Mahaney  
G. Andersen  
R. Queenan

TENNESSEE VALLEY AUTHORITY

D. Wilson

UNITED ENGINEERS & CONSTRUCTORS

B. Hale

CONSUMERS POWER COMPANY

T. Sullivan  
R. Huston

AGENDA FOR SUPPLY SYSTEM/NRC MEETING  
ON INADEQUATE CORE COOLING

1. INTRODUCTION, NEED FOR NRC INDICATION OF APPROVAL OF PROPOSED CHANGES. AG HOSLER
2. REQUIREMENTS FOR INSTRUMENTATION FOR THE DETECTION OF INADEQUATE CORE COOLING (ICC) IN NUREG 0737. GC SCHIECK
3. DEFINITION OF ICC AS IT APPLIES TO NUREG 0737. GC SCHIECK
4. INDICATION OF THE APPROACH AND ONSET OF ICC. GC SCHIECK,  
GE ANDERSON
5. ICC INSTRUMENTATION PROVIDED ON WNP 1/4. RM QUEENAN
  1. RC SATURATION METER
  2. EXTENDED RANGE THOT
  3. RCS LEVEL INDICATION (WR, NR, URV)
  4. INCORE THERMOCOUPLE INDICATION (SIXTEEN PLANNED TO HAVE IE READOUT)
6. HARDWARE JUSTIFICATION AND ANALYSIS TO SUPPORT ICC INSTRUMENTATION DESIGN REQUIRED BY NUREG 0737. GC SCHIECK
7. ANALYSES PLANNED FOR OPERATING PROCEDURE DEVELOPMENT GC SCHIECK
8. SUMMARY OF ICC INSTRUMENTATION PROVISIONS AND COMMITMENTS GC SCHIECK,  
RL WEBRING
9. NRC PRESENT THEIR OBSERVATIONS AND CONCURRENCE NRC STAFF

SUPPORTABILITY OF SUPPLY SYSTEM ICC COMMITMENTS

PROVIDE:

RC SATURATION METER  
NARROW RANGE RC LEVEL INDICATION  
WIDE RANGE RC LEVEL INDICATION  
INCORE THERMOCOUPLE QUALIFICATION  
INCORE THERMOCOUPLE QUALIFIED READOUT FOR  
16 THERMOCOUPLES

PERFORM:

ANALYSIS TO DEFINE OPERATOR USE OF INSTRUMENTATION  
PROVIDED  
ANALYSIS TO CORRELATE INCORE THERMOCOUPLE READINGS  
TO FUEL CLAD TEMPERATURES  
HUMAN FACTORS ANALYSIS OF DISPLAYS AND ALARMS



REQUIREMENTS FOR INSTRUMENTATION FOR THE DETECTION  
OF INADEQUATE CORE COOLING  
(NUREG 0737, ITEM II.F.2)

- 0 PROVIDE UNAMBIGUOUS INDICATION OF ICC
- 0 SHOW THAT THE EXISTENCE OF INADEQUATE CORE COOLING CAUSED BY VARIOUS PHENOMENA IS INDICATED
- 0 SHOW THAT ADVANCED WARNING OF ICC IS GIVEN
- 0 SHOW THAT THE FULL RANGE FROM NORMAL OPERATION TO COMPLETE CORE UNCOVERY IS COVERED
- 0 SHOW THAT INADEQUATE CORE COOLING IS NOT ERRONEOUSLY INDICATED
- 0 PROVIDE NECESSARY ANALYSIS TO SUPPORT DESIGN OF PROPOSED INSTRUMENTATION
- 0 HUMAN-FACTORS ANALYSIS OF TYPE AND LOCATION OF DISPLAYS AND ALARMS

HARDWARE JUSTIFICATION AND ANALYSIS  
TO SUPPORT ICC INSTRUMENTATION  
DESIGN

- 0 DEMONSTRATE THAT THE DISPLAY AND ASSOCIATED HARDWARE BEYOND THE ISOLATION DEVICE FROM THE COMPUTER (IF USED) IS ENERGIZED BY A BATTERY BACKED SOURCE.
- 0 COMPUTER PROCESSED SIGNALS MUST BE SHOWN TO BE 99% AVAILABLE, HAVE POST ACCIDENT ACCESSIBILITY FOR MAINTENANCE, AND HAVING COMPLETELY QUALIFIED DIVERSE METHODS OF ICC MONITORING.
- 0 INCLUDE RV WATER LEVEL INDICATION IN EVALUATION.
- 0 EVALUATE CONFORMANCE OF INCORE THERMOCOUPLES WITH "DESIGN AND QUALIFICATION CRITERIA FOR PWR INCORE THERMOCOUPLES".
- 0 EVALUATION FOR CONFORMANCE OF ICC MONITORING SYSTEM TO DESIGN AND QUALIFICATION CRITERIA.
- 0 DESCRIPTION OF OPERATING PROCEDURES.
- 0 DESCRIPTION OF ANALYSIS USED IN DEVELOPING PROCEDURES.

DEFINITION OF "INADEQUATE CORE COOLING"  
AS USED IN NUREG 0737

INSUFFICIENT REACTOR CORE HEAT REMOVAL TO PRECLUDE  
CONTINUING FUEL CLAD TEMPERATURE INCREASE TO THE POINT  
OF SUBSTANTIAL FUEL DAMAGE.

