NMC
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Point Beach Nuclear Plant
Operated by Nuclear Management Company, LLC

September 1, 2005

NRC 2005-0109
10 CFR 50.54(f)

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, Maryland 20852

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266 and 50-301
License Nos. DPR-24 and DPR-27

Nuclear Management Company Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," for Point Beach Nuclear Plant

By letter dated September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02. By letter dated March 7, 2005, Nuclear Management Company, LLC (NMC) provided the required 90-day response.

In GL 2004-02, the NRC required that the Part 2 response be provided by September 1, 2005. NMC is providing the Part 2 response to GL 2004-02 for the Point Beach Nuclear Plant (PBNP). Enclosure 1 contains the response.

Summary of Commitments

This letter contains 4 new commitments and no revisions to existing commitments.

1. NMC will evaluate and modify as appropriate the PBNP Unit 1 and Unit 2 Emergency Core Cooling (ECCS) systems to support long-term decay heat removal and resolve the issues identified in GL 2004-02 by December 31, 2007.

2. NMC will update the PBNP licensing basis to reflect the results of the analyses and modifications performed to demonstrate compliance with the regulatory requirements of GL 2004-02. This update will be performed in accordance with 10 CFR 50.71.

3. NMC will establish administrative controls at PBNP to have proposed insulation changes inside containment reviewed and approved by engineering. This will ensure insulation upgrades, repairs, and replacements do not result in an unanalyzed debris mix or quantity. These controls will be established prior to the beginning of the spring 2007 (Unit 1) refueling outage.

4. NMC will provide a separate submittal to update the responses to requests (d)(i) through (d)(iii), and (d)(v) through (d)(vii) within 60 days of acceptance of

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the final screen design. Acceptance of the final screen designs by the PBNP Plant Oversight Review Committee (PORC) is scheduled for February 15, 2006 (Unit 2) and June 22, 2006 (Unit 1).

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 1, 2005.

for

Dennis L. Koehl
Site Vice President, Point Beach Nuclear Plant
Nuclear Management Company, LLC

Enclosure (1)

cc: Administrator, Region III, USNRC
Project Manager, PBNP, USNRC
Resident Inspector, PBNP, USNRC Document Control Desk

This enclosure provides response to Part 2 of Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," for Point Beach Nuclear Plant (PBNP), Units 1 and 2.

Plant Description

PBNP Units 1 and 2 are Westinghouse two loop pressurized water reactors. The containment arrangement is similar for both units. The Emergency Core Cooling Systems (ECCS) is comprised of the Safety Injection (SI) and the Residual Heat Removal (RHR) systems. Following a loss of coolant accident (LOCA), the SI and RHR pumps initially draw suction from the Refueling Water Storage Tank (RWST). The transfer to recirculation of the containment sump liquid is initiated after the liquid in the RWST reaches a set level prescribed in the Emergency Operating Procedures. Recirculation of the liquid in the containment sump is only required following a LOCA. The Containment Spray System (CSS) is not used during post-LOCA recirculation operation. However, in anticipation of re-licensing the PBNP accident analyses using the Alternate Source Term (AST), the replacement sump strainers will be designed to accommodate operation of the CSS while on sump recirculation.

SI System

The primary purpose of the SI System in the event of a loss of coolant accident is to automatically deliver borated water to the Reactor Coolant System (RCS).

The SI System consists of two redundant high head pumps. If, during recirculation operation, RCS pressure is above the RHR Pump discharge pressure, the RHR Pump(s) are aligned to provide suction to the SI Pump(s) for high head recirculation.

The SI Pumps discharge into both cold legs. The design flow rate for the SI Pumps is 700 gpm each.

RHR System

The RHR Pumps serve dual functions. The normal function of the RHR Pumps is to remove residual heat during reactor shutdown. During normal power operation the RHR pumps are aligned to perform the low head safety injection function. During post accident mitigation, the RHR Pumps are used to inject borated water to the Reactor Coolant System through nozzles in the Reactor Vessel (upper plenum injection). The RHR Pumps are also used to recirculate liquid from the containment sump and pump to the reactor vessel and/or to the suction of the high head SI Pumps (if required).

The RHR System consists of two redundant low head pumps. During the injection phase of post-accident mitigation, the RHR Pumps draw suction from the RWST. Should RCS pressure be above the RHR Pump discharge pressure, the pumps would initially be discharging through the minimum flow bypass line during the injection phase.

During the recirculation phase of post-accident mitigation, the RHR pumps discharge to the suction of the SI Pumps ("piggy-back" mode). The design flow rate of the RHR Pumps is 1560 gpm each.

Containment Accident Sump ("Sump B") is the basement elevation of containment. This sump provides water collection for the suction of the RHR Pumps during recirculation. In this mode, either or both RHR Pumps can draw suction from Sump B through independent redundant suction lines. During a LOCA, Sump B will fill and a liquid level will be established on the basement floor. Switchover from injection to recirculation is performed manually based on Refueling Water Storage Tank (RWST) level indications.

To provide bounding results, the analyses discussed below assume the minimum liquid water level in containment with maximum anticipated pump flow rates.

Nuclear Regulatory Commission (NRC) Request

2. Addressees are requested to provide the following information no later than September 1, 2005:

(a) Confirmation that the ECCS and CSS recirculation functions under debris loading conditions are or will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this generic letter. This submittal should address the configuration of the plant that will exist once all modifications required for regulatory compliance have been made and this licensing basis has been updated to reflect the results of the analysis described above.

NMC Response

NMC confirms that the PBNP Emergency Core Cooling System (ECCS) will be in compliance with the regulatory requirements of 10 CFR 50.46 to provide long term decay heat removal by December 31, 2007. In light of the recently identified concerns related to GSI-191, this will require the replacement of the existing containment sump strainers with strainers of substantially greater surface area. No other modifications are expected to be necessary to fully meet the intent of GL 2004-02 with respect to the ECCS system.

The current license bases analyses for PBNP do not credit any operation of the Containment Spray System (CSS) while on sump recirculation. As a result, PBNP does not rely on CSS operation during sump recirculation to meet the requirements of 10 CFR Part 100 or 10 CFR 50.67, and the concerns of GSI-191 have no impact on the ability of the CSS to meet its license basis.

In anticipation of re-licensing the PBNP accident analyses using the Alternate Source Term (AST), the replacement strainers will be designed to accommodate operation of the CSS while on sump recirculation. In support of that anticipated future submittal, additional plant modifications may be necessary to ensure that maximum RHR pump flows are limited to an acceptable level; however, those details are outside the scope of this response.

Activities to support bringing all aspects of PBNP into full compliance with the issues of GSI-191 include:

- Containment walkdowns to quantify potential debris sources (completed)
- Debris generation and transport analysis (completed)
- Calculation of required and available NPSH (pending)
- Defining screen requirements (completed)
- Screen structural analyses (pending)
- Procedures to address sump screen blockage (completed)

- Downstream effects evaluation (in progress)
- Upstream effects evaluation (pending)

The status, schedule, and technical details of these activities are further discussed in the responses to questions that follow.

The PBNP licensing basis will be updated to reflect the results of the analyses and modifications performed to demonstrate compliance with the regulatory requirements. This update will be performed in accordance with 10 CFR 50.71.

