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Perry Nuclear Power Plant
Docket No. 50-440
Response to NRC Bulletin 96-03, Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors

Ladies and Gentlemen:

On May 6, 1996, the Nuclear Regulatory Commission (NRC) issued the subject bulletin regarding a safety issue that could degrade performance of the Emergency Core Cooling Systems (ECCS) in Boiling Water Reactors (BWRs). The bulletin required, within 180 days, a report indicating whether licensees intended to comply with the requested actions, including a description of planned actions, the schedule for implementation and proposed technical specifications (if appropriate).

The Cleveland Electric Illuminating Company (CEI) and Entergy are working cooperatively to resolve the issues raised by NRC Bulletin 96-03 for the Perry Nuclear Power Plant (PNPP), River Bend Station and Grand Gulf Nuclear Station. Similarly, a close working relationship has been maintained with the NRC staff on this issue, particularly through the BWR Owners Group. These interactions have been constructive and valuable in framing the issues and identifying potential solutions.

The efforts of CEI and Entergy have resulted in completion of a detailed analysis of Bulletin 96-03 options. PNPP has selected installation of a large capacity passive strainer design as the preferred approach.

Design

The conceptual strainer design employs a floor mounted strainer that circles the suppression pool. The large passive strainer is being designed to achieve a very low approach velocity at the surface of the strainer, sufficient to minimize compaction of debris at the strainer surface thereby allowing greater flow through the debris and the strainer. Although final design and testing are not yet complete, the strainer design is expected to meet the guidance provided in Regulatory Guide 1.82, Revision 2.

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The calculation methodology specified in GESSAR II is used to determine appropriate hydrodynamic loads acting on the conceptual design, with one exception. In order to realistically characterize the upward loads on the strainer, CEI and Entergy have elected to use acoustic theory - a methodology that has previously been used to analyze hydrodynamic loads produced in both Mark II and III containments.

Testing

In addition to more generic testing performed through the BWR Owners Group, CEI and Entergy have initiated a testing program to validate that the conceptual design for a large passive strainer will perform as intended. Tests are being conducted in a 1/4 scale mockup of a Mark III containment at the Factory Mutual Research Corporation test center. Testing will address a range of issues associated with strainer performance including variations in ECCS flow rates and quantities of simulated post-LOCA debris and other fouling agents. The primary data collected will relate to strainer performance including differential pressure across the strainer, debris loading on the strainer and suppression pool velocity.

License/Design Basis

Assuming the analytic and testing results are favorable, it will be necessary to change the licensing and design basis of the PNPP facility to reflect the new strainer design. In accordance with SECY-95-300, "Nuclear Energy Institute's Guidance document, 'Guidelines for Managing NRC Commitments'", dated December 20, 1995, PNPP will evaluate the passive strainer design under 10 CFR 50.59. In the event it is determined that an unreviewed safety question is present, NRC approval will be sought in accordance with 10 CFR 50.90.

Technical Specifications

Bulletin 96-03 suggests the addition of Technical Specification (TS) surveillance requirements for passive strainer designs and suppression pool cleanliness. If appropriate, TS changes will be submitted in accordance with 10 CFR 50.90 once the final design is determined. Such requirements are not mandated for the current ECCS strainers, nor should they be considered for a new, improved strainer design which is less susceptible to clogging than the existing strainers. Rather, strainer and suppression pool cleanliness should be, and is, programmatically controlled similar to other preventive maintenance practices and inservice inspection activities.

Schedule

PNPP intends to make every effort to meet the implementation schedule requested by Bulletin 96-03, i.e., by the end of the first refueling outage starting after January 1, 1997. Our key short-term milestones are the following:

- November 1996 - Quarter scale testing complete
- December 13, 1996 - Complete analysis of testing data
- December 13, 1996 - Complete 10 CFR 50.59 evaluation
- January 6, 1997 - Release strainer design for fabrication
- September 1997 - Strainer installed

This schedule is optimistic and predicated upon several key factors. The following conditions must be met in order to meet the schedule; any impact will likely result in extending the strainer installation schedule at least one refueling cycle:

- Favorable completion of analyses supporting compliance with Regulatory Guide 1.82, Revision 2.
- Favorable completion of testing supporting compliance with Regulatory Guide 1.82, Revision 2.
- Determining that no unreviewed safety question is associated with implementing the strainer design.

Should it be determined that an unreviewed safety question exists, it will be necessary to prepare and submit a license amendment request for NRC review and approval. At that point, design and fabrication activity will be suspended thereby jeopardizing the schedule for implementation. As indicated above, safe plant operation in the interim is assured through the existing combination of programmatic controls for suppression pool cleanliness, minimization of potential strainer fouling material sources, and operations guidance.

