PHILADELPHIA ELECTRIC COMPANY

2301 MARKET STREET

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SHIELDS L. DALTROFF
VICE PRESIDENT
ELECTRIC PRODUCTION

March 6, 1984

Docket No. 50-277

Mr. John F. Stolz, Chief
Operating Reactor Branch No. 4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Stolz:

On July 4, 1983, Peach Bottom Unit 2 was shut down for augmented in-service inspection of non-conforming austenitic stainless steel piping welds in the recirculation system and the residual heat removal system (RHR) in accordance with I.E. Bulletin 83-02. During the outage, a total of 126 welds were inspected and reportable indications were detected at 26 locations: six 12-inch riser welds, eight RHR system welds, eight 28-inch recirculation welds and four 22-inch recirculation manifold welds.

Evaluations submitted by Philadelphia Electric Company to the NRC, by letters dated October 6, 1983, October 19, 1983, and November 18, 1983, reported that intergranular stress corrosion cracking (IGSCC) had been detected at 26 weld locations. Twenty-one of these weld locations were weld overlay repaired; the IGSCC at the five remaining weld locations were of a size that permitted Unit 2 to operate within the ASME code allowable limits for a period of 24 months without any weld overlay repair.

By Confirmatory Order issued November 30, 1983, from J. F. Stolz, USNRC, to E. G. Bauer, Jr., Philadelphia Electric Company, restart of Unit 2 was authorized. Unit 2 was allowed to operate for up to 4,100 hours with enhanced surveillance measures for containment leak detection.

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In accordance with the instructions to submit plans for pipe replacement for NRC staff review one month prior to the start of such work contained in the Confirmatory Order of November 30, 1983, the attachment to this letter documents Philadelphia Electric Company's plans for performing the pipe replacement during the upcoming Unit 2 refuel outage.

It is the intention of Philadelphia Electric Company to proceed with work as described in the attachment and have all modification/refueling outage work completed within thirty-two weeks.

If you have any questions or required additional information in this manner, please do not hesitate to contact us.

Very truly yours,

Attachment

cc: A. R. Blough, Site Inspector

DESCRIPTION OF PLANS

FOR

RECIRCULATION AND RESIDUAL HEAT REMOVAL SYSTEMS

PIPING REPLACEMENT

AT

PEACH BOTTOM UNIT 2

DOCKET NO. 50-277

Description of Plans for

Peach Bottom Unit 2

Recirculation and Residual

Heat Removal Systems Piping Replacement

Outline

Item (Continued)

8.0 Training

- 8.1 Mockup Training
- 8.2 Welder Qualification
- 8.3 Health Physics

9.0 Piping Analyses

- 9.1 Nuclear Class I Component Evaluation Based On ASME Section III
- 9.2 Piping Stress Analysis
- 9.3 Pipe Support Design
- 9.4 Pipe Whip Restraint Design

ATTACHMENTS

Attachment 1. Existing Recirculation System and Residual Heat Removal System Piping Configuration

Attachment 2. Modified Recirculation System and Residual Heat Removal System Piping Configuration

1.0 Introduction

1.1 Purpose

This submittal describes the activities and system design in order to support the replacement of the recirculation system piping on Peach Bottom Unit 2.

1.2 Scope

This submittal describes the engineering, design, procurement, removal and installation of the recirculation system piping and portions of the residual heat removal (RHR) system piping.

1.3 Future Reports

In accordance with NRC Confirmatory Order, November 30, 1983, a justification for continued operation will be submitted for NRC review and approval prior to restart following this outage.

2.0 Project Description

The project task is to replace the existing 304 stainless steel piping in the Peach Bottom Atomic Power Station Unit 2 Reactor Recirculation System and RHR System (inside containment) with material which is resistant to IGSCC. The specific piping sections included in the plans are shown on the Attachments 1 through 3.

2.1 Overall Organization

The project is organized with Philadelphia Electric Company (PECo) providing the overall direction to the engineers and contractors involved. PECo will also review and approve the specifications and procedures to be used.

Each engineer or contractor will perform his work under the controls provided by his or PECo's Quality Assurance Plan and implementing procedures. An overall project interface document has been prepared to provide control of the interfaces between the individual organizations' procedures.

2.2 Project Management

PECo is responsible for overall project management. The services of the engineers and contractor are used to prepare major documents and schedules at PECo's request.

2.3 Engineering

Engineering and major material procurement will be provided in general by the organizations which did so for the original plant installation. General Electric Company (GECo) will design and provide material for the Reactor Recirculation System. Bechtel Power Corporation (Bechtel) will design and provide material for the portions of the RHR System which are being replaced.