NRC Request

(b) A general description of and implementation schedule for all corrective actions, including any plant modifications, that you identified while responding to this generic letter. Efforts to implement the identified actions should be initiated no later than the first refueling outage starting after April 1, 2006. All actions should be completed by December 31, 2007. Provide justification for not implementing the identified actions during the first refueling outage starting after April 1, 2006. If all corrective actions will not be completed by December 31, 2007, describe how the regulatory requirements discussed in the Applicable Regulatory Requirements section will be met until the corrective actions are completed.

NMC Response

A description of and implementation schedule for each of the activities listed in response to NRC Request 2(a) above are provided below.

Containment walkdowns to quantify potential debris sources

Detailed containment walkdowns to identify and quantify the types and locations of insulation were completed during the fall 2003 (Unit 2) and spring 2004 (Unit 1) refueling outages (U2R26 and U1R28, respectively).

The walkdowns also inventoried other miscellaneous debris (i.e., tape, tags, labels, etc.).

At the beginning of the Unit 2 spring 2005 refueling outage, a sampling of latent dirt and dust in Unit 2 containment was performed. A formal evaluation of the potential latent debris is pending a similar sampling of the Unit 1 containment in the fall of 2005.

Debris generation and transport analysis

The debris generation analyses were completed in March 2005 for both units. The results of these analyses are summarized in Attachment 1 of this submittal.

The debris transport analyses (for debris generated from insulation materials; all other debris are assumed to be transported to the sump screens as detailed in Attachment 1) were completed in May 2005 for both units. A summary of the results debris transport analyses is contained in Attachment 2 of this submittal.

Calculation of required and available NPSH

An existing NPSH calculation is being used to establish the limitations for the design of the replacement strainers. While these calculations are being revised and upgraded as part of an overall calculation improvement project, no changes that would impact the design of the replacement strainers are expected.

The calculation demonstrates that with no strainer head losses and no vortexing effects, the Low Head SI (RHR) pumps have adequate NPSH when water level is even with the floor of containment (i.e. 8 ft. elevation). This is the case for the full flow of an RHR pump limited by system hydraulic resistance alone when discharging to a depressurized RCS (i.e., no throttling). The same holds for an RHR pump providing unthrottled flow to both RCS injection and a High Head SI pump in parallel with the RCS depressurized.

Using this information, the conceptual design for the strainers is proceeding using only the available submergence at the time of switchover to sump recirculation. This will assure that necessary ECCS pump NPSH is maintained.

Defining screen requirements

The screen design requirements have been fully defined in a bid specification and a contract has been awarded based on a proposal that meets the bid specification. Pertinent sections of the specification are included as Attachment 3 of this submittal. A notable exception to the bid specification in the conceptual design is the depth of submergence. The bid specification required limiting submergence to 20 in., while the conceptual design credits a minimum submergence of 38 in. The acceptability of this deviation is discussed in more detail in the response to question (c) below (calculation of NPSH requirements).

Screen structural analyses

The structural analyses of the replacement screens will be completed as part of the screen design (see Attachment 3 items 3.6.15, 4.2, and 4.6). Final site approval of the Unit 2 replacement screen design is scheduled for February 15, 2006. Final approval of the Unit 1 replacement screens is scheduled for June 22, 2006. This is scheduled to support the installation of the replacement screens during the fall 2006 (Unit 2) and spring 2007 (Unit 1) refueling outages.

Procedures to address sump screen blockage

Emergency Contingency Action ECA 1.3 (Containment Sump Blockage) was created and issued for each unit in July 2005. The procedures are not dependent upon sump screen design, and the change to the replacement screens is intended to be transparent to the Operator. Therefore, no additional change in procedures is anticipated.

Downstream effects evaluation

The downstream effects analyses for both the fuel and mechanical components (pumps, valves, etc.) are in progress and are scheduled for completion on September 23, 2005.

Please refer to the response to item (d)(v) below for preliminary details.

Upstream effects evaluation

An evaluation of the upstream effects of debris on the strainers is an integral part of the strainer design process. Scale testing of the conceptual design with a debris mix and loading that bounds the PBNP debris transport analysis has been performed by the vendor selected to design and fabricate the replacement screens (AREVA / PCI). It is expected that final acceptance of the replacement screens will be based on the demonstrated test performance, and not on extensive evaluation of postulated phenomena.

Final site approval of the Unit 2 replacement screen design is scheduled for February 15, 2006. Final approval of the Unit 1 replacement screens is scheduled for June 22, 2006. This is scheduled to support the installation of the replacement screens during the fall 2006 (Unit 2) and spring 2007 (Unit 1) refueling outages.

NRC Request

(c) *A description of the methodology that was used to perform the analysis of the susceptibility of the ECCS and CSS recirculation functions to the adverse effects of post-accident debris blockage and operation with debris-laden fluids. The submittal may reference a guidance document (e.g., Regulatory Guide 1.82, Rev. 3, industry guidance) or other methodology previously submitted to the NRC. (The submittal may also reference the response to Item 1 of the Requested Information described above. The documents to be submitted or referenced should include the results of any supporting containment walkdown surveillance performed to identify potential debris sources and other pertinent containment characteristics.)*

NMC Response

<u>Containment walkdowns to quantify existing and potential debris sources</u>

The containment walk downs were performed by plant personnel in two teams of two individuals each to provide verification of findings. All results are fully documented.

The walkdowns and documentation searches identified a variety of insulation types, including Reflective Metal Insulation (RMI), asbestos, Calcium Silicate (CalSil), fiberglass, and mineral wool. The location, sizes (length, piping diameter, and nominal insulation thickness; sizes of insulated components, etc.) were documented and verified using independent walk downs and/or controlled plant reference drawings as applicable. The detailed itemized listings were then used to provide input to the debris generation and transport analyses (discussed later).

In addition to insulation materials, the walk downs specifically looked for tape, tags, labels, tie-wraps, rubber hoses (such as fire fighting hose reels), filter media, foam sealants (for fire barriers) and general cleanliness. These were all documented during the walk downs and are conservatively assumed to be 100% transported to the sump screens.

The sampling for latent dust and lint was made by wiping down representative surfaces of known area with pre-weighed decontamination wipes. The increase in weight of the wipes was recorded together with the location and surface area covered.

There were 21 representative locations sampled, including vertical surfaces, routinely cleaned horizontal surfaces (accessible floors), and horizontal surfaces that are infrequently or never cleaned (overhead cable tray covers and HVAC ducts). The debris loadings ranged from 0.002 gm/ft^2 to 1.577 gm/ft^2 over a total sample area of 965 ft^2. A preliminary extrapolation of these samples over the entire containment surface area resulted in an estimated loading of 30 lbs of latent debris.

This is only 20% of the 150 lbs assumed to exist and be transported to the sump screens (see Attachment 1).

Debris generation and transport analysis

The debris generation analyses were initially performed in accordance with the guidance in the draft version of NEI 04-07, and subsequently re-performed after the formal issuance of NEI 04-07 and the associated NRC Safety Evaluation. Areva performed these analyses.

The analyses considered several cases (5 for Unit 1, and 7 for Unit 2) to evaluate the possible debris generation scenarios in accordance with the guidance of NRC RG 1.82, Revision 3. The results of these analyses are summarized in Attachment 1 of this submittal.