Although not necessary to satisfy the Bulletin 96-03 response requirement, attached is additional descriptive information concerning our conceptual design, analytic approach and testing plans. Also attached, for information, is a discussion of the acoustic methodology being used to address certain hydrodynamic loads imposed on the strainer. This information may change in the future and is not intended as a PNPP commitment. Rather, this information may be helpful in understanding the approach used to resolve the issue. Additionally, as testing and analysis proceeds, a meeting with the NRC would be beneficial to share the results. Contact will be made with the NRC Project Manager for PNPP to schedule such a meeting.

If you have questions or require additional information, please contact
Mr. James D. Kloosterman, Manager - Regulatory Affairs, at (216) 280-5833.

Very truly yours,

Lew W Myers

Lew W. Myers
Vice President - Nuclear

Attachments

TAH:sc

cc: NRC Region III
NRC Resident Inspector
NRC Project Manager

I, Lew W. Myers, being duly sworn state that (1) I am Vice President, Nuclear of the Centerior Service Company, (2) I am duly authorized to execute and file this certification on behalf of The Cleveland Electric Illuminating Company and Toledo Edison Company, and as the duly authorized agent for Duquesne Light Company, Ohio Edison Company, and Pennsylvania Power Company, and (3) the statements set forth herein are true and correct to the best of my knowledge, information and belief.

Lew W. Myers

Lew W. Myers

Sworn to and subscribed before me, the 4th day of November, 1996.

Jane E Mott

JANE E. MOTT
Notary Public, State of Ohio
My Commission Expires Feb. 20, 2000
(Recorded in Lake County)

CODED/8838/SC

1.0 Overview

On May 6, 1996, the Nuclear Regulatory Commission (NRC) issued Bulletin 96-03, *Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling Water Reactors*. This bulletin requires boiling water reactor (BWR) licensees to take actions that will ensure that the emergency core cooling systems (ECCS) retain their capability to perform their safety functions following a loss of coolant accident (LOCA).

NRC Bulletin 96-03 was issued based on a series of events at operating BWRs and subsequent analysis of the events by the Boiling Water Reactor Owners Group (BWROG) and the NRC.

Analyses of these events indicated that blockage of ECCS suction strainers could result in insufficient net positive suction head (NPSH) for the ECCS pumps. This could lead to failure to meet the requirements for providing adequate core cooling following an accident and long term cooling capability following a LOCA to remove decay heat and ensure that the core temperature is maintained at acceptably low values. These requirements are specified in Section 50.46 of Title 10 of the Code of Federal Regulations.

Cleveland Electric Illuminating (CEI) Company and Entergy Inc., the owners and operators of the Perry Nuclear Power Plant (PNPP), the Grand Gulf Nuclear Station, and River Bend Station, initiated a cooperative effort to evaluate ECCS suction strainer plugging and develop a common approach to resolving the issue. These three plants are BWR6/Mark III containment plants with substantially similar designs. This report provides a summary of the program undertaken by CEI and Entergy, the conceptual design we have jointly developed for a new ECCS suction strainer, and a description of a test program to validate the conceptual design.

CEI and Entergy have worked closely with the BWROG in addressing the ECCS suction strainer plugging issue. Representatives from the three plants have worked with the BWROG subcommittee conducting generic analysis and testing for the domestic BWR plants to address this issue. The joint program undertaken by CEI and Entergy builds upon the work of the BWROG and utilizes analytical methodology and test results obtained by the group as the basis for design assumptions for the conceptual design.

CEI and Entergy initially completed a detailed evaluation of options to resolve the ECCS suction strainer plugging issue. The utilities considered replacement of current insulation in the drywell with reflective metal insulation and, if necessary, installation of new ECCS suction strainers to provide sufficient capacity to cope with corrosion products and non-insulation debris produced as a result of postulated accidents. In addition, the utilities evaluated installation of three types of strainers without replacement of existing insulation: (1) active strainers with gravity self-cleaning capability, (2) continuous backwash strainers, and (3) large passive strainers. Following a careful analysis of technical issues, costs, and

potential schedules for implementing each option, the utilities determined that installation of a large passive strainer represented the best overall option for resolution of the issue based on data available at the time. A key factor contributing to the selection of the large passive strainer option was its ability to minimize sensitivity of the design to uncertainties associated with meeting the guidance provided in Regulatory Guide 1.82, Revision 2. In particular, the large passive strainer design is less sensitive to uncertainties regarding quantities of debris and corrosion products present during routine plant operation, debris generation as a result of the LOCA, and effects of long term head loss during the extended period of operation after the accident to provide long term cooling of the containment. This option is also superior with regards to the impact of installation and reliable operation over the life of the plant.