APPROACH OF ICC INDICATED BY:

LOSS OF SUBCOOLING MARGIN

LOSS OF RC INVENTORY

INCREASE IN FUEL CLAD TEMPERATURES

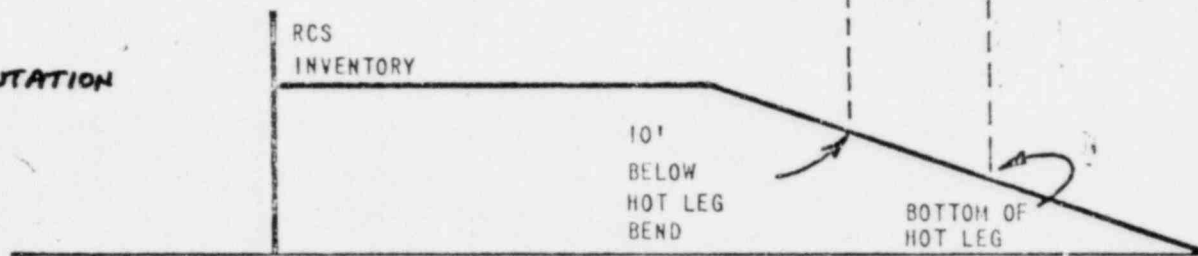
ONSET OF ICC INDICATED BY:

EXCESSIVE FUEL CLAD TEMPERATURES

# INSTRUMENTATION FOR DETECTION OF THE APPROACH AND ONSET OF INADEQUATE CORE COOLING

PARAMETER	NORMAL OPERATION	NATURAL CIRCULATION	LOSS OF RC INVENTORY		CORE UNCOVERY
RC PRESSURE	PRESSURIZER PRESSURE	-----	-----	-----	----->
RC FLOW	RC FLOW METER →	-----	-----	-----	-----
RC HOT LEG TEMPERATURE	<b>T<sub>HOT</sub></b>	-----	-----	-----	----->
SATURATION MARGIN	SATURATION METER	-----	-----	-----	----->
RCS INVENTORY	PRESSURIZER LEVEL	----->	NARROW RANGE LEVEL	WIDE RANGE LEVEL	-----
FUEL CLAD TEMPERATURE	-----	-----	INCORE THERMOCOUPLES	-----	----->

**□** INDICATES NEW OR MODIFIED INSTRUMENTATION



RCS LEVEL VS. VOLUME CORRELATION

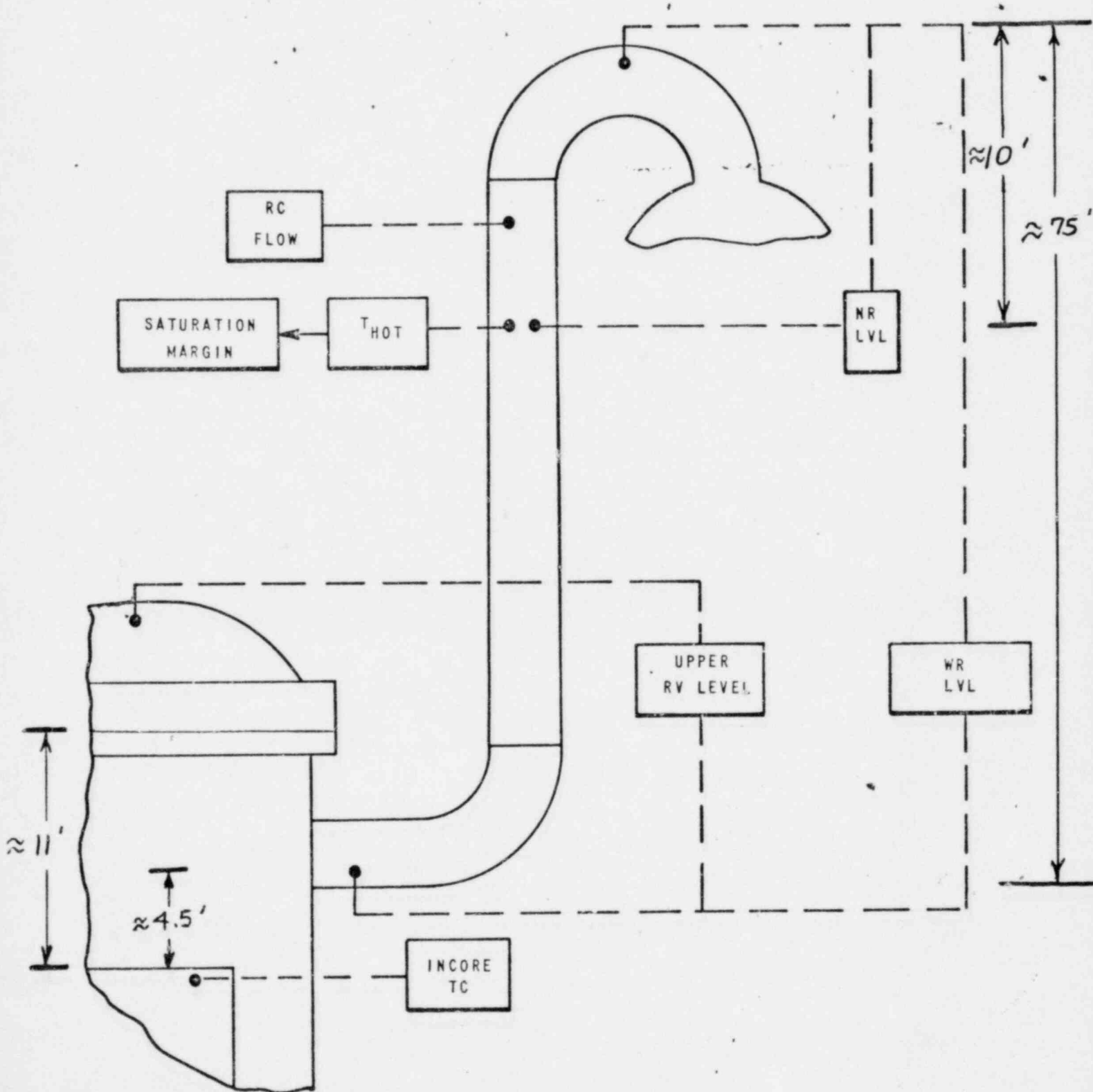
TOTAL RCS LIQUID VOLUME FOR 205 FA PLANT = 11,870 FT<sup>3</sup> EXCL. PZR LIQ.  
 = 13,160 FT<sup>3</sup> INCL. PZR LIQ.