2.4 Contractor

Chicago Bridge and Iron Company (CBI) will be the prime contractor for the pipe replacement work.

2.5 Support Services

2.5.1 Quality Assurance

Each engineer and contractor provides the required quality control services for items within his scope of work. In addition, Philadelphia Electric Company performs periodic audits of the project participants to verify compliance with contractor's QA/QC plan and procedures.

2.5.2 Health Physics

The required health physics controls are provided by PECo. Peach Bottom personnel will be assisted by subcontractors working directly for CBI.

2.5.3 Consultants

Consultants will be retained as needed to provide specific expertise or supplement the activities of PECo personnel.

2.5.4 Licensing

Licensing will be directed by PECo with specific assistance being provided for submittals by the engineers and contractor.

2.5.5 Authorized Nuclear Inspector

The authorized nuclear inspector will be Hartford Steam Boiler Inspection and Insurance Company.

3.0 Description of Work

3.1 Defueling/Fueling

Prior to initiation of the piping replacement, the entire core will be off-loaded and stored in the fuel pool. Following core off-loading, it is anticipated that, due to ALARA considerations, some peripheral control rods will be removed as well.

Following completion of the pipe replacement and other maintenance tasks associated with the refueling outage, the core will be reloaded to complete the refueling portion of the outage.

3.2 Work Sequence

The construction plan is divided into four phases.

- Phase One - Interference Removal and Piping Decontamination
- Phase Two - Sever/Remove existing piping
- Phase Three - Machine/Install new piping
- Phase Four - Interference Restoration/Testing

(1) Phase One - INTERFERENCE REMOVAL AND PIPING DECONTAMINATION
During this phase, final planning will be done, drywell systems which will interfere with the piping changeout will be checked and, where appropriate, temporarily removed. The drywell RHR and recirculation systems piping will be prepared for removal. Both systems will be decontaminated to the extent practical to minimize exposure to those personnel involved in the modifications.

(2) Phase Two - SEVER/REMOVE EXISTING PIPING
Following system decontamination and the removal of interferences in the drywell, equipment will be set-up to cut and remove the recirculation and RHR piping. To accelerate this removal, the existing system will be cut into manageable pieces for removal from the drywell. System severing will be done with the use of plasma cutting or machining. Mockups will be made and a system for containing airborne contamination for certain cutting and welding operations will be tested prior to use inside the drywell.

(3) Phase Three - MACHINE/INSTALL NEW PIPING
This phase covers the preparation of in-place weld joints, and installation of the new recirculation and RHR piping loops. Remote automatic welding and machining processes will be utilized as much as possible for ALARA considerations.

(4) Phase Four - INTERFERENCE RESTORATION/TESTING
Inventory control implemented when systems or structures are removed will assure proper restoration of replaced, modified, and temporarily modified components and systems within the drywell prior to restarting the unit.

3.3 <u>System Testing for Startup</u>

Non-destructive examination (NDE) techniques involving radiographics, ultrasonics, liquid penetrant testing and/or magnetic particle testing will be employed as required by the applicable codes during fabrication and installation. Testing will be performed in accordance with PECo approved procedures.

Upon completion of installation work, a baseline examination will be made of all new piping welds in accordance with Section XI of the ASME Code and the PECo In-Service Inspection (ISI) program.

A pre-operational test program will be developed and implemented for replaced, modified, and systems temporarily modified for interference removal. In addition, surveillance testing will be performed prior to startup in accordance with the technical specifications.

4.0 Design Description

4.1 Recirculation System & RHR System - Existing Design

Peach Bottom Unit 2 is a single cycle forced circulation, BWR-4 reactor licensed to operate at 3293 Mwt.

Forced circulation through the reactor core is provided by the recirculation system. This system consists of two external loops with associated pumps and twenty internal jet pumps. The design bases of the existing recirculation system is as follows:

External Loops	
Number of Loops	2
Pipe Sizes (nominal O.D.)	
Pump Suction	28 inches
Pump Discharge	28 inches
Discharge Manifold	22 inches
Recirculation Inlet Line	12 inches
Cross-Tie Line	22 inches
Design Pressure (psig)/Design Temperature (degrees F)	
Suction Piping	1148/562
Discharge Piping	1326/562
Pumps	1500/575
Operation at Rated Conditions	
Recirculation Pump	
Flow (approximate)	45,200 gpm
Flow	17.1 x 10P6 lbs/hr
Total Developed Head	710 ft.
Suction Pressure (static)	1032 psia
Available NPSH (min.)	500 ft.
Water Temperature (max.)	528 degrees F
Pump Hydraulic HP (min.)	6130 hp
Flow Velocity at Pump Suction (approximate)	27.5 fps
Drive Motor and Power Supply	
Frequency (at rated)	56 Hz
Frequency (operating range)	11.5-57.5 Hz

Total Required Power to M-G Sets	
kW/set	6730 kW
kW total	13,460 kW
Jet Pumps	
Number	20
Total Jet Pump Flow	102.5 x 10P6 lbs/hr
Throat I.D.	8.18 inches
Diffuser I.D.	19.0 inches
Nozzle I.D. (representative)	3.14 inches
Diffuser Exit Velocity	15.3 fps.
Jet Pump Head	76.1 ft.

