UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 23 1980

MEMORANDUM FOR: L. S. Rubenstein, Assistant Director
for Core and Containment Systems
Division of Systems Integration

THRU: R. O. Meyer, Acting Chief
Core Performance Branch
Division of Systems Integration

FROM: L. E. Phillips, Section Leader, Thermal Hydraulics
Section, Core Performance Branch, DSI

SUBJECT: SUMMARY OF NRC/CE OWNERS GROUP MEETING ON INADEQUATE CORE COOLING (ICC)

A meeting was held at NRC in Bethesda, Maryland, on May 28, 1980, to review the ICC program. The agenda of the meeting and a list of meeting attendees is attached. The general purpose of the meeting was to review the current status and schedule for the CE Owners Group response to Lessons Learned Inadequate Core Cooling requirements.

The owners were informed that pursuant to the NRR reorganization, the ICC review would be managed by the Thermal Hydraulics Section of Core Performance Branch (CPB), NRC. The review responsibilities of other branches relevant to the ICC program were described.

CE presented a summary of CEN-117 conclusions and further studies including causes of ICC, ground rules and the scope of ICC study, etc. CE also presented a discussion of the Reactor Vessel Level Monitoring System (RVLMS) of CEN-115, including the objective, design basis, functional requirements, and design criteria. Copies of slides from the presentations are attached.

Gary Holahan of NRC presented the preliminary conclusions from his review of "CE Post-TMI Evaluation, Task 2, Conceptual Design for a Reactor Vessel Level Monitoring System," as follows:

1. The system sensitivity to changes in the coolant condition needs to be addressed; and the expected response to Small Break and Large Break LOCA's needs to be evaluated by CE.

2. The range of the instrumentation is described as, "from the top of the reactor vessel head to the bottom of the reactor vessel outlet nozzle." This range is not adequate. We prefer a range extending down to the bottom of the core, but recognize that this is beyond the present state-of-the-art for heated junction thermocouples. However, the range must be extended down to the elevation of the upper core alignment plate. (This change has already been implemented.)

3. The core exit thermocouples are needed to complement the heated thermocouples and should therefore be qualified for use during post accident conditions.

4. The proposed display (continuous monitoring and recording of the signal from each level sensor) is not sufficient.

5. The core exit thermocouples and the level sensors should be integrated into an easy-to-interpret display.

6. We strongly encourage the development of a standard display and standard terminology to be used for instrumentation to detect inadequate core cooling.

7. Procedures and training in the use of this system are required.

George Liebler, Chairman of CE Owners Group -- ICC, presented a schedule for completion of the program as follows:

Task 1 (System functional design) by November 30, 1980;
Task 2 (hardware design) by December 31, 1980;
Task 3 (Prototype testing) by March 31, 1981;
Task 4 (System qualification) by November 30, 1981.

A copy of the schedule is attached. There was general recognition of the fact that the schedule does not satisfy the January 1981 implementation requirements of the Lessons Learned Task Force. L. Rubenstein agreed to consider whether a letter should be issued to reflect the staff position on the CE proposal approach.

L. E. Phillips, Section Leader
Thermal Hydraulics Section
Core Performance Branch, DSI

Attachments:
As stated

cc: G. Liebler, Florida Power & Light Company
(10 cys. for Owners Group Attendees)

ATTENDEES

NRC/CE Owners Group Meeting

May 28, 1980

Name	Organization
Larry Phillips	NRC - DSI/CPB
Gary Holahan	NRC - DST/SPEB
L. Rubenstein	NRC - DSI/CCS
Jose Ibarra	NRC -
Chang Li	NRC - DOL/ORB-3
Monte Conner	NRC - DOL/ORB-3
Bill Morris	NRC - DSI/ICSB
Tai Huang	NRC - DSI/CPB
Jack Guttmann	NRC - DSI/RSB
Rich Olson	Balt. Gas & Elec.
Alan Thornton	Balt. Gas & Elec.
Harry G. O'Brien	Tenn. Valley Auth.
Joe Gasper	Omaha Public Power
Len Casella	Florida Power & Light
George Liebler	Florida Power & Light
Jim Osborne	Florida Power & Light
Bill Burchill	C-E
C. H. Neuschaefer	C-E
R. Bryan	C-E
J. M. Westhoven	C-E
C. Brinkman	C-E (Bethesda)
R. Ivany	C-E
Lionel Bandz	C-E
Ralph Phelps	So. Cal. Edison Co.

MEETING AGENDA

C-E OWNERS GROUP - INADEQUATE CORE COOLING

I. INTRODUCTION — George Liebler, Fla. Power & Light

- Owners Group
- NRC

II. REVIEW OF CEN-117 CONCLUSIONS AND FURTHER STUDIES — Dick Ivany, CE

III. REVIEW OF CEN-125 AND FURTHER STUDIES — Bob Bryan, CE.

IV. CONCLUSION

- Owners Group
- NRC

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INADEQUATE CORE COOLING

OBJECTIVE:

RESPOND TO BULLETIN 79-06C, ITEM 5.

"PROVIDE ANALYSES AND DEVELOP GUIDELINES AND PROCEDURES RELATED TO INADEQUATE CORE COOLING (AS DISCUSSED IN SECTION 2.1.9 OF NUREG-0578,---) AND---".

SHORT TERM RESPONSE ONLY:

PROVIDE A "STUDY OF INSTRUMENT RESPONSE GOING INTO AND OUT OF INADEQUATE CORE COOLING".

