UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 18, 1995

LICENSEE: Consumers Power Company

FACILITY: Palisades Nuclear Plant

SUBJECT: PALISADES REACTOR VESSEL ANNEALING MEETING SUMMARY

A meeting was held at NRC Headquarters on June 6, 1995, between Consumers Power Company and the NRC to discuss the Palisades reactor vessel annealing. This was the first working level meeting between the staff and the Palisades Annealing Team. During the meeting, Palisades provided an overview of its annealing plan. In addition, the schedule and content of Palisades' application was discussed.

A list of attendees is provided as Attachment 1. Attachments 2 and 3 are the handout and slides presented at the meeting, respectively. Attachment 4 is a schedule of upcoming meetings related to the Palisades annealing and the Marble Hill demonstration project.

BACKGROUND

The staff issued a safety evaluation (SE) on April 12, 1995, for the Palisades plant which concluded that the margins of safety intended by the pressurized thermal shock (PTS) rule will be satisfied through the 14th refueling outage, scheduled for late 1999. In accordance with 10 CFR 50.61, 3 years prior to exceeding the screening criteria the licensee shall submit a plant-specific analysis to determine if operation beyond the screening criteria is acceptable. As stated in the April 12 SE, submission of an annealing plan will be an acceptable alternative to a plant-specific analysis.

PRESENTATION/DISCUSSION

Consumers Power began its presentation by reviewing the overall schedule of its annealing project. The contract to anneal the reactor vessel was awarded to Westinghouse. Consumers plans a four-phase project: Phase (I) conceptual design, Phase (II) detailed design, Phase (III) construction, and Phase (IV) implementation. The timeframes associated with the phases are provided in Attachment 3. Consumers plans on submitting an Application for Approval for Thermal Annealing (AFATA) at the end of Phase I, scheduled for October 1, 1995; select portions of the application may be submitted earlier as available. Consumers is requesting NRC approval of the AFATA by June 1, 1996, to support authorization for the construction phase scheduled to begin October 1996. Currently, Consumers has only been authorized by its senior management to proceed with Phase I. The staff questioned the existing schedule and the availability of the Marble Hill results prior to completion of NRC's review.

Consumers presented a technical overview of the annealing method. They used Draft Regulatory Guide-1027, "Format and Content of Application for Approval for Thermal Annealing of Reactor Pressure Vessels," to present an outline of

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the Thermal-Annealing Operating Plan. The outline is provided in Attachment 2. Significant technical issues discussed during this portion of the meeting are presented below.

General Overview of Method/Expected Recovery

The vessel will be annealed using an indirect gas heating system. General sketches are provided in Attachment 3. Ductwork and exhaust ventilation will be routed through the equipment and/or escape hatch. Inside the reactor vessel, there will be five heating zones with two independent burners per zone. Palisades currently plans on a controlled thermal profile during heat-up with a 7-day soak at 850°F and a 25°F/hr cooldown. Temperature inside the rig at the source will be approximately 1400°F. The ductwork route will be walked down during this outage which began on May 22, 1995.

Consumers predicts approximately an 80% or greater recovery from the annealing; however, it estimates only 40% recovery is required to reach its target of 2011, which includes recapturing the construction period.

Demonstration Project/Plant Comparison

A demonstration project is scheduled for April 1996 at Marble Hill, a 4-loop Westinghouse plant. This demonstration project is being performed independent of the Palisades annealing program; however, it is expected to provide information useful to the Palisades project. Palisades is a Combustion Engineering plant with four inlet nozzles and two outlet nozzles. A sketch with dimensional comparisons of the Palisades and Marble Hill plants is provided in Attachment 3. Additional design comparisons are also provided in Attachment 3 tables. The Palisades reactor vessel is supported on two inlet nozzles and one outlet nozzle. The Marble Hill reactor vessel is supported on two inlet nozzles and two outlet nozzles.

A comparison of preliminary instrumentation locations between Palisades and Marble Hill is provided in Attachment 3.

Radiation Protection

Shielding of primary sources will include the reactor vessel, the upper guide structure, and the core support barrel. The upper guide structure will be air lifted with temporary shielding and will be placed in the core barrel. These components will be shielded by a wall with a top installed prior to draining. Shielding will be placed around the reactor vessel and the heating system will be installed during reactor cavity draindown. Dose rates are expected to be around 50 mrem/hr on the refueling deck (general area) and 500 mrem/hr in the cavity.

Total dose for the project is estimated at 215 person-rem. This is comparable to the annual dose for the plant. The most dose-intensive activity involves installation of instrumentation around the reactor. A summary of dose estimates/activity is provided in Attachment 3. The estimates provided will be confirmed during this outage.

Structural Issues

The bioshield temperature will be monitored during normal operation following the installation of instrumentation this outage. The temperature limit at the bioshield is approximately 200°F. The shield is cooled by embedded cooling coils. Options for additional cooling during the annealing include augmented air cooling of the area and chilled water circulating through the embedded cooling coils.

Mechanical Issues

An initial inservice inspection of components will be conducted as part of the efforts. Thermal stress analysis will be performed using the ANSYS computer code. The analysis will include the reactor vessel, nozzles, attached piping and other discontinuities.

Surveillance Capsules

During the refueling outage which began on May 22, 1995, Palisades will install two new capsules which will include specimens of weld wire heats W5214, 348009, and 27204, as well as standard reference material. These will be placed in accelerated locations which have a lead factor of 10. One capsule will be removed during the fall 1997 refueling outage. One group of the specimens from this capsule will be Charpy tested following removal. A second group will be Charpy tested following annealing, and a third group will be tested after being reembrittled. The second capsule will be removed in 1998.

SUMMARY

In preparation for the review of the AFATA, future meetings will include a trip to the Palisades plant by NRC staff during this outage and a trip to the Marble Hill site which is currently scheduled for late August. Individual meetings will be held between the staff and Palisades Annealing Team to discuss technical issues involving specific review disciplines. If there are any questions regarding this meeting summary, contact Marsha Gamberoni at (301) 415-3024.

Marsha Gamberoni

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Attachments: As stated (4)

cc w/att: See next page

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MEETING ATTENDEES

JUNE 6, 1995

NAME	AFFILIATION
Marsha Gamberoni	NRC
Jack Strosnider	NRC
Keith Wichman	NRC
Robert Hermann	NRC
Mike Parker	NRC
Kamal Manoly	NRC
Cynthia Carpenter	NRC
Ken Battige	NRC
Chen Tan	NRC
Robert Rothman	NRC
David Shum	NRC
Cayetano Santos, Jr.	NRC
Elinor Adensam	NRC
Glenn Kelly	NRC
Ed Hackett	NRC
John Jacobsen	NRC
Barry Elliot	NRC
Glenn Dentel	NRC
Carolyn Fairbanks	NRC
John Tsao	NRC
Andrea Wilford	NRC
Lawrence Kokajko	NRC
Gilbert Millman	NRC
Lambros Lois	NRC
Iqbal Ahmed	NRC
Alfred Taboada	NRC
Micheal Vassilaros	NRC
Charles Hinson	NRC
Dick Smedley	CPCo
Jack Hanson	CPCo
Ken Powers	CPCo
John Kneeland	CPCo
George Goralski	CPCo
William Beckius	CPCo
William Doolittle	CPCo
David Howell	Westinghouse
Rick Rishel	Westinghouse
Brad Maurer	Westinghouse
Glenn Campbell	Cooperheat
William Server	ATI Consulting
Jim Nakos	DOE
John Warren	DOE
Dennis Harrison	DOE
Lynn Connor	STS, Inc.
R. Borsum	BWNT
Bob Steele	MPR Associates
Nancy Chapman	Bechtel

ATTACHMENT 1

CONSUMERS POWER/NRC VESSEL ANNEALING MEETING

JUNE 6, 1995 Rockville, Maryland

AGENDA

	TOPIC	RESPONSIBLE	DURATION
1.	INTRODUCTION Purpose of Meeting Overall Schedule	Consumers	15 minutes
2.	TECHNICAL OVERVIEW Annealing Method Summary Recovery/Re-Embrittlement Summary	Consumers	15 minutes
3.	OPEN DISCUSSION ON AFATA CONTENT Discuss Elements of the Attached AFATA Content Summary Which are of Particular Interest/Concern	NRC & Consumers	2 Hours
4.	CLOSURE Identification of NRC AFATA Reviewers Timing of AFATA Submittal Action Items Future Meetings	NRC & Consumers	30 Minutes

ATTACHMENT 2

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

THERMAL ANNEALING OPERATING PLAN	COMMENTS
1. Identification of general considerations a. Identify reactor b. Provide reasons for annealing c. Provide expected remaining operating life after annealing d. Describe operating history of reactor (power-time-temperature history) e. Specify reactor vessel beltline temperatures during reactor operation f. Describe results of ongoing surveillance program (# of specimens, initial values for RT_{ndt} & USE, shifts of RT_{ndt} and USE, also pre-anneal RT_{ndt} and USE values	No deviations from the guidance of DG-1027 are proposed.
2. Provide description of the reactor vessel a. Detailed description of the reactor vessel b. Identify parts of vessel to be annealed c. Include all vessel data used for determining the Thermal Annealing Operating Plan, the proposed inspections and tests, and the programs for recovery and re-embrittlement. For each heat of material in the reactor vessel beltline region include: - material compositions - mechanical properties - fabrication history and techniques - NDE t[illegible] results (in-shop) (ISI) - Neutron fluence exposures - if available, $RT_{ndt,u}$ (NB-2300), USE_u (E185) - material heats of base metal and weld metal to be used for measuring % recovery & subsequent surveillance purposes to be identified d. All vessel dimensions reported (diameter, wall thickness, cladding thickness, nozzle dimensions, flange dimensions, transition section dimensions, gaps between vessel & concrete structures, internal permanent structures & insulation) e. Identify/describe attachments to reactor that could be affected by annealing operations, and expected effects, such as changes in properties of vessel insulation, effects of thermal growth of reactor vessel sliding support structures, and overheating of instrumentation and attachments	No deviations from the guidance of DG-1027 are proposed.

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

THERMAL ANNEALING OPERATING PLAN	COMMENTS
3. Equipment, components, and structures affected by thermal annealing a. Description of all equipment, structures, and components that could be affected, either thermally or mechanically, by annealing operation and the expected effects (degradation of biological shield, effects of vessel growth, distortions on attached piping) b. Identify significant thermal and mechanical loadings projected for each item and actions proposed to avoid damage from these loadings c. Description of biological shield - dimensions - materials - irradiation exposures - unique features - cooling provisions - properties - design temperature eliminations - justification for exceeding design temperatures d. Description of piping - material types - dimensions - restraints - design requirements (temperature, bending stress or strain limitations) identified - NDE results (ISI) e. Physical descriptions of other equipment or instrumentation that could be affected by the thermal annealing f. Description of overall containment as it relates to core removal and storage as well as annealing - Special requirements should be described in detail (storage of core internals)	No deviations from the guidance of DG-1027 are proposed.
4. Thermal annealing operating conditions a. Description of proposed annealing parameters (temperatures, times, HU and CD schedules) b. Identify limitations and permitted variations in these conditions (axial, azimuthal, and through-wall gradients, permissible temperature profiles in the HU, CD, and steady state heating) c. Describe test and analyses used to establish these annealing parameters	No deviations from the guidance of DG-1027 are proposed.

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

THERMAL ANNEALING OPERATING PLAN	COMMENTS
5. Description of annealing method, instrumentation, and procedures a. Describe method of heating vessel in detail b. Describe method of instrumentation in detail that permits on-line measurements of the temperatures at the locations needed to assess the entire temperature profile of the vessel, and adjacent structures and equipment; of the stress profiles including thermal gradients in the axial, azimuthal, and through thickness directions during all transient and steady-state conditions of the annealing operation c. Identify expected instrumentation accuracies, and reliability d. Describe in detail the operational steps to be taken during the annealing operation including QA measures - identify controls and how applied - installation and removal of heat treatment equipment - procedures to be used to control radioactive contamination - drainage and drying of vessel prior to annealing - precautions to preclude cooling water leakage into vessel during annealing	No deviations from the DG-1027 guidelines are proposed.
6. Proposed annealing equipment a. Description of equipment - heating apparatus - general plant layout - controls and instrumentation including redundancy controls - equipment for measuring and recording the temperatures and temperature profiles - support equipment - ALARA provisions - protection of instruments and equipment from temperature effects during annealing	No deviations from the DG-1027 guidelines are proposed
7. Thermal and stress analyses a. Detailed thermal and structural analyses to establish appropriate time and temperature profiles b. Specify the limiting parameters established by analyses, including the highest temperature, highest stress, and limiting HU and CD rates	No deviations from the DG-1027 guidelines are proposed

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

THERMAL ANNEALING OPERATING PLAN		COMMENTS
8.	Proposed annealing conditions; identify proposed annealing conditions (time, temperature, HU and CD rates, critical stresses and strains)	No deviations from the DG-1027 guidelines are proposed.
9.	ALARA Considerations a. Description of steps to minimize occupational exposure b. Description of equipment and procedures for monitoring and control of airborne radioactive particles c. Identification of precautions to avoid excessive exposure from radiation streaming when the reactor internals are being removed and stored, when the reactor coolant is removed from the reactor, and when the heating equipment is being moved into and out of the vessel d. Description of steps to minimize exposure due to radioactive waste processing, radioactive materials decontamination, and radioactive waste shipment	No deviations from the DG-1027 guidelines are proposed.
10.	Summary of the Thermal Annealing Operating Plan	No deviations from the DG-1027 guidelines are proposed.

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

REQUALIFICATION INSPECTION AND TEST PROGRAM		COMMENTS
1.	Identification of the measurements and locations that will be used to monitor the annealing process and to verify that the conditions of the Operating Plan are not exceeded; describe measurement type, the number of measurements to be made for each component, measurement sensitivity, measurement frequency, and recording method	Due to ALARA concerns and physical access constraints, measurements will be optimized such that the proposed annealing conditions evaluated in the AFATA are not exceeded and the annealing process can be adequately monitored. The intent of DG-1027 will be achieved.
2.	Description of the inspection program to affirm that the annealing operation has not damaged the reactor vessel or related equipment, components, or structures; describe the type and number of examinations, the locations of the examinations, the acceptance criteria, qualification requirements, and reporting requirements	No deviations from the DG-1027 guidelines are proposed.
3.	Description of the test program to demonstrate the effectiveness of the annealing operation, and to assure that the reactor vessel, attached piping and appurtenances, and adjacent concrete have not been degraded; describe the type and number of tests, the locations/components of the tests, the purpose of the tests. the acceptance criteria, qualification requirements, and reporting requirements	No deviations from the DG-1027 guidelines are proposed.