The RHR system is designed for three modes of operation to satisfy its safety objectives and design bases. Each mode of operation is defined as a subsystem of the RHR and are as follows:

- Containment Cooling
- Low Pressure Coolant Injection
- Shutdown Cooling and Reactor Vessel Head Spray

The design bases of the existing RHR system is as follows:

Pumps

Number Installed per Unit -	4
Capacity per Pump -	33 1/3% (LPCI)
Design Temperature -	350 degrees F
Design Pressure -	450 psig

Design Conditions per pump at 20 psid*

Discharge Flow -	10,000 gpm
Discharge Head -	542 ft.

Operating Conditions per Pump

Discharge Flow -	0 to 12,000 gpm
Discharge Head -	800 to 372 ft
Differential Pressure -	295 to 0 psid

Attachment 1 depicts the arrangement of the existing recirculation system and RHR system.

The existing recirculation piping materials were purchased in accordance with General Electric's specification, "Recirculation Loop Piping". The material used in the original design was Type 304

Austenitic Stainless Steel. This piping was designed in accordance with ANSI B31.1. The existing RHR piping material, also type 304 Stainless Steel, was designed in accordance with ANSI B31.1.

4.2 Replacement Design

4.2.1 Material Selection

Replacement piping for the recirculation and RHR systems will be fabricated from Type 316 Nuclear Grade (NG) stainless steel.

Type 316 NG is an austenitic stainless steel with a high resistance to IGSCC in the BWR environment due to its low carbon content (less than 0.02 percent by weight). In addition, nitrogen is added to this alloy to add strength due to the relatively low carbon content. Increased pitting and sensitization resistance is provided by the addition of molybdenum.

4.2.2 Design Conditions

The replacement piping will be designed to meet or exceed the existing piping design pressures and temperatures stated below.

	Design Pressure (psig)	Design Temperature (Degrees F)
Recirc Pump Suction Piping	1148	562
Recirc Pump Discharge Piping	1326	562
RHR Suction Piping	1148	562
RHR Return Piping	1326	562

4.2.3 Piping Design Improvements

Design improvements consist of:

- Use of bent pipe for the 12-inch risers to reduce the number of welds.

- Use of long tangent and super long tangent 28-inch elbows to reduce the number of welds and to aid in the use of automatic welding and NDE equipment.

- Deletion of end caps by using 12-inch bent pipe and a reducer on ends of the 22-inch headers to reduce the number of welds and to eliminate the crud traps formed by the end caps.

- Deletion of header sweepolets by using a header with extruded outlets. Preliminary calculations of the stress indices for the extruded outlets show that the indices are lower than those for the original sweepolets.

- Use of a single forged pipe fitting to replace the RHR return tee, header cross and reducer.

- Counterbore length of two times the pipe wall thickness at all piping weld end preps to facititate ISI.

- Two-inch minimum extension at the reduced ends and at the ends of elbows to facilitate ISI.

- To minimize problems associated with welding new pipe to existing equipment, such as pumps, valves and safe ends, a wall thickness greater than the code required minimum wall will be provided.

- Deletion of unnecessary branch connections, such as the riser pressure taps formerly used for low pressure coolant injection (LPCI) loop selection logic.

- Deletion of the recirculation loop tie valves.

- Mechanical polishing to minimize/oxide radiation buildup.

Attachment 2 shows the proposed recirculation replacement piping and the RHR system piping (replaced in same configuration as existing RHR system piping.)

The recirculation piping was redesigned to eliminate as many fittings as possible; and in addition, bent pipe was utilized in order to reduce the number of welds. The replacement piping has approximately 48 less circumferential welds than the existing pipe. The pipe material specified, Type 316 Nuclear Grade stainless steel, has a low carbon content to reduce the possibility of IGSCC. To further minimize IGSCC, all of the piping material (shop welds and field welds are not included) will be solution heat treated.

The physical location of all field welds has been specified to allow easier access for automated welding equipment and for subsequent ISI. This is expected to significantly reduce future inspection time and inspection radiation exposure.