LONGER TERM RESPONSE TO NUREG-0578:

REQUIRES EXTENSIVE SURVEY OF TRANSIENTS AND ACCIDENTS, WITH SUBSEQUENT REVISIONS TO GUIDELINES AND EMERGENCY PROCEDURES.

POSSIBLE CAUSES OF INADEQUATE CORE COOLING

CORE DNBR - FLOW BLOCKAGE

- POWER DISTRIBUTION ANOMALY

LOSS OF COOLANT INVENTORY - LOCA

LOSS OF HEAT SINK - LOSS OF FEEDWATER

LOW POWER/SHUTDOWN EVENTS

APPROACH TO DNB

DNBR = FUNCTION OF
- TEMPERATURE
- PRESSURE
- POWER
- FLOW RATE
- POWER DISTRIBUTION

INDICATION TO OPERATOR
- ANO-2 - COLSS POWER OPERATING LIMIT
- PRE-ANO-2 - THERMAL MARGIN LOW PRESSURE TRIP PRESSURE & PRE-TRIP ALARM

ADEQUATE INDICATION TO NORMALLY TRAINED OPERATOR FOR EVENTS WHICH ARE SLOW ENOUGH FOR HIM TO ACT

ASSUMES NO CORE ANOMALY EXISTS

TYPICAL ALARMS RELATED TO DETECTING A CORE ANOMALY

SYSTEM	PARAMETER	ALARM
EX-CORE	1/4 CHANNEL INCREASES	NUCLEAR INSTRUMENT CHANNEL DEVIATION
CPC	CORE POWER DISTRIBUTION	VARIABLE OVERPOWER
		HIGH LOCAL POWER DENSITY
		TM/LP
IN-CORE	FLUX/TEMPERATURE	HIGH LOCAL POWER DENSITY
COLSS	CORE POWER DISTRIBUTION	AZIMUTHAL TILT
		KW/FT MARGIN
		DNB MARGIN

GROUNDRULES

SELECT EVENTS WHICH HAVE A POTENTIAL FOR DEGRADING INTO INADEQUATE CORE COOLING IF NO ACTION IS TAKEN

USE APPROACH TO CORE UNCOVERY, DISCUSSED IN CEN-114, AS ANALYTICAL MEASURE OF CORE COOLING ADEQUACY

BEST ESTIMATE ANALYTICAL METHODS ARE UTILIZED PER NUREG-0578

C-E 2560 MWT CLASS OF REACTORS AS IN CEN-114 AND CEN-115

INADEQUATE CORE COOLING

- CORE COOLING WILL BE INADEQUATE ONLY IF SIGNIFICANT CORE UNCOVERY EXISTS FOR A SUBSTANTIAL PERIOD OF TIME

- CORE UNCOVERY CAN ONLY OCCUR AS THE RESULT OF A NET LOSS OF >70% OF THE INITIAL RCS INVENTORY

- THE NSSS IS DESIGNED TO PREVENT ICC FROM OCCURING WITH ONLY A MINIMAL RELIANCE ON OPERATOR ACTION

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C-E 2560 MWT CLASS OF REACTORS AS IN CEN-114 AND CEN-115

EVENTS ANALYZED (CEN-117)