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

FRACTURE TOUGHNESS RECOVERY AND RE-EMBRITTLEMENT ASSURANCE PROGRAM		COMMENTS
1.	Description of the methods to be used for quantifying the percent recovery of the RT_{NDT} and Charpy USE values	No deviations from the guidance of DG-1027 are proposed.
2.	Description of the methods to be used for estimating the re-embrittlement rate of the RT_{NDT} and Charpy USE	No deviations from the guidance of DG-1027 are proposed.
3.	Description of the methods to be used for monitoring the re-embrittlement rate of the RT_{NDT} and Charpy USE during subsequent plant operation	No deviations from the guidance of DG-1027 are proposed.

PALISADES PLANT REACTOR VESSEL ANNEAL
THERMAL ANNEALING APPLICATION (AFATA) CONTENT

CERTIFICATION OF ANNEALING PROCESS AND RECOVERY ESTIMATE	COMMENTS
1. Description of Overall Process	AFATA will describe methodology that will be used for certification
2. Evaluation of Inspection and Tests	AFATA will describe methodology that will be used for certification
3. Determination of Percent Recovery	AFATA will describe methodology that will be used for certification
4. Determination of Re-embrittlement Rate	AFATA will describe methodology that will be used for certification
5. Description of Modified Surveillance Plan	AFATA will describe methodology that will be used for certification
6. Allowable Operating Period	AFATA will describe methodology that will be used for certification

CONSUMERS POWER/NRC VESSEL ANNEALING MEETING

JUNE 6, 1995 Rockville, Maryland

PURPOSE

- To obtain a common understanding of the Palisades vessel annealing project's status by Consumers Power providing an:
  - Overview of the Annealing Process
  - Overview of the Annealing Project's Schedule.

- To begin Application for Approval for Thermal Annealing (AFATA) open communications between Consumers Power and the NRC.

- To provide an opportunity for discussion to obtain an understanding of any issues which the NRC believes are critical to the overall approval of the AFATA.

ATTACHMENT 3

CONSUMERS POWER/NRC VESSEL ANNEALING MEETING

JUNE 6, 1995 Rockville, Maryland

AGENDA

	TOPIC	RESPONSIBLE	DURATION
1.	INTRODUCTION	Consumers	15 minutes
	Purpose of Meeting		
	Overall Schedule		
2.	TECHNICAL OVERVIEW	Consumers	15 minutes
	Annealing Method Summary		
	Recovery/Re-Embrittlement Summary		
3.	OPEN DISCUSSION ON AFATA CONTENT	NRC & Consumers	2 Hours
	Discuss Elements of the Attached AFATA Content Summary Which are of Particular Interest/Concern		
4.	CLOSURE	NRC & Consumers	30 Minutes
	Identification of NRC AFATA Reviewers		
	Timing of AFATA Submittal		
	Action Items		
	Future Meetings		

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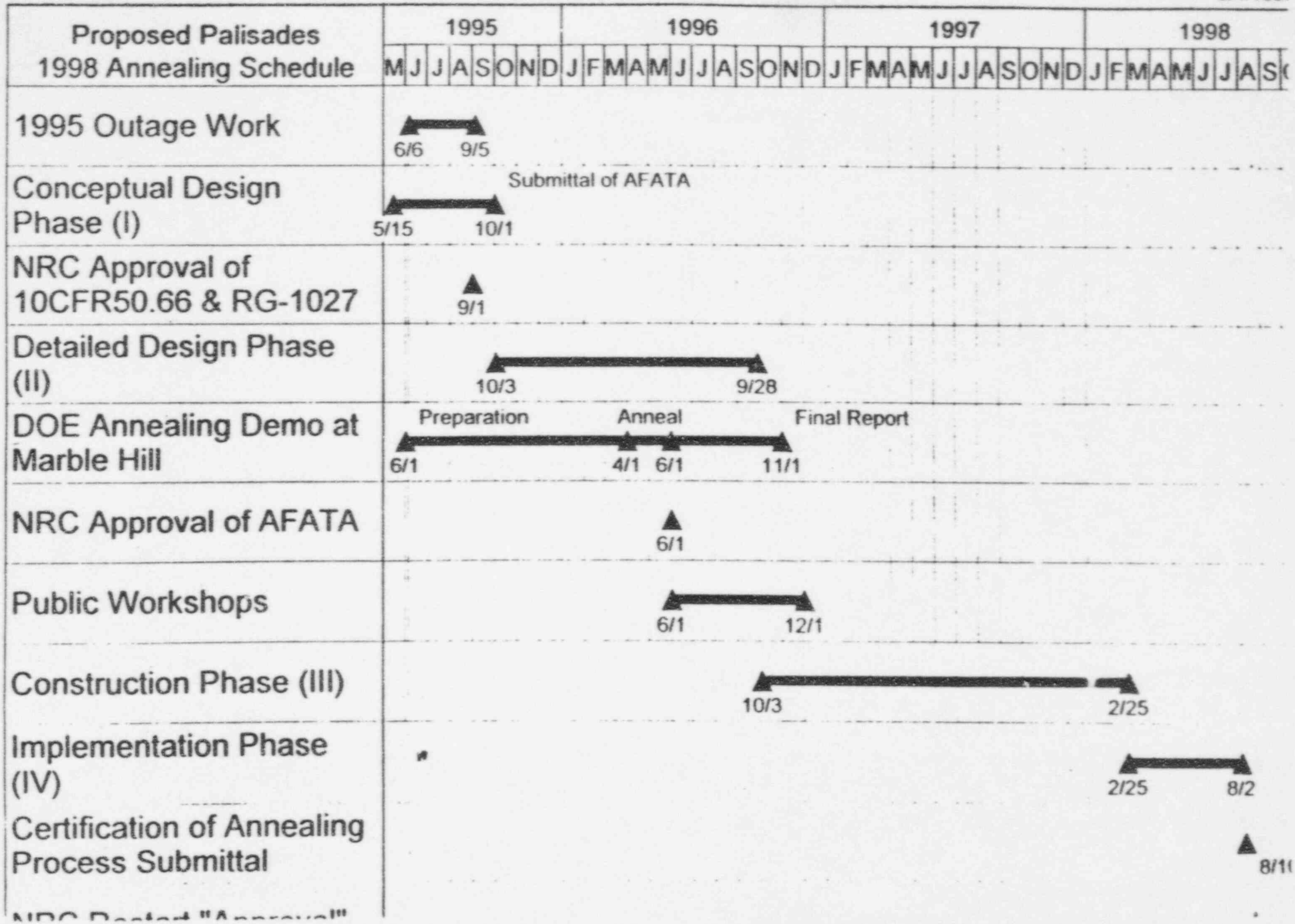
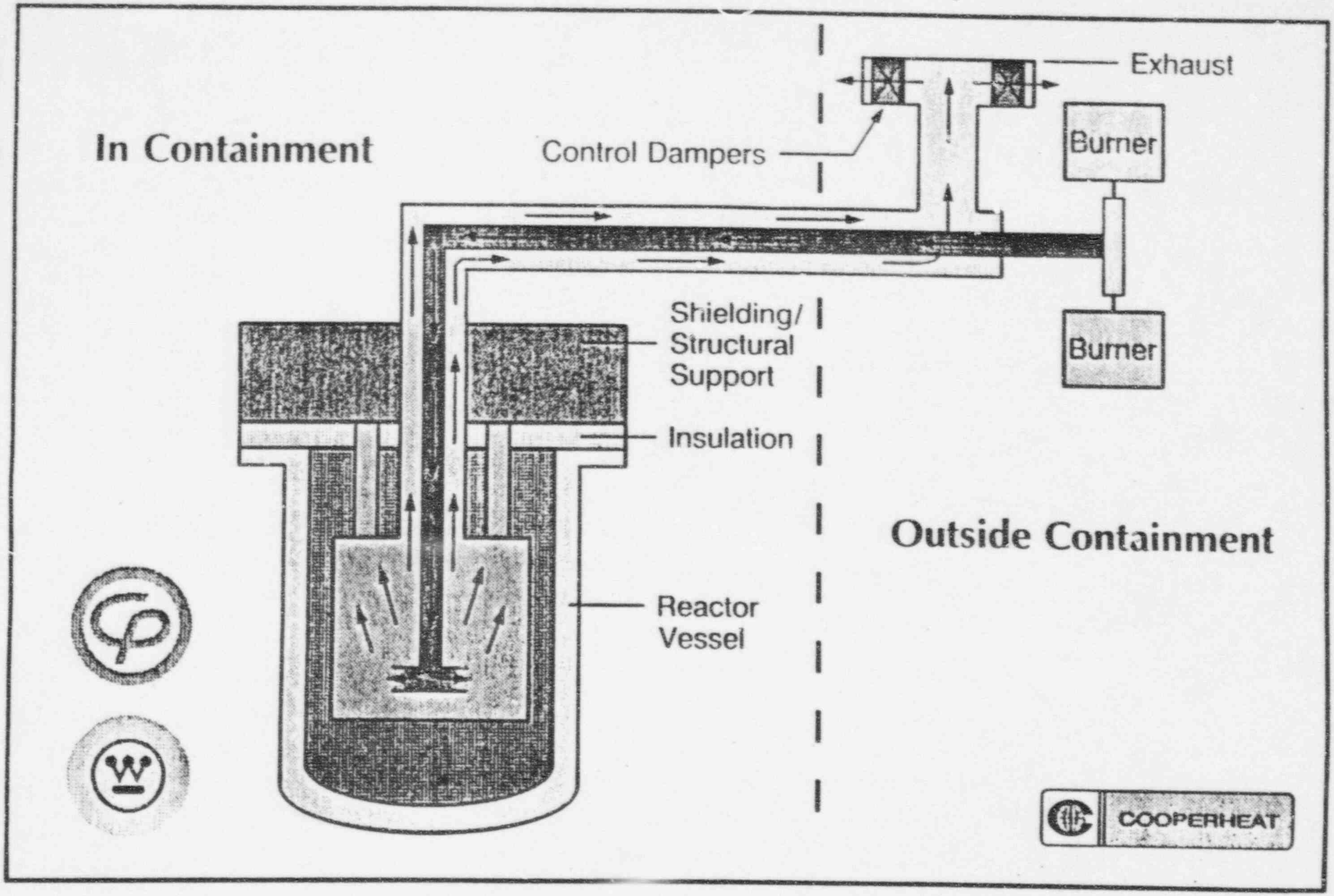
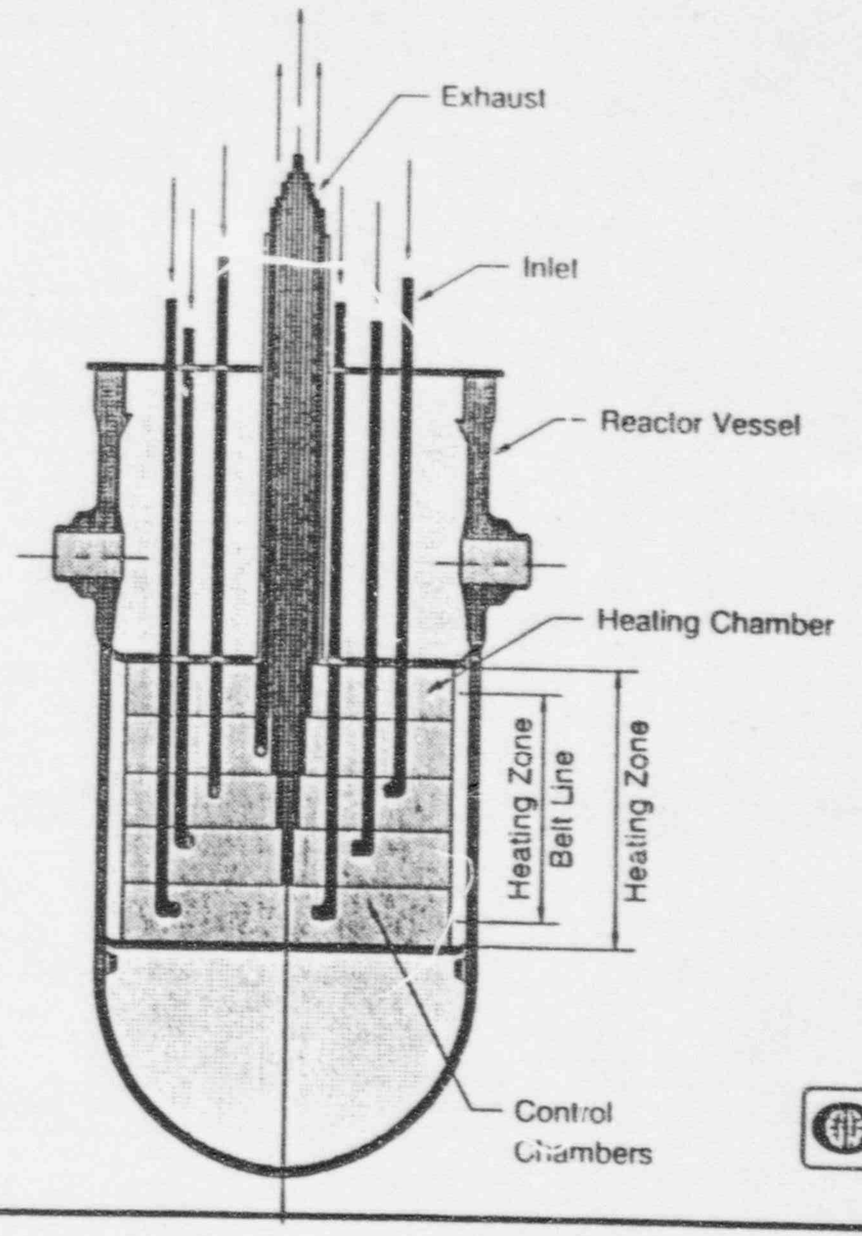

Proposed Palisades
1998 Annealing Schedule
1995
1996
1997
1998
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
1995 Outage Work
6/6
9/5
Conceptual Design Phase (I)
Submittal of AFATA
5/15
10/1
NRC Approval of 10CFR50.66 & RG-1027
9/1
Detailed Design Phase (II)
10/3
9/28
DOE Annealing Demo at Marble Hill
Preparation
Anneal
Final Report
6/1
4/1
6/1
11/1
NRC Approval of AFATA
6/1
Public Workshops
6/1
12/1
Construction Phase (III)
10/3
2/25
Implementation Phase (IV)
2/25
8/2
Certification of Annealing Process Submittal