Following selection of the large passive strainer option, CEI and Entergy initiated a design and testing program to develop a conceptual design for the strainer. The effort has focused on establishing the appropriate design basis, selecting the best conceptual approach, investigating design loads, and evaluating potential constraints on fabrication and installation. Details regarding the conceptual design are presented in section 2.0 of this report.

CEI and Entergy have initiated a testing program to validate that the conceptual design for the large passive strainer will perform as intended. The testing will be completed in the 1/4-Scale Test Facility (QSTF) that was originally constructed in 1984 at the Factory Mutual Research Corporation (FMRC) Test Center near West Gloucester, Rhode Island, to perform large-scale hydrogen combustion experiments on behalf of the Mark III Owners. The QSTF is an accurate model of a Mark III containment and suppression pool. Testing will address a range of issues associated with strainer performance including variations in ECCS flow rates and quantities of simulated post-LOCA debris and other fouling agents. The primary data collected will relate to strainer performance including differential pressure across the strainer, debris loading on the strainer, and suppression pool velocity. The testing program is discussed in section 4.0 of this document.

An aggressive program of design, analysis and testing has been initiated to resolve the issue of ECCS suction strainer plugging. CEI and Entergy are working together to complete necessary activities so that final design for plant modifications can be completed along with procurement, fabrication, and installation. The overall schedule for remaining activities to be completed by CEI is discussed in section 6.0.

2.0 Conceptual Design

2.1 Design Description

The large passive strainer is designed to achieve a very low approach velocity at the surface of the strainer. This low approach velocity minimizes compaction of the debris

mixture at the strainer surface thereby allowing greater flow through the debris and the strainer. In addition, relatively loose debris mixtures at the surface of the strainer may be swept off the surface of the strainer by bulk suppression pool motion resulting from operation in the suppression pool cooling mode or turbulence induced by post accident phenomena such as condensation oscillation or chugging. Based on limited testing by the BWROG, an approach velocity in the range of 0.015 - 0.04 ft/sec should achieve the desired objectives. CEI and Entergy intend to complete additional testing in the QSTF to evaluate the impact of a range of approach velocities on debris bed formation and differential pressure loss across the strainer.

The design option selected for the conceptual design effort is a floor mounted strainer that circles the suppression pool (Figure 1). The strainer cross section is hemicircular and approximates the shape of two quarter sections of pipe (Figure 2).

The conceptual design for the strainer was selected to optimize installation during normal plant refueling outages. Individual sections of the strainer will be brought into the containment through either the containment equipment hatch or the containment personnel airlock doors. The sections will be bolted together in the suppression pool without draining the pool below the levels required by limiting conditions for operation in Mode 5. The conceptual design requires no welding during installation thereby minimizing the complexity of assembly operations.

Figure 2 shows details of the construction and the exterior surface area of a typical strainer section. Each section of the strainer is divided into two separate sections providing flow conduits to the pump suction plenum sections where the flow path for the two sections flow paths join together.

2.2 ECCS Functional Groups

The ECCS are divided into three functional groups to ensure that critical safety functions will be fulfilled under the most limiting conditions involving a single failure in conjunction with the initiating break that results in a LOCA. The three functional groups are:

1. Low Pressure Core Spray and one Low Pressure Coolant Injection subsystem (Division I)
2. Two Low Pressure Coolant Injection subsystems (Division II)
3. High Pressure Core Spray (Division III)

Equipment in each group is independent from the equipment in the other groups. In addition, the High Pressure Core Spray and the Reactor Core Isolation Cooling System are independent from each other to provide additional diversity for high pressure water sources.

The ECCS must also provide long term suppression pool cooling and decay heat removal. To accomplish this objective, one ECCS pump must be operating to provide water to the reactor pressure vessel and a RHR heat exchanger must be available to reject heat to the ultimate heat sink. For this design function, the most limiting single failure is the loss of one loop that contains a RHR heat exchanger. Under this condition, one fully redundant loop containing a separate heat exchanger supported by its own emergency service water train would still be available.

The strainer is designed to achieve separation between ECCS functional groups thereby precluding the potential for common mode failure. Dividers will be installed internal to the flow channels of the strainer to provide this separation. Dividers will be fabricated to provide a structural separation boundary and will incorporate strainer material such that flow can pass through the divider from one strainer section to another. Two dividers will be provided at the interface of Division 1 and Division 2 strainer sections to ensure that a single failure of the divider does not result in loss of both divisions. The center channel between the inner and outer halves of the strainer provides the physical separation between Division 2 and Division 3.