Pipe Break Location Selection

The pipe break locations were chosen in accordance with the criteria of NRC RG 1.82, Revision 3. These requirements could be met efficiently by examining breaks in the RCS piping proximate to major equipment such as the Steam Generators. Because the RCS lines are the largest-bore lines in containment, they tend to result in the largest Zones of Influence, and therefore encompass the greatest quantities of potential debris; they also tend to maximize the number of different types of thermal insulation (and other debris sources) that are affected. Break locations centered at connections to the SG nozzles tend to have ZOIs located such that they envelope nearly the entire Steam Generator as well as the Reactor Coolant Pump(s). Break locations farther from the SG nozzles tend to result in lesser quantities of debris because their ZOIs envelope smaller portions of the Steam Generators themselves.

It is theoretically possible for smaller lines that are physically closer to the ECCS recirculation sumps to generate a greater quantity of debris that will actually be transported to the sump, so attention is also given to the pressurizer surge line. Additionally, auxiliary lines inside the outer Reactor Coolant Pressure Boundary (RCPB) isolation valves are identified and examined to determine whether any of these are routed in the immediate vicinity of the ECCS recirculation sump. Breaks at locations outside the second RCPB valve were not considered, since they are isolable from the reactor and RCS. Break locations at RCS connections to the Reactor Vessel nozzles are also examined, but due to the location inside the primary bioshield and the torturous flow path from this point through containment to the ECCS recirculation sump suctions, breaks at the RV nozzles typically do not present the same degree of debris accumulation on the ECCS suction screens that is credited for breaks in RCS piping outside the primary bioshield.

Main Steam and Feedwater lines need only be analyzed as potential break locations in plants where ECCS recirculation is required to mitigate

the effects of breaks in these lines. The ECCS recirculation is not required for breaks in Main Steam and Feedwater lines at PBNP because the RCS remains intact.

Zone of Influence

The break Zones of Influence (ZOI) as defined by NUREG/CR-6808 were determined in accordance with the guidance of NRC RG 1.82, Revision 3. Each break was assumed to be a double-ended guillotine break.

Each ZOI was modeled as a spherical shape. Pressure decay (rather than energy release) was used to link initial thermodynamic conditions prevalent in the fluid released through the break to debris source material destruction pressures.

Calculations to model the spherical ZOI volume began with consideration of the thermodynamic conditions of the fluid released from a given break location, and the destruction pressure experimentally observed for selected debris source materials (primarily various types of thermal insulation). The approach taken is consistent with the references identified in Reg Guide 1.82 Rev 3 Section 1.3.2.2, which are based upon ANSI/ANS-58.2-1988, "Design Basis for Protection of Light Water Nuclear Power Plants against the Effects of Postulated Pipe Rupture." ANSI/ANS-58.2-1988 provides an accepted model of the geometry and thermodynamic conditions characterizing the expanding jet downstream of a ruptured pipe. This model is used to determine the isobaric contours of the jet for all of the destruction pressures of interest. The volume enclosed by these contours is then determined by numerical integration. The volume enclosed by a destruction pressure contour of interest defines the volume of the ZOI for debris types of that particular destruction pressure. With its volume defined, the radial dimension of the ZOI was calculated.

Since there are two jets for a double ended guillotine break (DEGB) in RCS piping, the volume calculated for a single jet was doubled, then set equal to the volume of the spherical ZOI.

All potential debris sources determined to lie within the spherical ZOI were considered to be damaged or destroyed by the break. The quantity of debris sources that were within the respective material-specific ZOIs and not shielded from LOCA blast/blowdown effects by robust structural barriers were summed to determine the total debris generated for each break.

In the cases where debris sources are located within the spherical ZOI, but on the other side of a robust structural barrier such as the secondary bioshield or loop cubicle wall (protected from LOCA blast and jet blowdown effects), ZOI volume was truncated at the structural barrier.

Destruction Pressures

The methodology utilized ZOIs based on the destruction pressures established for respective debris source materials of interest. The destruction pressures given in Table 3-2 of the NEI "PWR Sump Performance Evaluation Methodology," Volume 2, are assumed to be applicable. In the cases where Table 3-2 of Volume 2 does not specifically list the debris type of interest, Table 4-1 of Volume 1 is consulted to ascertain the experimentally determined destruction pressure of the debris type. This destruction pressure is then reduced by 40% per guidance in Section 3.4.2.2 of Volume 2. An L/D value was picked from Table 3-2 in Volume 2 using these newly reduced destruction pressures.

The following table lists the resulting ZOIs for each insulation type evaluated:

Insulation Type	Destruction pressure (psig)	ZOI L/D
Transco RMI	114	2.0
Asbestos	6.0	17.0
Buckled NUKON	6.0	17.0
CalSil	24.0	5.45
Fiberglass	6.0	17.0
Fiberglass Blanket	6.0	17.0
Fiberglass/Mineral Wool combination	6.0	17.0
Mineral Wool	6.0	17.0
NUKON	6.0	17.0
Temp-Mat/Insulbatte	10.2	11.7

All coatings within a 10D ZOI are assumed to fail and be transported to the sump screens.

Debris Transport Analyses

The debris transport analyses (performed by Alden Research Laboratory) follow the methodology outlined in NEI 04-07 using the break locations and debris characterizations provided by the debris generation analyses. The computational fluid dynamics was performed using the FLUENT computer code with the computational mesh and boundary conditions generated by the GAMBIT computer code. Two dimensional CAD drawings used for input files for GAMBIT were created in CADKEY.

Available transport test data from NEI 04-07 (corrected by NUREG/CR 6772 and NUREG-0897 Rev. 1 for RMI and Nukon/fiberglass) were used to determine incipient tumbling velocities. However, some insulation types used at PBNP are not found in the available literature. Some assumptions based on similar physical characteristics were necessary for these non-tested materials.

The disintegration fractions and sizing factors used were obtained from NUREG/CR 6808.

The debris transport analysis performed to arrive at these loadings assumed the current installed strainer configuration. These are substantially smaller than the replacement strainers currently being designed. As a result, the near-field approach velocities are considerably higher, and even the far-field flow velocities may be significantly greater in the debris transport analysis than can be expected in the final design configuration.

The current project plan requires re-performance of the debris transport analysis once the screen design has been finalized. The results of the new transport analysis, when compared with the current (replacement screen design basis) analysis will establish the available design margin in the screen design for future contingencies, insulation replacements, etc.

It is expected that the reduction in approach velocity of an order of magnitude will substantially reduce the quantity and type of debris that reaches the screens, and will have a significant beneficial impact on the final analysis results.

A summary of the current (screen design bases) debris transport analyses is contained in Attachment 2 of this submittal.

<u>Calculation of required and available NPSH</u>

Existing NPSH calculations (performed by site Engineering) used Proto-Flo Version 4.01 to model and calculate a ratio of the existing NPSH available to the NPSH requirements for each ECCS pump. The software also contains default friction factors for the standard piping and standard valves. These were used where appropriate. Appropriately conservative (bounding) friction factors were derived and used for non-standard valves or fittings.

Significant inputs and assumptions are:

1) The water in the containment building is at the level of the containment floor (e.g., zero submergence at the ECCS suctions).
2) The containment sump temperature is 212 deg F and 14.7 psia. This reflects saturation conditions and eliminates any credit for containment over-pressure due to non-condensable gases.
3) Sump submergence, screen dP, and vortexing effects are not included. These will be addressed as part of the sump screen / strainer design.