5.0 Health Physics Controls

A job specific radiation protection program has been formulated to assure that reasonable steps will be taken to reduce radiation exposure and contamination. A description of the administration of the plan will be submitted to the NRC by March 9, 1984.

6.0 Codes and Standards

The original piping systems were installed in accordance with ANSI B31.1.0 - 1967. For replacement work, as designed in ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, 1980 Edition, the replacements may meet all or portions of the requirements of later editions of the Construction Code. Based on compliance with Section XI and the current design criteria applicable to this piping, we are specifying compliance with upgraded sections of the construction codes.

The piping replacement work as related to the code requirements will be split into four areas (fabrication, design, installation, and examination).

The piping is being fabricated in accordance with ASME B&PV, Section III, 1980 Edition through Winter 1980

Addenda. The piping systems will be designed in accordance with ASME B&PV Code, Section III, 1980 Edition through Winter 1981 Addenda. The systems will be installed in accordance with ASME B&PV Code, Section XI, 1980 Edition through 1981 Addenda.

The nondestructive examination will be in accordance with ASME B&PV Code, Section XI, 1980 Edition through Winter 1981 Addenda. This will, however, refer back to Section III and Section V for the actual compliance requirements.

The baseline inservice inspection will comply with the Peach Bottom ISI program which requires inspection in accordance with ASME B&PV Code, Section XI, 1974 Edition through Summer 1975 Addenda.

7.0 Quality Assurance/Quality Control

The replacement work will be controlled by Chicago Bridge and Iron's (CBI) Quality Assurance Program. The program utilizes CBI's standard manuals, namely, "Nuclear Quality Assurance Manual for Repairs and Alternations", and "Nuclear Quality Assurance Manual for ASME Section III Products". Both of these program have been approved by an ASME survey team. CBI's Quality Assurance and Quality Control activities will be subject to audit by PECo's Engineering & Research Department Quality Assurance Organization. In addition, their work will be inspected by an Authorized Nuclear Inspector.

8.0 Training

8.1 Mockup Training

8.1.1 Plasma Arc Cutting and Machining Operations

Operators for either the Plasma Arc Cutting or machining operation will be trained on mockups simulating expected drywell conditions.

Operators shall demonstrate their ability to perform the required operation(s) in the drywell.

8.1.2 Welding Processes

Physical restraints such as space, position, and obstructions, etc. will be mocked-up full scale. Welders will be required to demonstrate an ability to make quality welds under these conditions prior to performing work inside the drywell.

8.2 Welder Qualification

Each welder and welding operator will be required to pass applicable code welding tests by producing test coupons in accordance with specified welding procedures. Test coupons will be examined non-destructively and/or destructively to prove each welder's capability.

8.3 Health Physics

All personnel involved in the pipe replacement work will be required to receive training and pass the necessary tests administered by PECo Nuclear Training Section. Training is provided in two categories - General Employee Training (GET) and General Respiratory Training (GRT). GET provides the employee with training in radiation contamination and its reduction, nuclear plant rules, Radiation Work Permit's dosimetry and dressing out in Anti-C clothing. GRT provides the employee with training in the use and fitting of protective respiratory gear.

9.0 Piping Analyses

9.1 Nuclear Class 1 Component Evaluation Based on ASME Section III

The piping will be analyzed in accordance with the rules of NB-3600 of ASME Section III Boiler and Pressure Vessel Code 1980 Edition through winter 1981 addenda.

The following will be evaluated in the analysis of the piping system:

a. The pipe minimum wall thickness will be determined such that there is adequate wall thickness for the various design and operating pressures defined in the design specification. Pressure design will be in accordance with the rules in NB-3640, 3654, 3655, 3656 and 3657.

b. Primary stress intensity limits of Equation (9) in NB-3652, 3654, 3655 and 3656 will be met.

c. Primary plus secondary stress intensity range limits will be met for the pressure, temperature and earthquake duty cycles defined in the design specification.

   Primary plus secondary stress intensity range limit will be met by satisfying the requirement of Equation (10) in NB-3653-1. If the stress range calculated by Equation (10) exceeds 3 Sm, the simplified Elastic-Plastic analysis Equations (12) and (13) will be satisfied.

d. The cumulative usage factor will be met for the pressure, temperature and earthquake duty cycles defined in the design specification. The cumulative usage will be evaluated in accordance with NB-3653-6.

9.2 Piping Stress Analysis

Due to the change in the piping configuration, the recirculation piping and connecting portions of the RHR piping will be reanalyzed. The recirculation piping and the RHR suction and return piping, between the tee connection and the drywell wall penetration, will be included in the analyses.

Thermal Expansion Analysis

Three thermal conditions have been selected for analysis. These three thermal conditions will be used to simulate the service levels contained in NB-3600.