3.0 Dynamic Loads

Components or structures located in the Mark III containment pressure suppression pool must be designed to withstand dynamic loads including seismic loads, post-LOCA hydrodynamic loads, and Safety Relief Valve (SRV) hydrodynamic loads. The large toroidal passive strainer will be designed to withstand applicable combinations of these loads. The conceptual design locates the proposed strainer on the suppression pool floor and as close to the containment wall as possible to minimize the impact of postulated dynamic loads.

Preliminary calculations indicate that the hydrodynamic loads for the critical load combinations calculated using the GESSAR II methodology include significant upward loads on the strainer that would tend to lift the strainer off the floor of the suppression pool. For example, the SRV air bubble load and the condensation oscillation load case both produce large uplift loads. To simplify the design of an appropriate restraint system for the passive strainer, CEI and Entergy have elected to use acoustic theory to reanalyze loads produced by certain hydrodynamic phenomena to provide a more realistic definition of the loads. This methodology has previously been used to analyze hydrodynamic loads produced in both the Mark III containment and the Mark II containment (references 1 and 2). Attachment 2 of this submittal describes the proposed application of the acoustic methodology for defining the submerged structure loads on the large toroidal strainer and discusses past application of this methodology for defining loads in both Mark III and Mark II containments.

4.0 Validation Testing

CEI and Entergy have initiated a test program to validate the performance of the conceptual design. The principal intent of the test program is verification of a large passive strainer design by performance testing a scale model that is geometrically similar to the strainers intended for installation at full scale. Testing will not include simulations of hydrodynamic phenomena that could impose loads on the strainer such as SRV discharge, condensation oscillation, or chugging; analysis of these loads is discussed in section 3.0 of this attachment. The primary performance criterion will be the head loss across the fouled strainer. If head loss is sufficiently low, the operability of the ECCS pumps will not be jeopardized.

The low approach velocity strainer test program is designed with the following goals:

1) Verify the low approach velocity strainer concept;

2) Confirm that the passive suction strainer design will perform as intended and will handle the scaled equivalents of Mark III post-LOCA debris loadings, even without potential cleaning produced by using the RHR system in the suppression pool cooling mode;

3) Confirm, on a plant-specific basis, whether or not the strainer can be cleaned of debris (either locally or completely) by circulating the suppression pool with the RHR system;

4) Test various other phenomena and plant-specific design details to the extent necessary to ensure that testing is sufficiently comprehensive, such that the final strainer designs will meet the intent of 10 CFR 50.46, RG 1.82 Revision 2, and NRC Bulletin 96-03.

An appropriate scaling methodology has been selected to ensure that the results from the testing in the QSTF will be representative of conditions in the full scale plants. The tests will be conducted such that the full-scale suppression pool velocity will be preserved in the model. The model strainer will have the same size mesh as the full scale strainer design. In addition, the insulation debris will correspond in size to full-scale debris. Accordingly, the Reynolds number at the strainer interface with the debris bed should be the same in the QSTF as in the full-scale plants.

Tests will be completed to evaluate the performance of the conceptual strainer design for plant specific conditions associated with the design of PNPP, Grand Gulf Nuclear Station, and River Bend Station. Plant specific features that will be modeled include discharge locations and orientations for the suppression pool cooling return lines, ECCS flow rates, and quantities/types of insulation debris. Tests will be conducted to parametrically

investigate issues such as strainer approach velocity, pump flow rates, water chemistry, and data repeatability.

5.0 Evaluation Against Positions in Regulatory Guide 1.82, Rev 2

Appendix A to this attachment provides a summary of how the conceptual design of the large toroidal passive strainer satisfies the regulatory positions in Regulatory Guide 1.82, Rev 2.

6.0 Schedule

PNPP intends to comply with the requirements of Bulletin 96-03 to install the proposed conceptual design in the plant during the first refueling outage after January 1, 1997. This is conditional upon the results from the planned validation testing demonstrating that the conceptual design will perform as intended and timely resolution of licensing issues that may arise during the review of test results and analyses.

Key milestones for meeting this schedule are as follows:

1. November 1996 - Quarter scale testing complete
2. December 13, 1996 - Analysis of data from quarter scale testing complete
3. December 13, 1996 - Complete 10 CFR 50.59 evaluation
4. January 6, 1997 - Release of strainer design for fabrication

7.0 References

1. *Mark II Containment Program Load Evaluation and Acceptance Criteria*, C. Anderson, Generic Technical Activity A-8, NUREG-0487, Supplement No. 2, U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, February 1981.