APPROACH TO INADEQUATE CORE COOLING BY DRYOUT OF STEAM GENERATOR

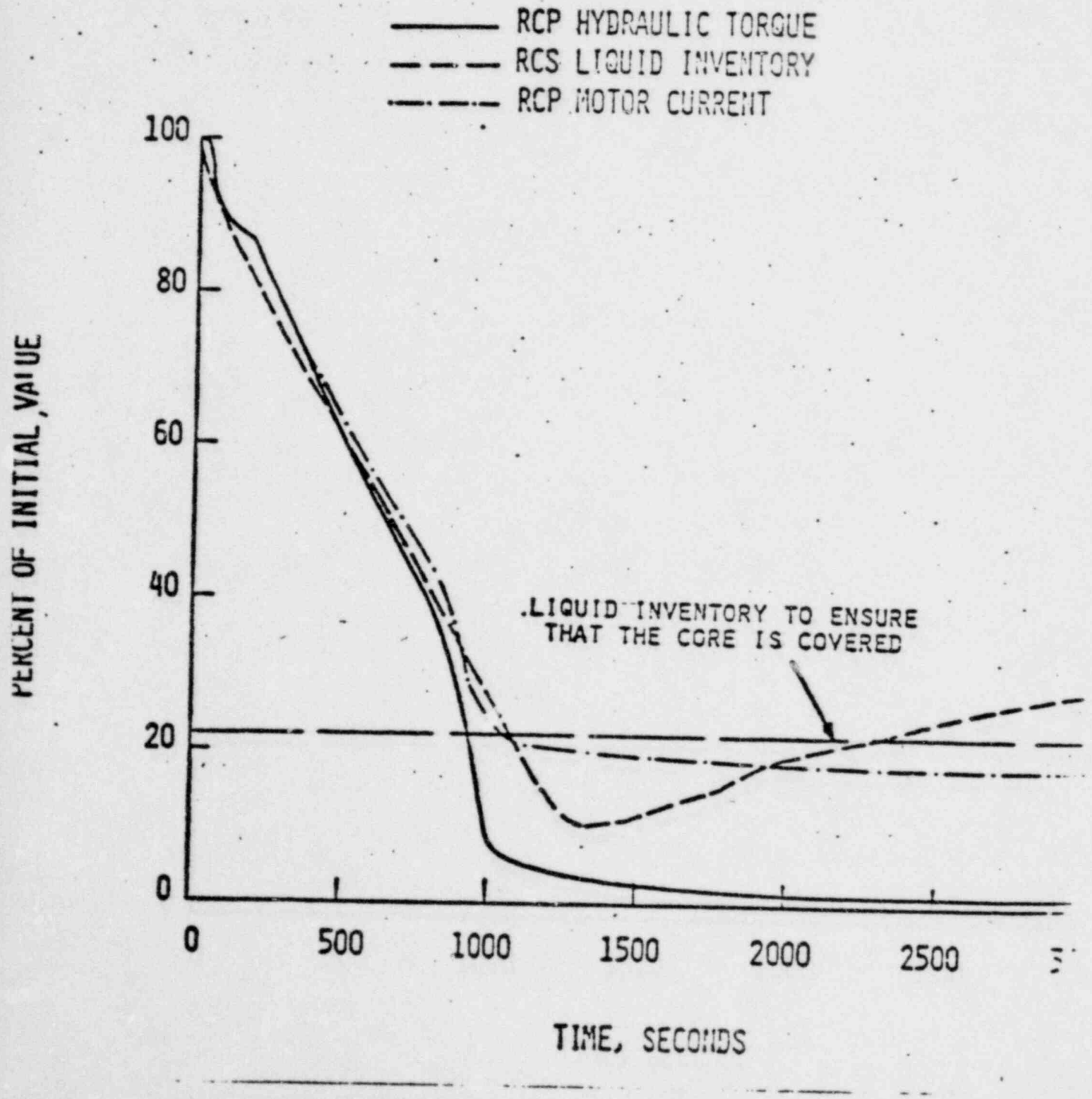
4) COMPLETE LOSS OF FEEDWATER WITH LOSS OF NATURAL CONVECTION, RCPs OFF

5) COMPLETE LOSS OF FEEDWATER WITH RCPs ON

6) FEEDWATER LINE BREAK, RESULTS IN ADVERSE CONTAINMENT ENVIRONMENT, LOSS OF NATURAL CONVECTION, RCPs OFF

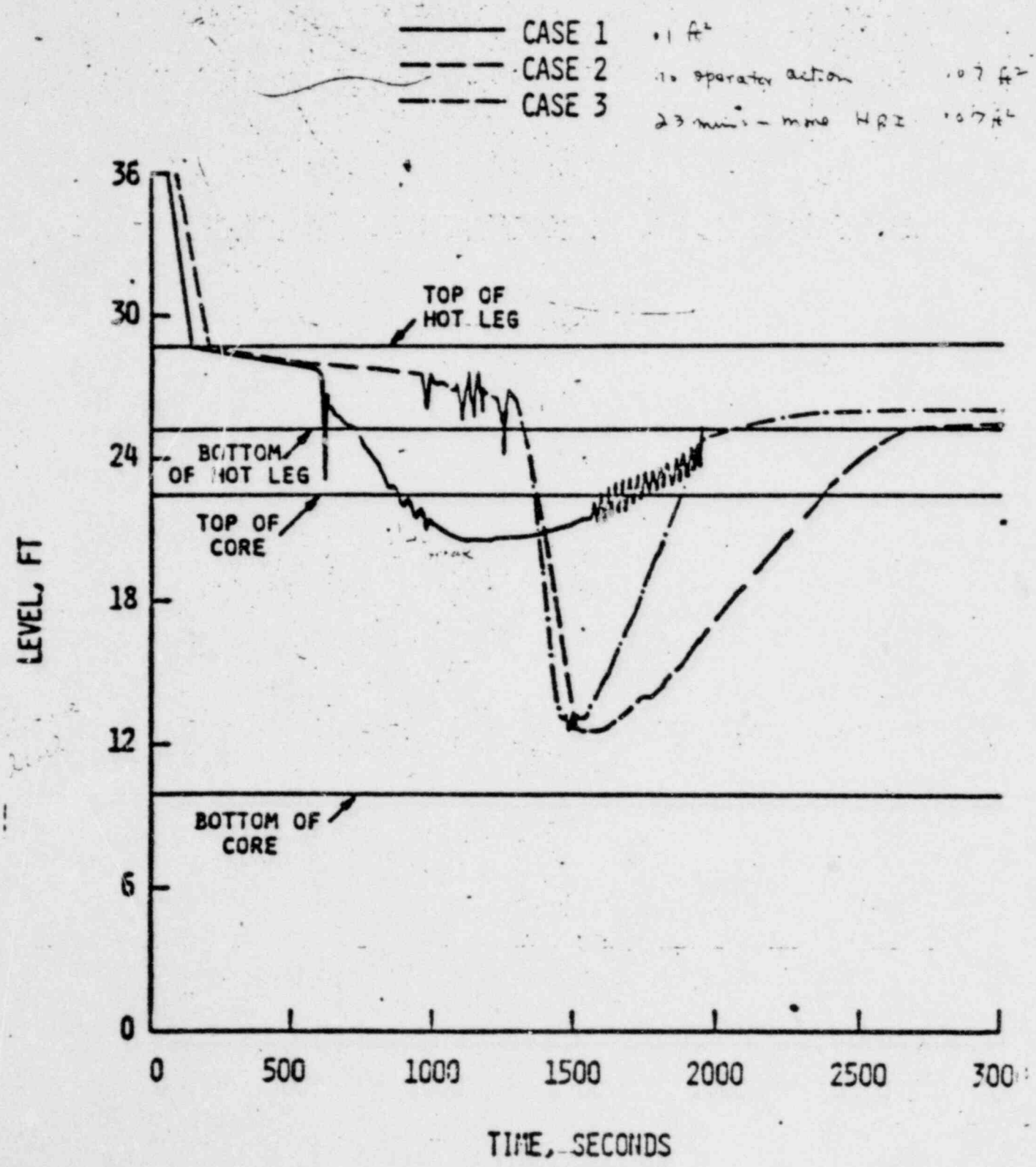
7) FEEDWATER LINE BREAK, RCPs ON

LOSS OF PRIMARY SYSTEM INVENTORY
RCP MOTOR CURRENT, HYDRAULIC TORQUE,
AND RCS INVENTORY
(CASE 2)