Seismic Analysis

The recirculation piping and connecting RHR piping will be modeled as a lumped mass system with enough details to accurately predict piping dynamic response up to a frequency of 33 Hz. The weight of the piping contents plus insulation will be added to the weight of the pipe in the form of a uniformly distributed load (lbs/ft). The weight of pumps and valves will be included in the mass model. For the pump motors and valve operators, the extended mass will be modeled as an additional weight at the respective center of gravity.

The stiffness of each support will be included in the piping mathematical model.

The earthquake analysis will be performed using the response spectra method. The dynamic analysis utilizes response spectrum curves for the site based on ground motion accelerations of 0.05g (design earthquake) and 0.12g (maximum credible earthquake).

The forces and moments due to earthquake differential anchor movements will be determined by a static analysis with the movement at supports as input.

9.3 <u>Pipe Support Design</u>

The pipe support design will optimize the use of existing support hardware to minimize the number of the new components to be procured, to minimize drywell changes, and to simplify installation. In addition, the supports will be designed to minimize the necessity for welded attachments to the piping.

The existing hangers were designed and purchased to the requirements of USAS B31.7 and the existing snubbers were designed and purchased to the requirements of the ASME Section III, Subsection NF. Due to the change in the piping configuration, the existing hangers and snubbers will be re-evaluated to the code they were purchased to. If any new piping support hardware is required, it will meet the materials, design fabrication and erection requirements of ASME Section III, Subsection NF.

