FPL Energy
Seabrook Station

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SBK-L-08033
Docket No. 50-443

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Seabrook Station

Supplemental Response to NRC Generic Letter 2004-02,
"Potential Impact of Debris Blockage on Emergency Recirculation
During Design Basis Accidents at Pressurized-Water Reactors"

References:

1. Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," September 13, 2004.

2. Letter from J. A. Stall (FPL) to U. S. Nuclear Regulatory Commission "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," March 4, 2005.

3. Letter from V. Nerses (U. S. Nuclear Regulatory Commission) to M. E. Warner (FPL Energy Seabrook, LLC), "Seabrook Station, Unit 1 – Request for Additional Information (RAI) Related to Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized Water Reactors," June 3, 2005.

4. Letter from J. A. Stall (FPL) to U. S. Nuclear Regulatory Commission "Request for Additional Information - Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," July 20, 2005.

5. Letter from J. A. Stall (FPL) to U. S. Nuclear Regulatory Commission "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors – Second Response," September 1, 2005.

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6. Letter from J. A. Stall (FPL) to U. S. Nuclear Regulatory Commission "Supplement to Response to NRC Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," January 27, 2006.

7. Letter from G. E. Miller (U. S. Nuclear Regulatory Commission) to G. F. St. Pierre (FPL Energy Seabrook, LLC) "Seabrook Station, Unit No. 1, Request for Additional Information Re: Response to Generic letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," February 9, 2006.

8. Letter from C. T. Haney (U. S. Nuclear Regulatory Commission) to Holders of Operating Licensees for Pressurized Water Reactors, "Alternative Approach for Responding to the Nuclear Regulatory Commission Request for Additional Information RE: Generic Letter 2004-02," March 28, 2006.

9. Letter from G. E. Miller (U. S. Nuclear Regulatory Commission) to G. F. St. Pierre (FPL Energy Seabrook, LLC) "Seabrook Station, Unit 1 – Requested Extension of Completion Schedule for NRC Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," April 11, 2006.

10. Letter from C. T. Haney (U. S. Nuclear Regulatory Commission) to Holders of Operating Licenses for Pressurized Water Reactors, "Alternative Approach for Responding to the Nuclear Regulatory Commission Request for Additional Information Letter Regarding Generic Letter 2004-02," January 4, 2007.

11. Letter from W. H. Ruland (U. S. Nuclear Regulatory Commission) to A. Pietrangelo (Nuclear Energy Institute), "Content Guide for Generic Letter 2004-02 Supplemental Responses," August 15, 2007.

12. Letter from W. H. Ruland (U. S. Nuclear Regulatory Commission) to A. Pietrangelo (Nuclear Energy Institute), "Revised Content Guide for Generic Letter 2004-02 Supplemental Responses," November 21, 2007.

13. Letter from W. H. Ruland (U. S. Nuclear Regulatory Commission) to A. Pietrangelo (Nuclear Energy Institute), "Supplemental Licensee Responses to Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," November 30, 2007.

14. Letter from J. A. Stall (FPL) to U. S. Nuclear Regulatory Commission "Request for Extension of Completion Date of the St. Lucie Unit 1, St. Lucie Unit 2 and Turkey Point Unit 3 Generic Letter 2004-02 Actions," December 7, 2007.

The purpose of this submittal is to provide the FPL Energy Seabrook, LLC (FPL Energy Seabrook) supplemental response to Generic Letter (GL) 2004-02 (Reference 1) for Seabrook Station. The Nuclear Regulatory Commission (NRC) issued Reference 1 to request that addressees perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions in light of the information provided in the GL and, if appropriate, take additional actions to ensure system functions.

Additionally, the GL requested addressees to provide the NRC with a written response in accordance with 10 CFR 50.54(f). The request was based on identified potential susceptibility of the pressurized water reactor (PWR) recirculation sump screens to debris blockage during design basis accidents requiring recirculation operation of ECCS or CSS and on the potential for additional adverse effects due to debris blockage of flow paths necessary for ECCS and CSS recirculation and containment drainage.

Reference 2 provides the initial FPL Energy Seabrook response to the GL. Reference 3 requested additional information regarding the Reference 2 response to the GL for Seabrook Station. Reference 4 provided the FPL Energy Seabrook response to Reference 3. Reference 5 provides the second of two FPL Energy Seabrook responses requested by the GL. In Reference 6, FPL Energy Seabrook requested a short extension for the completion of the corrective actions required by the GL for Seabrook Station until the Station spring 2008 refueling outage. This request for extension was approved in Reference 9. Reference 7 requested FPL to provide additional information to support the NRC staff's review of Reference 2, as supplemented by References 4 and 5.

Reference 8 provided an alternative approach and timetable that licensees may use to address outstanding requests for additional information (i.e., References 3 and 7). Reference 10 supplemented Reference 8 with the NRC expectation that all GL 2004-02 responses will be provided no later than December 31, 2007. For those licensees granted extensions to allow installation of certain equipment in spring 2008, the NRC staff expects that the facility response will be appropriately updated with any substantive GL corrective action analytical results or technical detail changes within 90 days of the change or outage completion. As further described in Reference 10, the NRC expects that all licensees will inform the NRC, either in supplemental responses to GL 2004-02 or by separate correspondence as appropriate, when all GSI-191 actions are complete.

Reference 11 describes the content to be provided in a licensee's final GL 2004-02 response that the NRC staff believes would be sufficient to support closure of the GL. Reference 12 revised the guidance provided in Reference 11 by incorporating minor changes which were viewed by the NRC as clarifications. However, Reference 12 was issued after major development of this response, using the guidance of Reference 11. Therefore, this response was prepared using the guidelines of Reference 11.

Reference 13 authorized all PWR licensees up to two months beyond December 31, 2007 (i.e., to February 29, 2008), to provide the supplemental responses to the NRC.

In accordance with References 1, 7, 8, 9, and 11, FPL Energy Seabrook is providing in Attachment 1 to this letter the necessary supplemental response that addresses the GL actions at Seabrook Station.

Regulatory commitments made in this submittal are summarized in Attachment 2.

This information is being provided in accordance with 10 CFR 50.54(f).

Should you have any questions regarding this letter, please contact Mr. James M. Peschel, Regulatory Programs Manager, at (603) 773-7194.

Very truly yours,

FPL Energy Seabrook, LLC.

Gene St. Pierre
Site Vice President

Attachments (2)

cc: S. J. Collins, NRC Region I Administrator
G. E. Miller, NRC Project Manager, Project Directorate I-2
W. J. Raymond, NRC Senior Resident Inspector

FPL Energy
Seabrook Station

AFFIDAVIT

SEABROOK STATION UNIT 1

Facility Operating License NPF-86
Docket No. 50-443

Supplemental Response to NRC Generic Letter 2004-02,
"Potential Impact of Debris Blockage on Emergency Recirculation
During Design Basis Accidents at Pressurized-Water Reactors"

I, Gene F. St. Pierre, Site Vice President of FPL Energy Seabrook, LLC hereby affirm that the information and statements contained within this supplemental response to Generic Letter 2004-02 are based on facts and circumstances which are true and accurate to the best of my knowledge and belief.