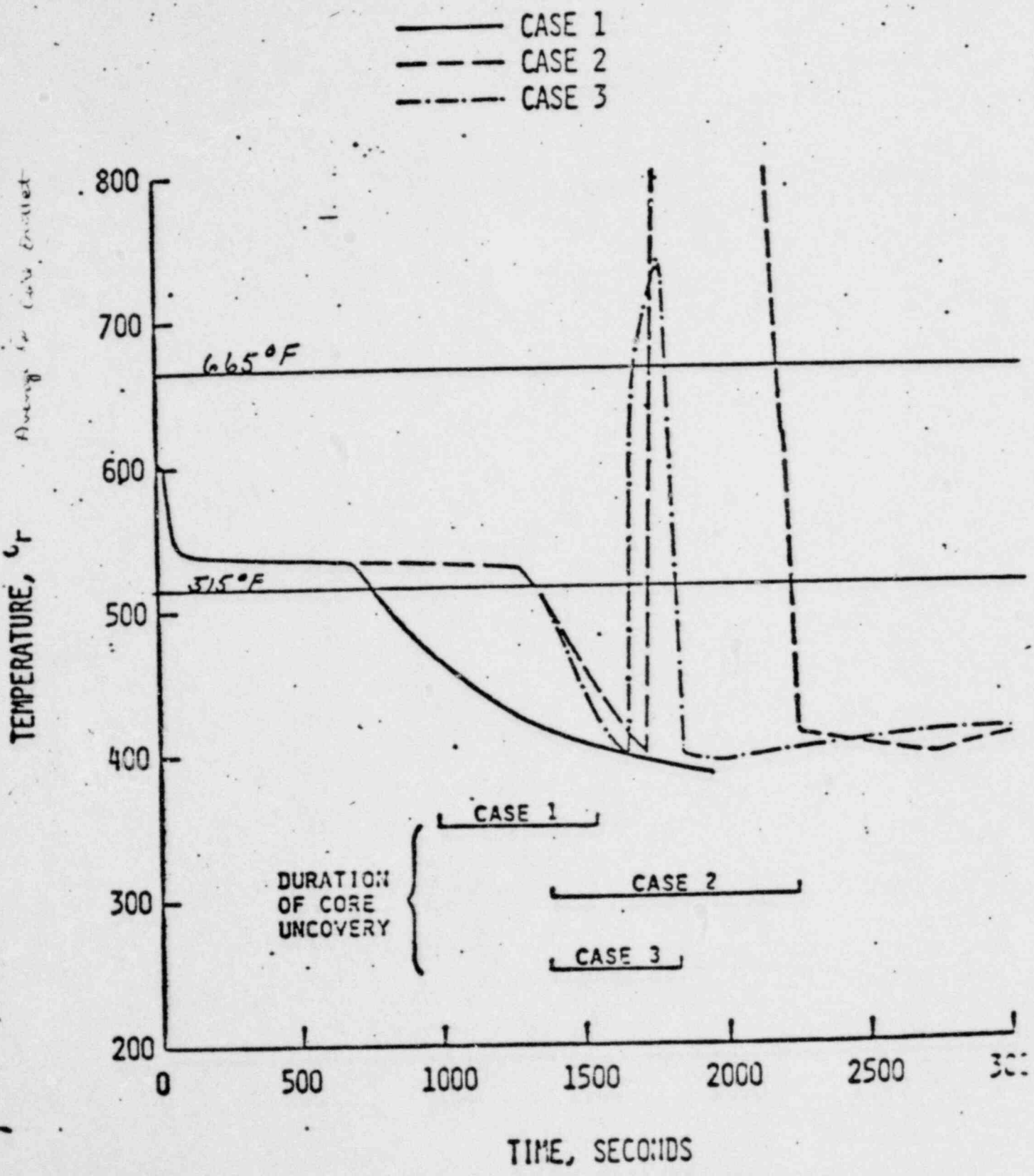
LOSS OF PRIMARY SYSTEM INVENTORY

REACTOR VESSEL TWO-PHASE LEVEL



LOSS OF PRIMARY SYSTEM INVENTORY

AVERAGE CORE EXIT FLUID TEMPERATURE



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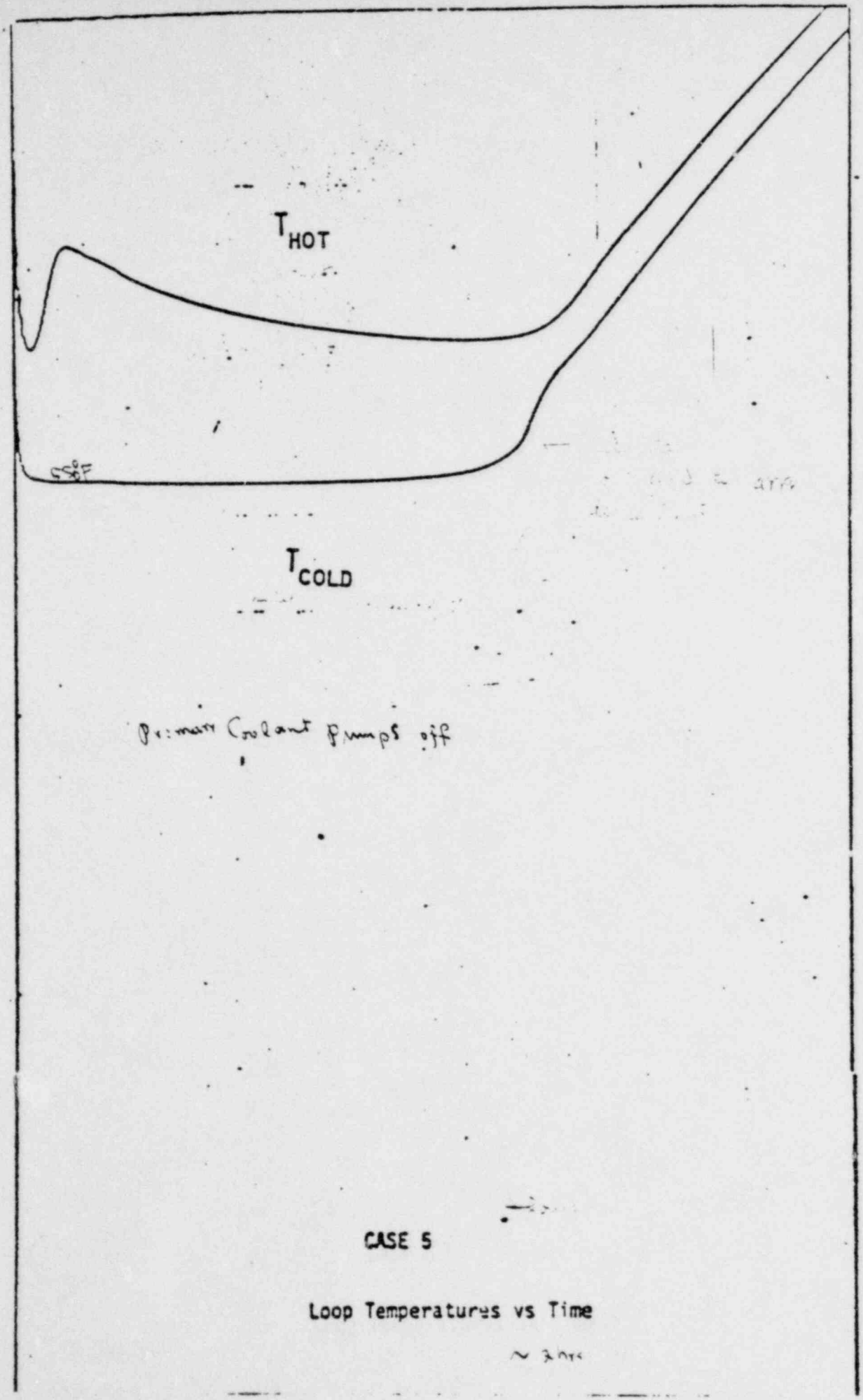


CASE 5

Loop Temperatures vs Time

CONCLUSIONS OF CEN-117

1. REQUIRE LARGE ANOMALY TO REACH DNB. CORE NON-SYMMETRY PROBABLY OBSERVABLE.

2. PUMP MOTOR CURRENT IS GOOD MEASURE OF APPROACHING CORE UNCOVERY.

3. INSTRUMENTS SHOW WHETHER ESSENTIAL SAFETY EQUIPMENT IS FUNCTIONING.

4. ANALYSES SHOW ACCEPTABLE CONSEQUENCES IF OPERATOR AND EQUIPMENT FUNCTION AS PRESCRIBED IN GUIDELINES.

5. WITH PUMPS OFF, NO DIRECT AND CONVENIENT INSTRUMENT TO SHOW APPROACHING CORE UNCOVERY.

6. AFTER CORE UNCOVERY, HOT LEG RTD AND CORE EXIT THERMOCOUPLES CAN SHOW SUPERHEAT AND APPROACHING INADEQUATE CORE COOLING. EXTENSION OF RANGE DESIRABLE.

OBJECTIVE OF CONTUING STUDY

DERIVE THE THERMAL AND HYDRAULIC FUNCTIONAL REQUIREMENTS FOR INSTRUMENTS TO MEASURE ICC