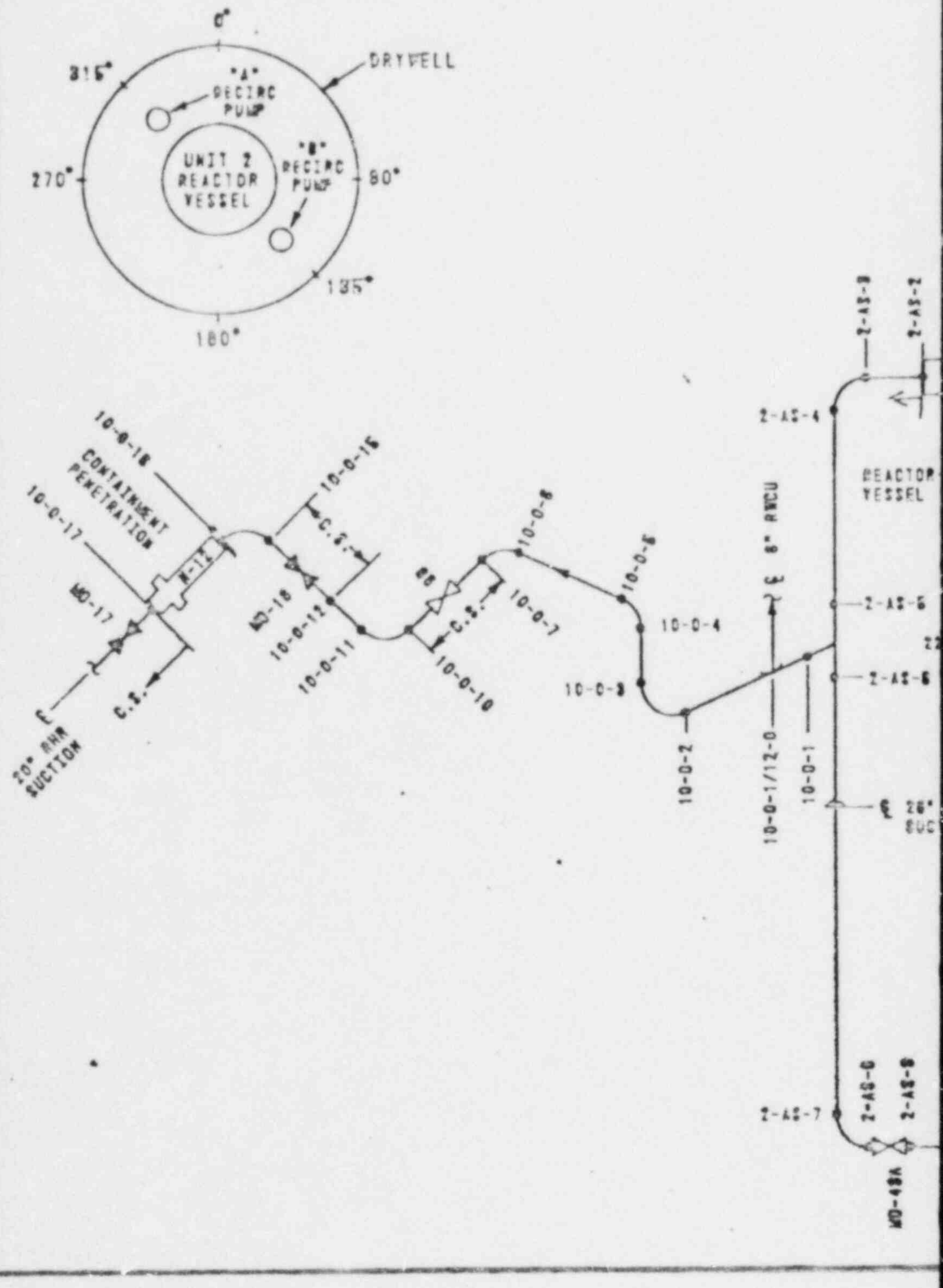
9.4 <u>Pipe Whip Restraint Design</u>

Where the piping configuration has not been changed and existing pipe whip restraints can be reused, the criteria for break location will be in accordance with the original design basis. The original design basis was the General Electric Document, "Design Report Recirculation System Pipe Whip Restraint for the BWR 4, 218 and 251 Mark I and Mark II Product Line Plant". Where the piping configuration has been changed, as with the header, and new pipe whip restraint design and/or analysis is needed, it will be done to the latest criteria: NRC Regulatory Guide 1.46, Standard Review Plan 3.6.2 and Branch Terminal Position MEB 3-1 requirements.

Consideration is being given to applying the latest restraint design criteria to the sections of piping where the configuration has not been changed. By applying the latest criteria, some of the existing restraints could be eliminated. The elimination of some of the restraints would facilitate piping removal, installation and ISI and would reduce the associated outage time and man-rem exposure.