IF RCS LEVEL DROPS TO	APPROXIMATE TOTAL AMOUNT (FT <sup>3</sup> ) OF LIQUID LOST IS . . .		% OF RCS LIQUID LEVEL LOSS (BASED ON 11,870 FT <sup>3</sup> ) IS . . .	
	<u>PZR DOES NOT DRAIN</u>	<u>PZR DRAINS</u>	<u>PZR DOES NOT DRAIN</u>	<u>PZR DRAINS</u>
BOTTOM OF NARROW RANGE HOT LEG LEVEL	330	1,620	3	14
BOTTOM OF WIDE RANGE HOT LEG LEVEL	8,210	9,500	69	80
TO TOP OF CORE	8,720	10,010	73	84

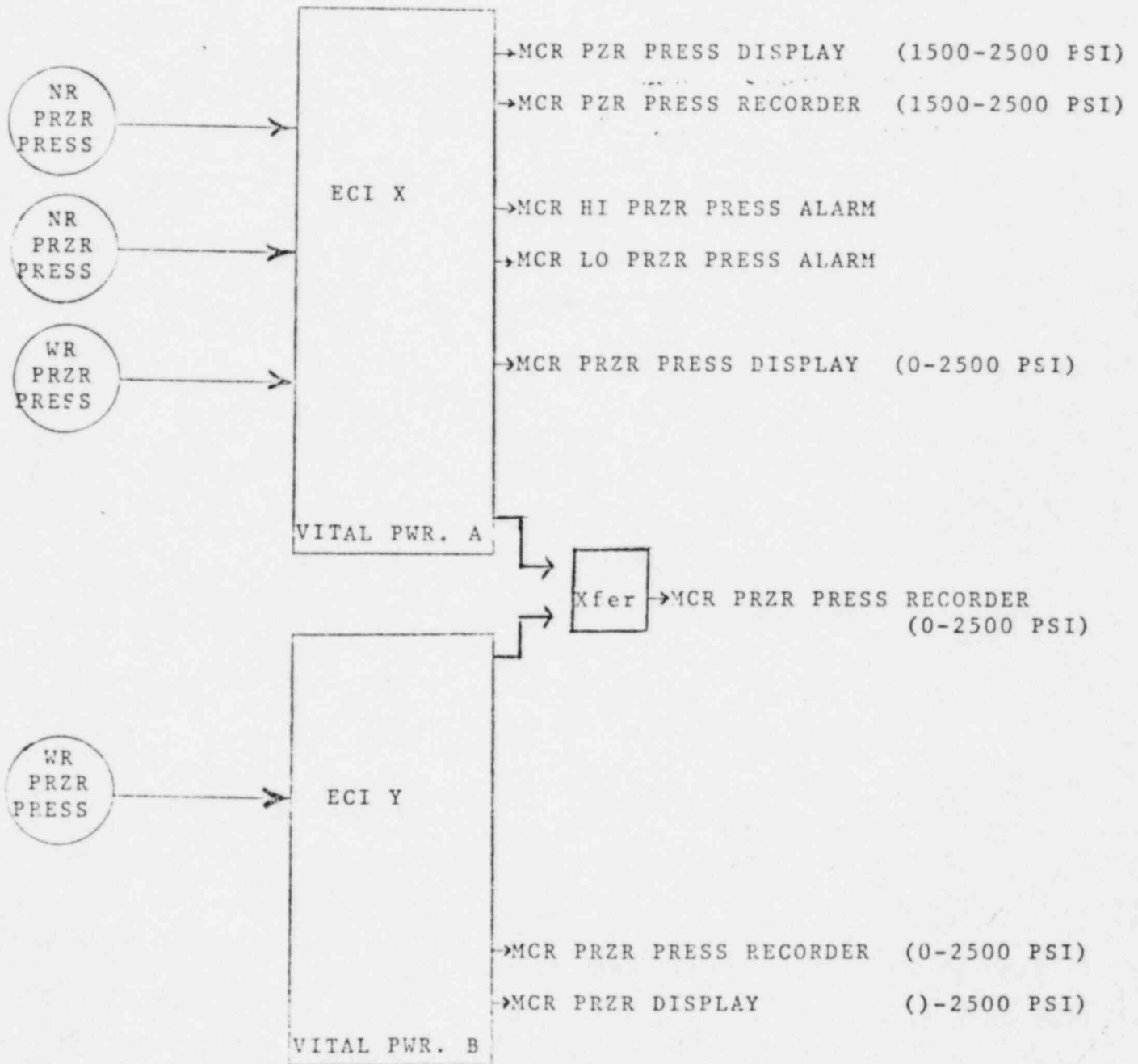
WITH LIQUID AT TOP OF CORE

REMAINING IN RV	2,350 FT <sup>3</sup>	20% OF ORIGINAL TOTAL (11,870 FT <sup>3</sup> )
REMAINING IN LOOPS	800 FT <sup>3</sup>	7% OF ORIGINAL TOTAL (11,870 FT <sup>3</sup> )