Sworn and Subscribed
before me this
28th **day of** February**, 2008**

Shirley Sweeney
Notary Public

SHIRLEY SWEENEY
MY COMMISSION EXPIRES OCT. 6, 2009
NOTARY PUBLIC
NEW HAMPSHIRE

Gene St. Pierre
Site Vice President

Attachment 1

Supplemental Response to NRC Generic Letter 2004-02,
"Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

ATTACHMENT 1

Topic 1: Overall Compliance

FPL Response

The response to GL 2004-02 that was submitted to the NRC on September 1, 2005 (September 1 response) was based on the information that was available at that time.

Subsequent to the September response, FPL Energy Seabrook installed debris interceptors during outage OR11 (fall 2006) to mitigate the effects of debris generated by a postulated LOCA, enhanced programmatic controls for coatings, and developed additional corrective actions for implementation (e.g., a program to reduce the quantity of labels available for transport to the strainers). Preparations are in progress for completing the installation of the replacement strainers and scupper debris interceptors, and final testing and analyses (e.g., chemical effects testing of the final strainer design and downstream effects analyses).

It is anticipated that upon completion of the planned corrective actions and confirmatory tests and analyses, Seabrook Unit 1 will be demonstrated to be in compliance with the regulatory requirements listed in Applicable Regulatory Requirements section of GL 2004-02.

However, although not expected, the final testing and analyses may result in further reexamination of original assumptions and bases of other calculations or, potentially, additional corrective actions. In the case that additional corrective actions are required, FPL Energy Seabrook will contact the NRC.

Additional information to support the staff's evaluation of Seabrook Unit 1 compliance with the regulatory requirements of GL 2004-02 was requested by the NRC in a "Request for Additional Information" (RAI) dated February 9, 2006 (NRC Letter to FPL (G. F. St. Pierre), Seabrook Station, Unit 1, Request for Additional Information RE: Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors" (TAC No. MC4716), February 9, 2006). Each RAI question is addressed in this response. The RAI question (and specific RAI response) is identified by the RAI question number in the following format: **[RAI ##]**, where ## is the RAI question number.

Topic 2: General Description of and Schedule for Corrective Actions

FPL Response

Subsequent to the September 1 response, FPL Energy Seabrook requested a short extension to permit completion of corrective actions associated with GL 2004-02 during outage OR12 which is scheduled for the spring of 2008 (FPL to NRC Letter L-2006-028, "Supplement to Response to NRC Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors, " January 27, 2006). The NRC approved the extension request in a letter dated April 11, 2006 (NRC Letter to FPL Energy Seabrook (G. F. St. Pierre), Seabrook Station, Unit No. 1, Requested Extension of Completion Schedule for NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors" (TAC No. MC4716), April 11, 2006). As part of the extension request, FPL Energy Seabrook committed to, and installed, debris interceptors during outage OR11 (fall 2006) to mitigate the effects of debris generated by a postulated LOCA. The installed debris interceptors are described in the response to NRC Topic 3.j, *Screen Modification Package.* The remaining identified corrective actions, which are planned for outage OR12 (spring 2008), are discussed below. Enhancements to programmatic controls are described in the responses to NRC Topics 3.h, *Coatings Evaluation* and 3.p, *Foreign Material Control Programs.*

The original sump screens will be completely replaced with strainers that provide a strainer surface area of approximately 2,412 ft^2 in each sump. The new strainers are passive (i.e., the strainers do not have any active components or rely on back flushing). The strainers are described in the response to NRC Topic 3.j, *Screen Modification Package*

Additional debris interceptors will be installed on the scuppers in the bioshield wall to further reduce the debris that can be transported to the sump strainers from a postulated LOCA. The scupper debris interceptors are described in the response to NRC Topic 3.j, *Screen Modification Package.*

Cable tray labels will be removed to reduce the miscellaneous debris that could be generated by labels that fail due to a postulated LOCA. The label modification is described in the response to NRC Topic, 3.d, *Latent Debris.*

Many of the confirmatory testing and analyses have already been completed. However completion of tests and analyses that depend upon resolution of chemical effects issues and those that are impacted by the recent revision to WCAP-16406-P (WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191", Revision 1, August, 2007) are scheduled to be completed prior to the end of outage OR12 (spring 2008).

Information not supplied herein will be provided in the follow-on supplemental response to be submitted 90 days after completion of outage OR12.

Although not expected, the final testing and analyses may result in further reexamination of original assumptions and bases of other calculations or, potentially, additional corrective actions. In the case that additional corrective actions are required, FPL Energy will contact the NRC.

Topic 3.a: Break Selection

FPL Response

In agreement with the staff's safety evaluation (SE) of Nuclear Energy Institute (NEI) 04-07, the objective of the break selection process was to identify the break size and location which results in debris generation that will maximize the head loss across the containment sump strainers. Breaks were evaluated based on the methodology in NEI guidance document NEI 04-07 as modified by the staff's SE of NEI 04-07.

The following specific break location criteria were considered:

- Breaks in the reactor coolant system with the largest amount of potential debris within the postulated zone of influence (ZOI),
- Large breaks with two or more different types of debris, including breaks with the most variety of debris,
- Breaks in areas with the most direct path to the sump,
- Medium and large breaks with the largest potential particulate debris to insulation ratio by weight, and
- Breaks that generate an amount of fibrous debris that, after transport to the sump strainers, could form a uniform "thin bed".

[RAI 34] All Reactor Coolant System (RCS) piping and attached energized piping was considered for potential break locations. Feedwater and main steam piping was not considered for potential break locations because ECCS in recirculation mode is not required for Main Steam or Feedwater line breaks.

[RAI 33] Only one type of insulation (Nukon) will be affected by a bounding break at Seabrook Unit 1. This means that any break location will yield a similar debris mix. Therefore, inside the bioshield, the discrete approach described in Section 3.3.5.2 of the staff's SE of NEI 04-07 was used to identify limiting break locations based on the debris source term and the transport potential. The staff's SE of NEI 04-07 notes that the concept of equal increments is only a reminder to be systematic and thorough. As stated in the staff's SE of NEI 04-07, the key difference between many breaks (especially large breaks) will not be the exact location along the pipe, but rather the envelope of containment material targets that is affected.

Inside the bioshield, breaks in the hot leg (29-inch ID), crossover leg (31-inch ID), cold leg (27½-inch ID), pressurizer surge line (14-inch nominal), RHR hot leg recirculation line (12-inch nominal), and cold leg safety injection line (10-inch nominal) were considered. The RHR, safety injection and other piping in the same general area inside the bioshield are smaller diameter than the reactor coolant lines. Therefore, breaks in these lines are bounded by breaks in the reactor coolant lines. The crossover leg has the largest diameter and produces the largest ZOI. A break in the loop 4 crossover leg was selected for analysis because it is close to the containment sump. A break in the loop 4 hot leg was also selected for analysis because it is close to the sump, and is also near loop 1 where it will generate debris from both loops. A break in the loop 3 crossover leg was selected for analysis because the pressurizer and associated piping are on this loop.