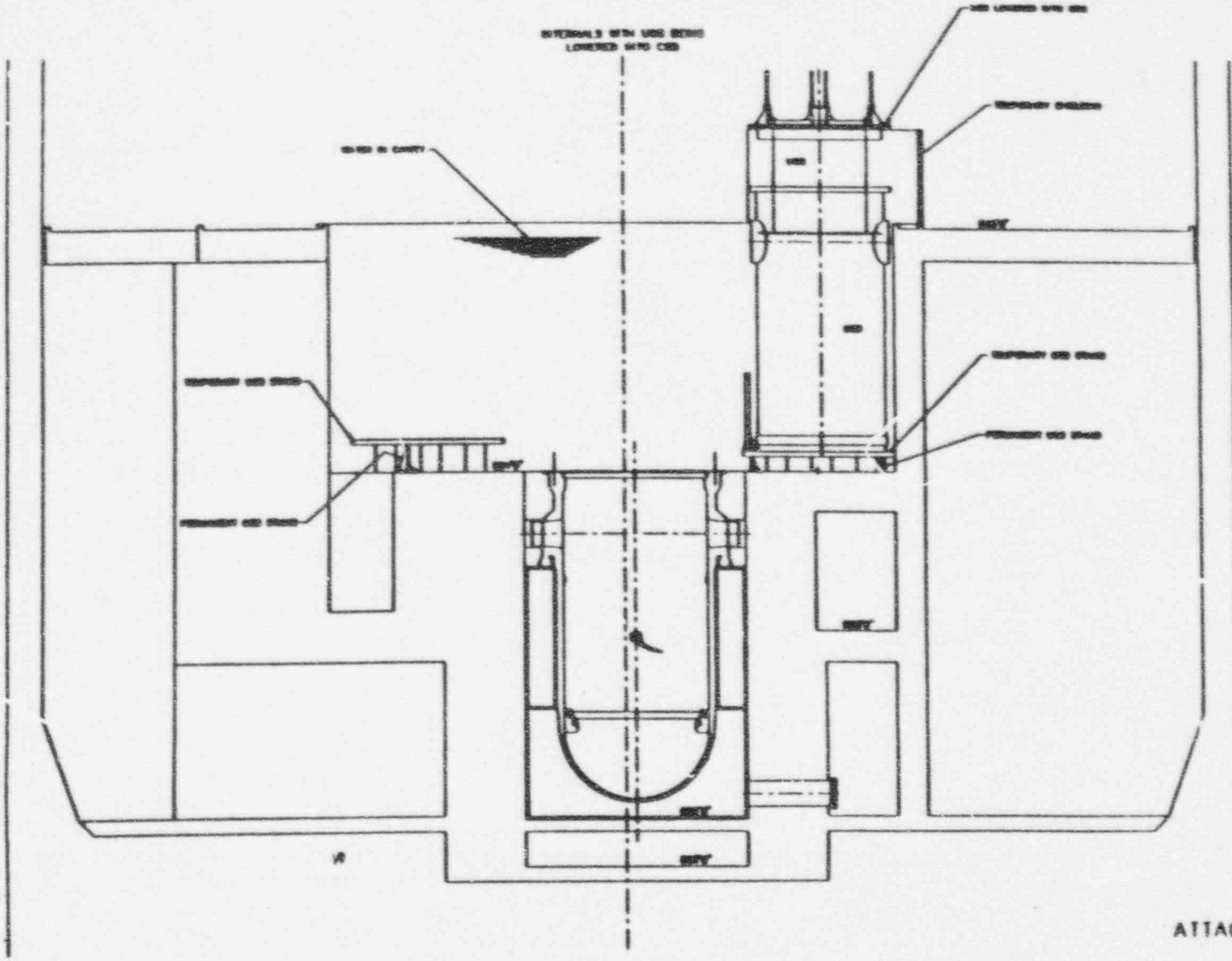
TECHNICAL OVERVIEW

ANNEALING METHOD SUMMARY

- HEATING METHODS AND CONTROLS
- INSTRUMENTATION
- SHIELDING

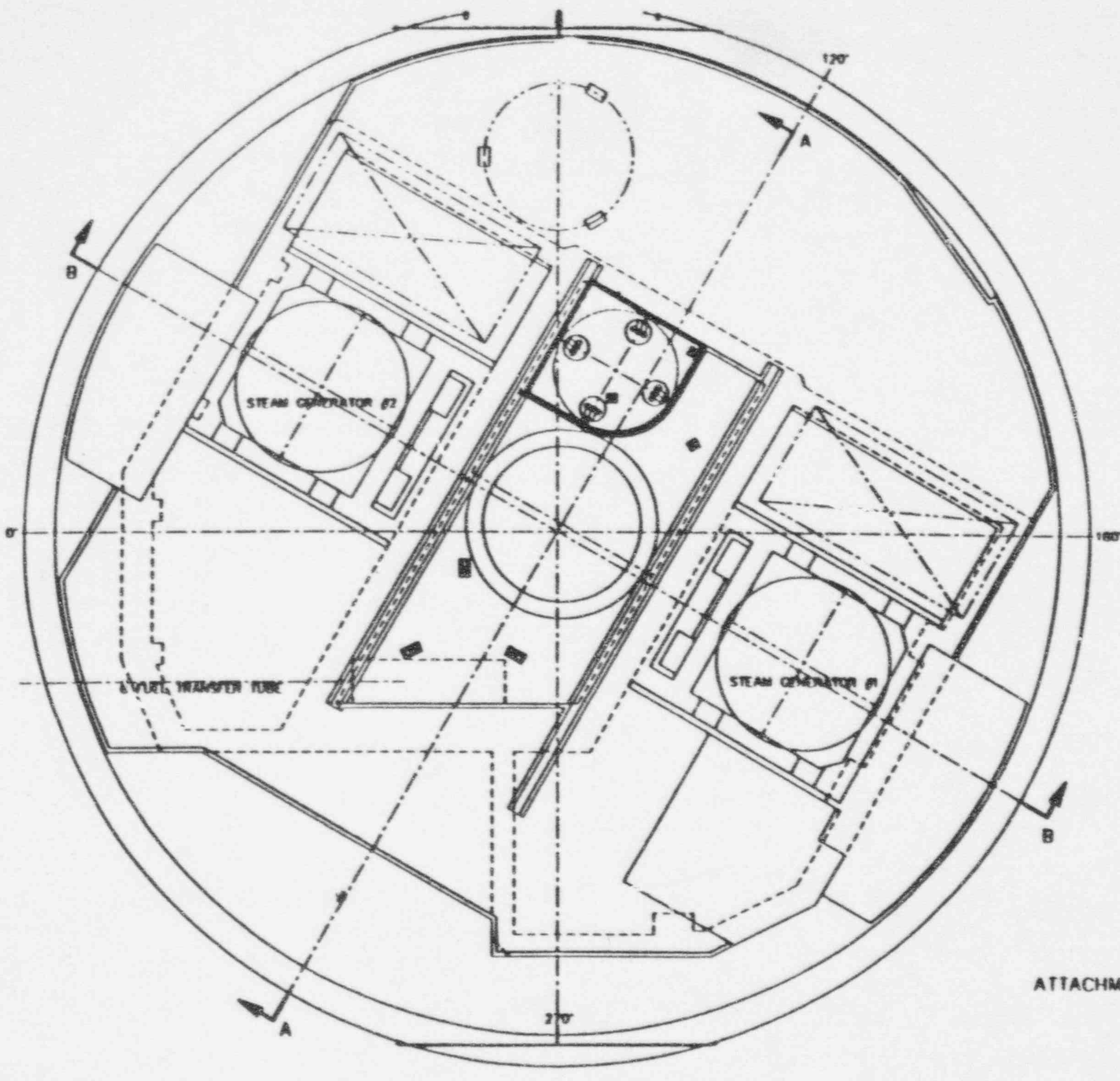

Exhaust
In Containment
Control Dampers
Burner
Burner
Shielding/
Structural
Support
Insulation
Outside Containment
Reactor
Vessel
COOPERHEAT


Exhaust
Inlet
Reactor Vessel
Healing Chamber
Heating Zone
Belt Line
Heating Zone
Control
Chambers
COOPERHEAT



SECTION A-A

ATTACHMENT M 5



ATTACHMENT M-8

TECHNICAL OVERVIEW

RECOVERY/RE-EMBRITTLEMENT SUMMARY

- EQUATION

- EXISTING SURVEILLANCE MATERIAL

- SUPPLEMENTAL SURVEILLANCE PROGRAM

THERMAL ANNEALING APPLICATION CONTENT

- THERMAL ANNEALING OPERATING PLAN
- REQUALIFICATION INSPECTION AND TEST PROGRAM
- FRACTURE TOUGHNESS RECOVERY AND RE-EMBRITTLEMENT ASSURANCE PROGRAM
- CERTIFICATION OF ANNEALING PROCESS AND RECOVERY ESTIMATE

THERMAL ANNEALING APPLICATION CONTENT

THERMAL ANNEALING OPERATING PLAN

1. Identification of general considerations
2. Provide description of the reactor vessel
3. Equipment, components, and structures affected by thermal annealing
4. Thermal annealing operating conditions
5. Description of annealing method, instrumentation, and procedures
6. Proposed annealing equipment
7. Thermal and stress analyses
8. Proposed annealing conditions
9. ALARA Considerations
10. Summary of the Thermal Annealing Operating Plan

THERMAL ANNEALING APPLICATION CONTENT

REQUALIFICATION INSPECTION AND TEST PROGRAM

1. Identification of the measurements and locations

2. Description of the inspection program

3. Description of the test program

THERMAL ANNEALING APPLICATION CONTENT

FRACTURE TOUGHNESS RECOVERY AND RE-EMBRITTLEMENT ASSURANCE PROGRAM

1. Description of the methods for quantifying the percent recovery

2. Description of the methods for estimating the re-embrittlement rate

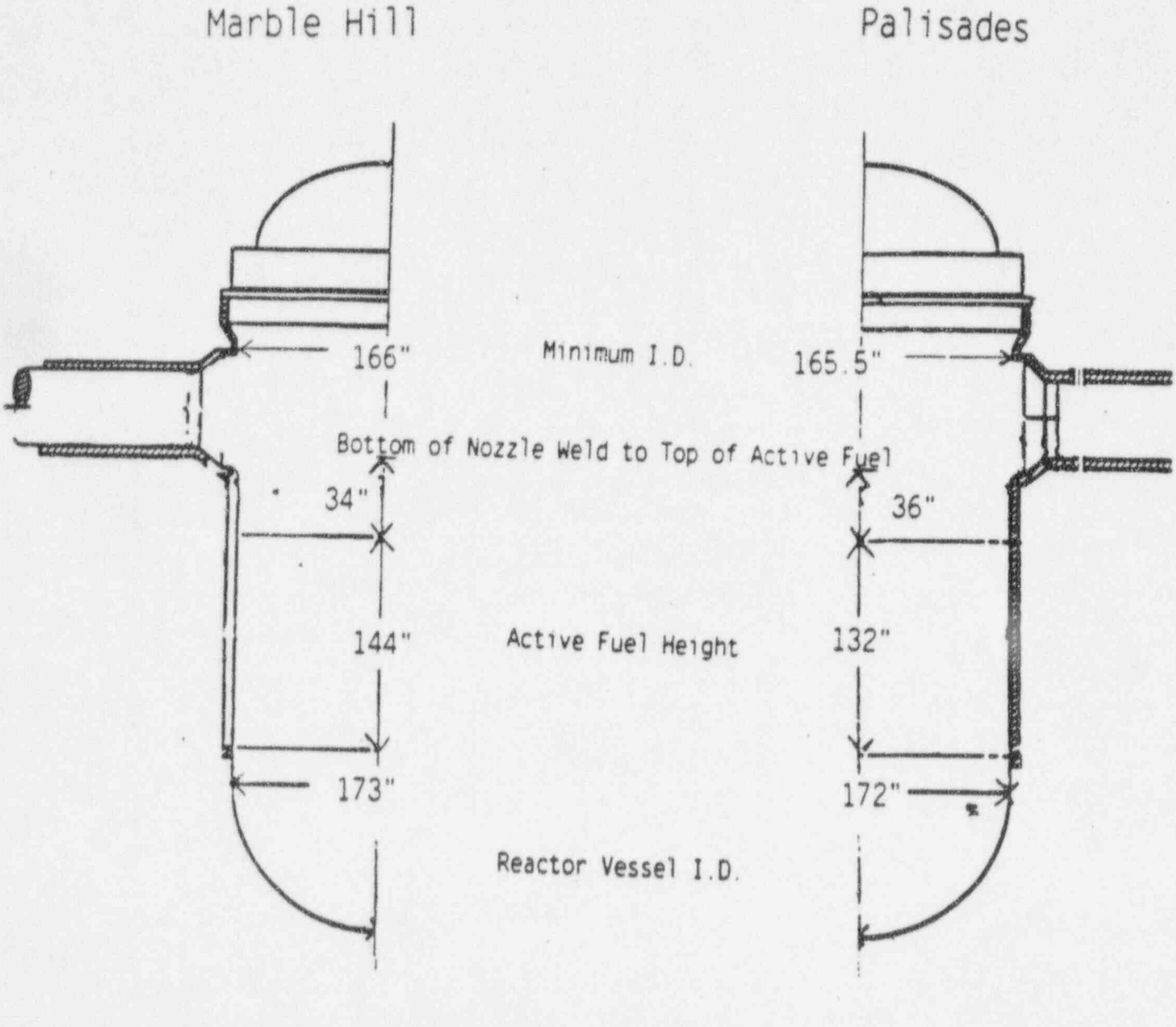
3. Description of the methods for monitoring the re-embrittlement rate

THERMAL ANNEALING APPLICATION CONTENT

CERTIFICATION OF ANNEALING PROCESS AND RECOVERY ESTIMATE

1. Description of Overall Process
2. Evaluation of Inspection and Tests
3. Determination of Percent Recovery
4. Determination of Re-embrittlement Rate
5. Description of Modified Surveillance Plan
6. Allowable Operating Period