INSTRUMENTATION FOR DETECTION OF THE APPROACH  
AND ONSET OF INADEQUATE CORE COOLING

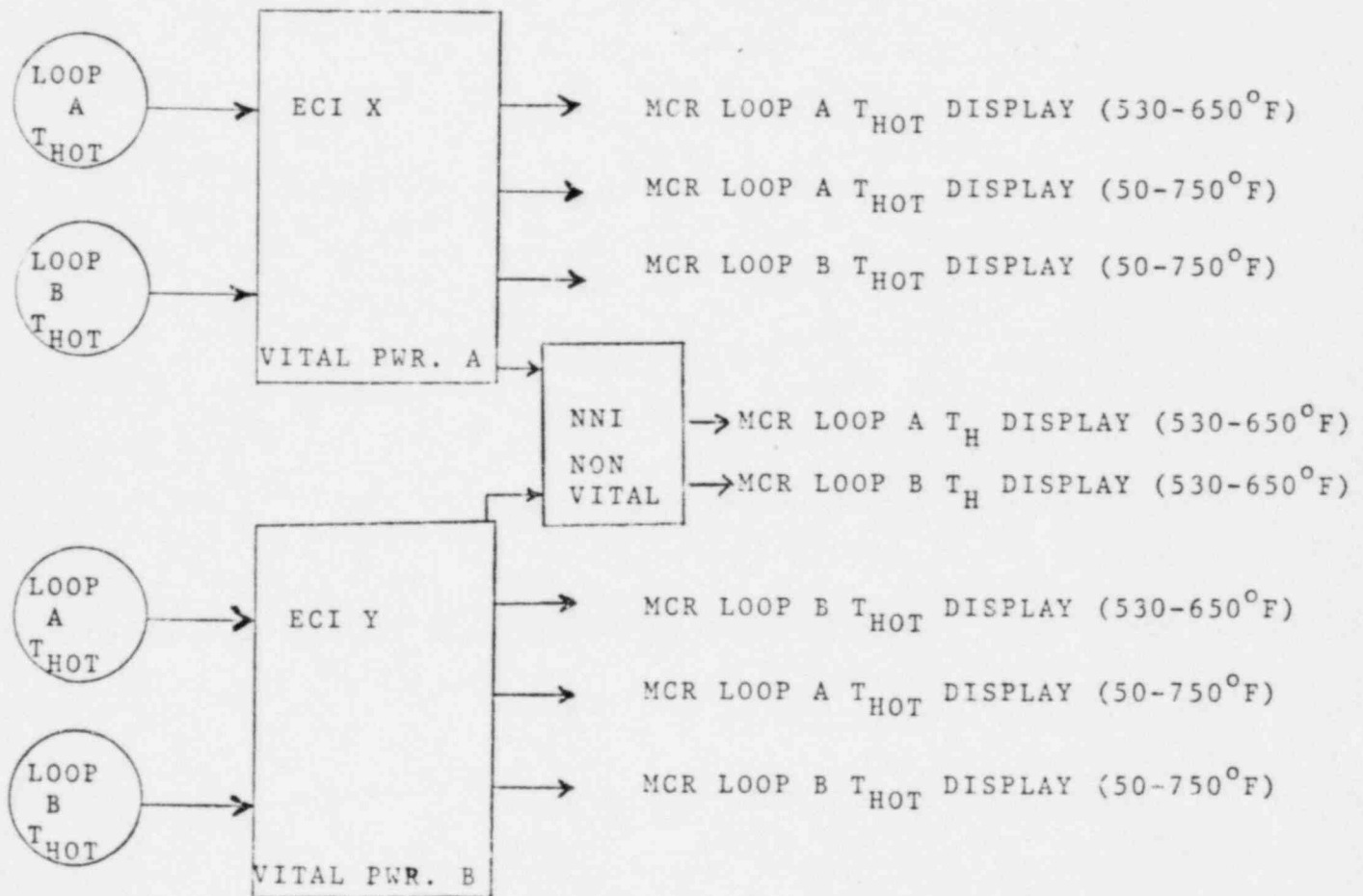


RC PRESSURE DISPLAY  
 (Protection System Equipment not Shown)