A hot leg or cold leg line break at the reactor pressure vessel (RPV) was also considered. The RPV is covered with Transco reflective metal insulation (RMI). This break would affect the reactor insulation and the insulation on the RCS lines adjacent to the break up to the penetrations. However, this debris would fall to the bottom of the reactor vessel cavity, and would not have a transport path to the sump. In addition, the debris interceptors would further reduce the possible quantity of RMI that could be transported to the sump. Finally, Transco RMI is less detrimental to sump performance than fiber debris, and the amount of debris would be bounded by a hot or cold line break elsewhere in the line. Therefore, a hot leg or cold leg break at the RPV would not be bounding and was not analyzed.

Outside the bioshield, breaks were considered in the RHR recirculation lines. The RHR recirculation lines are of smaller diameter than the RCS piping. Therefore, inside the bioshield, a break in these lines would be bounded by the reactor coolant loops. However, the RHR recirculation lines travel outside the bioshield before the second isolation valve, directly above the sumps. Therefore breaks in these lines were selected for analysis in order to include a break outside the bioshield. A break in line RC-58 produced the most debris among potential break locations outside the bioshield.

The postulated break locations were as follows:

- S1 Loop 4 hot leg at the base of the steam generator (29-inch ID)
- S2 Loop 4 crossover leg at the base of the steam generator (31-inch ID)
- S3 Loop 3 crossover leg at the base of the steam generator (31-inch ID)
- S4 RHR recirculation line RC-58 outside the bioshield (12-inch nominal)

Break S3 generated the greatest quantity of debris. Therefore, it was selected for the strainer design basis.

Topic 3.b: Debris Generation/Zone of Influence (ZOI) (excluding coatings)

FPL Response

The debris generation calculation used the methodologies of Regulatory Guide 1.82, Rev. 3, NEI 04-07 and the staff's SE of NEI 04-07. However, there have been changes in the input to the analyses since the September 1 response.

Debris-specific ZOIs were used in the debris generation calculation. The ZOIs for insulation, except for jacketed Nukon, were obtained from Table 3-2 of the staff's SE of NEI 04-07. Refinements to the ZOIs that were provided in NEI 04-07 are based on test data (i.e., ZOI for jacketed Nukon). The ZOI for each debris type is discussed below.

The ZOI used for unjacketed Nukon is 17.0D, which was obtained from Table 3-2 of the NRC staff's SE of NEI 04-07. The ZOI for jacketed Nukon is 7.0D. The ZOI reduction from 17.0D to 7.0D for jacketed Nukon is supported by tests documented in WCAP-16710-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) of Min-K and NUKON® Insulation for Wolf Creek and Callaway Nuclear Operating Plants," Rev. 0, October 2007.

The ZOI used for Transco RMI is 2.0D, which was obtained from Table 3-2 of the NRC staff's SE of NEI 04-07.

The updated debris generation calculation makes use of two assumptions related to non-coating debris generation.

Assumption 1

Supporting members fabricated from steel shapes (e.g., angles, plates) are installed to provide additional support for RMI on equipment such as reactor coolant pumps, Steam Generators and Pressurizer. It is assumed that, as a result of the postulated pipe break, these supporting members will be dislodged from the equipment, and may be bent and deformed, but will not become part of the debris that may be transported to the sump.

Assumption 2

In the September 1 response, it was noted that an analytical process was used that conservatively overstated the quantity of debris from insulation by 5-15%. That analytical process has been completely replaced, and the debris quantity is no longer overstated. However, 100 ft^3 has been added to the Nukon insulation volume results for margin. In addition, a uniform factor of 1.1 is applied to the ZOI that is used for calculating piping insulation volumes to account for minor variances such as insulation around valves, irregularities in the as-installed configuration.

The quantities of debris and the ZOI for each debris type are provided in Table 3.b-1 below.

Table 3.b-1: Destruction ZOI and Break Comparison

Debris Type	Destruction ZOI	Break S1 (Note 1)	Break S2 (Note 1)	Break S3 (Note 1)	Break S4 (Note 1)
Nukon (Total)		988.21 ft^3	1024.82 ft^3	1233.14 ft^3	92.70 ft^3
Jacketed	7.0D				
Unjacketed	17.0D				
Insulation Jacketing	7.0D	2397.61 ft^2	2417.77 ft^2	2938.89 ft^2	172.24 ft^2
Qualified Coatings (Note 2)					
Concrete	4.0D	1.32 ft^3	1.32 ft^3	1.32 ft^3	0.24 ft^3
Steel (Note 3)	4.0D	1.80 ft^3	1.80 ft^3	1.80 ft^3	0.50 ft^3
Steel (Note 3)	10.0D	3.45 ft^3	3.45 ft^3	3.45 ft^3	0.00 ft^3
Unqualified Coatings - Total	N/A	22.36 ft^3	22.36 ft^3	22.36 ft^3	22.36 ft^3
Latent Debris (Note 4) (15% Fiber, 85% Particulate)	N/A	40.7 lbm	40.7 lbm	40.7 lbm	40.7 lbm
Foreign Materials (Note 5)	N/A	696 ft^2	696 ft^2	696 ft^2	696 ft^2

Notes:

1. Break locations are discussed in the response to NRC Topic 3.a, *Break Selection.*
2. The destruction ZOIs for qualified coatings is discussed in the response to NRC Topic 3.h, *Coatings Evaluation.*
3. A ZOI of 4D was applied to those qualified steel coatings that were tested and passed the test criteria for use of a 4D ZOI. A ZOI of 10D was applied to qualified steel coatings that were not included in the test for applicability of a 4D ZOI.
4. The measured quantity of latent debris was 40.7 lbm. However, the quantity of latent debris used in the transport analysis was conservatively increased to 200 lbm.
5. Strainer Foreign Materials ("Sacrificial Area") include the surface area of all signs, placards, and similar materials in containment. However, a corrective action has been initiated to reduce the quantity of labels during outage OR12 (spring of 2008), which will reduce the total quantity of foreign materials. The quantity estimated in Table 3.b-1 will be updated when the results of the reduction program are available, and will be provided with the supplemental response that is to be submitted within 90 days after completion of outage OR12 (spring 2008).

Topic 3.c: Debris Characteristics

FPL Response

[RAI 35] The potential sources of debris in the Seabrook containment are reflective metal insulation (RMI), coatings, Nukon and Nukon insulation jacketing, latent and miscellaneous debris. The RMI is located on the reactor vessel, and the limiting breaks are not close enough to the reactor vessel to generate RMI debris. Therefore, the debris in the Seabrook containment is made up of coating debris, Nukon, Nukon jacketing, latent and miscellaneous debris.

All coating debris was modeled as small fines.