The NPSH calculation uses non-degraded pump curves to maximize the flow delivered, which in turn maximizes the NPSH requirements.

As noted previously, either an RHR pump alone, or an RHR pump in series with an HHSI pump have sufficient NPSH available under all postulated conditions (strainer head losses not included). However, if an RHR pump is aligned to supply both RCS injection and a CSS pump, NPSH will be inadequate unless throttling of the pump(s) outlet flow can be assured. As previously stated, the PBNP license bases does not currently require the operation of CSS while on containment sump recirculation, and provisions for positive flow control (i.e., throttling valves or flow limiting devices) as necessary will be made prior to implementing any changes that could require such an alignment. With this in mind, the replacement sump screens have been specified to accommodate the anticipated flows in such an alignment.

Adequate NPSH without crediting submergence of the ECCS suctions is being retained as a working design criterion for the replacement screens. In other words, head losses through the replacement screens must be no greater than the minimum submergence depth of the screens. This will ensure that the original design intent for NPSH available to the ECCS system is maintained.

Using an inventory balance between the RWST and the containment building, the containment water level will be a minimum of 38 in. above the level of the ECCS suctions at the time of initial switchover (this includes margin for instrument uncertainties). While the preliminary screen design criteria called for a maximum credited submergence of 20 in., evaluation of the proposals provided found that this caused the "footprint" of the various screens to be greatly enlarged. This caused additional concerns, including obstruction of access to plant equipment, increased risk of damage during handling, etc. Therefore, the current working design credits the minimum available depth of 38 in.

Finally, it has been specified that the replacement strainers be designed for full submergence to preclude air entrainment and vortexing (See Attachment 3, item 4.1).

<u>Downstream effects evaluation</u>

The evaluation is being performed in accordance with the guidance of Westinghouse WCAP-16406, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," and will address both particulate and fibrous suspended solids. Working assumptions for these analyses include that the screen / strainer perforation size is 0.125 in. diameter, and that the upstream debris loadings are from the previously discussed transport analyses.

See the response to request (d)(v) below for further details regarding downstream effects.

Chemical effects evaluation

This aspect of the design has not yet been fully vetted, but the current working assumptions are that ICET test #4 results are most applicable to PBNP (NaOH buffer with 80% CalSil and 20% Fiberglass).

A 15% head loss design margin has been reserved in the conceptual design to accommodate the results of ongoing chemical effects testing.

The design of the replacement strainers is highly modular, and there is area available for expansion of the strainer assemblies if necessary. This will permit expansion late in the strainer design cycle or later in plant life if desired.

NRC Request

(d) The submittal should include, at a minimum, the following information:

(i) The minimum available NPSH margin for the ECCS and CSS pumps with an unblocked sump screen.

NMC Response

Calculation of required and available NPSH

With zero submergence and no screen head losses, the existing NPSH calculation demonstrates a minimum NPSH ratio (NPSHa / NPSHr) of 2.18 with an NPSHa of 19.6 feet for the RHR pump(s) delivering unrestricted flow to a depressurized core outlet plenum. This is ample margin when only delivering to the reactor outlet plenum. However, when delivering unrestricted flow to both a depressurized core outlet plenum and an HHSI pump in parallel, the flow rates increase and the NPSHa requirements likewise increase. In this case, a minimum NPSH ratio of 1.18 with an NPSHa of 16.4 feet was calculated.

The NPSH available to support concurrent RHR and CS pump operation is not being addressed at this time since such operation is outside of the current plant design and license basis.

Minimum sump water level at the time of sump switchover is 38 in. (including RWST level instrument uncertainty). Therefore, there is an additional 38 in. of available margin in the calculations to accommodate screen head losses. To simplify and segregate the various supporting analyses, only the depth of water above the floor (sump) elevation of the containment is credited for the operation of the screens, while only the elevation head below the floor (sump) is credited for supplying pump NPSH requirements.

A separate submittal to update the response to this item will be made when the replacement screen design has been finalized.

NRC Request

(ii) The submerged area of the sump screen at this time and the percent of submergence of the sump screen (i.e., partial or full) at the time of the switchover to sump recirculation.

NMC Response

The following information is preliminary, and is based on the working design of the replacement sump screens that is currently in progress.

Each screen (one per train) will be fully submerged at the time of switchover to sump recirculation. Each screen has an effective surface area of 1,495 sq ft with perforations 1/8" or less in diameter.

A separate submittal to update the response to this item will be made when the replacement screen design has been finalized.

NRC Request

(iii) The maximum head loss postulated from debris accumulation on the submerged sump screen, and a description of the primary constituents of the debris bed that result in this head loss. In addition to debris generated by jet forces from the pipe rupture, debris created by the resulting containment environment (thermal and chemical) and CSS washdown should be considered in the analyses. Examples of this type of debris are disbonded coatings in the form of chips and particulates and chemical precipitants caused by chemical reactions in the pool.

NMC Response

Please refer to Attachment 1 for a tabulation of the latent debris and coatings debris postulated for the strainer design. Please refer to Attachment 2 for a tabulation of the design transported debris mix and volumes. As previously discussed, the transported debris is based on design flow rates to the currently installed screens, and not those being designed. As a result, it is expected that the final analyzed quantity and mix of debris that reaches the screens will be substantially reduced by the large reduction in the approach velocity to the replacement screens.

The working values for head loss are based on testing previously completed with a bounding debris mix and loading. Those test results demonstrated a head loss of less than 0.2 feet. As a point of reference,

the calculated peak head loss (thin bed regime) using the methodology of NUREG CR/6224 is 1.16 feet.

With an available head of at least 38 in., there is ample margin to accommodate chemical effects as they become better understood. Additionally, there is space available to accommodate expansion of the strainers if needed.

A separate submittal to update the response to this item will be made when the replacement screen design has been finalized.

NRC Request

(iv) The basis for concluding that the water inventory required to ensure adequate ECCS or CSS recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths.

NMC Response

The floors of the PBNP containment are supported independent of and without contact with the containment building walls. The resulting annular flow areas at each floor preclude any appreciable accumulation and hold-up of spray or break flow.

The flow paths from the RCS loop compartments are several large open areas in each of the loop compartment walls (on the order of 10 ft. wide and 7 ft. high each) at the bottom of the loop compartments. The floor of the loop compartments is 2 ft. higher than the surrounding general area. The replacement ECCS suction strainers will be situated in this surrounding general area. As such, there are ample direct flow paths from any of the postulated break locations directly to the ECCS suction screens/strainers without any intervening choke-points.

The reactor cavity drain is maintained open with an installed strainer to ensure that containment spray (or break flow emanating from the head region) drains freely to the 8 ft. elevation of containment. The insulation on the reactor head is entirely RMI, and located within the reactor head shroud. The strainer in the refueling canal sump contains 200 – 1 in. diameter holes (net open area of 157 in^2), varying in elevation from 1 in. to approximately 18 in. above the floor of the sump.

The reactor cavity strainer combined with the limited quantity of RMI insulation, are judged to be sufficient to preclude significant blockage of the drain path to the containment basement. Additionally, any LOCA originating from a break in the reactor head region could be terminated when the RCS has been depressurized and normal RHR cooling in mid-

loop is restored. Containment sump recirculation would not be necessary to keep the core covered since the RCS piping loops would be intact.