2. *An Approach to Chugging, Assessment of RHR Steam Discharge Condensation Oscillation in Mark III Containments,* G. K. Ashley II and T. S. Leong, Bechtel Power Corporation, March 1984.

Appendix A
Evaluation Against Regulatory Guide 1.82, Revision 2, Positions

Regulatory Guide Position	Basis for Compliance
RG2.1.1.1. A suction strainer design (i.e., size and shape) should be chosen that will avoid the loss of NPSH from debris blockage during the period that the ECCS is required to operate in order to maintain long-term cooling or maximize the time before loss of NPSH caused by debris blockage when used with an active mitigation system (see Regulatory Position 2.1.4).	The conceptual design for the strainer minimizes the potential for loss of NPSH caused by debris blockage. Data from the QSTF will demonstrate the effectiveness of the conceptual design.
RG2.1.1.2. The size of the openings in the suppression pool suction strainers should be based on the minimum restrictions found in systems served by the suppression pool. The minimum restriction should take into account the operability of the systems served. For example, spray nozzle clearances, coolant channel openings in the core fuel assemblies, and such pump design characteristics as seals, bearings, and impeller running clearances will need to be considered in the design to ensure long-term pump operability. An assessment should be performed to determine the ECCS pumps' susceptibility to degradation from debris ingestion and abrasive effects, and actions should be taken to minimize the potential for degradation of long-term recirculation pumping capacity.	The current licensing basis has been maintained in that the size of openings in the conceptual design strainer is essentially the same as the openings in the existing ECCS suction strainers.
RG2.1.1.3. ECC pump suction inlets should be designed to prevent degradation of pump performance through air ingestion and other adverse hydraulic effects (e.g., circulatory flow patterns, high intake head losses).	The current licensing basis is maintained in that the low approach velocity to the strainer and the submergence of the suction piping eliminates the potential for vortexing and minimizes the potential for air ingestion.
RG2.1.1.4. All drains from the upper regions of the reactor building should terminate in such a manner that direct streams of water, which may contain entrained debris, will not impinge on the suppression pool suction strainers.	The current licensing basis is maintained in that there will be no modification in the arrangement of drains from the upper floors of the containment.
RG2.1.1.5. The strength of the suction strainers should be adequate to protect the debris screen from missiles and other large debris. Each suction strainer should be capable of withstanding loads imposed by missiles, debris accumulation, and LOCA-induced hydrodynamic loads.	The current licensing basis is maintained in that the ECCS strainer is not subject to impact by postulated missiles. The strainer is sufficiently strong to withstand the effects of large debris. PNPP will use GESSAR II combined with Acoustic Methodology to demonstrate that the strainer can withstand the LOCA induced hydrodynamic loads.
RG2.1.1.6. The suction strainers should be designed to withstand the vibratory motion of seismic events without loss of structural integrity.	The current licensing basis is maintained since the strainers will be designed to withstand existing seismic loads.

Regulatory Guide Position	Basis for Compliance
RG2.1.1.7. Material for suction strainers should be selected to avoid degradation during periods of inactivity and normal operations.	The current licensing basis is maintained since the conceptual design uses the same materials as the current ECCS strainers.
RG2.1.2.1. Containment cleanliness programs should be designed for control and removal of foreign materials from containment, or	PNPP has established a containment cleanliness program for the control of foreign materials, and other programs to minimize the potential for strainer fouling from operations generated debris.
RG2.1.2.2. Debris interceptors in the drywell in the vicinity of the downcomers or vents may serve effectively in reducing debris transport to the suppression pool. In addition to meeting Regulatory Position 5.1.1, debris interceptors between the drywell and the wetwell should not reduce the suppression capability of the containment.	PNPP intends to take no credit for LOCA generated debris hold up in the drywell.
RG2.1.3. Instrumentation If relying on operator actions to prevent the accumulation of debris on suction strainers or to mitigate the consequences of the accumulation of debris on the suction strainers, safety-related instrumentation that provides operators with an indication and audible warning of impending loss of NPSH for the ECCS pumps should be available in the control room.	The current licensing basis is maintained in that the passive strainer requires no operator actions to prevent or mitigate accumulation of debris on the strainer. PNPP has control room indication for the ECCS pumps' suction pressure, and control room annunciation for low suction pressure for RHR A, RHR B and HPCS. ECCS pump suction pressure is addressed in the Plant Emergency Instructions.
RG2.1.4. Active Strainers An active component or system should be provided to prevent the accumulation of debris on a suction strainer. An active system should be able to prevent debris that may block restrictions found in the systems served by the ECCS pumps from entering the system. The operation of the active component should not adversely affect the operation of other ECC components or systems.	This position is not applicable. The conceptual design is a passive strainer.
RG2.1.5. Inservice Inspections Inservice inspections should be established that include (1) inspection during every refueling outage to ensure cleanliness of the suppression pool, (2) a visual examination for evidence of structural degradation or corrosion of the suction strainers and strainer system, and (3) an inspection of the wetwell and the drywell, including the vents, downcomers, and deflectors, for the identification and removal of debris or trash that could contribute to the blockage of the suppression pool suction strainers.	CEI will continue to conduct comprehensive inspections each refueling outage to evaluate the cleanliness of the suppression pool. The strainer will be periodically monitored by visual inspection for evidence of structural degradation or corrosion.