The Nukon (fiber) transport was modeled in two stages for the purposes of determining the strainer debris load and head loss. As discussed in the response to NRC Topic 3.e, *Debris Transport*, Stage 1 covers the time period up to the start of recirculation, and Stage 2 covers the time after the start of recirculation. Stage 1 modeled fiber transport to the first encountered debris interceptor and does not consider debris size. Stage 2 modeled fiber transport from the debris interceptors to the sump strainers and does consider debris size. The size distributions used for the fiber transport in the Stage 2 transport model are provided in Table 3.c-1 below.

Because the debris interceptors prevent insulation jacketing from reaching the sump strainers, the debris characteristics for insulation jacketing were not required for the transport analysis, and therefore were not developed.

The technical basis for the surface areas of signs, placards, tags, tape, etc., is provided in the response to NRC Topic 3.d, *Latent Debris.*

The specific surface area, S_V, is a parameter that is used in the NUREG/CR-6224 head loss correlation. The head loss across the strainers was determined by testing, not the NUREG/CR-6224 correlation. Therefore, the specific surface area was not calculated or used. The head loss determination is described in the response to NRC Topic 3.f, *Head Loss and Vortexing.*

The bulk densities used in the analyses and tests are provided in Table 3.c-2 below.

Table 3.c-1: Fiber Debris (Nukon) Size Distribution

Transport Stage	Category	Size Percentage
Stage 1	17.0D ZOI	
	Fines	8%
	Small Pieces	25%
	Large Pieces	32%
	Intact	35%
Stage 1	7.0D ZOI	
	Fines	25%
	Small Pieces	75%
	Large Pieces	0%
	Intact	0%
Stage 2	Fines and Small Pieces	100%

Table 3.c-2: Bulk Densities Used For Sector Tests

Debris Type	Surrogate	Bulk density
Nukon Fiber	Transco Fiberglass Insulation	2.4 lbs/ ft^3
Particulates	Silicon Carbide	94 lbs/ ft^3

Topic 3.d: Latent Debris

FPL Response

The bases and assumptions related to latent and miscellaneous debris, and the resulting quantities used for analyses and testing, have been updated since the September 1 response. In that response it was noted that the quantity of latent debris was an assumed value in lieu of applied survey results, and that the sacrificial area for miscellaneous debris was an estimated value. Subsequently, walkdowns have been completed in the Seabrook Unit 1 containment specifically for the purposes of characterizing latent and miscellaneous (foreign) debris. These walkdowns utilized the guidance in NEI 02-01 and the staff's SE of NEI 04-07.

The methodology used to estimate the quantity and composition of latent debris in the Seabrook containment is that of the staff's SE of NEI 04-07, Section 3.5.2.2. Samples were collected from eight surface types; floors, containment liner, ventilation ducts, cable trays, walls, equipment, piping, and grating. Where feasible, for each surface type a minimum of (4) samples were collected, bagged and weighed to determine the quantity of debris that was collected. A statistical approach was used to estimate an upper limit of the mean debris loading on each surface. The horizontal and vertical surface areas were conservatively estimated. The total latent debris mass for a surface type is the upper limit of the mean debris loading multiplied by the conservatively estimated area for that surface type, and the total latent debris is the sum of the latent debris for each surface type.

Based on the walkdown data, the quantity of latent debris in the Seabrook Unit 1 containment is estimated to be 40.7 pounds. However, for conservatism, the strainer test was based on 200 pounds of latent debris. The latent debris composition is assumed to be 15% fiber and 85% particulate in agreement with the staff's SE of NEI 04-07.

The walkdown for miscellaneous (foreign) debris was performed for the purpose of identifying and measuring plant labels, stickers, tape, tags and other debris. The estimated quantity of miscellaneous debris in the Seabrook Unit 1 containment, based on the walkdown, is provided in Table 3.d-1 below. However, a corrective action has been initiated to reduce the quantity of labels. This corrective action consists of removing cable tray and wire way labels, and will be implemented during outage OR12 (spring of 2008). The estimated quantities in Table 3.d-1 will be updated when the results of the label reduction program are available, and will be provided with the supplemental response that is to be submitted 90 days after completion of outage OR12 (spring 2008).

Table 3.d-1: Estimated Miscellaneous (Foreign) Debris in Containment Prior to Debris Reduction Program

Item	Containment Total
Labels, Stickers, Tape, etc.	442.541 ft^2
Tags, Placards, etc.	11.649 ft^2
Glass (containment lighting)	241.775 ft^2
Adhesive	0.00217 ft^3

Topic 3.e: Debris Transport

FPL Response

The Seabrook Unit 1 containment is a "mostly uncompartmentalized containment" as described in Section 3.6.2 of NEI 04-07. Debris interceptors are utilized to limit the quantity of debris that reaches the strainers by trapping debris and allowing the remaining debris more time to settle. Debris interceptors have been installed in all but one of the bioshield access openings, and are scheduled to be installed in all scuppers during outage OR12 (spring of 2008). The bioshield access opening farthest from the sumps is left open so that flow is assured from the inner annulus to the outer annulus, regardless of the debris accumulation on the other bioshield debris interceptors. The debris interceptors (including locations) and sump strainers are described in the response to NRC Topic, 3.j, *Screen Modification Package*.

[RAI 41] In the September 1 response it was noted that debris transport would be analyzed using the computational fluid dynamics (CFD) based methodology outlined in NEI 04-07. Subsequently, for the purposes of determining the strainer debris load and head loss, it was decided to use a two stage approach that is based on a combination of analysis and testing. Stage 1 covers the time period up to the start of recirculation (i.e., pool fill-up). This stage modeled fiber transport up to the first encountered debris obstacle. Stage 2 covers the time after the start of recirculation. This stage modeled fiber transport from the debris interceptors to the sump strainers. Transport of particulates, latent, and miscellaneous debris is discussed separately below. The results of the transport analyses used for the strainer debris load and head loss are summarized in Table 3.e-1.

The Stage 1 analysis considered three main debris transport modes of NEI 04-07 for insulation debris: (1) blowdown transport, (2) washdown spray transport, and (3) pool fill-up transport. No credit was taken for debris settling in the Stage 1 analyses.

Due to the relative simplicity of the transport analysis, logic trees were not required and were not used in the Stage 1 analysis. For insulation debris, the blowdown transport analyses used the approach in Appendix VI of the staff's SE of NEI 04-07. For mostly uncompartmentalized containments, Section 3.6.3.2 of NEI 04-07 states that all RMI debris (small and large) is conservatively postulated to fall to the containment floor. Although NEI 04-07 does not specifically state that all fiber debris is assumed to fall to the containment floor, it was conservatively modeled as such. Thus all LOCA generated debris was modeled as falling to the containment floor.