Dimensional Comparison of Palsiades and Marble Hill Reactor Vessel



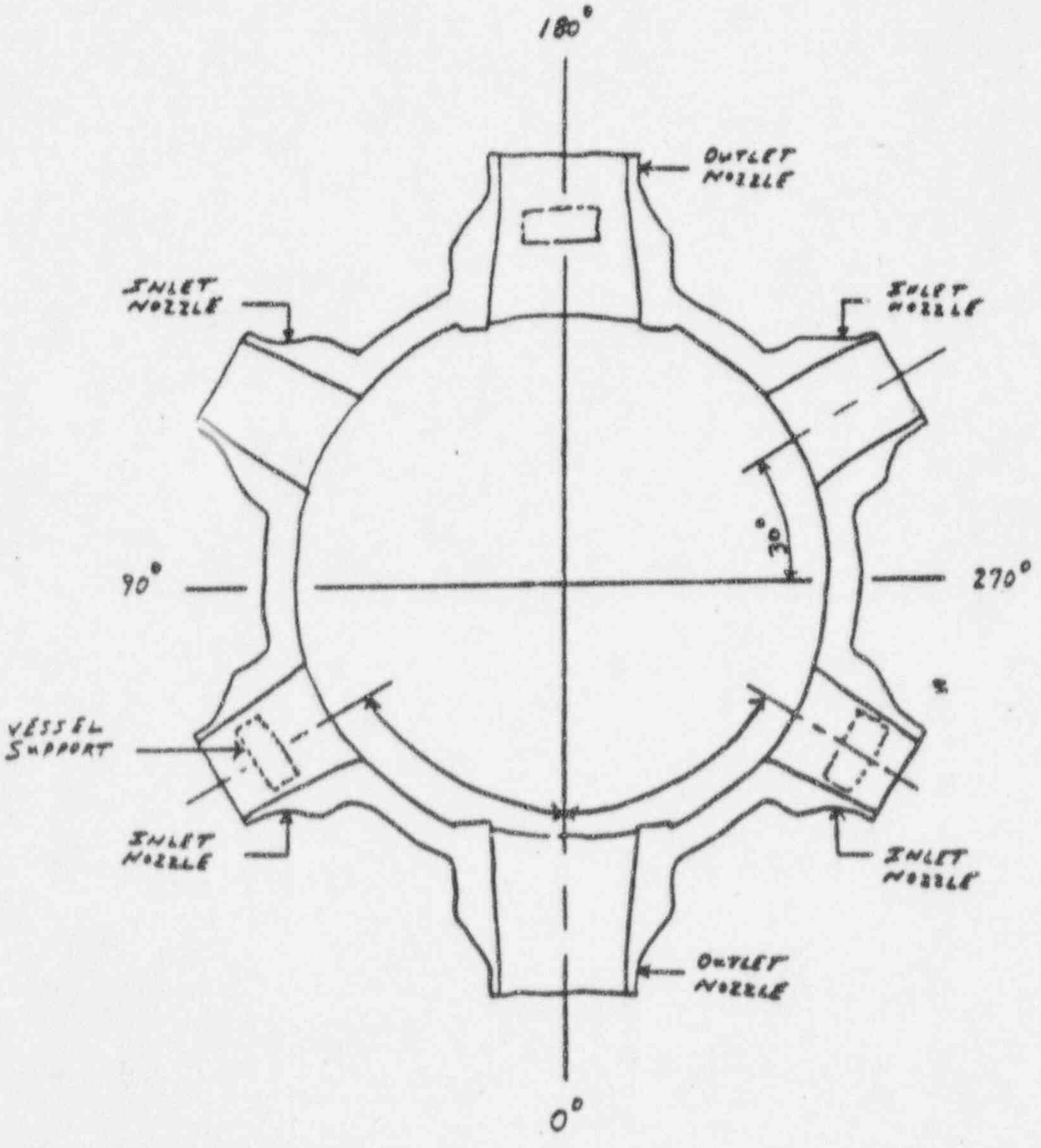
PALISADES AND MARBLE HILL

VESSEL DESIGN COMPARISONS

Vessel Dimensions Comparisons		
Dimension (inches)	Marble Hill	Palisades
Vessel Clad I.D. at Beltline	173	172
Minimum Vessel Base Metal Beltline Thickness	8.63	8.50
Nominal Cladding Thickness	0.16	0.25
Active Fuel Height	144	132
Bottom of Nozzle Weld to Top of Active Fuel	≈34	≈36
Minimum Vessel I.D.	166	≈165

Other Design Comparisons		
Design Feature	Marble Hill	Palisades
Number of Hot and Cold Leg Nozzles	8	6
Thermal Expansion Accommodated by Movement of PCS Equipment	Yes	Yes
Type of Vessel Support	Nozzle Supported 2 Inlets 2 Outlets	Nozzle Supported 2 Inlets 1 Outlet
Cladding Material, Weld Deposited	308/309 S.S.	304 S.S.
Original Vessel Heat Treatment	1100 - 1150°F	1100 - 1175°F
Exterior Vessel Beltline Insulation	Metal Reflective	Metal Reflective

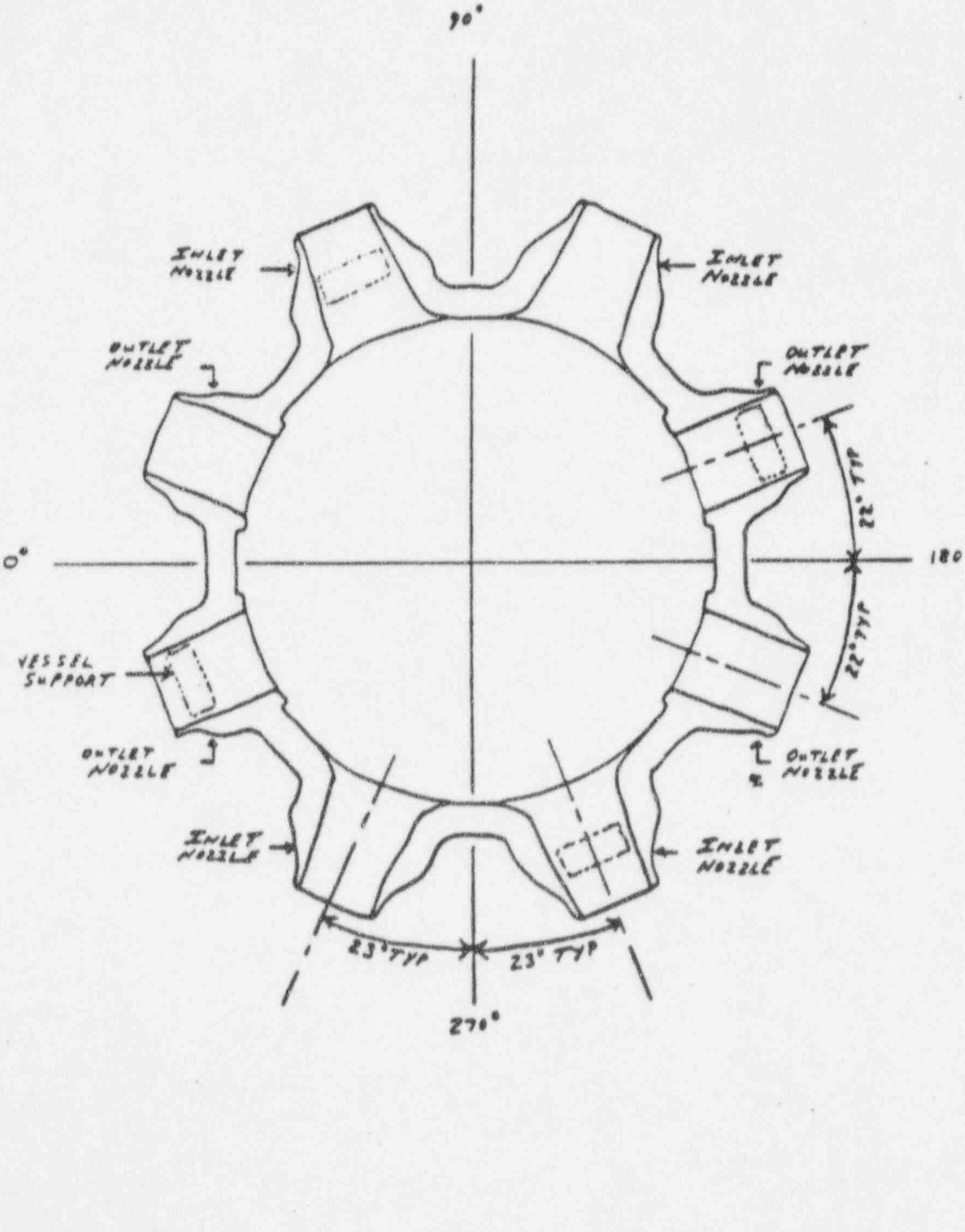
PALISADES REACTOR VESSEL



Reference CE Dwg MIBA Sh 72

Sketch 6-3-95 GA

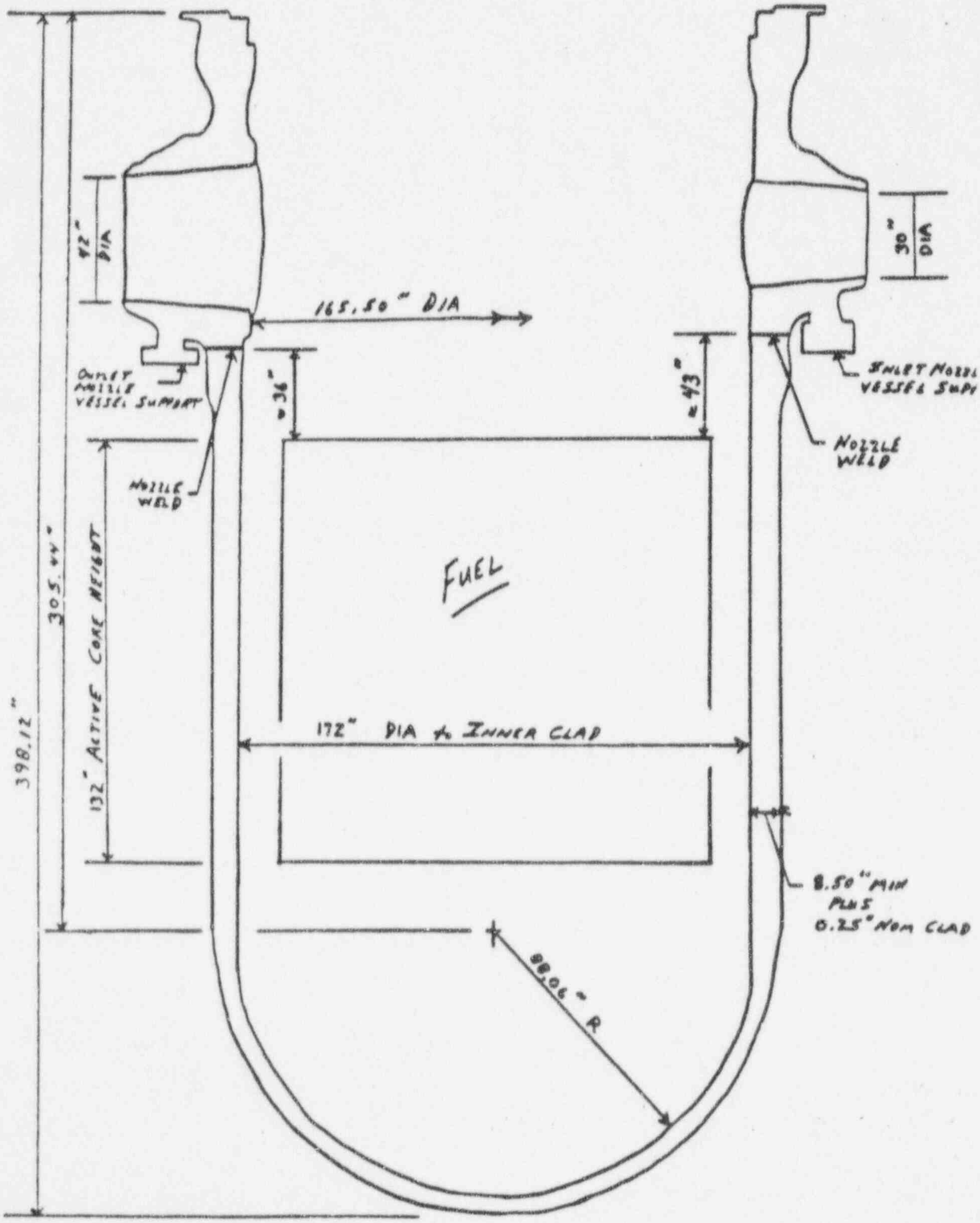
MARBLE HILL REACTOR VESSEL



Reference CE Dwg 11673-171-005

Sketch 6·3·95 GHG

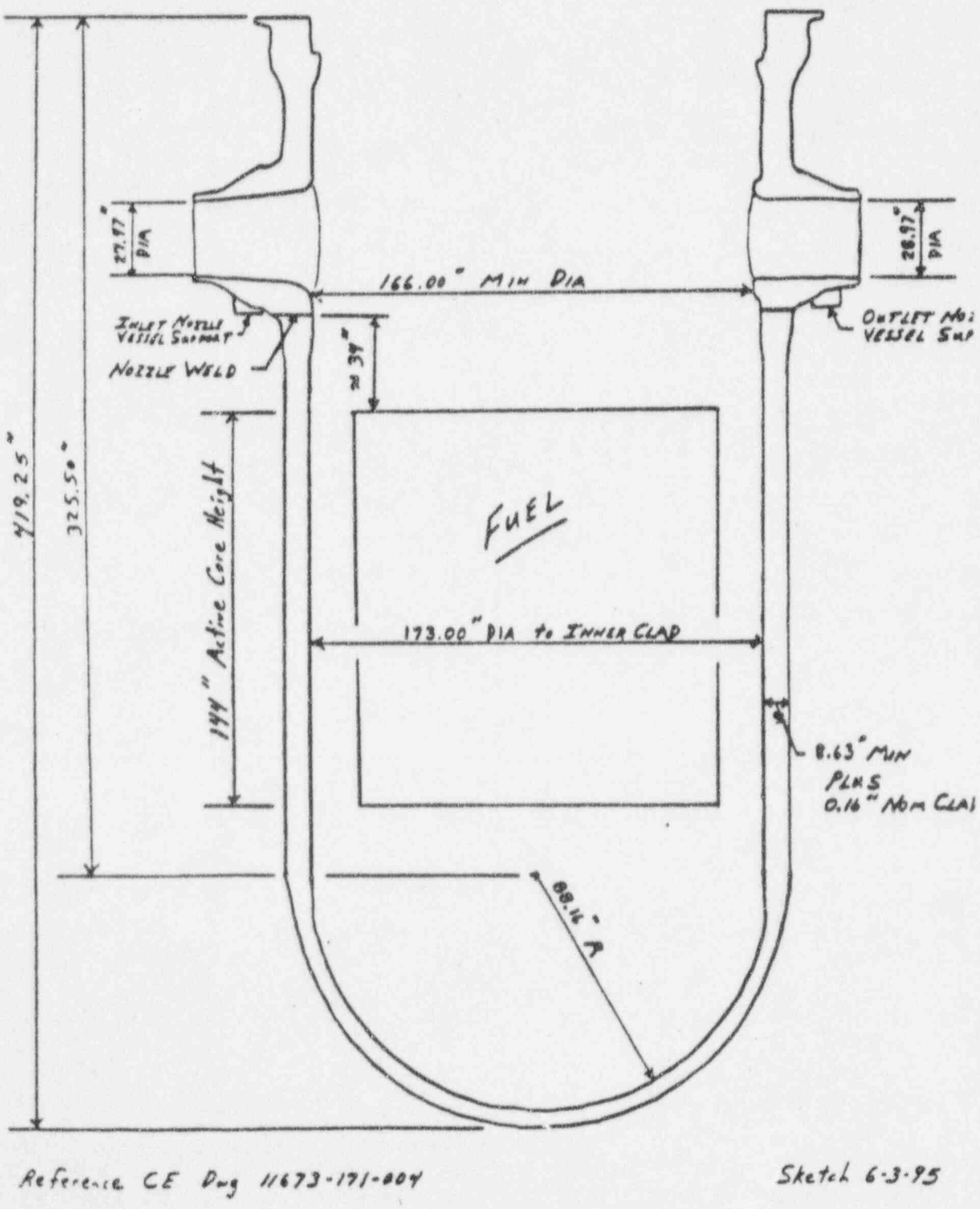
PALISADES REACTOR VESSEL



Reference CE Dwgs M1BA Sh 273, 1752, 114

Sketch 6-3-95 GHG

MARBLE HILL REACTOR VESSEL



Reference CE Dwg 11673-171-004

Sketch 6-3-95

COMPARISON OF INSTRUMENTATION LOCATIONS - PALISADES AND MARBLE HILL (PRELIMINARY)