All other spaces / locations in the containment subject to direct containment spray (such as the RCS loop compartments) open directly to the 8 ft. elevation of the containment. Condensate from the containment fan coolers and all floor drains are routed to the containment building sump (i.e., Sump A), which in turn has open communication with the 8 ft. elevation in the case of containment flooding (the containment building sump is located below the 8 ft. elevation).

NRC Request

(v) The basis for concluding that inadequate core or containment cooling would not result due to debris blockage at flow restrictions in the ECCS and CSS flowpaths downstream of the sump screen, (e.g., a HPSI throttle valve, pump bearings and seals, fuel assembly inlet debris screen, or containment spray nozzles). The discussion should consider the adequacy of the sump screen's mesh spacing and state the basis for concluding that adverse gaps or breaches are not present on the screen surface.

NMC Response

The downstream effects evaluation is in progress, and is expected to be completed by the end of September 2005. However, preliminary indications are that there are no significant concerns with these effects.

PBNP does not have any cyclone separators (an identified vulnerability where installed). Both the low head SI (RHR) pumps and containment spray pumps are of relatively robust single stage design without intervening hydrostatic bearings. System piping is free from small orifices: the CSS header orifices are 3/8 in. diameter (considerably larger than the working screen perforation size of 0.125 in. or less), and there are no caged-plug type valves in ECCS recirculation mode flow paths. Valves that are capable of being remotely throttled for flow control are relatively large fail-open butterfly valves (8 in.) in the RHR system and normally open gate valves (6 in.) in the SI system.

See the response in the following section for a description of the potential HHSI pump vulnerability to excessive wear.

The downstream effects analysis for the core is therefore focusing on the upper internals, fuel top nozzles, and intermediate grid straps as potential "pinch points" for trapping suspended debris. The fuel inlet debris screens are not expected to be relevant to the PBNP downstream effects analyses.

Preliminary results are suggesting that substantial quantities of particulate material (primarily from the dissolution of CalSil insulation) may be a challenge to the reactor fuel cooling function. PBNP and their contracted vendor (Areva) are exploring potential refinements, including strainer near field effects, settling of higher density particulates in low velocity flow streams, and strainer penetration fractions.

A separate submittal to update the response to this item will be made when the replacement screen design has been finalized.

NRC Request

(vi) Verification that close-tolerance subcomponents in pumps, valves and other ECCS and CSS components are not susceptible to plugging or excessive wear due to extended post-accident operation with debris-laden fluids.

NMC Response

The verification of acceptability of wear is part of the downstream effects analysis that is currently in progress.

The ex-core components that are most susceptible adverse downstream effects are the High Head SI pumps. These multi-stage pumps have a number of wear rings and an internal hydrostatic bearing, all of which may be susceptible to long-term degradation if operated with abrasive media. Preliminary evaluations of the wear potential on these pumps are positive, and indicate that the increase in wear ring clearance will be less than 2%. Based on these preliminary results, it is expected that the final results will be acceptable.

A separate submittal to update the response to this item will be made when the replacement screen design has been finalized.

NRC Request

(vii) Verification that the strength of the trash racks is adequate to protect the debris screens from missiles and other large debris. The submittal should also provide verification that the trash racks and sump screens are capable of withstanding the loads imposed by expanding jets, missiles, the accumulation of debris, and pressure differentials caused by post-LOCA blockage under predicted flow conditions.

NMC Response

This will be ensured by the final design.

The working design does not credit any debris interceptors or trash racks for debris loading mitigation, although substantial structures exist as part of the existing plant configuration. These structures are horizontal working platforms fabricated from structural steel and bar grating that are located at various levels in the RCS loop compartments. The lowest of these platforms underlies all of the RCS loop piping and most of the major components (known exceptions include tangential portions of an RCP bowl, etc.). These platforms are expected to provide substantial barriers to missiles, while permitting expanding jets to pass through and discharge their energy. Being mostly open area, the platforms are not expected to generate significant differential pressures. If debris were to accumulate on these grates, the existing open areas for ladders and access would provide a drainage path to ensure the platforms do not form "choke points" for continued flow returning to the sump.

The location of the conceptualized replacement strainers place them adjacent to the containment liner, and in areas that are shielded from missiles that may be generated by an energetic LOCA. The shielding structures are the loop compartment walls themselves (3 ft. thick concrete), and in areas where there are openings in the walls, by the previously discussed bar-grate working platforms located below the RCS loops.

Missiles caused by massive, rapid failure of the reactor vessel, steam generator, pressurizer, main coolant pump casings and drives, and RCS piping are not considered credible (consistent with plant licensing under 10 CFR 50 GDC 4). The plant licensing basis considers the following missiles originating from the RCS to be credible, and the plant design specifically protects the containment liner plate from impact from each of these missiles:

1. Valve stems
2. Valve bonnets
3. Instrument thimbles
4. Various sizes of nuts and bolts
5. Complete control rod drive mechanisms or parts thereof
6. Reactor coolant pump flywheels

None of these postulated missiles have credible primary trajectories to the proposed location of the replacement strainers, and the intervening bar grates and/or loop compartment walls and containment floors would intercept rebounding missiles.

The working strainer design is inherently robust, being fabricated primarily of 18 gauge perforated stainless steel, reinforced as needed to be self supporting and capable of withstanding seismic and full design dP loads. The strainers would be expected to deform rather than tear from a low

velocity impact. There is no wire screen material in the proposed configuration that would be susceptible to gross perforation or tearing from incidental effects.

Finally, the redundancy afforded by separate strainers for each train ensures that even in the highly unlikely event of a loss of pump suction due to a strainer failure (e.g., collapse due to debris impact), the remaining train would remain available to provide continued operation.

A separate submittal to update the response to this item will be made when the replacement screen design has been finalized.

NRC Request

(viii) *If an active approach (e.g., backflushing, powered screens) is selected in lieu of or in addition to a passive approach to mitigate the effects of the debris blockage, describe the approach and associated analyses.*

NMC Response

The working design for the replacement screens at PBNP is entirely passive.

NRC Request

(e) *A general description of and planned schedule for any changes to the plant licensing bases resulting from any analysis or plant modifications made to ensure compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this generic letter. Any licensing actions or exemption requests needed to support changes to the plant licensing basis should be included.*

NMC Response

At this time, no licensing submittals are expected to result from GSI-191 effort at PBNP.

As previously described, modifications to install increased capability strainers are scheduled to be completed during the fall 2006 (Unit 2) and spring 2007 (Unit 1) refueling outages.

NRC Request

(f) *A description of the existing or planned programmatic controls that will ensure that potential sources of debris introduced into containment*

(e.g., insulations, signs, coatings, and foreign materials) will be assessed for potential adverse effects on the ECCS and CSS recirculation functions. Addressees may reference their responses to GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," to the extent that their responses address these specific foreign material control issues.

NMC Response

PBNP recognizes that positive control of potential debris sources inside of containment is very important, and that debris sources that are introduced to containment need to be identified and assessed. Potential debris sources can be generally categorized into the following general areas: insulation, coatings (both qualified and unqualified), miscellaneous sources (labels, tags, tape, etc.), and dirt/dust. PBNP currently implements the following controls for these potential sources of debris.