The initial insulation debris dispersion in the blowdown transport analysis was modeled using an approach similar to that in Section VI.3.3.2.1 of the staff's SE of NEI 04-07. However, because of the Seabrook containment design, it was acceptable to base the insulation debris dispersion on floor area instead of compartment volume. The basement floor inside containment was divided into pie shaped regions at 45° intervals, and the area of each region was computed. Each region was then assigned a baseline value based on its fraction of the whole area, and a weighting factor for each break that was based on the region's proximity to each break. These values were then used to determine the initial debris dispersion for each break.

A Stage 1 washdown spray transport analysis was not required or performed because, as stated above, it was conservatively assumed that all LOCA-generated insulation debris was deposited on the floor of the containment during blowdown.

In the Stage 1 pool fill-up analysis, due to velocities inside the bioshield being as high as 2 to 3 m/s, all insulation debris was assumed to transport to a debris interceptor in the bioshield doorways during pool fill-up with one exception. That exception is the transport pathway through the single bioshield doorway opening that is not blocked by a debris interceptor. Large and intact debris that is transported through the open doorway is assumed to remain at rest outside this doorway in the Stage 1 transport analysis. All other debris that is transported through this doorway is assumed to transport to the nearest debris interceptor in the annulus outside the bioshield.

Sequestration of debris in inactive volumes during pool fill-up is considered as part of the Stage 1 analysis. The quantity of fine debris sequestered in inactive volumes is limited to 15% in accordance with the staff's SE of NEI 04-07.

The Stage 2 analyses modeled fiber transport during recirculation. The starting point was the fiber distribution generated for the bounding break in the Stage 1 transport analysis. Simulated bioshield fiber transport tests were run to determine the fraction of the fiber that is transported through the doorway that does not contain a debris interceptor. The results of the tests are that 70% of the fiber is transported through the doorway for single train operation and 53% of the fiber is transported through the doorway for dual train operation. The Stage 2 transport analyses were then performed for two recirculation flow cases; 13,180 gpm and 8,050 gpm. In both cases the velocity was based on the minimum water level. These flow velocities were then correlated with the test velocities to determine the amount of fiber held up at each debris interceptor. The effectiveness of the debris interceptors with regard to retaining fiber was determined by testing in a 20-foot flume with approach velocities that ranged from 0.252 ft/sec to 0.517 ft/sec.

Particulates, latent, and foreign debris were modeled separately. For the purpose of establishing the debris load used for strainer head loss testing, it was assumed that all particulate, latent, and foreign debris was transported to the strainer. The latent debris load was assumed to be 200 pounds. This is significantly larger than the value that was determined based on walkdown data, 40.7 lbm (See the response to NRC Topic 3.d, *Latent Debris*.).

In the Stage 1 analysis, debris from qualified coatings was transported using the same methodology and weighting factors as the insulation debris described above. The locations of many unqualified sources were identified from the unqualified coatings log. Where the location of an unqualified coating source was able to be determined, the debris from that source was distributed to the appropriate debris interceptor and/or the sump strainer. The remainder of the unqualified coating debris was distributed equally between all the debris interceptors and sump strainers. Latent debris consists of 85% particulate and 15% fiber. The particulate latent debris was modeled as being divided between the inner and outer annulus based on the area ratio of the two, and then was distributed equally between the debris interceptors and sump strainers in the inner and outer annuli respectively. Foreign material was modeled with an initial distribution of 75% in the outer annulus (which is where the sump strainers are located), and distributed equally between the outer annulus debris interceptors and the sump strainers. The 25% of the foreign debris that was initially distributed to the inner annulus was distributed equally between the debris interceptors at the inner annulus doors.

For the case where both trains are operating, the debris is assumed to be distributed equally between the two sumps. For the case where a single train is operating the debris is assumed to be transported to the operating train's strainer.

Table 3.e-1: Test Debris at Sump Strainer Modules for Limiting Case

Constituent	*Quantity Generated*	*Quantity at Strainer* (Note 1) 8050 gpm	13,180 gpm
Fiber			
Nukon	1233.14 ft^3	35.35 ft^3	117.93 ft^3
Latent Fiber (30 lbm) (Note 3)	12.5 ft^3	12.50 ft^3	6.25 ft^3
Total		47.85 ft^3	124.18 ft^3
Insulation Jacketing (Note 2)	2938.89 ft^2	0.00 ft^2	0.00 ft^2
Coatings			
Qualified - Concrete	1.32 ft^3		
Qualified - Steel	5.25 ft^3		
Unqualified - All	22.36 ft^3		
Total	28.93 ft^3	28.93 ft^3	14.46 ft^3
Latent Particulate (Note 3)	170 lbm	170 lbm	85 lbm
Foreign Materials (Note 4)	696 ft^2	150 ft^2	75 ft^2

Notes:

1. When both trains are operating it is assumed that the total debris load is equally divided between both sumps. In addition, the quantity of insulation fiber transported to the strainers included the effects of the decreased velocity for single train flow during recirculation, which was not applied to latent fiber or particulate debris. (i.e., 100% of particulate debris was transported to the strainers).
2. Insulation jacketing can not pass beyond the first encountered debris interceptor.
3. The measured quantity of latent debris was 40.7 lbm. However, the quantity of latent debris in the Stage 2 transport analysis was conservatively increased to 200 lbm, with a breakdown of 85% particulates and 15% fiber.
4. Foreign material is actually a "sacrificial area" and a transport fraction is not applicable. A corrective action has been initiated to reduce the quantity of foreign materials available for transport during outage OR12 (spring of 2008). The quantity estimated in Table 3.e-1 will be updated when the results of the reduction program are available, and will be provided with the supplemental response that is to be submitted within 90 days of the conclusion of outage OR12 (spring of 2008).

Topic 3.f: Head Loss and Vortexing

FPL Response

A piping schematic of the ECCS and containment/reactor building spray systems is provided in Figure 3.f-1. A description of the strainers and debris interceptors, including the capability to accommodate thin bed effects, is provided in the response to NRC Topic 3.j, *Screen Modification Package.*

[RAI 37] [RAI 40] The strainers are expected to be fully submerged from the initiation of recirculation through the duration of the event. At the minimum LBLOCA water level, the submergence of the strainer modules is expected to be at least 3 inches.

The absence of vortex formation and air ingestion was confirmed by the full scale sector tests, where no vortexing or air entrainment was observed during the tests. The clean sector vortex tests were performed with a submergence of 2½ inches (which is less than the minimum expected submergence of 3 inches), and a test velocity that was equal to or greater than the expected strainer approach velocity.

[RAI 40] FPLE intends to perform additional vortexing and air ingestion testing as part of the chemical effects testing. The results of the testing will be provided in the follow-on supplemental response that is to be submitted within 90 days of the conclusion of outage OR12 (spring of 2008).

[RAI 40] To develop a circumscribed bed, the gap must fill and overflow with fiber and particulate. The strainer can hold over 668 ft^3 of fiber while the maximum amount transported to the strainer is 124.18 ft^3. Therefore there is insufficient fiber to form a circumscribed bed.