Zone Description	Surface	Instrument	Palisades	Marble Hill
Bottom of Reactor Vessel	OD of RV	Thermocouple Displacement Strain Gauge	1 1 0	1 1 1
Coincident with Core Support Lugs	OD of RV	Thermocouple	3	7
Vessel Beltline, Mid-Region	OD of RV	Thermocouple Displacement	3 3	7 4
Vessel Top of Beltline into Transition	OD of RV	Thermocouple	3	7
RV Nozzle, Bottom Side	OD of RV	Thermocouple Strain Gauge	0 0	8 8
RV Nozzle, Upper Side	OD of RV	Thermocouple	0	7
RV Between Nozzle and Flange	OD of RV	Thermocouple	0	7
RV Flange	OD of RV	Thermocouple	0	7
Nozzle to Pipe Weld, Lower Side	OD of RV	Thermocouple Strain Gauge	0 0	8 8
Nozzle to Pipe Weld, Upper Side	OD of RV	Thermocouple Strain Gauge	0 0	8 8
Nozzle Support	On support	Thermocouple	2	4
Reactor Cavity Liner, Beltline Region	On liner	Thermocouple	2	4
Each Loop Located Midway Between S/G or Pump & Vessel Outside of Bioshield Wall	On piping	Displacement	6	8
Nozzle to Pipe Weld, Bottom Side	ID of RV	Thermocouple	6	8
Nozzle to Pipe Weld, Upper Side	ID of RV	Thermocouple	6	8
Vessel Beltline, Heating Zone	ID of RV	Thermocouple	42	42
RV Shell Above RV Nozzles	ID of RV	Thermocouple	12	12
TOTAL LOCATIONS	OD of RV	Thermocouple Displacement Strain Gauge	14 10 0	75 13 25
TOTAL LOCATIONS	ID of RV	Thermocouple	66	70

AFATA THERMAL AND STRESS EVALUATIONS

AFATA will include a complete evaluation for the following components based on the conceptual design of the annealing equipment which will be defined in the AFATA.

Reactor Vessel

Nozzles

PCS Piping, Restraints, and Supports

Biological Shielding

Reactor Vessel Insulation

Flow Skirt

Cladding

Capsule Holders

Reactor Vessel Flange

Instrumentation

Other Components as Determined during the Conceptual Review Effort

PALISADES THERMAL ANNEALING PROGRAM PLAN TO ACHIEVE ALARA GOALS

1. Thermal Annealing to be performed utilizing indirect gas heating system, can be installed during Reactor Cavity draindown.

2. Upper guide structure would be stored dry inside the core support barrel behind temporary shielding during the thermal anneal.

3. As many activities as practical are performed with the reactor cavity flooded utilizing long handle tools.

4. Appropriate instrumentation will be installed on the Palisades Reactor Vessel taking advantage of the experience at Marble Hill, to minimize dose for installation at Palisades.

ATTACHMENT H-2

PALISADES THERMAL ANNEAL PROGRAM - DOSE ASSESSMENTS
ALTERNATIVE CASE

1995 PROGRAM

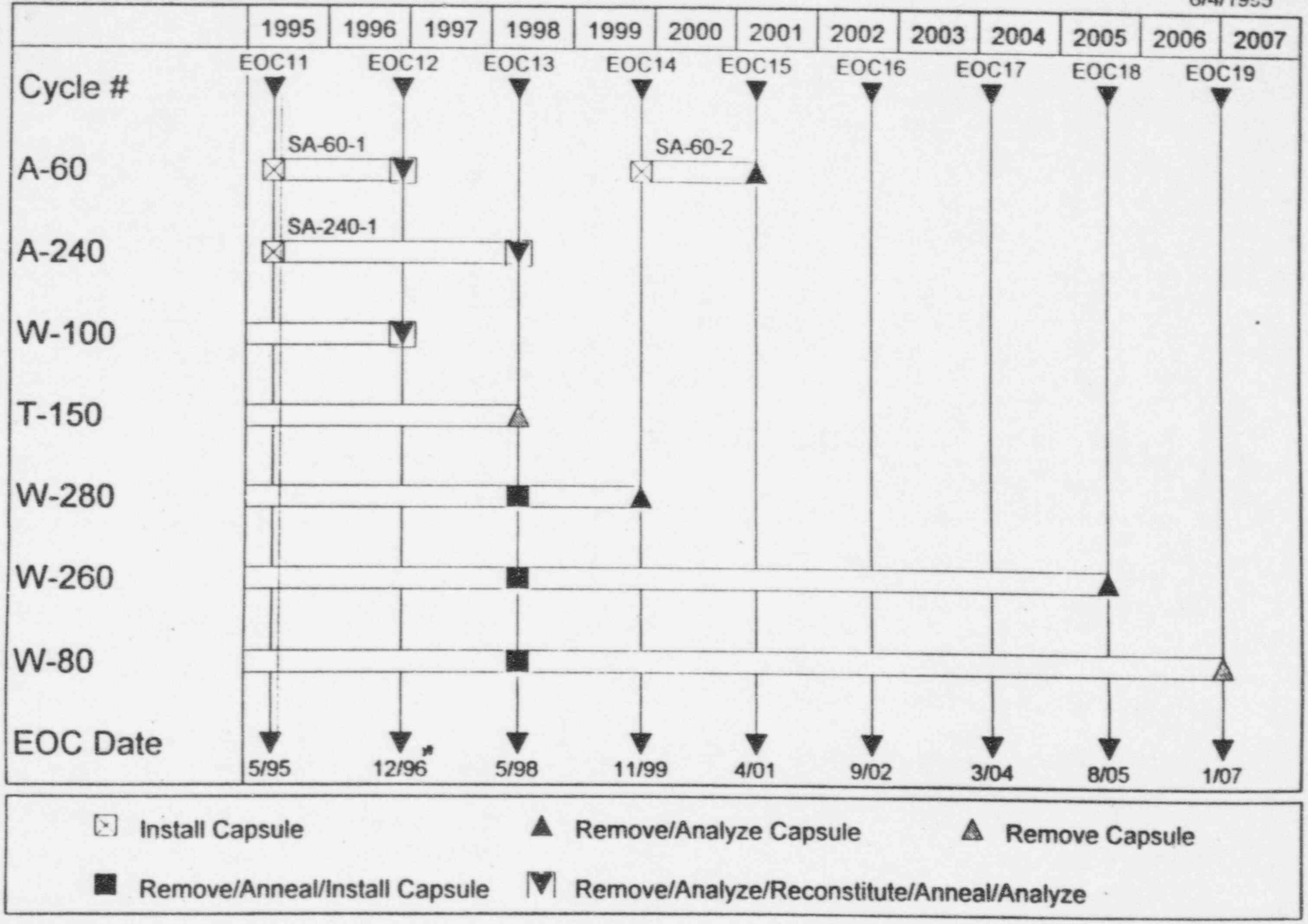
ID		LOCATION	DURATION [hr]	AVERAGE DOSE RATE [mr/hr]	CREW SIZE	TOTAL DOSE [Man-Rem
1	Complete Containment Walkdown	DECK	100	5	4	2
2	Install Instrumentation Around Vessel	SUMP	2.5	4000	1	10
	TOTAL DOSE ASSESSMENT - 1995 PROGRAM					12

1997/1998 PROGRAM

ID		LOCATION	DURATION [hr]	AVERAGE DOSE RATE [mr/hr]	CREW SIZE	TOTAL DOSE [Man-Rem
3	Install temperature resistant RV stud hole plugs if required	DECK	12	5	4	0.
4	Move equipment into containment	DECK	60	5	4	1.
5	EQUIPMENT SETUP					
6	Assemble furnace in preparation for test	DECK	144	5	4	2.
7	Install/setup support equipment	DECK	276	5	4	5.
8	Complete furnace ducting	DECK	24	2	4	0.
9	Install instrumentation around RX	SUMP	40	4000	1	160.
10	Place UGS into temporary storage stand	DECK	6	10	4	0.
11	Remove CSB and place into temporary storage stand	DECK	8	30	4	1.
12	Place temporary shield at EL 649 around cavity/move UGS to CSB	DECK	8	60	4	1.
		DECK	3	20	4	0.
13	Install temporary shielding around internals and top cap	DECK	12	60	4	2.
		DECK	8	30	4	1.
14	Perform reactor vessel/internals pre anneal measurements	DECK	24	30	4	2.
15	PERFORM PRE ANNEAL ISI - BY OTHERS					
16	Perform furnace containment test	DECK	48	10	4	1.
17	Remove annealing capsules from the RV	DECK	12	30	4	1.
18	Drain reactor cavity to vessel flange	DECK	18	60	4	4.
19	Install nozzle plugs if required	DECK	12	60	4	2.
20	Cavity decon/Ventilation hookup/RV purge/Cavity seal ring removed	CAVITY	9	500	2	9.
21	Lower furnace into RX/drain RV/system walkdown	CAVITY	0.5	500	1	0.
		DECK	4	60	3	0.
22	System heatup to temperature	DECK	45	15	1	0.
23	Anneal reactor vessel	DECK	168	15	1	2.
24	Cooldown to ambient USING FORCED AIR	DECK	144	15	1	2.
25	Pull furnace/fill reactor vessel and cavity	CAVITY	4	500	2	4.
		DECK	24	15	1	0.
26	Remove internals shielding/move UGS to temp. stand	DECK	12	30	4	1.
27	Make confirmation measurements	DECK	24	30	4	2.
28	PERFORM POST ANNEAL ISI - BY OTHERS					
29	Complete moveout of containment	DECK	24	5	4	0.
30	INSTALL CSB - BY OTHERS					
31	FUEL, INSTALL UGS, INSTALL HEAD, REASSEMBLY, STARTUP					
	TOTAL DOSE ASSESSMENT - 1997/1998 PROGRAM					21

PLANNED PALISADES REACTOR VESSEL SURVEILLANCE PROGRAM

6/4/1995



PALISADES REACTOR VESSEL
ANNEAL AND REEMBRITTLEMENT RATE ASSURANCE PROGRAM

SUPPLEMENTAL CAPSULES SA-60-1 AND SA-240-1

MATERIAL	18 MM CHARPY	L-T CHARPY
W5214 *	36	
34B009 *	36	
27204 +	36	
HSST02		12

* STEAM GENERATOR WELDS HEAT TREATED @1160°F FOR 2 HOURS. COOLED @ 100°F

\+ LINDE 1092 VS 124

LEAD FACTOR > 10

RECONSTITUTE AND TEST ⅓ OF IRRADIATED SPECIMENS

ANNEAL, RECONSTITUTE AND TEST ⅓ OF IRRADIATED SPECIMENS

ANNEAL AND INSTALL ⅓ OF IRRADIATED SPECIMENS IN SA-60-2

CAPSULE W-100 MATERIAL	CHARPY
BASE METAL (L-T)	12
BASE METAL (T-L)	12
3277	12

TEST IRRADIATED SPECIMENS

ANNEAL, RECONSTITUTE AND TEST ½ OF IRRADIATED SPECIMENS

ANNEAL AND INSTALL ½ OF IRRADIATED SPECIMENS IN SA-60-2

PALISADES REACTOR VESSEL
ANNEALING RECOVERY PROGRAM

AVAILABLE IRRADIATED TESTED CHARPY SPECIMENS

MATERIAL	W-290	W-110	A-240
BASE METAL (L-T)	12	12	12
BASE METAL (T-L)	12		12
HSST01		12	
3277	12	12	12

SURVEILLANCE CAPSULE REMOVAL

CAPSULE	END OF CYCLE	FLUENCE (10^{19} N/CM²)
A-240	2 (1978)	4.60
W-290	5 (1983)	1.09
W-110	10 (1993)	1.78

VESSEL FLUENCE (10^{19} N/CM²)

END OF CYCLE	@0°	@16°	@30°
13 (1998)	1.37	1.92	1.43

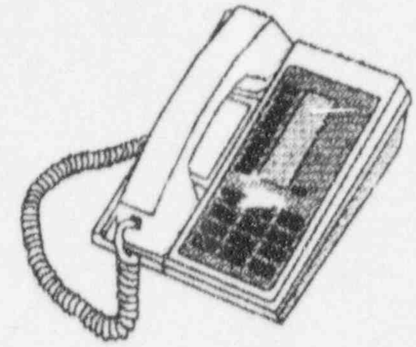
FUTURE MEETINGS

DATE	LOCATION
June 28-30, 1995	NRC staff tour of Palisades
Mid-July 1995	Proof of principal test of heater (Piscataway, New Jersey)
August 24 & 25, 1995	Marble Hill plant tour

ATTACHMENT 4

FAX COVER SHEET

From FAX No. 505-844-8734



Date: 6/19/95

To: Mike Mayfield, NRC

FAX Number: 301-415-5074

Telephone Number: 301-415-6690

This message consists of 17 pages

From: Jim Nakos, DOE's LWR Technology Center @ Sandia
(505) 844-4495

Mike: Enclosed please find a preliminary ADP Instrumentation Plan in three (3) parts:

1) MPR Team proposal instrumentation plan
2) ASME Team proposal instrumentation plan
3) DOE/SNL's enhanced instrumentation plan proposal

The DOE/SNL proposal is preliminary and has not fully incorporated the information from the CPCo/NRC meeting on June 6, 1995.

We look forward to discussing this with you at your convenience.

Thanks for your help.