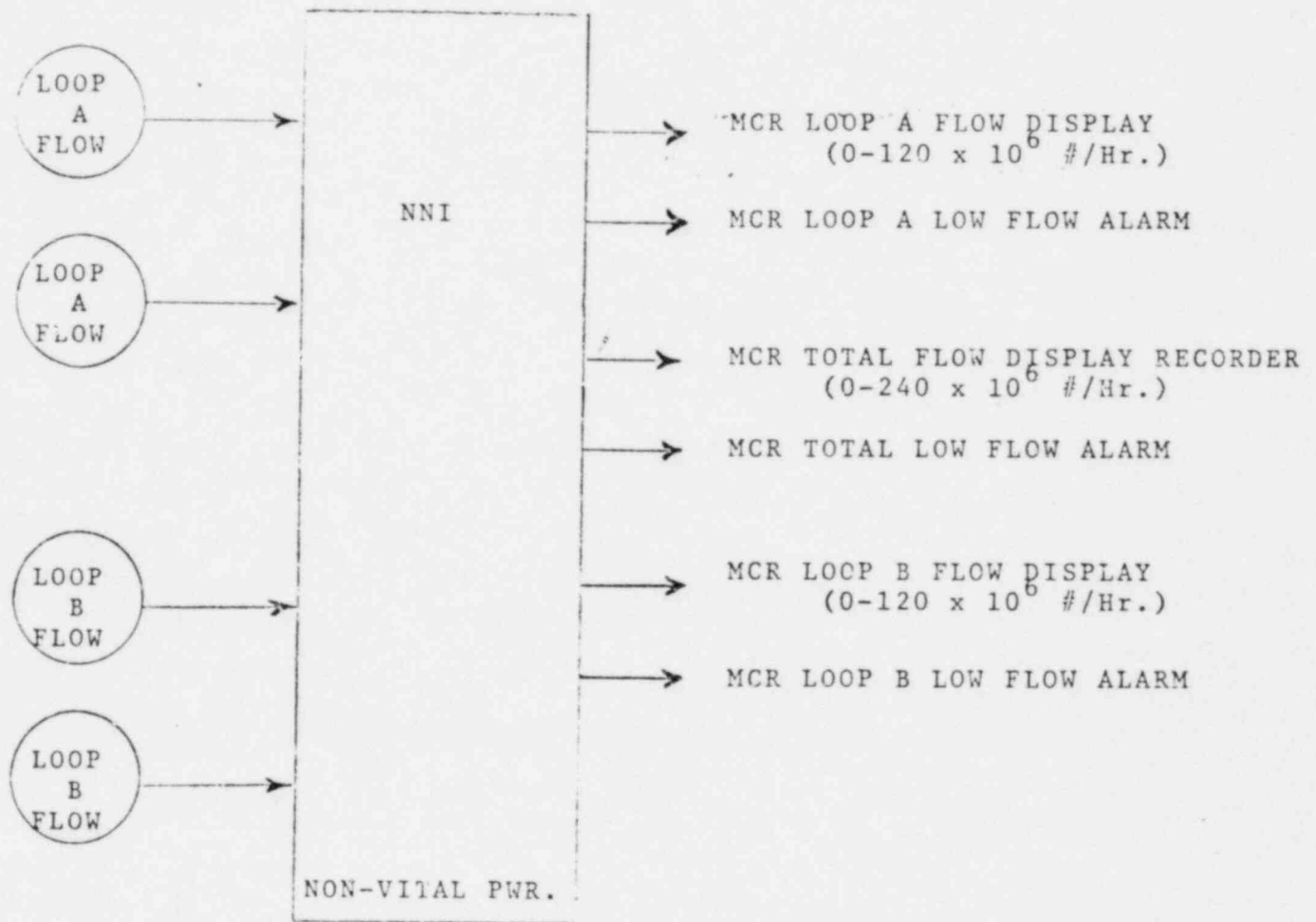




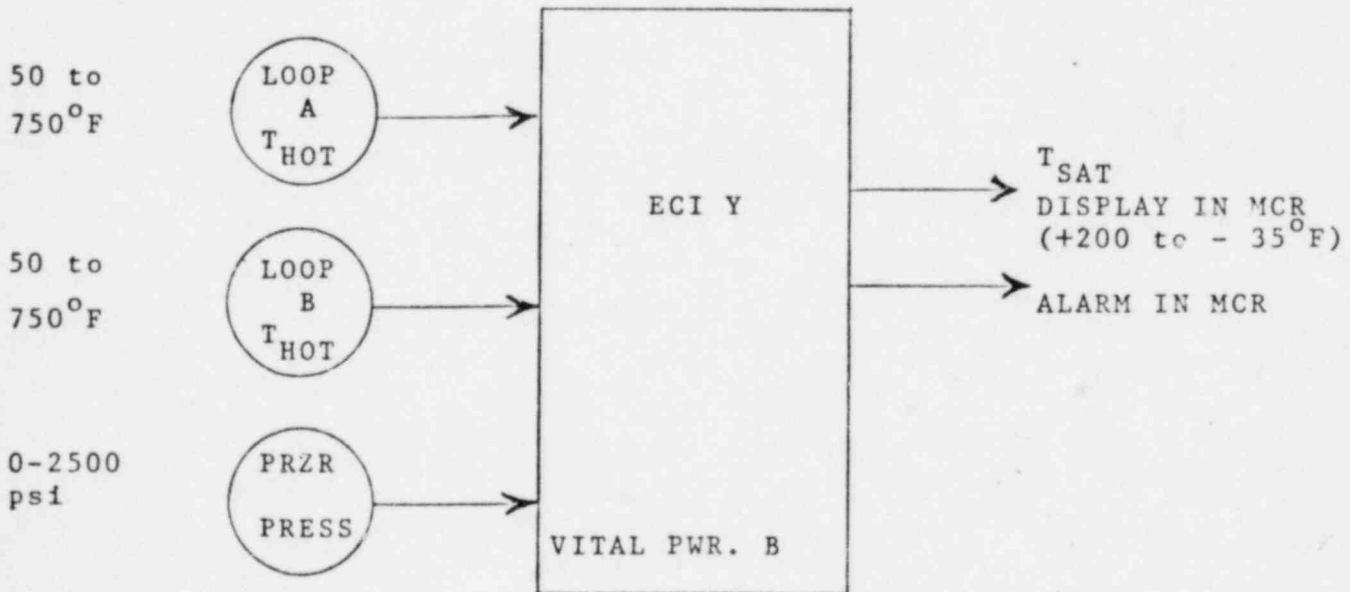
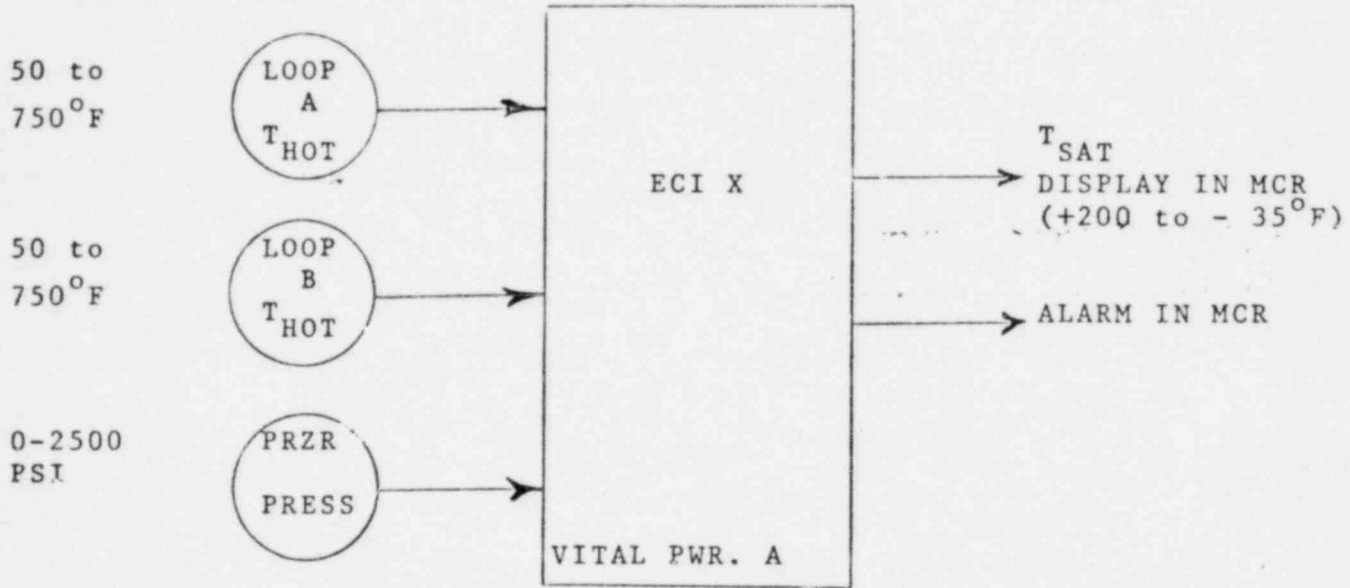
R.C. HOT LEG TEMPERATURE DISPLAY  