Insulation

Thermal insulation used inside of containment is identified on site drawings and controlled by specifications. These specifications were established during original construction and to support subsequent replacements. The primary concerns of the specifications are to ensure that installed insulation meets the thermal performance requirements, is chemically compatible with the piping or components it is insulating (specifically free of halogens when installed on austenitic stainless steel), provides adequate access for inspections and maintenance, and is within the analyzed seismic envelope for weight. Provided that these concerns are met, the specifications largely permit the substitution of one type of insulation for another.

The existing specifications and work controls do not consider the potential for different debris generation and transport characteristics when replacing or repairing existing insulation. PBNP has documented this deficiency in the Corrective Action program and is imposing a mandatory Engineering review of any work packages on insulation inside containment pending the establishment of programmatic controls. A review of activities during the last refueling outage (back to the point when the walk-downs were performed) has been completed and no changes have been identified.

Coatings

With the exception of isolated minor touch-up repairs (i.e., less than 1 ft^2), all coating repairs, maintenance, and applications inside containment is required to be performed with qualified protective coatings. This includes all coatings on the containment steel shell, concrete, structural steel and

components. The PBNP response to NRC Generic Letter 98-04 (dated November 11, 1998) provides further details of these controls.

The design debris loading of the replacement sump screens/strainers assumes that 100% of the non-qualified coatings, and all qualified coatings within a 10 pipe diameter ZOI are transported to the sump. Since the containment coatings program ensures all coating replacements are as good or better than the existing coatings, future configurations will remain within the analyzed loading.

Dirt and Dust

Existing general housekeeping and decontamination activities have been shown to be sufficient in keeping the accumulation of latent dust and lint well below the level assumed to exist in the debris generation analysis (150 lbs per containment). The sampling of latent dirt and dust already performed in Unit 2 was described previously. Similar sampling will be performed in Unit 1 as previously committed. In order to ensure that the debris generation analysis remains bounding, NMC intends to perform these types of measurements every other refueling outage in each respective unit. For example, the measurements in Unit 2 were taken during the refueling outage in the spring of 2005. The next measurements in Unit 2 will be performed during the refueling outage in the spring of 2008. Assuming the results indicate that the housekeeping practices continue to provide a wide margin to the assumed latent dirt and dust loadings, NMC may choose to relax the 3 year frequency in the future.

Other Miscellaneous Debris

As part of the modification process, addition and removal of components in containment, including materials that could affect sump performance must be identified and evaluated.

Administrative procedures control the types of tags and labels that can be used inside of containment. These are limited to high temperature stainless steel tags secured with stainless steel aircraft cable, lockwire, or banding.

At the end of an outage and prior to entering Mode 4, a formal containment close-out inspection is performed. The close-out is performed to ensure that no materials are left in the containment that would block the suction path of the low head safety injection (RHR) pumps, that the accident suction inlets are free of debris, and that the debris strainers are free of structural distress or abnormal corrosion. All deficiencies are documented and must be corrected before the inspection can be approved.

During operation above Mode 5, containment is treated as a foreign material exclusion (FME) zone. The control is implemented through the personnel accountability process. Any materials noted that are suspected of not belonging in containment are to be identified and reported. If applicable, these are to be removed. An engineering evaluation must be performed for any items brought into containment and not removed, or for any loose items created by the activity (e.g., insulation removed for piping visual inspection) that are not subsequently removed.

ATTACHMENT 1
SUMMARY OF DEBRIS ANALYSIS RESULTS

UNIT 1

For each case considered, the same bounding values for miscellaneous debris is assumed to be transported to the sump screens (100% of postulated containment inventory):

Particulate (ft^3)	Fibrous (ft^3)	Foam Sealant (ft^3)	Film (ft^2)
4.1	38.2	12.0	147.7

For each case considered, the same bounding values for unqualified and degraded coatings is assumed to be transported to the sump screens (100% of containment inventory):

Elevation of Ctmt	**Unqualified Coatings (ft^2)**	**Degraded Coatings (ft^2)**	**Total (ft^2)**
El 8' total	3,811.5	4,464.5	8,276
El 21' total	1,032	1,079	2,111
El 46' total	1,295	548	1,843
El 66' total	13,751	772	14,523
Ctmt Total	**19,889.5**	**6,863.5**	**26,753**

For each case considered, the same bounding values for latent dirt and dust is assumed to be transported to the sump screens:

Type of Debris	**Particulate (lbs)**	**Fibrous (lbs)**
Dirt and Dust	127.5	22.5

For each case considered, the same bounding value for the volume of qualified coatings transported to the sump screens is assumed (based on the limiting largest ZOI and coating involvement):

Qualified Coatings	**Volume (ft^3)**
Total	6.29

In the following summaries of the cases considered, the various zones listed are:

102: 8' elevation adjacent to B RCP cubicle (contains ECCS sump suctions)
103: 8' elevation NW area between A and B loop compartments
104: 8' elevation Eastern area adjacent to B SG cubicle
105: 8' SE area between A and B loop compartments

UNIT 1 (Continued)

Debris Distribution After Blast and Pool Fill Transport

Case Number		RMI	Asbestos	CalSil	Fiber Glass	Temp Mat	Mineral Wool
		A (ft²)	V (ft³)	V (ft³)	V (ft³)	V (ft³)	V (ft³)
1	Totals:	5050.13	296.74	113.05	179.38	23.44	203.11
2	Totals:	5386.11	275.37	110.50	125.87	20.61	0.00
3	Totals:	4945.37	160.81	59.53	78.02	7.30	0.00
4	Totals:	4945.37	159.70	63.57	98.75	11.82	0.00
5	Totals:	5103.05	296.74	89.36	181.40	23.44	218.99

Case #	Case Description
1	Break of the B Hot Leg at the S/G nozzle. This break also generates the greatest variety of debris.
2	Cold Leg break at the B Reactor Coolant Pump nozzle. This case is also the most direct path to the ECCS sump.
3	Break on the Pressurizer Surge Line to Hot Leg connection.
4	Break on the Pressurizer Surge Line where it traverses the intermediate leg.
5	Break on the intermediate leg where it connects to the B Steam Generator nozzle.

UNIT 2

For each case considered, the same bounding values for miscellaneous debris is assumed to be transported to the sump screens (100% of postulated containment inventory):

Particulate (ft^3)	Fibrous (ft^3)	Foam Sealant (ft^3)	Film (ft^2)
3.0	5.4	8.4	189

For each case considered, the same bounding values for unqualified and degraded coatings is assumed to be transported to the sump screens (100% of containment inventory):

Elevation of Ctmt	Unqualified Coatings (ft^2)	Degraded Coatings (ft^2)	Total (ft^2)
El 8' total	3,319	9,478	12,797
El 21' total	1,287	1,163	2,450
El 46' total	1,488	401	1,889
El 66' total	15,377	1,970	17,347
Ctmt Total	**21,471**	**13,012**	**34,483**

For each case considered, the same bounding values for latent debris is assumed to be transported to the sump screens:

Type of Debris	Particulate (lbs)	Fibrous (lbs)
Dirt and Dust	127.5	22.5

For each case considered, the same bounding value for the volume of qualified coatings transported to the sump screens is assumed (based on the limiting largest ZOI and coating involvement):