Copy to:
DOE-HQ Dennis Harrison
DOE-HQ John Warren
6471 Gary Rochau

9604260120 2pp

Preliminary ADP Instrumentation Plan

DOE's LWR Technology Center @ Sandia proposes an enhanced instrumentation set to more fully characterize the overall system response and to make redundant measurements in critical areas. The basis for this proposal is from the following sources:

1) MPR Team proposal
2) ASME Team proposal and Palisades proposal of June 6, 1995
3) NUREG/CR-4212, "In-Place Annealing of Nuclear Reactor Pressure Vessels," by W.L. Server, April 1985.
4) Sandia field test experience (Jim Nakos, Gary Rochau)
5) Finite-element models developed under the "RPV Thermal Response and Temperature Measurement" project at Sandia.

We offer this proposal as a starting point to communicate what each of the contractors has proposed, and suggest a more enhanced set of instrumentation for consideration by both DOE and NRC.

After discussions with DOE and NRC, a more refined list can be defined and this plan modified. Also, each of the contractors should be consulted to discuss the enhanced instrumentation plan. At that time a more detailed set of drawings (e.g., similar to the enclosed isometric for the 2-loop B&W plant) can be generated to more clearly show where all of the instrumentation is located. Drawings are not available at this time.

Note: This plan is preliminary and should be thought of as a starting point for discussions. Information from the Palisades presentation of 6/6/95 has not yet been fully incorporated into the plan for the "enhanced" instrumentation package.

A) MPR Team Proposal:

The amount and location of instrumentation proposed by the MPR Team is as follows:

1) Thermocouples (TCs) = 49 on RPV, RCS piping, cavity concrete, etc. [Note: there are 42 retractable TCs mounted on heater to measure temperature on inside of RPV.]
2) Strain gages (SGs) = 4 total
3) Displacement gages (DGs) = 10 total

1) Thermocouples: 49 total

a) Primary nozzles (24 total)
   1. 4 spaced 90° apart on one hot leg nozzle @ RPV outer wall (4)
   2. 4 spaced 90° apart on one cold leg nozzle @ RPV outer wall (4)
   3. 4 spaced 90° apart at a distance from RPV wall on cold leg piping (4) (same pipe as item 2)
   4. 4 spaced 90° apart at a distance from RPV wall on hot leg piping (4) (same pipe as item 1)
   5. 2 @ 90° and 180° on other hot leg nozzle (2)
   6. 2 @ 90° and 180° on other 3 cold leg nozzles (6)

b) RPV beltline (12 total): 2 azimuthal locations, both between hot and cold legs:
   - One azimuthal location - 8 TCs above and below nozzles (8)
   - Second azimuthal location - 4 TCs above and below nozzles (4)

c) RPV cavity wall: (12 total)
   - Locations that match both RPV beltline region azimuthal locations (12)

d) RPV bottom: (1 total)
   - One TC located at the center bottom (1)

2) Displacement gages: 10 total

a) Primary piping: (6 total)
   - One hot leg, 3 locations (3)
   - One cold leg, 3 locations (3)

b) Core flood tank: (2 total)
   - One to measure radial movement (1)
   - One to measure vertical movement (1)

c) Hot and cold leg piping: (2 total) (away from RPV)
   - One to measure vertical movement on hot leg piping (1)
   - One to measure vertical movement on cold leg piping (1)

3) Strain gages: 4 total

a) 4 spaced 90° apart on one cold leg pipe nozzle (4) (same as TC primary nozzle item 2)

Preliminary ADP Instrumentation Plan

B) ASME Team Proposal:

The amount and location of instrumentation proposed by the ASME Team is as follows:

1) Thermocouples (TCs) = 70 on RPV, RCS piping, cavity concrete, etc. [Note: there will be 42 retractable TCs mounted on heater to measure temperature on inside of RPV.]
2) Strain gages (SGs) = 25 total
3) Displacement gages (DGs) = 13 total

Exact locations not yet defined, but overall locations were shown in the following table provided during the CPCo/NRC meeting on June 6, 1995:

COMPARISON OF INSTRUMENTATION LOCATIONS - PALISADES AND MARBLE HILL (PRELIMINARY)

Zone Description	Surface	Instrument	Palisades	Marble Hill
Bottom of Reactor Vessel	OD of RV	Thermocouple Displacement Strain Gauge	1 1 0	1 1 1
Coincident with Core Support Lugs	OD of RV	Thermocouple	3	7
Vessel Beltline, Mid-Region	OD of RV	Thermocouple Displacement	3 3	7 4
Vessel Top of Beltline into Transition	OD of RV	Thermocouple	3	7
RV Nozzle, Bottom Side	OD of RV	Thermocouple Strain Gauge	0 0	8 8
RV Nozzle, Upper Side	OD of RV	Thermocouple	0	7
RV Between Nozzle and Flange	OD of RV	Thermocouple	0	7
RV Flange	OD of RV	Thermocouple	0	7
Nozzle to Pipe Weld, Lower Side	OD of RV	Thermocouple Strain Gauge	0 0	8 8
Nozzle to Pipe Weld, Upper Side	OD of RV	Thermocouple Strain Gauge	0 0	8 8
Nozzle Support	On support	Thermocouple	2	4
Reactor Cavity Liner, Beltline Region	On liner	Thermocouple	2	4
Each Loop Located Midway Between S/G or Pump & Vessel Outside of Bioshield Wall	On piping	Displacement	6	[illegible]
Nozzle to Pipe Weld, Bottom Side	ID of RV	Thermocouple	6	8
Nozzle to Pipe Weld, Upper Side	ID of RV	Thermocouple	6	8
Vessel Beltline, Heating Zone	ID of RV	Thermocouple	42	42
RV Shell Above RV Nozzles	ID of RV	Thermocouple	12	12
TOTAL LOCATIONS	**OD of RV**	**Thermocouple Displacement Strain Gauge**	**14 10 0**	**75 13 25**
TOTAL LOCATIONS	**ID of RV**	**Thermocouple**	**66**	**70**

Post-it™ brand fax transmittal memo 7671 | # of pages ▸
To Mike Mayfield | From Jim Nakos
Co. NRC | Co. Sandia
Dept. | Phone # 505 844 4495
Fax # 301 415 5074 | Fax #

C) DOE's LWR Technology Center @ Sandia Proposal:

I. For the MPR Team/Midland RPV: See Figure 1

1) Thermocouples (TCs) = 96 on RPV, RCS piping, cavity concrete, etc. + 42 retractable TCs mounted on heater to measure temperature on inside of RPV
2) Strain gages (SGs) = 36 total
3) Displacement gages (DGs) = 17
4) Temperature "labels" = unknown number based on predicted temperatures

Note: "Temperature labels" are inexpensive glue-on devices that have colored "dots" that change color when a certain temperature is reached. The labels have multiple dots per label; each dot having a different temperature value when it changes color. These can be used to estimate temperatures post-test by viewing the colored dots that have changed.

1) **Thermocouples: 96 total**

a) Primary nozzles (40 total)
   1. 4 spaced 90° apart on one hot leg nozzle @ RPV outer wall (4)
   2. 4 spaced 90° apart on one cold leg nozzle @ RPV outer wall (4)
   3. 4 spaced 90° apart at a distance from RPV wall on cold leg piping (4) (same pipe as item 2)
   4. 4 spaced 90° apart at a distance from RPV wall on hot leg piping (4) (same pipe as item 1)
   5. 4 spaced 90° apart at nozzle-safe end joint on cold leg piping (4) (same pipe as item 2)
   6. 4 spaced 90° apart at nozzle-safe end joint on hot leg piping (4) (same pipe as item 1)
   7. 4 spaced 90° apart on 1 other hot leg nozzle @ RPV outer wall (4) (redundant measurement)
   8. 4 spaced 90° apart on 1 other cold leg nozzle @ RPV outer wall (4) (redundant measurement)
   9. 4 spaced 90° apart at nozzle-safe end joint on 1 other cold leg pipe (4) (same pipe as item 8) (redundant measurement)
   10. 4 spaced 90° apart at nozzle-safe end joint on 1 other hot leg pipe (4) (same pipe as item 7) (redundant measurement)

b) Core Flood tank nozzles (4 total)
   - 2 @ 90° and 180° on each core flood nozzle @ nozzle-safe end joint (4)

c) RPV beltline (12 total): 2 azimuthal locations, both between hot and cold legs, on outside of RPV:
   - One azimuthal location - 6 TCs above and below nozzles (6)
   - Second azimuthal location - 6 TCs above and below nozzles (6)

Note that 2 of the adjacent axial locations on the outside of the RPV are on the nozzles so are not counted twice. Bottom most TC is located at RPV-skirt support junction.

d) RPV beltline (16 total): 2 azimuthal locations, both between hot and cold legs, on <u>inside</u> of RPV:
- One azimuthal location - 8 TCs above and below nozzles (8)
- Second azimuthal location - 8 TCs above and below nozzles (8)

Note that TCs on inside of the RPV will be tack welded to the RPV and will serve as a check on the accuracy of the retractable TC RPV temperature measurement scheme. Axial and azimuthal locations to match locations of retractable TCs.

e) RPV cavity wall: (18 total)
- Axial locations to match RPV beltline region locations @ both azimuthal locations (14)
- Two locations @ two RCS piping penetrations through RPV cavity wall (4)

f) RPV bottom head: (6 total)
- One TC located at the center bottom on inside (1)
- One TC located at the center bottom on outside (1)
- Two TCs located 1/2 way up head on inside (2)
- Two TCs located 1/2 way up head on outside (2)

2) Displacement sensors: 17 total

a) Primary piping: (6 total) (near RPV)
- One hot leg, 3 locations (vertical, horizontal and axial movement) (3)
- One cold leg, 3 locations (vertical, horizontal and axial movement) (3)

b) Core flood tank: (5 total)
- One to measure radial tank movement (1)
- One to measure vertical tank movement (1)
- Three to measure vertical, horizontal and axial movement of one core flood pipe (3)

c) Hot and cold leg piping far from RPV: (2 total)
- One to measure axial growth of hot leg piping (1)
- One to measure axial growth of cold leg piping (1)

d) RPV: (4 total)(outside of RPV)
- One at each azimuthal location @ beltline to measure radial growth (2)
- One at each azimuthal location @ top of RPV to measure axial growth (2)

3) Strain gages: 36 total (mounted on outside of RPV).

Note: Due to the temperature sensitivity of stain gage output in a varying temperature environment, a TC should be placed next to each SG to gather data for a temperature correction when the data are reduced.

a) RCS primary nozzles: (32 total)

1. 4 spaced 90° apart on one hot leg nozzle @ RPV outer wall (4)
2. 4 spaced 90° apart on one cold leg nozzle @ RPV outer wall (4)
3. 4 spaced 90° apart at nozzle-safe end joint on cold leg piping (4) (same pipe as item 2)
4. 4 spaced 90° apart at nozzle-safe end joint on hot leg piping (4) (same pipe as item 1)
5. 4 spaced 90° apart on 1 other hot leg nozzle @ RPV outer wall (4) (redundant measurement)
6. 4 spaced 90° apart on 1 other cold leg nozzle @ RPV outer wall (4) (redundant measurement)
7. 4 spaced 90° apart at nozzle-safe end joint on 1 other cold leg pipe (4) (same pipe as item 8) (redundant measurement)
8. 4 spaced 90° apart at nozzle-safe end joint on 1 other hot leg pipe (4) (same pipe as item 7) (redundant measurement)

b) RPV beltline and below: (4 total)

- One @ each azimuthal location in beltline region (2)
- One @ each azimuthal location at junction of bottom head near skirt (2)

4) Temperature labels: unknown number

These can be placed at numerous locations away from the RPV:

- Steam generators
- RC pumps
- Pressurizer
- RCS piping far from the RPV
- On RPV at un-instrumented locations
- Other locations

II. For the ASME Team/Marble Hill RPV: <u>See Figure 2</u>

1) Thermocouples (TCs) = 100 on RPV, RCS piping, cavity concrete, etc. + 42 retractable TCs mounted on heater to measure temperature on inside of RPV
2) Strain gages (SGs) = 36 total
3) Displacement gages (DGs) = 12 total
4) Temperature "labels" = unknown number

1) Thermocouples: 100 total

a) Primary nozzles (40 total) (all on outer wall)
   1. 4 spaced 90° apart on one hot leg nozzle @ RPV outer wall (4)
   2. 4 spaced 90° apart on one cold leg nozzle @ RPV outer wall (4)
   3. 4 spaced 90° apart at a distance from RPV wall on cold leg piping (4) (same pipe at item 2)
   4. 4 spaced 90° apart at a distance from RPV wall on hot leg piping (4) (same pipe at item 1)
   5. 4 spaced 90° apart at nozzle-safe end joint on cold leg piping (4) (same pipe at item 2)
   6. 4 spaced 90° apart at nozzle-safe end joint on hot leg piping (4) (same pipe at item 1)
   7. 4 spaced 90° apart on 1 other hot leg nozzle @ RPV outer wall (4) (redundant for item 1)
   8. 4 spaced 90° apart on 1 other cold leg nozzle @ RPV outer wall (4) (redundant for item 2)
   9. 4 spaced 90° apart at nozzle-safe end joint on 1 other cold leg pipe (4) (same pipe at item 8) (redundant for item 5)
   10. 4 spaced 90° apart at nozzle-safe end joint on 1 other hot leg pipe (4) (same pipe at item 7) (redundant for item 6)

b) RPV axial locations (12 total): 2 azimuthal locations (180° apart for redundancy), both between hot and cold legs, on <u>outside</u> of RPV:
   - One azimuthal location - 6 TCs above and below nozzles (6)
   - Second azimuthal location - 6 TCs above and below nozzles (6)

   Note that 2 of the adjacent axial locations on the outside of the RPV are on the nozzles so are not counted twice.

c) RPV axial locations (16 total): 2 azimuthal locations, both between hot and cold legs, on <u>inside</u> of RPV (purpose: to check RPV temperature measurement accuracy):
   - One azimuthal location - 8 TCs above and below nozzles (8)
   - Second azimuthal location - 8 TCs above and below nozzles (8)

   Note that TCs on inside of the RPV will be firmly mounted on the RPV and will serve as a check on the accuracy of the retractable RPV temperature measurement scheme. Axial and *azimuthal locations to match locations of retractable TCs.*

d) RPV cavity wall: (18 total)
- Axial locations to match RPV beltline region locations @ both azimuthal locations (14)
- Two locations @ two RCS piping penetrations through RPV cavity wall (4)

f) RPV bottom head: (6 total)
- One TC located at the center bottom on inside (1)
- One TC located at the center bottom on outside (1)
- Two TCs located 1/2 way up head on inside (2)
- Two TCs located 1/2 way up head on outside (2)

g) RCS supports: (8 total)
- Two TCs on two hot leg supports (4)
- Two TCs on two cold leg supports (4)