 (Protection System Equipment not Shown)



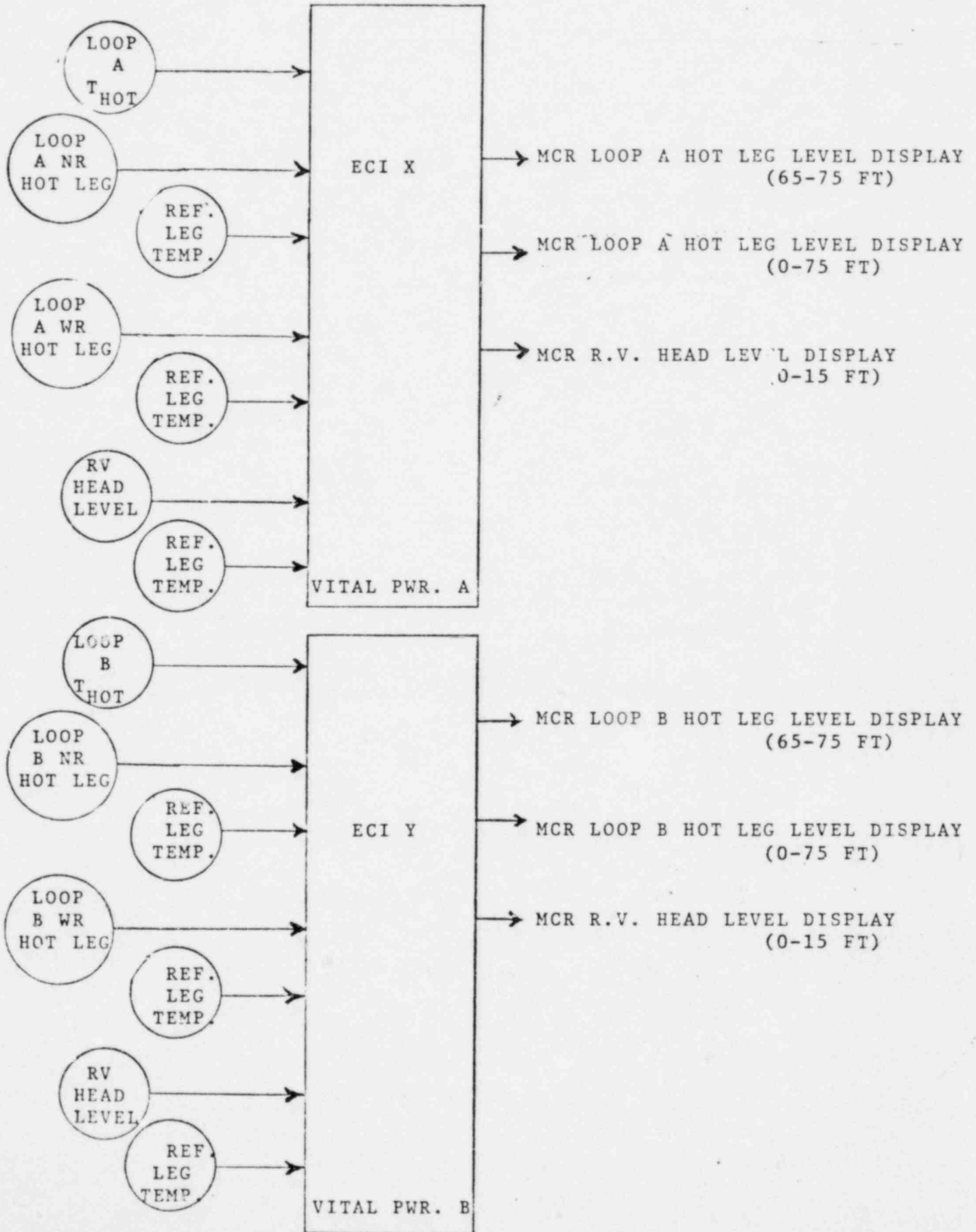
R.C. FLOW DISPLAY AND ALARM  
(Protection System Equipment not Shown)