Qualified Coatings	Volume (ft^3)
Total	6.29

In the following summaries of the cases considered, the various zones listed are:

106: 8' elevation SE area adjacent to B RCP & Pressurizer cubicles
112: 8' elevation SW area between A and B loop compartments
114: 8' elevation South area adjacent to B SG cubicle (contains ECCS sump screens)
111: 8' NE area between A and B loop compartments

UNIT 2 (Continued)

Debris Distribution After Blast and Pool Fill Transport

Case Number		RMI	Asbestos	CalSil	Fiber Glass	Temp-Mat/Insulbat te	Mineral Wool	Buckled NUKON	NUKON	Fiberglass/ Mineral Wool
		A (ft²)	V (ft³)	V (ft³)	V (ft³)	V (ft³)	V (ft³)	V (ft³)	V (ft³)	V (ft³)
1	Totals	0.00	116.07	88.46	107.48	89.28	267.21	0.00	1001.10	0.00
2	Totals	0.00	116.07	122.72	90.57	99.57	323.20	0.00	849.50	0.00
3	Totals	83.02	68.63	83.87	53.45	20.00	130.49	0.00	422.14	0.00
4	Totals	166.05	80.72	83.87	53.45	29.48	18.37	0.00	566.25	0.00
5	Totals	0.00	116.07	83.87	114.70	89.42	311.30	0.00	1046.65	0.00
6	Totals	0.00	2.37	5.50	53.70	0.00	0.00	0.00	0.00	0.00
7	Totals	117.39	116.07	111.84	107.35	89.77	291.43	0.00	937.77	0.00

Case #	Case Description
1	Hot Leg break at the B Steam Generator nozzle.
2	Cold Leg break at the B Reactor Coolant Pump nozzle.
3	Pressurizer Surge Line break at the Hot Leg connection.
4	Pressurizer Surge Line break where it traverses the intermediate leg.
5	Crossover Leg break at the B Steam Generator nozzle connection.
6	Break of the Safety Injection line that is closest to the ECCS sump.
7	Break at the Hot Leg and Surge Line connection (similar to Case 3). This break was postulated to generate the greatest variety of debris types possible.

ATTACHMENT 2
SUMMARY OF DEBRIS TRANSPORT RESULTS

In each of the following tables, the total volumes transported are from their original locations to the location of the ECCS suctions. These results reflect the transport of those debris generated by the LOCA blast only. Latent debris and debris from coatings will be added with the assumption of 100% transportability during the design of the replacement strainers (see Attachment 1 for quantities assumed).

Unit 1 Transport:

Case Number		RMI	Asbestos	CalSil	Fiberglass	TempMat	Mineral Wool	Insulabatte
		Transport By Insulation Type						
		A(ft2)	V(ft3)	V(ft3)	V(ft3)	V(ft3)	V(ft3)	V(ft3)
1	Totals	13.57	205.85	68.01	116.46	10.26	100.23	0.00
2	Totals	1518.14	191.25	66.63	79.63	10.35	0.00	0.00
3	Totals	1643.16	111.93	36.01	57.50	4.52	0.00	0.00
4	Totals	2754.68	128.65	47.51	78.91	9.23	0.00	0.00
5	Totals	3290.56	269.04	71.78	155.88	19.48	190.00	0.00

Unit 2 Transport:

Case Number		RMI	Asbestos	CalSil	Fiberglass	TempMat	Mineral Wool	Buckled Nukon	Nukon	Fiberglass/ Mineral Wool
		Transport By Insulation Type								
		A(ft2)	V(ft3)	V(ft3)	V(ft3)	V(ft3)	V(ft3)	V(ft3)	V(ft3)	V(ft3)
1	Totals	0.00	77.97	52.24	82.68	62.16	147.20	0.00	697.11	0.00
2	Totals	0.00	78.06	69.49	57.75	72.52	159.84	0.00	618.85	0.00
3	Totals	0.13	44.72	45.20	23.28	0.00	61.73	0.00	197.89	0.00
4	Totals	38.24	55.67	48.88	25.16	18.40	10.01	0.00	353.61	0.00
5	Totals	0.00	88.31	55.47	91.54	66.07	194.49	0.00	773.21	0.00
6	Totals	0.00	0.00	5.32	53.69	0.00	0.00	0.00	0.00	0.00
7	Totals	12.98	79.86	65.08	44.09	49.63	149.59	0.00	518.46	0.00

ATTACHMENT 3
REQUIREMENTS FOR REPLACEMENT SCREENS

The following are relevant excerpts from Point Beach Specification PB-681 for the procurement of the replacement ECCS suction strainers.

3.1 *Equipment Location*

Point Beach Nuclear Plant, Units 1 and 2 Containment Buildings...

3.5 *Equipment Operating Conditions*

3.5.1 The Strainer(s) provided shall be rated to provide continuous operation within a temperature range of 50°F to 250°F (Ref. 2.3).

3.5.2 Strainer operation shall be assumed to occur during containment flooding in 250°F (max.) water (Ref. 2.27). The collected sump water is expected to have a pH ranging from 7.0 to 10.5 (Ref. 2.23, 2.24 respectively). Assume saturated conditions.

3.5.3 Strainer operation shall be assumed to operate within a containment pressure range of 0 PSIG (min) to 60.0 PSIG (max.) (Ref. 2.3).

3.5.4 The Strainer(s), during normal radiological (non-accident) operating conditions, are subject to:
Gamma Dose, 40 yr. (Rad) = 1.35E+06 (Ref. 2.3)
Neutron Dose, 40 yr., (Rad) = 4.28E+05 (Ref. 2.3)

3.5.5 The Strainer(s), during abnormal radiological (accident) operating conditions, are subject to:
Gamma Dose, 1 yr. (Rad) = 7.92E+07 (Ref. 2.3)
Beta Dose, 1 yr., (Rad) = 2.00E+08 (Ref. 2.3)

3.5.6 Seismic ground accelerations of 0.06g for Operating Basis Earthquake (OBE) and 0.12g for Safe Shutdown Earthquake (SSE). See Section 10 Attachment C for specific information.

3.6 *Design Requirements*

3.6.1 The strainers shall be designed to automatically function without operator intervention or action.

3.6.2 The proposed strainer will optimize the available "footprint" within the containment building space for the required filter surface. This available space is shown on attached plan drawings.

3.6.3 The strainer design shall include provisions, integral to the design, to seal the opening to the Recirculation line to allow for penetration leakage rate testing, or allow testing with minimal effort to remove strainer components.

3.6.4 The strainer design shall provide access openings to facilitate inspection of strainer internals, vortex suppressors, and sump outlets.

3.6.5 The design shall incorporate a reserve NPSH margin available for debris head loss for chemical effects impacts. The design shall be flexible to allow changes in the reserve $NPSH_A$ once industry and or regulatory guidance becomes available.

3.6.6 The design shall achieve the lowest practical head loss through the strainer, thereby minimizing the impact on ECCS and CSS pumps $NPSH_{Available}$ during Recirculation. This shall be demonstrated for the clean strainer and the fully debris loaded strainer conditions.

3.6.7 Head loss calculations and / or testing shall be applicable for the specific strainer geometry proposed by the vendor and shall be approved by the Owner.