2) Displacement sensors: 12 total

a) Primary piping: (6 total) (may only need axial gages since nozzle supported)
- One hot leg, 3 locations (vertical, horizontal and axial movement) (3)
- One cold leg, 3 locations (vertical, horizontal and axial movement) (3)

b) Hot and cold leg piping far from RPV: (2 total)
- Two to measure axial movement on hot leg piping (1)
- Two to measure axial movement on cold leg piping (1)

c) RPV: (4 total)(mounted on outside of RPV)
- One at each azimuthal location @ beltline to measure radial growth (2)
- One at each azimuthal location @ bottom of RPV to measure axial growth (2)

3) Strain gages: 36 total (mounted on outside of RPV).

a) RCS primary nozzles: (32 total)
1. 4 spaced 90° apart on one hot leg nozzle @ RPV outer wall (4)
2. 4 spaced 90° apart on one cold leg nozzle @ RPV outer wall (4)
3. 4 spaced 90° apart at nozzle-safe end joint on cold leg piping (4) (same pipe as item 2)
4. 4 spaced 90° apart at nozzle-safe end joint on hot leg piping (4) (same pipe as item 1)

Note: the next 4 items (5-8) are redundant measurements for 1-4:

5. 4 spaced 90° apart on 1 other hot leg nozzle @ RPV outer wall (4)
6. 4 spaced 90° apart on 1 other cold leg nozzle @ RPV outer wall (4)
7. 4 spaced 90° apart at nozzle-safe end joint on 1 other cold leg pipe (4) (same pipe as item 8)
8. 4 spaced 90° apart at nozzle-safe end joint on 1 other hot leg pipe (4) (same pipe as

item 7)

b) RPV beltline and below: (4 total)
- One @ each azimuthal location in beltline region (2)
- One @ each azimuthal location at junction of bottom head (2)

4) **Temperature labels: unknown number**

These can be placed at numerous locations away from the RPV:
- Steam generators
- RC pumps
- Pressurizer
- RCS piping far from the RPV
- On RPV at un-instrumented locations
- Other locations

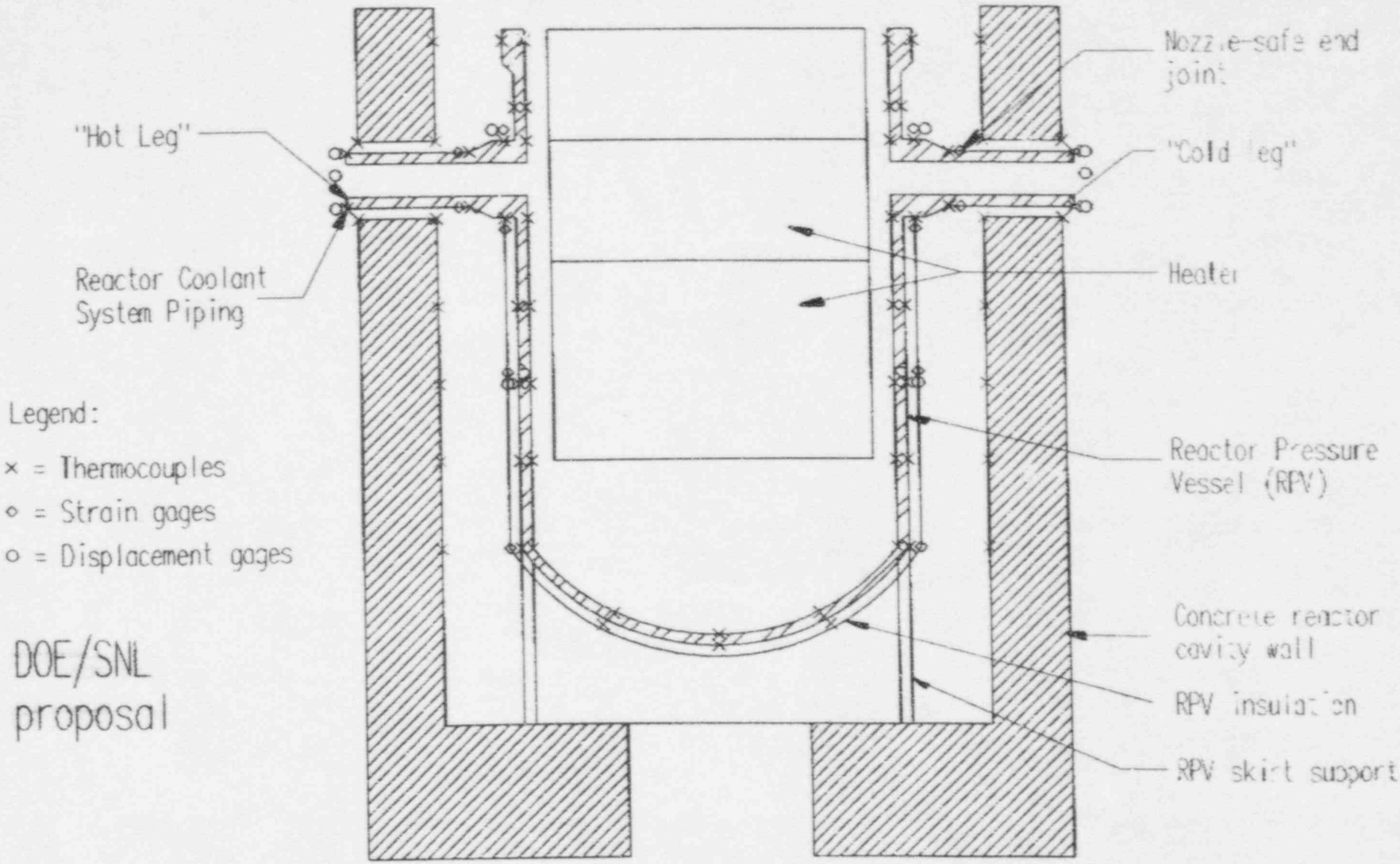


Figure 1: Schematic of Enhanced Midland Instrumentation

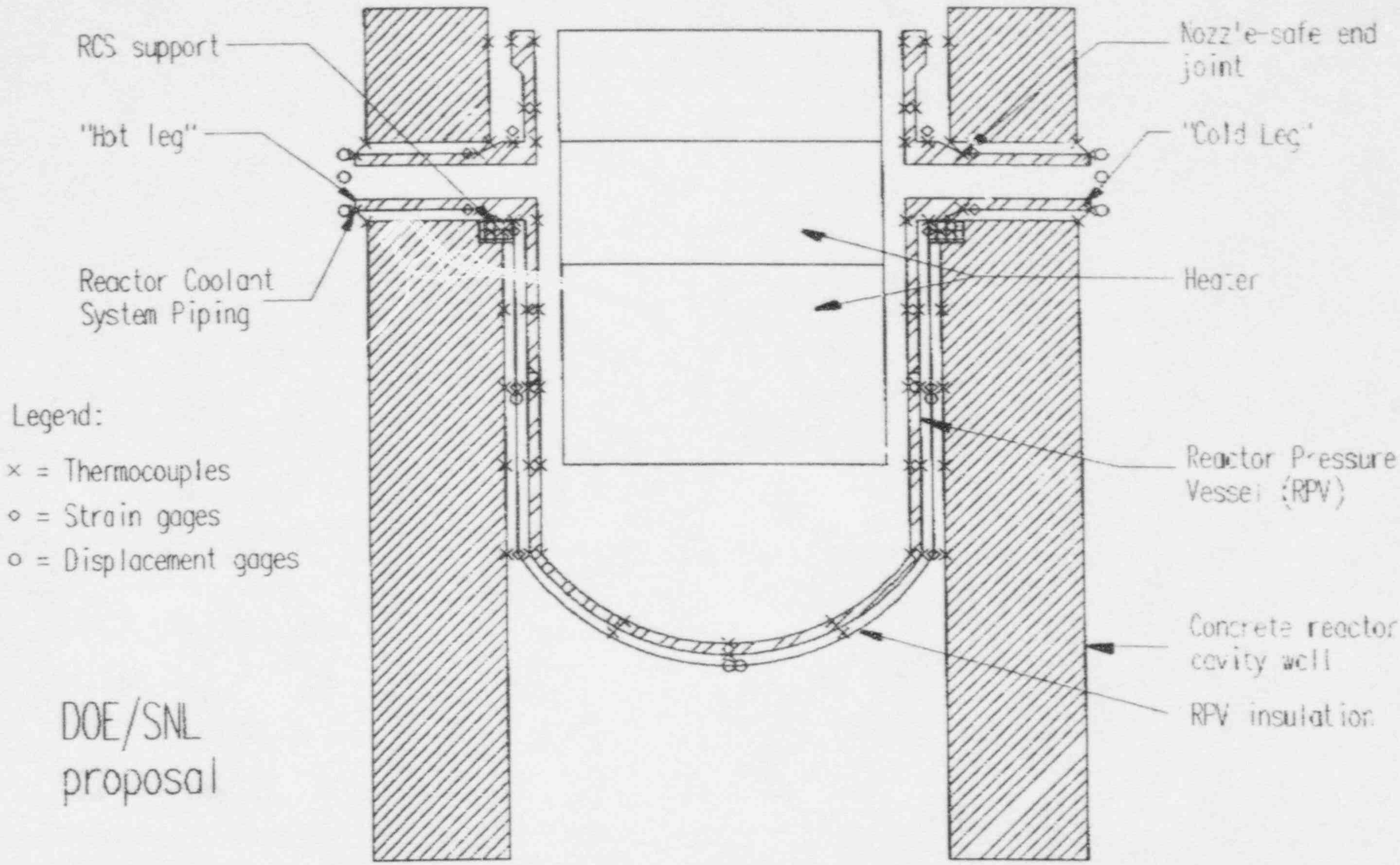
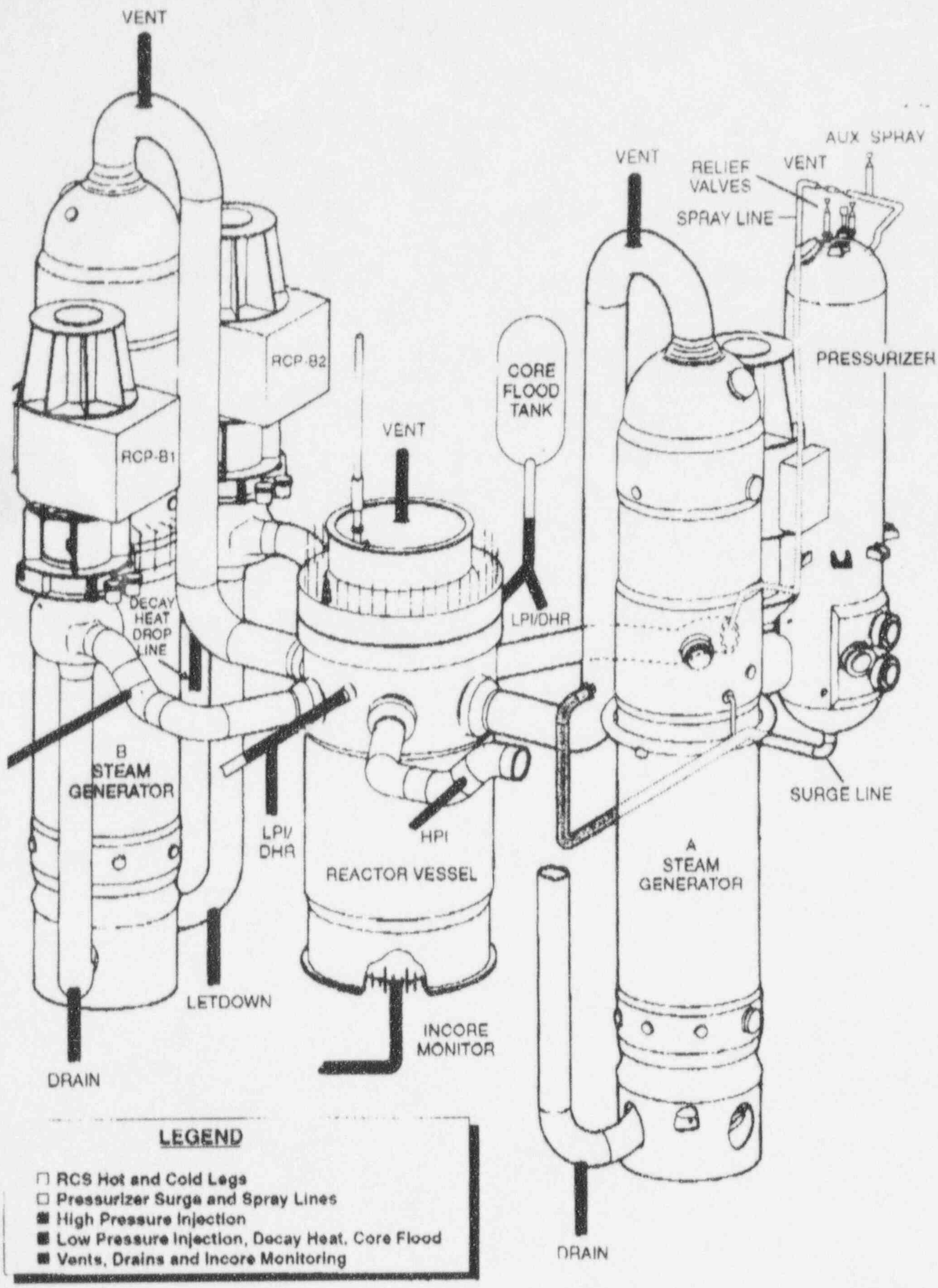
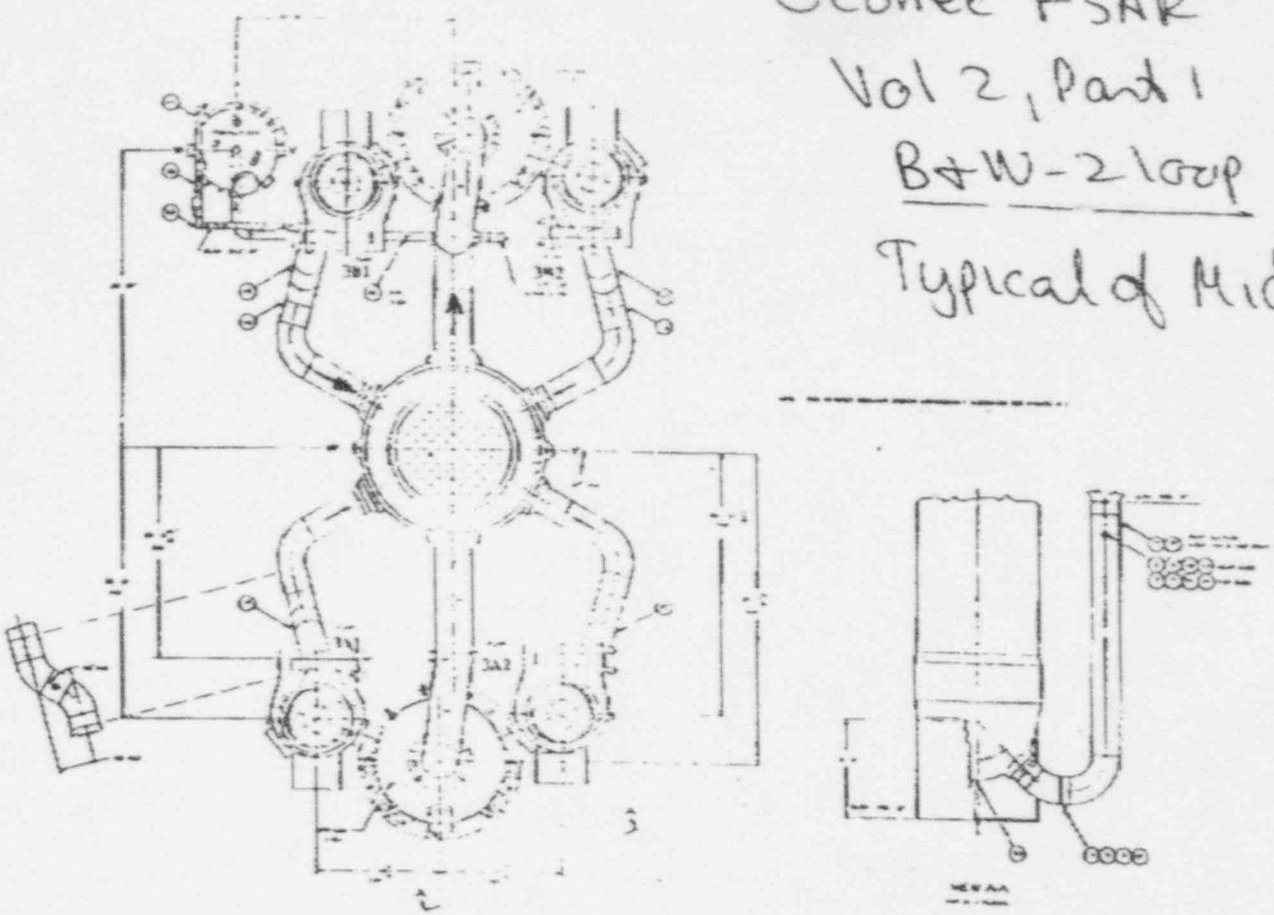