Regulatory Guide Position	Basis for Compliance
RG2.2. Evaluation and Alternate Water Sources: In order to demonstrate that a combination of the features and actions listed above are adequate to ensure long-term cooling and that the five criteria of 10 CFR 50.46(b) will be met following a LOCA, an evaluation using the criteria and assumptions in Regulatory Position 2.3 should be conducted. If a licensee is relying on operator actions to prevent the accumulation of debris on suction strainers or to mitigate the consequences of the accumulation of debris on the suction strainers, an evaluation should be performed to ensure that the operator has adequate indications, time, and system capabilities to perform the actions required. In addition to a combination of the features and actions described above, procedures may be established to use existing systems and sources of water other than the suppression pool to provide injection and long-term cooling to the core. Establishing procedures to use alternate water sources will provide a diverse means of providing injection and long term cooling to the core. Procedures to align alternate water sources may already be contained in emergency operating procedures. Because of the importance of the ECCS cooling function, consideration should be given to including the valves and piping needed to align alternate water sources in a plants' maintenance program.	The large toroidal passive strainer does not require operator actions to prevent the accumulation of debris on the strainer or to mitigate the consequences of debris accumulation. The conceptual design for the strainer provides sufficient area to accommodate the debris that is expected to be produced following a design basis LOCA. The Plant Emergency Instructions contain guidance to the operator on the use of alternate water sources to provide a diverse means of providing long term cooling to the core.
RG2.3.1.2. An acceptable method for determining the shape of the zone of influence of a break is described in NUREG/CR-6224. The volume contained within the zone of influence from the break should be supported by analysis or experiments for wave generated or the break and potential debris. The shock wave generated during postulated pipe break and the subsequent jet should be the basis for estimating the amount of debris generated within the zone of influence.	The shape and size of the zone of influence is based on the guidance provided by the BWROG Utility Resolution Guidance Document (URG) Draft Section 3.2.1.2.3, Method 2. The proposed strainer fouling capacity is based on the total amount of insulation installed in the drywell (BWROG URG Draft Section 3.2.1.2.3, Method 1). The quantity of "other" LOCA-generated debris is based on the recommendations contained in the BWROG URG Draft.
RG2.3.1.3. Identify all sources of fibrous materials in the containment such as fire protection materials, thermal insulation, or filters that are present during operation.	Refer to the letter from CEI (R. Stratman) to the NRC dated May 9, 1993 (PY-CEI/OIE-0402L), where a review of the types of various fibrous materials installed inside containment and drywell is summarized.

Regulatory Guide Position	Basis for Compliance
RG2.3.1.4. All insulation, painted surfaces, and fibrous, cloth, plastic, or particulate materials within the zone of influence should be considered debris sources. Analytical models or experiments should be used to predict the size of postulated debris.	PNPP will utilize methodology established in the BWROG URG Draft to quantify the debris resulting from painted surfaces, fibrous, cloth, plastic, or particulate materials within the zone of influence that may produce debris.
RG2.3.1.5. As a minimum, the following postulated break locations should be considered. • Breaks on the main steam, feedwater, and recirculation lines with the largest amount of potential debris within the expected zone of influence, • Large breaks with two or more different types of debris within the expected zone of influence, • Breaks in areas with the most direct path between the drywell and wetwell, and • Medium and large breaks with the largest potential particulate debris to insulation ratio by weight.	PNPP will utilize conservative methodology established in the BWROG URG Draft to establish the break locations to be considered.
RG2.3.1.6. The cleanliness of the suppression pool and containment during plant operations should be considered when estimating the amount and type of debris available to block suction strainers. The potential for such material (e.g., corrosion products) and foreign materials (e.g., tape, wire ties, wire, paper, plastic) to the impact head loss across the suction strainer should also be considered.	PNPP will utilize the methods prescribed in the BWROG URG Draft to establish the limits for debris in the suppression pool.
RG2.3.1.7. The amount of particulates estimated to be in the pool prior to a LOCA should be considered the maximum amount of corrosion products (i.e., sludge) expected to be generated since the last time the pool was cleaned. The size distribution and amount of particulates should be based on plant samples.	PNPP will utilize the methods prescribed in the BWROG URG Draft to establish the limits for accumulated sludge in the suppression pool. These limits will be based on PNPP specific measurements from previous suppression pool cleanings.
RG2.3.2.1. It should be assumed that all the postulated debris will be transported to the suppression pool. If debris interceptors (see Regulatory Position 2.1.2.2) have been installed in the drywell, the amount of debris transported to the suppression pool can be less than 100%. The amount of the reduction of the transport of debris to the suppression pool should be quantified experimentally or analytically.	Sizing of the conceptual design is based on the assumption that the postulated LOCA generated debris in the drywell is transported into the suppression pool.
RG2.3.2.2. It should be assumed that LOCA-induced phenomena (i.e., pool swell, chugging, condensation oscillations) will suspend all the debris assumed to be in the suppression pool at the onset of the LOCA.	Testing that will be completed in the QSTF will utilize the full quantity of debris that could be present in the suppression pool. No credit will be taken for the settling of debris in the suppression pool prior to the LOCA.