FORMULATE A RECOMMENDATION ON THE NEED FOR NEW INSTRUMENTATION

SCOPE OF ICC STUDY

1. ESTABLISH CRITERIA FOR INADEQUATE CORE COOLING BASED ON FUEL CLAD PERFORMANCE

2. PROVIDE THERMAL AND HYDRAULIC FUNCTIONAL REQUIREMENTS ON EXISTING AND NEW INSTRUMENTS FOR A SET OF EVENTS ANALYZED

3. OBTAIN DETAILED RESPONSE OF EXISTING INSTRUMENTS

    A. RTD THERMAL ANALYSIS
    B. SPND THERMAL ANALYSIS
    C. CORE EXIT THERMOCOUPLE THERMAL RESPONSE
    D. EX-CORE NEUTRON DETECTOR RESPONSE TO UNCOVERY

4. EVALUATE INSTRUMENT INDICATIONS AS A MEANS OF DETECTING ICC

    A. SUBCOOLED MARGIN MONITOR
    B. REACTOR VESSEL LEVEL MONITOR
    C. NATURAL CIRCULATION LOW FLOW MONITOR

5. FORMULATE CONCLUSION ON NEED FOR NEW INSTRUMENTS, 12/31/80

I. REACTOR VESSEL LEVEL MONITORING SYSTEM (RVLMS)

CONCEPTUAL DESIGN TASK

OBJECTIVE OF RVLMS CONCEPTUAL DESIGN TASK

RESPOND TO NRC REQUIREMENT TO DEVELOP SYSTEM CONCEPTUAL DESIGN AND FUNCTIONAL REQUIREMENTS (NUREG 0578, ITEM 2.1.3.B).