Figure 2: Schematic of Enhanced Marble Hill Instrumentation

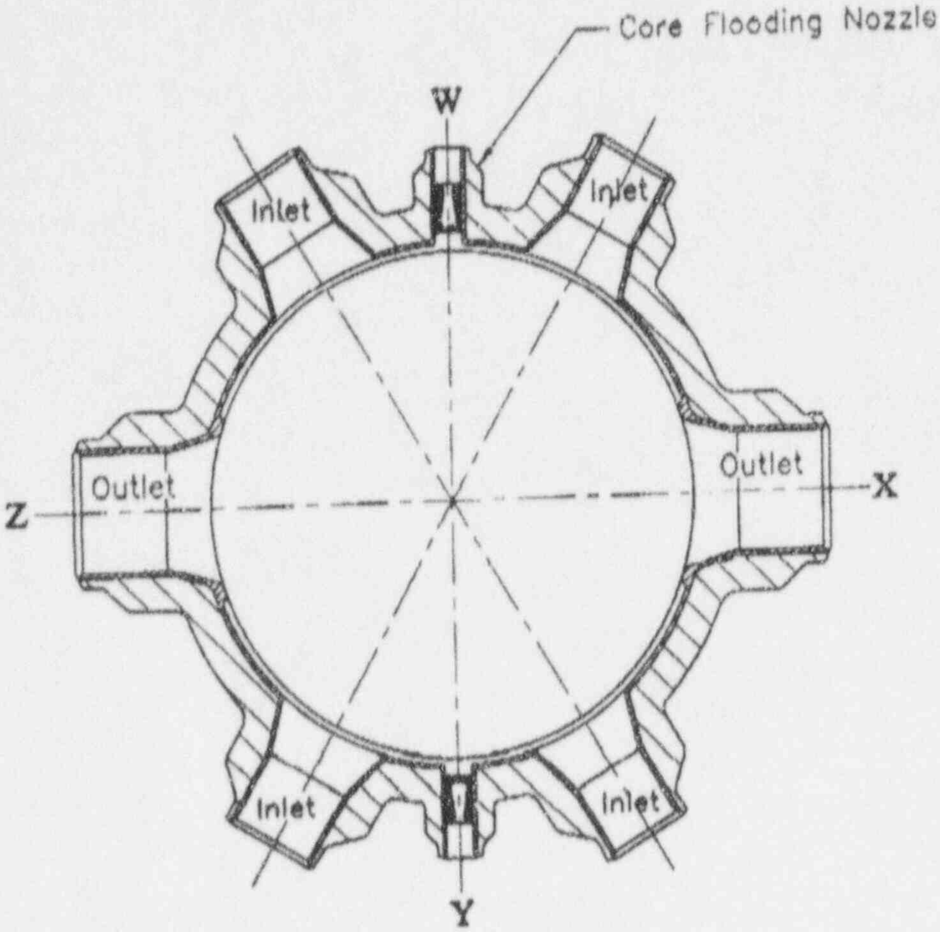

VENT
AUX SPRAY
VENT
RELIEF VALVES
VENT
SPRAY LINE
RCP-B2
CORE FLOOD TANK
PRESSURIZER
VENT
RCP-B1
DECAY HEAT DROP LINE
LPI/DHR
B STEAM GENERATOR
LPI/ DHR
HPI
SURGE LINE
A STEAM GENERATOR
REACTOR VESSEL
LETDOWN
INCORE MONITOR
DRAIN
LEGEND
RCS Hot and Cold Legs
Pressurizer Surge and Spray Lines
High Pressure Injection
Low Pressure Injection, Decay Heat, Core Flood
Vents, Drains and Incore Monitoring
DRAIN

Oconee FSAR
Vol 2, Part 1
B&W-2100p
Typical of Midland



REACTOR COOLANT SYSTEM
ARRANGEMENT – PLAN

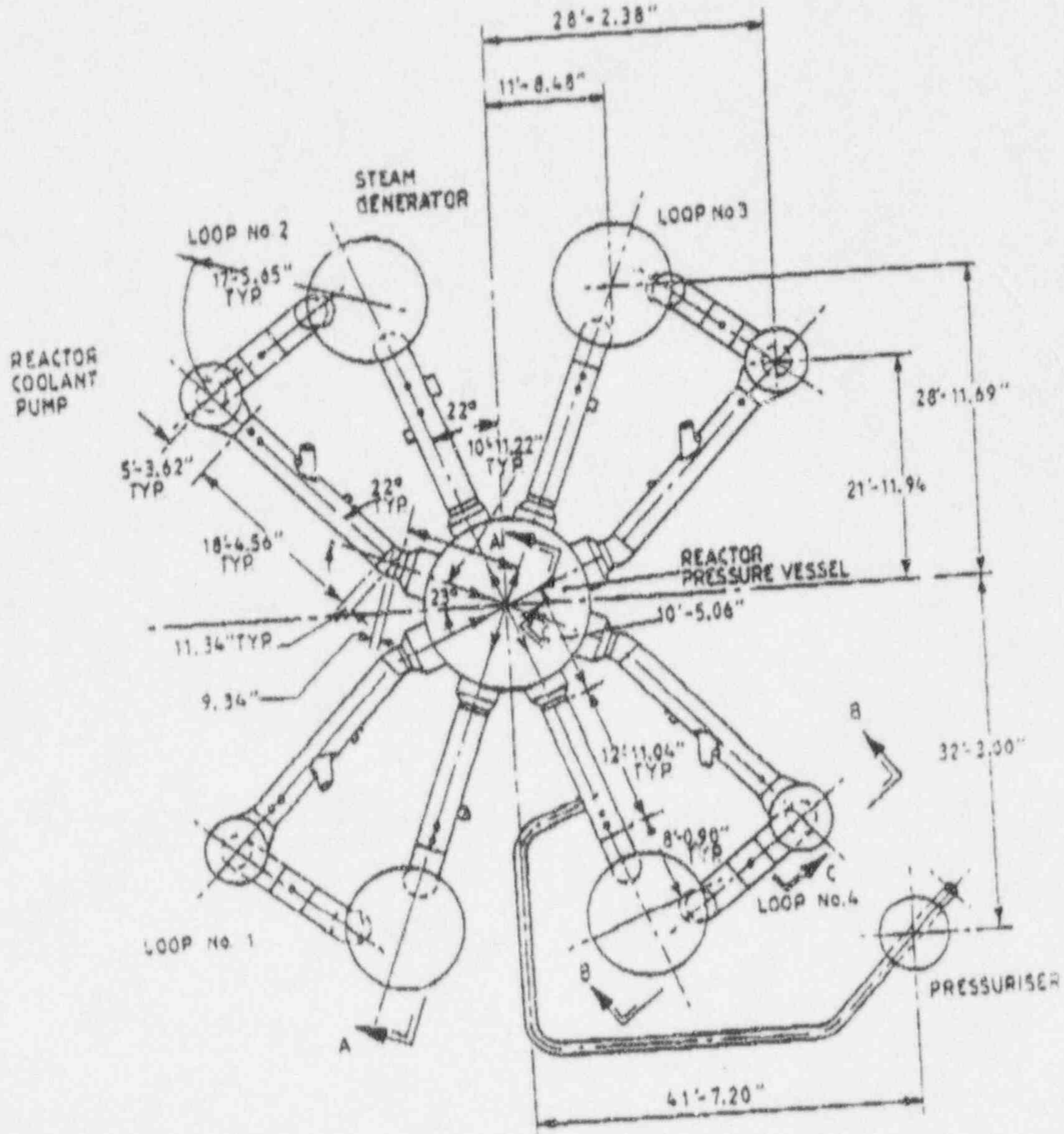
UNIT 3
OCONEE NUCLEAR STATION
Figure 4 - 3B
Rev. 9 8/11/70
Rev. 21. 7/26/72



Plan View

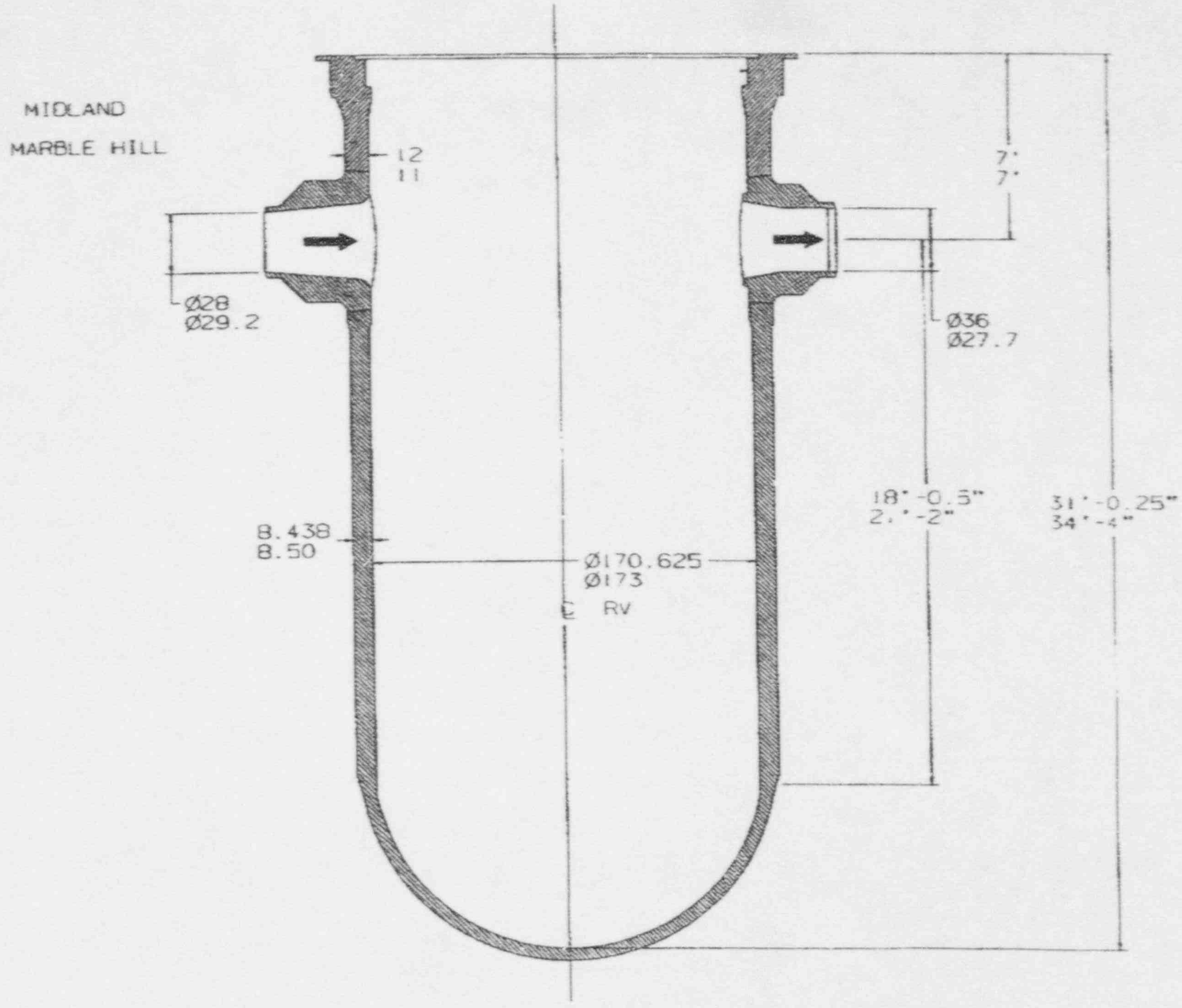
Figure 4. Hot And Cold Leg Primary Coolant Nozzles, Midland Reactor Vessel

4-loop W plant
Typical of Marble Hill



REACTOR COOLANT PIPEWORK - PLAN

FIG. No 5.9/1


MIDLAND
MARBLE HILL
12
11
Ø28
Ø29.2
7'
7'
Ø36
Ø27.7
18'-0.5"
2.'-2"
31'-0.25"
34'-4"
8.438
8.50
Ø170.625
Ø173
C RV