Docket No. 50-277

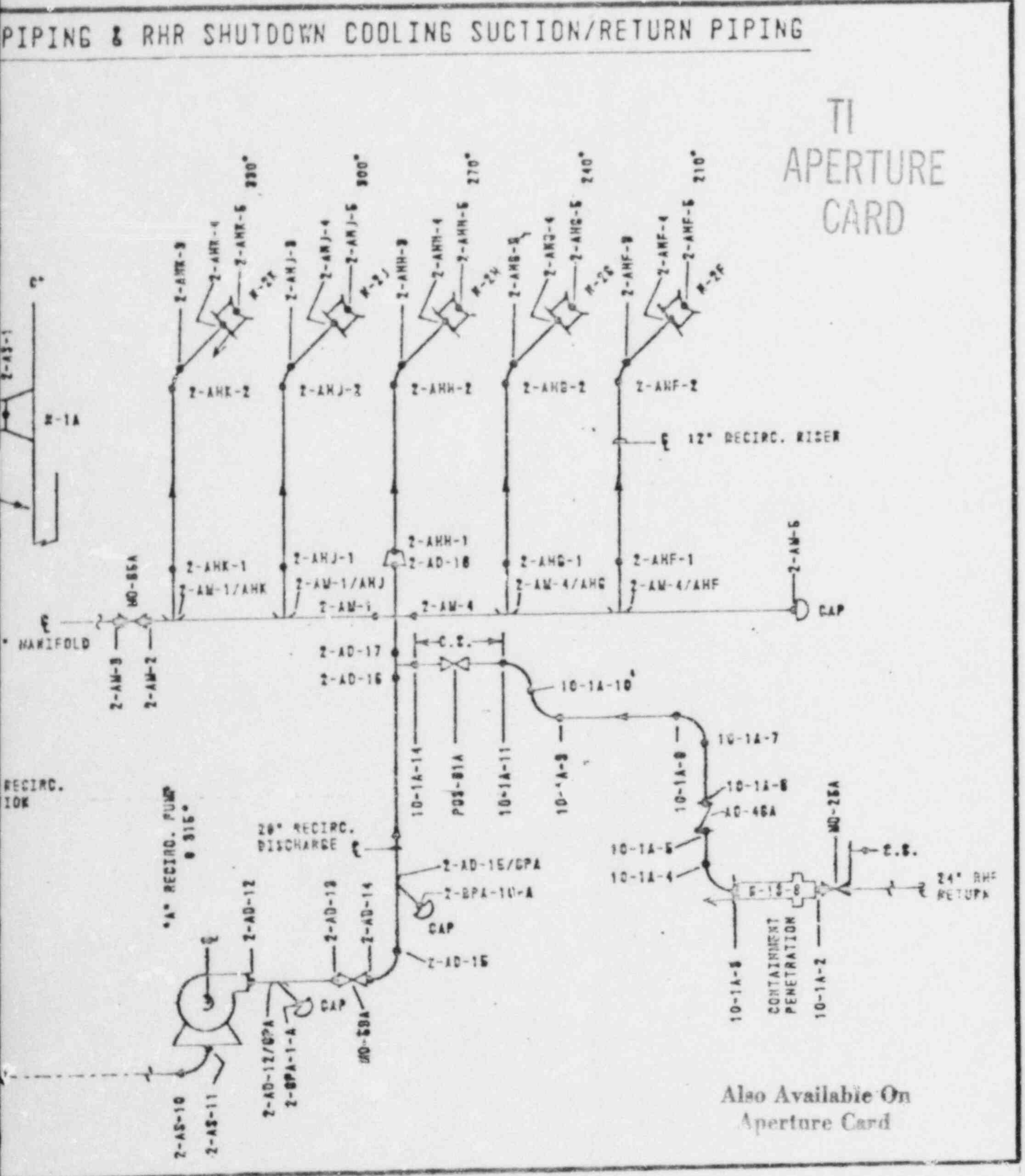
PBAPS-UNIT 2 "A" RECIRCULATION



ATTACHMENT 1

EXISTING RECIRCULATION SYSTEM AND RHR SYSTEM PIPING CONFIGURATION

PIPING & RHR SHUTDOWN COOLING SUCTION/RETURN PIPING



Also Available On Aperture Card