RVLMS DESIGN BASIS

INFORM THE PLANT OPERATOR THAT THE REACTOR VESSEL INVENTORY IS AFFECTED, SPECIFICALLY, BY AN EVENT.

- SENSE REACTOR VESSEL LEVEL
- CONTINUALLY RECORD
- PROVIDE ALARM AND ANNUNCIATION
- POST ACCIDENT MONITORING SYSTEM

FUNCTIONAL REQUIREMENTS

- REGULATORY GUIDE 1.97 POST ACCIDENT MON TORING SYSTEM
- SENSOR MEASURES FLUID IN REACTOR VESSEL
- RANGE FROM TOP OF HEAD TO TOP OF CORE
- DISPLAY REACTOR VESSEL LEVEL IN THE CONTROL ROOM
- ALARM TO ALERT THE OPERATOR
- QUALIFIED SEISMICALLY AND ENVIRONMENTALLY
- UNIQUE INDICATION OF SYSTEM MALFUNCTION

RVLMS DESIGN CRITERIA

DIRECT MEASUREMENT

NON-HYDRAULIC

NO MOVING PARTS

REDUNDANT

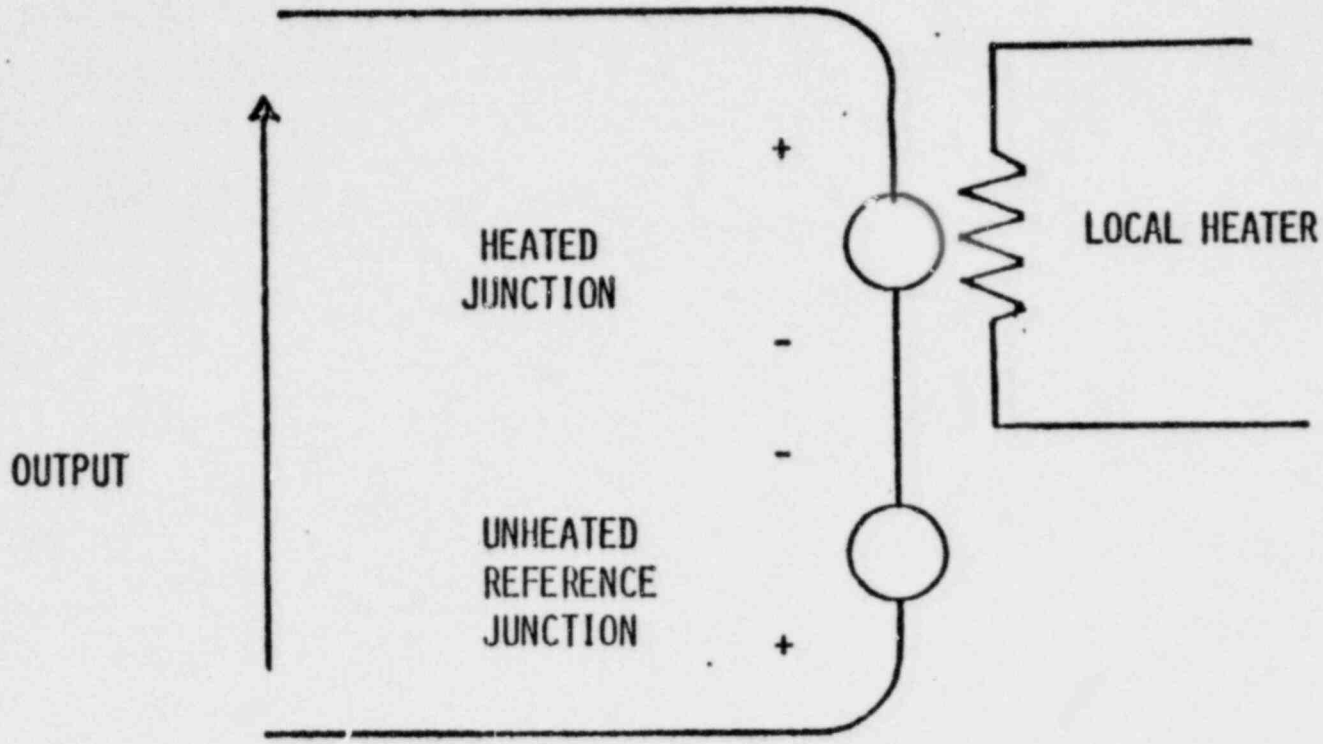
NO CHANGES TO EXISTING REFUELING PROCEDURES

MINIMUM IMPACT ON EXISTING NSSS DESIGN

NO IN-CONTAINMENT ELECTRONICS

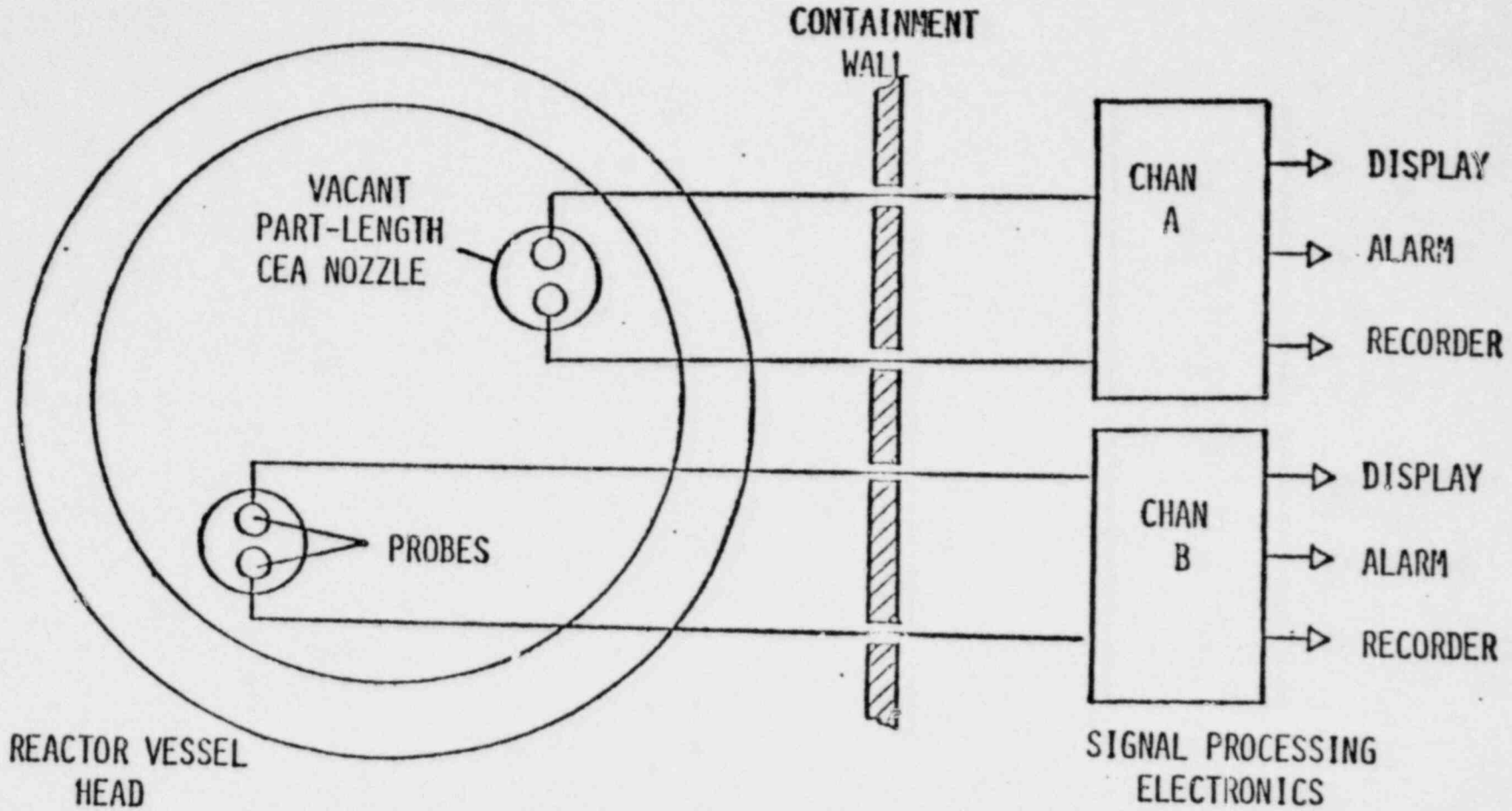
REPLACE SENSOR WITHOUT REMOVING THE R. V. HEAD

	DIRECT MEASURE	NON-HYDRAULIC	NO MOVING PARTS	REDUNDANT	NO REFUELING CHANGES	MINIMUM IMPACT ON NSSS DESIGN	NO IN-CONTAINMENT ELECTRONICS	SENSOR REPLACEMENT W/O HEAD REMOVAL
HJTC	X	X	X	X	X		X	
RF PROBE	X	X	X	X				
FLOATING SOURCE	X			X				
FIXED SOURCE	X		X	X			X	
FLOATING DIPSTICK	X			X			X	
ULTRASONIC PROBE	X	X	X	X				
BUOYANT FORCE	X			X				
D/P CELL				X				X