MARGIN-TO-SATURATION METER DISPLAY AND ALARM



R.C. INVENTORY DISPLAYS



ADDITIONAL HARDWARE & ANALYSES TO SUPPORT  
INSTRUMENTATION FOR DETECTION OF ICC

<u>HARDWARE</u>	<u>COMPLETE HARDWARE DESIGN</u>	<u>ESTIMATED HARDWARE SHIP</u>
RCS LEVEL	4/82	10/83
EXTENDED RANGE THOT	2/82	3/83
RC SATURATION METER	2/82	8/82
INCORE THERMOCOUPLE QUALIFICA- TION	--	--
INCORE THERMOCOUPLE DISPLAY	--	--

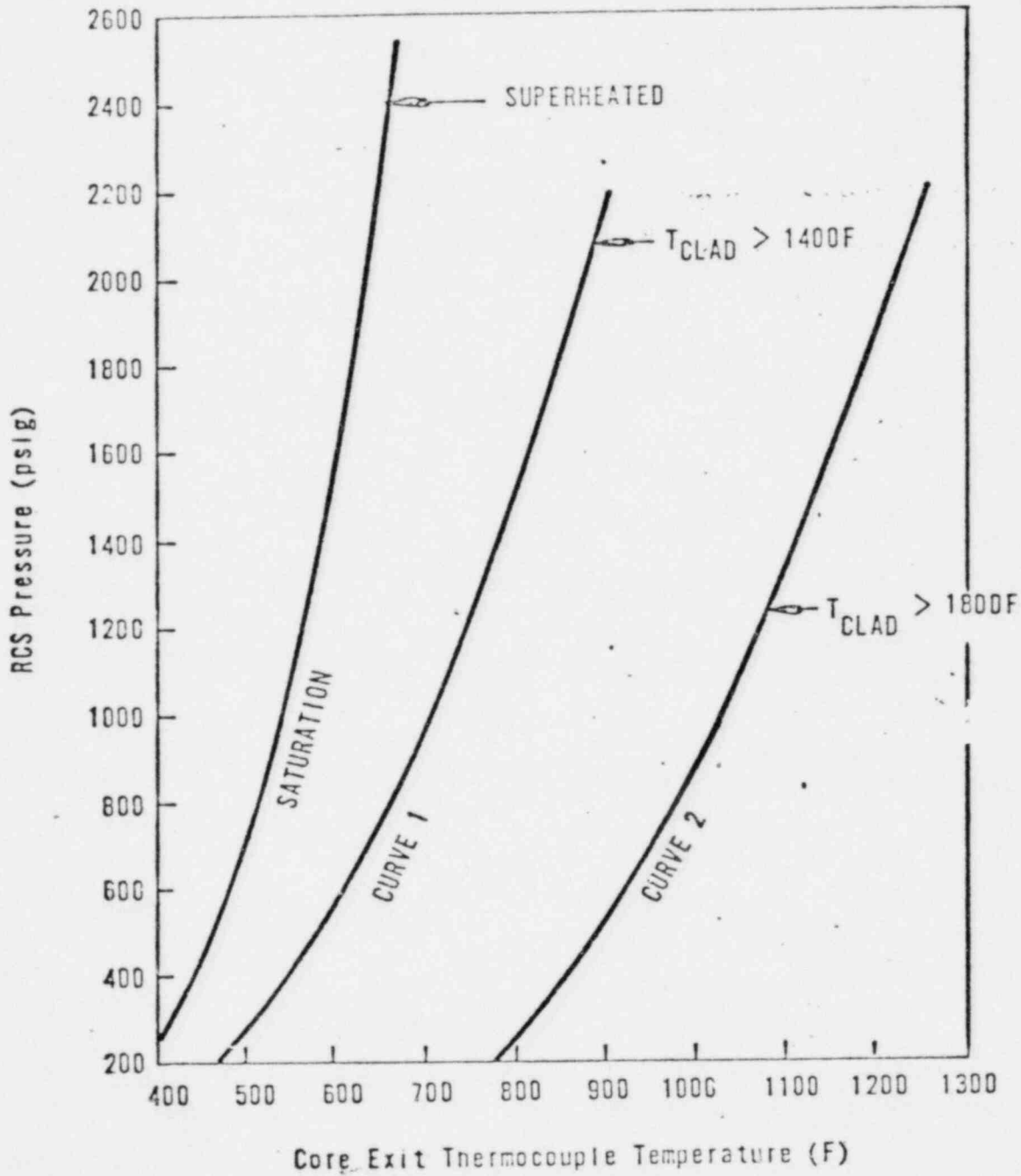
<u>ANALYSES</u>	<u>START</u>	<u>ESTIMATED COMPLETE</u>
INCORE THERMOCOUPLE UTILIZA- TION	7/81	1/82
ANTICIPATED TRANSIENT OPERATING GUIDELINES (ATOG)	6/81	3/83
HUMAN FACTORS ANALYSIS OF DISPLAYS AND ALARMS	--	--