[RAI 39] The new strainer system has a surface area of approximately 2,412 ft^2 in each sump, which can accommodate the maximum debris load from the bounding break discussed in the response to NRC Topic 3.a, *Break Selection*. The strainer capability to accommodate a thin bed is discussed in the response to NRC Topic 3.j, *Screen Modification Package*. The head loss is made up of the strainer head loss, the water level drop due to the debris interceptors, and the plenum head loss. The bounding case is single train operation because of the higher flow through the strainer.

The strainer head loss is based on the sector head loss tests that were run specifically for Seabrook Unit 1 by Continuum Dynamics, Inc (CDI). The test used a full scale test sector. Therefore, the head loss associated with traveling downward through the debris bed was captured in testing, and all other scaling issues were eliminated. The test sector modeled one sector of the strainer from the vertical centerline of the one disk set to the vertical centerline of the adjacent disk set. The test tank simulated the plenum sitting on the sump floor, and a mixing tank simulated the containment floor. The tests modeled a series of debris bed thicknesses, including the thin bed, to determine the limiting strainer head loss.

[RAI 36] Near-field settling was not credited in the sector tests. The steps taken to minimize near-field effects included directing the flow return along the bottom of the mixing tank to help suspend debris in the mixing tank before the mix of debris and water entered the test tank. In addition, at least two (2) motor driven mixers were used. The materials listed in Table 3.f-1 were used to represent the Seabrook Unit 1 debris in the test.

The water level drop due to the debris interceptors is from the hydraulic loss associated with the flow rate and the height of the debris interceptor. In effect, the debris interceptors can act as a weir dam. The water level drop has been calculated to be 0.48 inch at 8,050 gpm (single train).

The plenum head loss is due to the hydraulic losses associated with flow going through turns and other accelerations in the plenum. The plenum head loss has been calculated to be 3.323 inches at 8,050 gpm (one train with full flow through one strainer).

Assumptions, margins, and conservatisms used in establishing the head losses are:

- A temperature of 212 °F.
- The test used a single train flow rate of 8,050 gpm and a dual train flow rate of 13,180 gpm.
- The debris transport analysis assumed 200 lbm of latent debris vs. the calculated quantity, which was 40.7 lbm.
- The test assumed 28.93 ft^3 of coating particulates at the strainer vs. the calculated value of 1.75 ft^3.
- The strainer sacrificial area is assumed to be 200 ft^2, which includes a margin of 50 ft^2.
- The strainer head loss is based on results for a 1-inch thick fiber bed vs. the calculated fiber bed thickness which is 0.67-inch.

The resulting head loss for the strainer system, not considering chemical effects, is provided in Table 3.f-2.

Table 3.f-1: Sector Test Debris Materials

Debris Type	Material	Density	Manufacturer
Nukon	Transco Thermal Wrap (shredded)	2.4 lb/ft^3	Transco
Coatings	Silicon Carbide (~ 10 micron dia)	94 lb/ft^3	Electro Abrasives
Latent Debris			
Fiber	Transco Thermal Wrap (shredded)	2.4 lb/ft^3	Transco
Particulate	Silicon Carbide (~ 10 micron dia)	94 lb/ft^3	Electro Abrasives
Particulates	Silicon Carbide (~ 10 micron dia)	94 lb/ft^3	Electro Abrasives

Table 3.f-2: Strainer Head Loss Summary (Excluding Chemical Effects)

Condition	Flow Rate (gpm)	Strainer Head Loss (in)	Debris Interceptor Head Loss (Note 1) (in)	Total Head Loss (in)
Debris Laden	8,050	3.93	0.48	4.41
Clean	8,050	3.80	0.48	4.28

Notes:

1. The debris interceptor head loss is the water level drop downstream of the debris interceptors due to the weir dam effect.

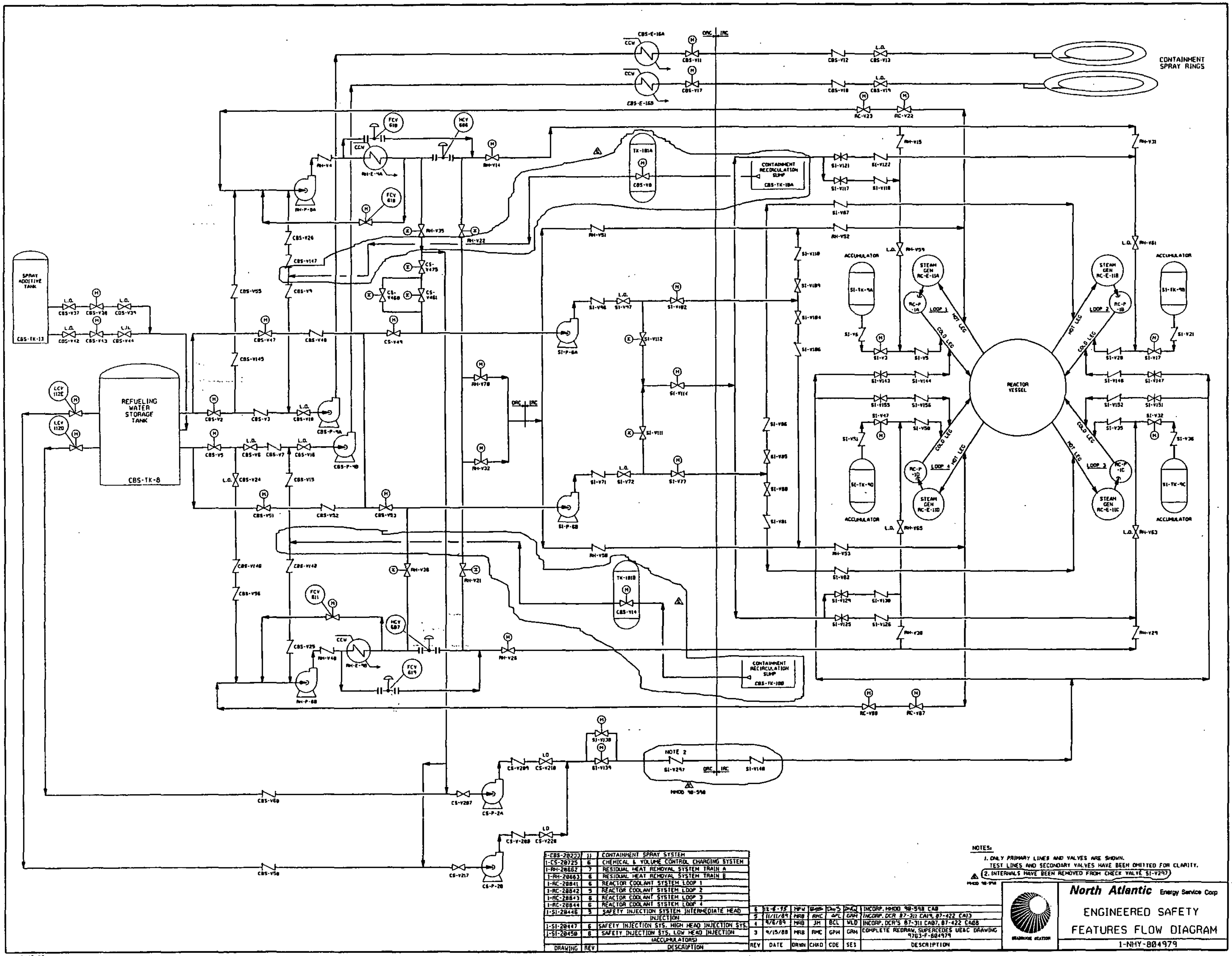

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Figure 3.f.1: ECCS/CBS Piping Schematic