Regulatory Guide Position	Basis for Compliance
RG2.3.2.3. The amount or concentration of debris in the suppression pool should be calculated based on the amount of debris estimated to reach the suppression pool from the drywell and the amount of debris and foreign materials estimated to be in the suppression pool prior to a postulated break.	The quantity of debris present in the suppression pool will be determined in accordance with the methodology specified in the BWROG URG Draft. This debris will include material produced as a result of the accident, debris already present in the suppression pool, corrosion products, and other foreign material.
RG2.3.2.4. Credit should not be taken for debris settling until LOCA-induced turbulence in the suppression pool has ceased. The debris settling rate for the postulated debris should be validated analytically or experimentally.	Testing in the QSTF will simulate long term performance characteristics of the conceptual design for the strainer including behavior of debris during long term cooling of the suppression pool. Phenomena associated with debris accumulation on the strainer as well as the potential settling of debris in the suppression pool will be simulated during the testing.
RG2.3.2.5. Bulk suppression pool velocity from recirculation operations, LOCA-related hydrodynamic phenomena, and other hydrodynamic forces (e.g., local turbulence effects or pool mixing) should be considered for both debris transport, including settling, and suction strainer velocity computations.	Testing in the QSTF will provide information on the effects of suppression pool bulk circulation under a range of ECCS flow conditions on debris accumulation on the conceptual design strainer.
RG2.3.3.1. Strainer blockage should be based on the amount of debris estimated using the assumptions and criteria described in Regulatory Position 2.3.1 and on the debris transported to the wetwell (Regulatory Position 2.3.2). This volume of debris, as well as other materials that could be present in the suppression pool prior to a LOCA, should be used to estimate the rate of accumulation of debris on the strainer surface.	The quantities of debris that could be produced as a result of the postulated accident and debris already present in the suppression pool., according to RG Position 2.3.1, will be scaled and used in testing to determine the resultant level of strainer blockage.
RG2.3.3.2. The flow rate through the strainer and the concentration of debris in the suppression pool should be used to estimate the rate of accumulation of debris on the strainer surface.	Test results will provide a representation of the rate of accumulation of debris on the strainer surface. Data from the testing will show the pressure drop across the strainer as a function of the accumulation of debris on the strainer.
RG2.3.3.3. The suppression pool suction strainer area should be used in determining the approach velocity and should conservatively account for blockage that may result. Unless otherwise shown analytically or experimentally, debris should be assumed to be uniformly distributed over the available suction strainer surface.	Testing in the QSTF will determine the approach velocity to the strainer under a range of potential ECCS operating characteristics. The testing will provide an accurate simulation of debris distribution over the available suction strainer surface area.

Regulatory Guide Position	Basis for Compliance
RG2.3.3.4. The NPSH available to the ECC pumps should be determined using the conditions specified in the plant's licensing basis (e.g., Regulatory Guide 1.1).	NPSH available to the ECCS pumps will be determined in accordance with Regulatory Guide 1.1. Pressure drop across the conceptual design or the suction strainer will be based on results from testing at the QSTF. The vapor pressure for suppression pool fluid will be based on a suppression pool water temperature of 185°F which is the maximum design temperature of the containment.
RG2.3.3.5. Estimates of head loss caused by debris blockage should be developed from empirical data based on the strainer design (e.g., surface area and geometry), postulated debris (i.e., amount, size distribution, type), and approach velocity. Any head loss correlation should conservatively account for filtration of particulates by the debris bed.	Tests in the QSTF will quantify head loss caused by debris blockage on the conceptual design strainer. Head loss measured during the testing should account for the possible filtration of particulates by the debris bed.
RG2.3.3.6. The performance characteristics of a passive or an active strainer for the debris types and amounts postulated should be supported by appropriate test data.	Tests will be conducted in the QSTF to determine the performance characteristics of the conceptual design passive strainer for the quantities and types of debris predicted following postulated accidents.