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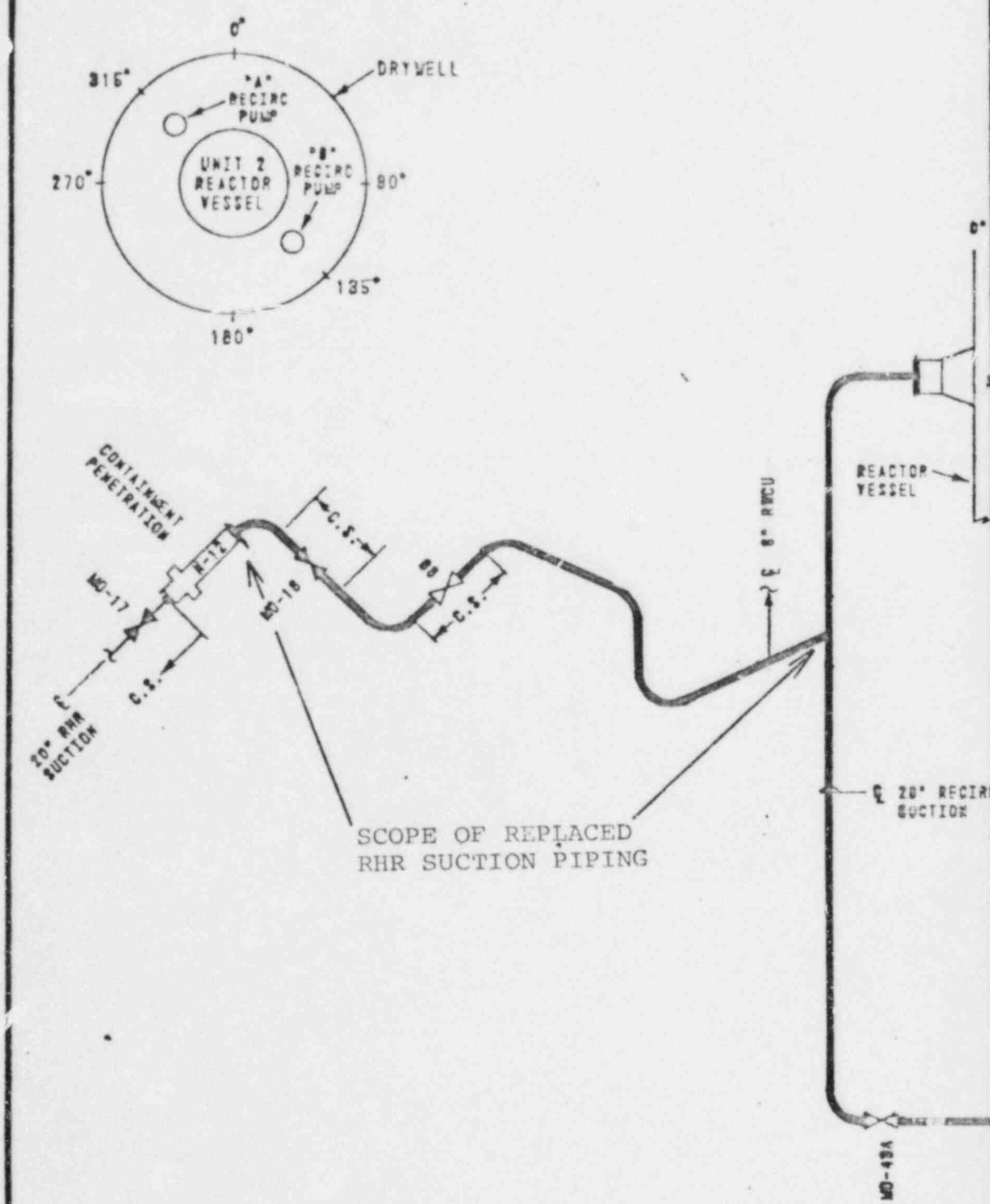
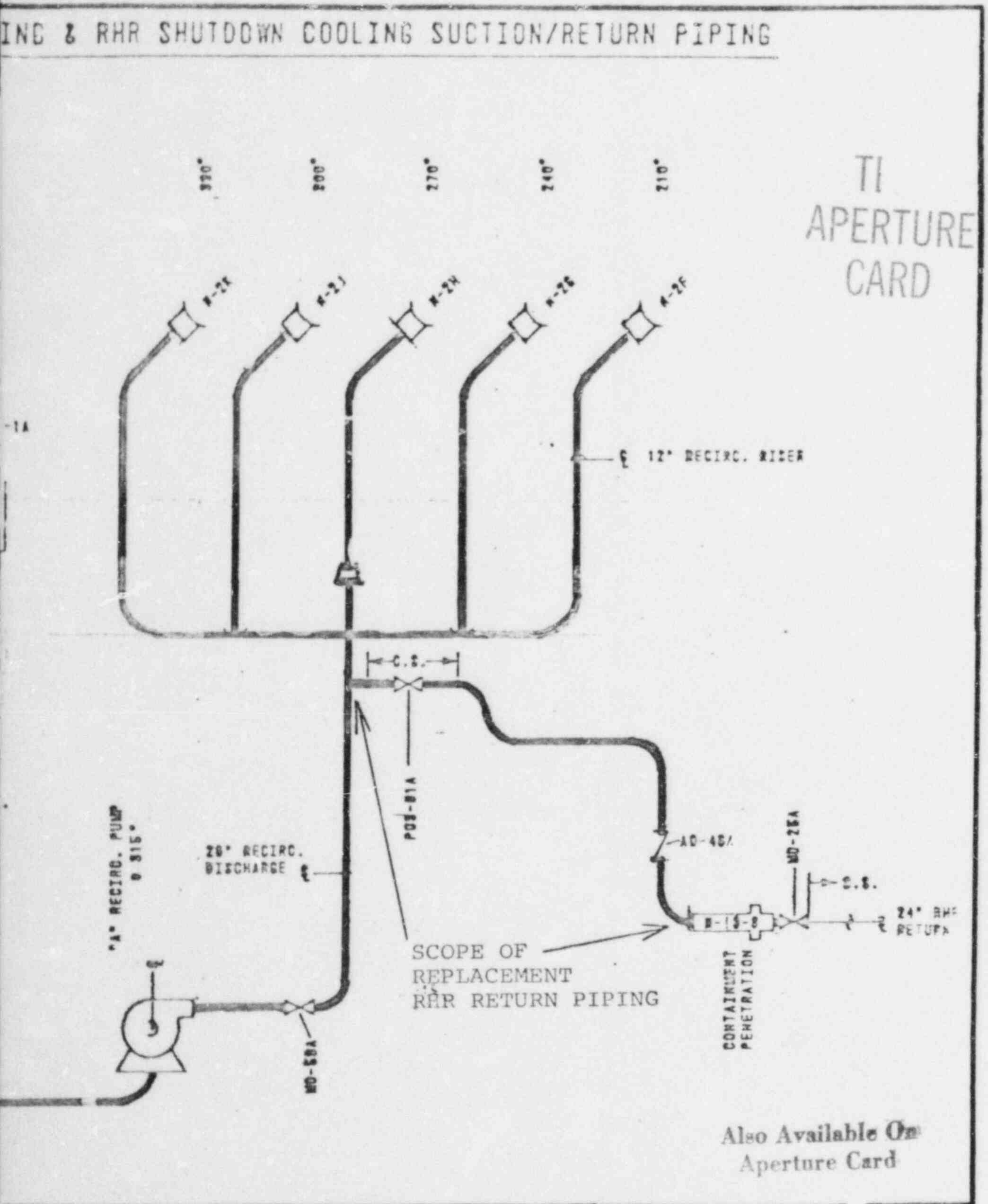
PBAPS-UNIT 2 "A" RECIRCULATION PIP



ATTACHMENT 2

MODIFIED RECIRCULATION SYSTEM AND RHR SYSTEM PIPING CONFIGURATION



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