Topic 3.g: Net Positive Suction Head Available (NPSH)

FPL Response

Following a large break LOCA (LBLOCA) both trains of the Residual Heat Removal (RHR) Pumps, Centrifugal Charging (CC) Pumps, Safety Injection (SI) Pumps, and Containment Building Spray (CBS) Pumps are automatically started (Operation of the CBS pumps is initiated by high containment pressure. Operation of the other pumps is initiated by the safety injection signal.). Recirculation is not initiated until at least 26 minutes after the LBLOCA. Recirculation is initiated by the Refueling Water Storage Tank (RWST) low-low level signal. Upon receipt of this signal, the RHR and CBS pumps are automatically re-aligned to take suction from the recirculation sumps. The CC pumps and SI pumps are then manually re-aligned to take suction from the RHR pumps discharge ("piggyback" mode) (The CC pumps are aligned to the RHR train A pump and the SI pumps are aligned to the RHR train B pump.). All pumps continue to operate in the recirculation mode until no longer required.

Following a small break (SBLOCA) it is possible that all pumps could be automatically started as described above for the LBLOCA. This would result in full ECCS and CBS flows. However, the debris loading on the strainer would be lower than the design basis debris load from an LBLOCA.

The minimum sump water level for the LBLOCA is 3.01 feet at 212 °F and 2.93 feet at 160 °F. The minimum sump water level for the SBLOCA is approximately 3 inches less. These water levels account for the following volumes.

- Water held up in the refueling canal (planned change to make this water available for recirculation is not credited)
- Water held up in spray piping
- Water in held up in suspended droplets
- Minimum water transferred from the RWST
- Minimum water available from the pressurizer

The additional volume of the debris interceptors and new strainers is not credited. Also, as discussed in the response to NRC Topic 3.1, *Screen Modification Package*, the design and layout of the debris interceptors ensures that they do not create choke points or otherwise prevent water from reaching the ECCS sumps after recirculation is initiated. For example, although the "weir dam" effect discussed in the response to NRC Topic 3.f, *Head Loss and Vortexing*, can affect NPSH, it does not affect the water volume or average water level.

The sump pool temperature range is as follows.

- Maximum Temperature: .... 260 °F
- Design Temperature...................................... 212 °F
- Long Term Temperature .... 160 °F

The maximum design flow rate is 8050 gpm per sump for single train operation and 6,590 gpm per sump (13,180 gpm total) for dual train operation. The maximum flow per sump is the sum of RHR pump flow (4,388 gpm) and the CBS pump flow (3,657 gpm). As noted above, the CC and SI pumps operate in "piggyback" mode during recirculation, so they are included in the total.

Under these conditions, the minimum available NPSH margin, without chemical effects, is 0.43

feet for the LBLOCA and ≥0.18 feet for the SBLOCA. However, the SBLOCA margin is calculated based on the LBLOCA debris load. Since the SBLOCA debris load will be much smaller, it is expected that the actual SBLOCA margin would be greater than 0.18 feet.

The following key assumptions were used in the calculation of these margins.

- Fluid vapor pressure equals the containment atmospheric pressure (i.e., credit is not taken for the partial pressure of air in containment).
- NPSH required is taken from RHR and CBS pump curves for the design basis flow for each pump.
- Strainer head loss is based on the tests described in the response to NRC item 3.f, *Head Loss and Vortexing*.
- Pump flow rates were rounded up when calculating the NPSH required, which increases NPSH required (e.g., using the exact flow rate for the CBS pump would reduce NPSH required by approximately 0.1 ft. Using the exact value would thus increase the minimum NPSH margin for the LBLOCA from 0.43 ft to 0.53 ft, and for the SBLOCA from 0.18 ft to 0.28 ft.).

Topic 3.h: Coatings Evaluation

FPL Response

Coatings are classified as qualified or unqualified. The qualified coating systems used in the Seabrook Unit 1 containment are listed in Table 3.h-1 below.

Table 3.h-1 Qualified Coatings in the Seabrook Unit 1 Containment

Substrate	Application	Coating Product	Applied Thickness (mils)
Steel			
3 coat system	1st Coat	Keeler & Long #6548 Epoxy White	8
	2nd Coat	Keeler & Long #6548 Epoxy White Primer – tinted	4
	3rd Coat	Keeler & Long #D-1 Series Epoxy Hi-Build Enamel	6
2 coat system A	1st Coat	Keeler & Long #6548 Epoxy White Primer or tinted	12
	2nd Coat	Keeler & Long #D-1 or #E-1Series Epoxy Enamel	6
2 coat system B	1st Coat	Ameron Dimetcote E-Z II Inorganic Zinc Primer	6
	2nd Coat	Ameron Dimetcote 66 Epoxy	9
1 coat system A	1st Coat	Keeler & Long #6548 Epoxy White Primer	18
1 coat system B	1st Coat	Keeler & Long #4500 Epoxy Self Priming Surface Enamel	18
1 coat system C	1st Coat	Ameron Dimetcote 6 Inorganic Zinc Silicate	12 mils
Concrete Floor			
4 coat system	1st Coat	Keeler & Long #4129 Epoxy Clear Curing Compound	1.5
	2nd Coat	Keeler & Long #6548 Epoxy White Primer	7
	3rd Coat	Keeler & Long #6548 Epoxy White Primer - tinted	7
	4th Coat	Keeler & Long #D-1 Series Epoxy Hi-Build Enamel	6
Concrete Wall			
3 coat system	1st Coat	Keeler & Long #4129 Epoxy Clear Curing Compound	1.5
	2nd Coat	Keeler & Long #4000 Epoxy Surfacer	50
	3rd Coat	Keeler & Long #D-1 Series Epoxy Hi-Build Enamel	6

Substrate	Application	Coating Product	Applied Thickness (mils)
2 coat system	1st Coat	Keeler & Long #4129 Epoxy Clear Curing Compound	1.5
	2nd Coat	Keeler & Long #4500 Epoxy Self Priming Surfacing Enamel	20

[RAI 30] For Seabrook Unit 1, the bounding analyzed LOCA case generated sufficient fiber to form a fiber bed approximately 0.67" thick. Consistent with the staff's SE of NEI 04-07 for thin fiber bed cases, all coating debris is treated as particulate. ElectroCarb black silicon carbide with 10-micron particle diameter was used as a surrogate for coatings because it matches the bulk density and the particle size of the majority of the coating debris.