Figure 1

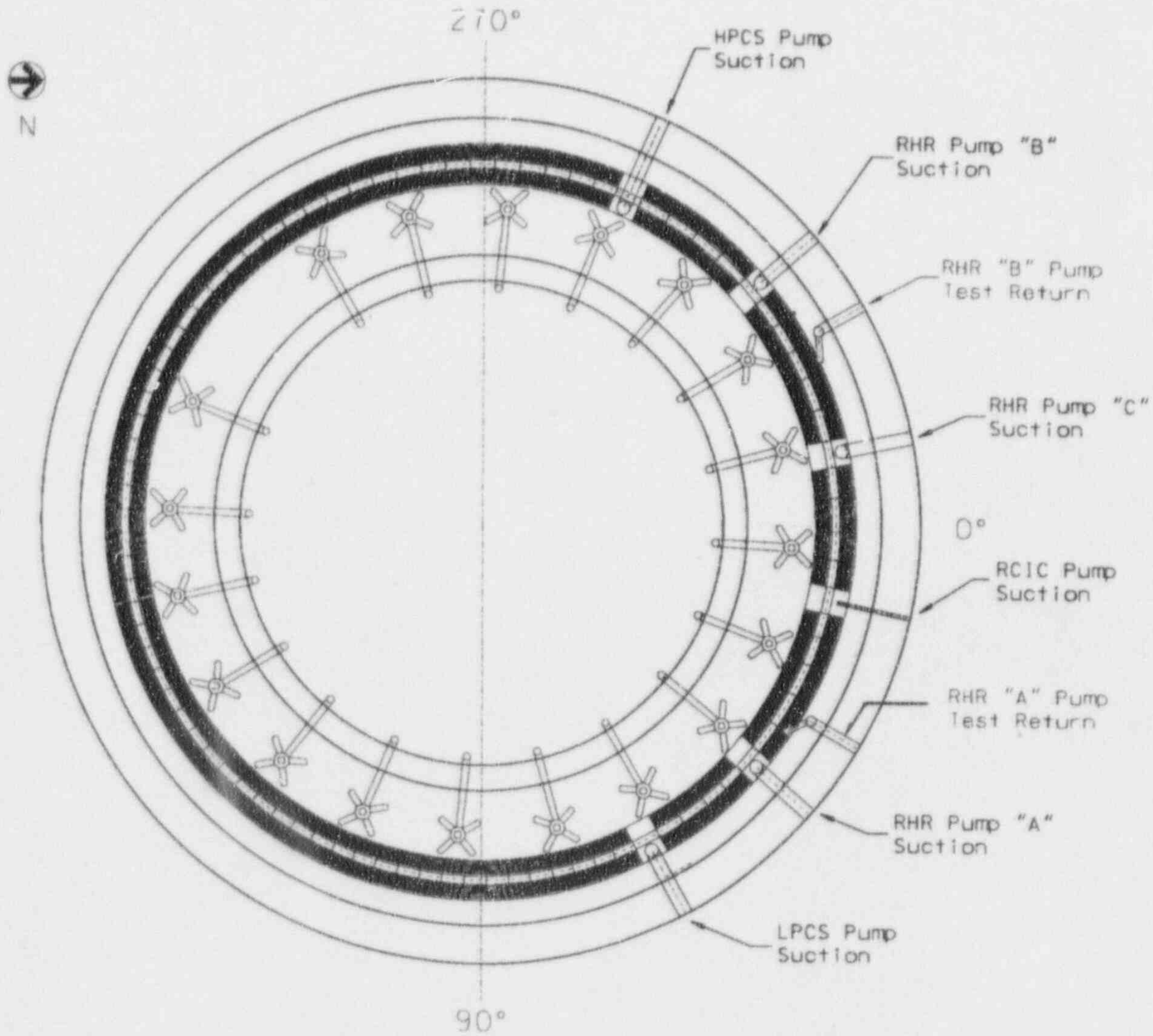
270°
N
HPCS Pump
Suction
RHR Pump "B"
Suction
RHR "B" Pump
Test Return
RHR Pump "C"
Suction
180°
0°
RCIC Pump
Suction
RHR "A" Pump
Test Return
RHR Pump "A"
Suction
LPCS Pump
Suction
90°

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Figure 2