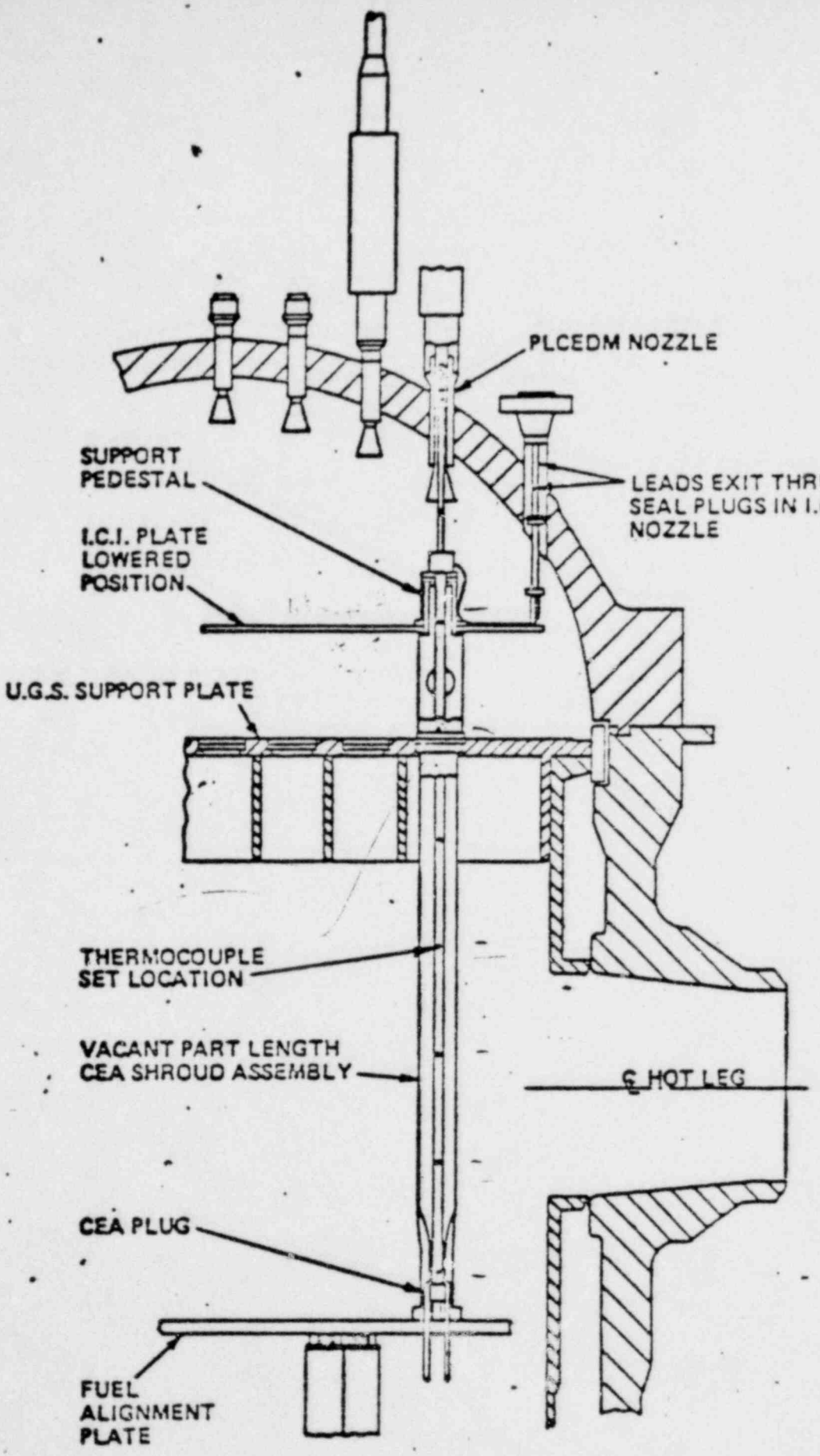
ELECTRICAL CONFIGURATION

REACTOR VESSEL LEVEL MONITORING SYSTEM



FUNCTIONAL CONFIGURATION

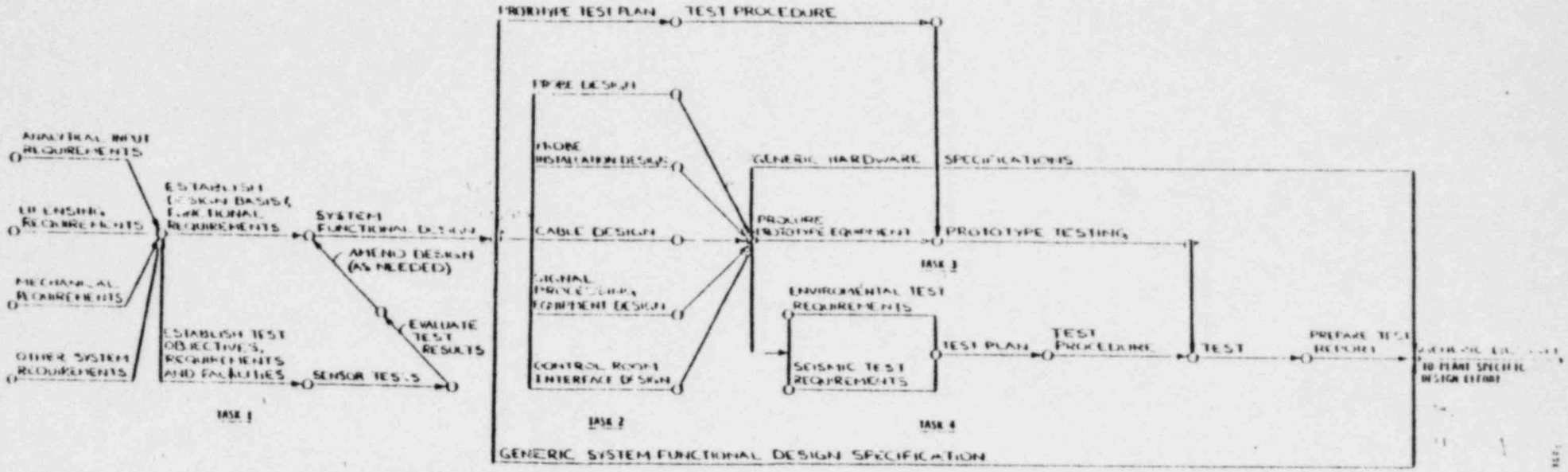
REACTOR VESSEL LEVEL MONITORING SYSTEM



RVLMS PROBE INSTALLATION

FIGURE 4.1

TASK PLAN FOR RVLIS DEVELOPMENT ACTIVITIES



*Milestones (See Table 5.1 for Schedule)