3.6.8 Friction losses shall be considered as a function of flow velocity.

3.6.9 Screen submergence is a design requirement. Exceptions and justification for screens not submerged shall be provided with proposal.

3.6.10 Support braces that cause any significant screen surface areas to be blocked shall be subtracted from the total screen area.

3.6.11 Clean strainer losses occurring inside the strainer due to internal structures, supports, and vortex suppressors shall be considered in the head loss calculations.

3.6.12 The supplier shall identify if vortex suppressors are included in the design or provide the basis for why the use of vortex suppressors is unnecessary.

3.6.13 There shall be no spaces or gaps in the final installation that would allow passage of debris past any strainer component or containment floor irregularities.

3.6.14 If possible, the new strainer should use the existing mounting hardware.

3.6.15 The design shall ensure that the strainer and debris interceptors (if required) are capable of withstanding the force of full debris loading, in conjunction with all design basis conditions including seismic, without collapse or structural damage.

3.6.16 If required, debris interceptors shall be provided to prevent large or medium pieces of post-LOCA generated debris from impacting the strainers and causing physical damage or inoperability of the strainer.

3.6.17 The design shall include provisions to prevent degradation of RHR, SI, and CS Pump performance due to air ingestion or other adverse hydraulic effects.

3.6.18 The design shall not adversely affect the performance of other Emergency Core Cooling or Containment Cooling components or systems.

3.6.19 The design shall provide for physical separation, to the extent practical, so that failure of one strainer does not adversely affect operation of the remaining strainer.

3.6.20 The design shall be flexible enough to accommodate changes in support anchor locations on the Containment Floor as a result of rebar or other structural interferences.

3.6.21 The design shall maximize use of existing space in the installation location, and shall not prevent access to the Containment walkways.

3.6.22 The design shall ensure adequate access to existing equipment for maintenance and operation.

3.6.23 To avoid heavy load requirements, individual components to weigh less than 1,750 lbs., if possible.

3.7 *QA Classification – Safety Related (*SR) The Strainers qualify as Safety-Related equipment as their operation directly impacts the Safety-Related function of the Emergency Core Cooling System (ECCS) (i.e., providing long-term emergency core cooling during the Recirculation Mode of a post-DBLOCA event). The Strainers provide a filtered, positive suction head to the RHR pumps, specifically during Low Head Safety Injection.

4. TECHNICAL REQUIREMENTS

4.1 *Strainer Pressure Drop*

Post-accident, when the Strainer is partially plugged with debris, the Strainer design shall not cause an additional pressure drop such that the available Net Positive Suction Head ($NPSH_A$), for the RHR pump, is less than the required Net Positive Suction Head ($NPSH_R$). Each Strainer shall produce a frictional flow head loss no greater than 38 inches of 212 °F water at 2200 gpm with projected debris accumulation. The ECCS (RHR) pump Net Positive Suction Head (NPSH) calculation of record (Ref. 2.19) does not credit any sump water level in containment and performs the analysis using 212 °F water. At least 38 inches of water will be available in the containment sump at the initiation of ECCS recirculation, (Ref. 2.26, Ref. 2.34 and Ref. 2.47). Therefore, by limiting Strainer head losses to no more than the minimum anticipated containment sump water level, the NPSH calculation of record will not be adversely affected. This 38 inch design head loss must also accommodate any effective $NPSH_A$ reduction due to vortex effects.

4.2 *Strainer Flow*

The Strainer(s), partially blocked with Large Break LOCA (DBLOCA) generated debris, shall be structurally capable of sustaining adequate filtered, long-term recirculation cooling flow under maximum projected debris accumulation. The Strainer(s) shall be constructed so as to conservatively allow (through either train) a 2200 gpm flow...

4.3 *Strainer Fabrication Materials*

All materials used in the construction and assembly of the strainers, and associated equipment shall be compatible with the containment environment and capable of supporting sustained operation in excess of one year. Aluminum shall not be used.

4.4 *Identification plates*

4.4.1 All Strainer identification plates and attachment pins shall be stainless steel.

4.4.2 Identification plates shall be fabricated per ASME B31.1 – 1998 guidance and shall include the manufacturer's name, serial number, date code, safety classification designation, unit and service train (if applicable) designation, material of fabrication, rated flow capacity and design pressure drop.

4.5 *Testing*

4.5.1 The Vendor shall conduct and be responsible for, the performance testing required to justify the Strainer sizing and to ensure that the Strainer(s), debris interceptors, mounting supports and associated equipment meet the design requirements.

4.5.2 The supplier shall submit a test plan to the Owner for review prior to performing any testing.

4.5.3 Prior to fabrication, the Supplier shall submit the testing data, analysis, and or calculations that predict the strainer head loss performance for both the clean and debris loaded strainer in accordance with the design conditions specified herein. The following are specific requirements for compliance:

4.5.3.a Clean strainer head loss calculations shall be performed for the condition of the strainer mechanical surfaces being in a clean, unfouled condition. Standard methods of fluid mechanics shall be used.

4.5.3.b Debris loading head loss performance shall be in accordance with defensible correlations to NUREG CR/6224 methodology and / or based upon actual debris testing prototypical flow and screen conditions.

I. If the module (s) and / or strainer system is comprised of more than one module, the vendor must justify how the test is representative and defensible for the entire screen system.

II. If the debris tests will include only one full scale module, or something other than the proposed module, the supplier must justify how the test plan is representative and defensible to predict the clean strainer and debris head loss performance of the entire strainer system.

4.5.4 Each Material Test Report shall include data identifying each component/system tested. That data shall be the Vendor's test method, test number, date of test, Supplier's name, contract (PO) number, Buyer's Site name and Unit and/or Train designation.

4.5.5 The Vendor shall provide at least fourteen (14) working days notice prior to conduct of testing so that arrangements may be made to have an authorized Owner's representative attend the testing.

4.5.6 Material Test procedures and results shall be subject to Owner's representative approval. All test procedures and certified copies of testing data/reports shall be submitted to the Owner prior to Vendor's equipment shipment preparation. The Vendor shall schedule testing far enough in advance of the shipping date to allow time for correction of any errors or omissions discovered during testing.

4.5.7 Any deficiencies in the Vendor's equipment or material brought out during these tests shall be promptly remedied by Vendor at no expense to the Owner.

4.5.8 The Vendor shall provide the following data information applicable to the new replacement Strainers, Debris Interceptors and associated equipment:

4.5.8.a Seismic analysis/test results according to criteria specified in Section 10, ATT. C.

4.5.8.b Equipment Qualification as specified in Section 3.7.

4.5.8.c Calculation modeling to verify the proposed Strainer(s) designed Head Loss characteristics as discussed in Section 4.1.

4.5.8.d The Vendor shall provide test reports that substantiate the Strainer's performance under the proposed debris loading conditions considered in References 2.31 and 2.32. This includes consideration of the all types and quantities of debris anticipated during a DBLOCA event.

4.5.8.e Shop testing, prior to shipment, that the Strainer assemblies meet the critical design attributes specified.

4.6 Seismic Consideration

The proposed Strainers and supporting or attachment structure will be categorized as Class I equipment, and are required to remain fully operational during and after an Operating Basis Earthquake (OBE) without overstressing any components/parts; and during and after a Safe Shutdown Earthquake (SSE) without impairing the components/parts function. See Attachment C for detailed information.