ANALYSIS PLANNED FOR OPERATING PROCEDURE DEVELOPMENT

ANTICIPATED TRANSIENTS OPERATING GUIDELINES (ATOG)

- BASE ANALYSIS
- SBLOCA SUPPLEMENT
- ICC GUIDELINE SUPPLEMENT

177 FA PLANT  
CORE EXIT FLUID TEMPERATURE FOR  
INADEQUATE CORE COOLING



- ① INCORE THERMOCOUPLES PROVIDE UNAMBIGUOUS INDICATION OF ICC
- ① ICC CAUSED BY VARIOUS PHENOMENA IS INDICATED
- ① ADVANCED WARNING OF ICC IS GIVEN
- ① THE FULL RANGE FROM NORMAL OPERATION TO COMPLETE CORE UNCOVERY IS COVERED
- ① ICC IS NOT ERRONEOUSLY INDICATED
- ① NECESSARY ANALYSIS TO SUPPORT THE DESIGN OF PROPOSED INSTRUMENTATION IS PLANNED OR IN PROGRESS
- ① A HUMAN FACTORS ANALYSIS OF THE TYPE AND LOCATION OF DISPLAYS AND ALARMS WILL BE PERFORMED



- 0 COMPUTER BASED SIGNALS ARE NOT USED FOR PRIMARY ICC INDICATIONS
- 0 RV WATER LEVEL INDICATION HAS BEEN EVALUATED AND UPPER RV LEVEL INDICATION WILL BE PROVIDED
- 0 DEVELOPMENT OF AN INCORE THERMOCOUPLE QUALIFICATION PROGRAM AND DISPLAY DESIGN MEETING THE REQUIREMENTS OF "DESIGN AND QUALIFICATION CRITERIA FOR PWR INCORE THERMOCOUPLES" IS IN PROGRESS
- 0 A PROGRAM TO PROVIDE CONFORMANCE OF THE ICC MONITORING SYSTEM TO DESIGN AND QUALIFICATION CRITERIA IS IN PROGRESS
- 0 A DESCRIPTION OF OPERATING PROCEDURES WILL BE PROVIDED
- 0 A DESCRIPTION OF THE ANALYSIS USED TO DEVELOP ICC OPERATING PROCEDURES WILL BE PROVIDED

MEETING SUMMARY DISTRIBUTION

Docket File 50-460  
NRC/PDR  
Local PDR  
TIC/NSIC/TERA  
LB #4 r/f  
H. Dneton  
E. Case  
D. Eisenhut  
R. Purple  
B. J. Youngblood  
A. Schwencer  
F. Miraglia  
J. Miller  
G. Lainas  
R. Vollmer  
J. P. Knight  
R. Bosnak  
F. Schauer  
R. E. Jackson  
Attorney, OELD  
OELD  
OIE (3)  
ACRS (10)  
R. Tedesco  
N. Hughes

NRC Participants:

L. Rubenstein  
L. Phillips  
T. Huang  
H. Li  
R. Hernan

bcc: Applicant & Service List

G. Lear  
S. Pawlicki  
V. Benaroya  
Z. Rosztoczy  
W. Haass  
D. Muller  
R. Ballard  
W. Regan  
R. Mattson  
P. Check  
O. Parr  
F. Rosa  
W. Butler  
W. Kreger  
R. Houston  
T. Murphy  
L. Rubenstein  
T. Speis  
W. Johnston  
S. Hanauer  
W. Gannill  
T. Murley  
F. Schroeder  
D. Skovholt  
M. Ernst  
K. Kniel  
G. Knighton  
A. Thadani  
D. Tondi  
J. Kramer  
D. Vassallo  
P. Collins  
D. Ziemann  
A. Toalston  
V. Moore  
M. Srinivasan  
Chief, SPEB:DST  
R. Gamble  
E. Adensam  
Project Manager R. Hernan  
Licensing Assistant M. Duncan



AUG 26 1981