The post-LOCA paint debris transport is described in the response to NRC Topic 3.e, *Debris Transport.* Selected features of the treatment of qualified and unqualified coatings in the determination of coating debris that reaches the sump strainers have been updated since the September 1 response. These changes are discussed individually below.

The qualified coating ZOI in the September 1 response for Seabrook Unit 1 was 10D. The ZOI for qualified coatings that have been tested has subsequently been reduced to 4D. The 4D ZOI is based on testing that was completed at the St. Lucie Plant during February of 2006. For qualified coating systems that have not been tested, the ZOI remains at 10D.

[RAI 29] A description of the test, test data, and evaluation of the test results was previously provided to the NRC staff for information on July 13, 2006 (FPL Letter L-2006-169, R. S. Kundalkar (FPL) to M.G. Yoder (NRC), "Reports on FPL Sponsored Coatings Performance Tests Conducted at St. Lucie Nuclear Plant," July 13, 2006). The evaluation of the test results confirms that a 4D ZOI is applicable to the in-containment qualified coating systems at Seabrook Unit 1. As stated in the test plan, heat, and radiation increase coating cross linking, which may enhance the coating physical properties. Therefore, since artificial aging, heat, or irradiation to the current plant conditions could enhance the physical properties and reduce the conservatism of the test, the test specimens were not aged, heated or irradiated.

The coating thicknesses in the September 1 response were assumed to be 3 mils of inorganic zinc primer plus 6 mils of epoxy (or epoxy-phenolic) top coat for qualified coatings and 3 mils of inorganic zinc (IOZ) for unqualified coatings. Subsequently, the analyses have been updated and now use the maximum specified application thickness for each coating system.

The coating area in the ZOI in the September 1 response was assumed to be equal to the surface area of the ZOI. Subsequently, the updated debris generation calculations calculate the quantity of qualified coatings for each break by using the concrete and steel drawings to determine the amount of coating that will be within the ZOI for each break. Coatings that are shielded from the jet by a robust barrier are not included in the total. The calculated volume of qualified steel coating is then increased by 10% to account for small areas of additional items such as piping, pipe/conduit/HVAC/cable tray supports, stiffener plates, ladders, cages, handrails and kick plates.

The estimated quantity of unqualified/failed coatings in the September 1 response was 14 ft^3. With the changes discussed above, the estimated quantity of unqualified/failed coatings is now 28.93 ft^3.

Subsequent to the September 1 response, the process for controlling the quantity of degraded qualified coatings in containment has been enhanced to ensure that the quantity of degraded qualified coatings does not exceed the design basis.

[RAI 25] The current program for controlling the quantity of unqualified/degraded coatings includes two separate inspections during each refueling outage. The first inspection takes place at the beginning of every refueling outage when all areas and components from which peeling coatings have the potential for falling into the reactor cavity or recirculation sumps are inspected. The second inspection takes place at the end of every refueling outage when the condition of containment coatings is assessed using guidance from EPRI Technical Report 1003102 "Guidelines On Nuclear Safety-Related Coatings," Revision 1, (Formerly TR-109937). All accessible coated areas of the containment and equipment are included in the second inspection.

The initial coating inspection process is a visual inspection. The acceptability of visual inspection as the first step in monitoring of Containment Building coatings is validated by EPRI Report No. 1014883, "Plant Support Engineering: Adhesion Testing of Nuclear Coating Service Level 1 Coatings," August 2007. Following identification of degraded coatings, the degraded coatings are repaired per procedure if possible. For degraded coatings that are not repaired, areas of coatings determined to have inadequate adhesion are removed. The assessment is by means of additional nondestructive and destructive examinations as appropriate. The acceptability of the as-left coating condition for restart is addressed in a condition report.

Topic 3.i: Debris Source Term Refinements

FPL Response

The fourth debris source term refinement discussed in Section 5.1 of NEI 04-07, "Modify Other Equipment Or Systems," was utilized. This refinement consists of removing selected labels on cable trays and wire ways to ensure that the area of miscellaneous debris at the sump strainers (sacrificial area) will be less than 150 ft^2.

Topic 3.j: Screen Modification Package

FPL Response
The original sump screens are scheduled to be completely replaced with new strainer modules during outage OR12 (spring 2008). Debris interceptors have already been installed to reduce the quantity of debris that can be transported to the strainer modules.

[RAI 32] The new strainers and debris interceptors are passive (i.e., there are no active components and the strainers do not utilize backflushing).

The new strainer system uses the General Electric disk strainers. The installed strainer surface area is expected to be approximately 2,412 ft^2 for each sump. The strainer perforations are nominal 1/16 inch diameter round holes (0.0625 inch diameter opening). The strainer modules use an arrangement of parallel, rectangular strainer disks that have exterior debris capturing surfaces of perforated plate covered with woven wire mesh. The wire mesh decreases the head loss across the strainer plates by breaking up debris beds. Each strainer disk, constructed of two plates, has an open interior to channel disk flow downward to the strainer plenum. The disks are mounted on the discharge plenum, which channels disk flow to the suction piping. All strainer components, with the possible exception of bolts and anchors, are fabricated from stainless steel.

Each strainer module interfaces with its associated ECCS inlet pipe. The ECCS inlet pipe is located inside a strainer "dog house" which is directly open to the strainer plenum. However, there is no physical connection between the strainer and the ECCS inlet pipe. The sides of the "dog house" are made of the same perforated plate/wire cloth composite design as the disks. The roof of the dog house is equipped with cover plates similar to those used in the rest of the plenum.

For Seabrook Unit 1, the analyzed LOCA cases generated sufficient fiber to form a thin fiber bed. However, the debris plate and the pitch between disks allow the GE Plenum Strainer to mitigate thin bed effects. The capability of the strainer system to accommodate the maximum mechanistically determined debris volume has been confirmed by a combination of testing and analysis. The volume of debris at the screen is discussed in the response to NRC Topic 3.e, *Debris Transport.*

The capability to provide the required NPSH with this debris volume is discussed in the response to NRC Topic 3.g, *Net Positive Suction Head (NPSH).* The capability to structurally withstand the effects of the maximum debris volume is discussed in the response to NRC Topic 3.k, *Sump Structural Analysis.*

Four types of debris interceptors are, or will be, installed in the Seabrook containment.

- Bioshield Debris Interceptors

  Bioshield debris interceptors are installed in the passageways in the bioshield wall except for the east most door. (This is to ensure that there is at least one unobstructed passageway for water from the break to the annulus.) The locations are shown in Figure 3.j-1. They are approximately 6-feet tall and have hinged gates (doors) where needed and feasible to allow for personnel and equipment access.

- Annulus Debris Interceptors

  Annulus debris interceptors are located radially around the containment building in the outer annulus area between the bioshield wall and the containment wall. The locations are shown in Figure 3.j-1. They are typically 17½ inches tall and have a hinged gate at each location to allow for personnel and equipment access. Most annulus debris interceptors also have an 18 inch wide horizontally oriented debris interceptor panel mounted on top.

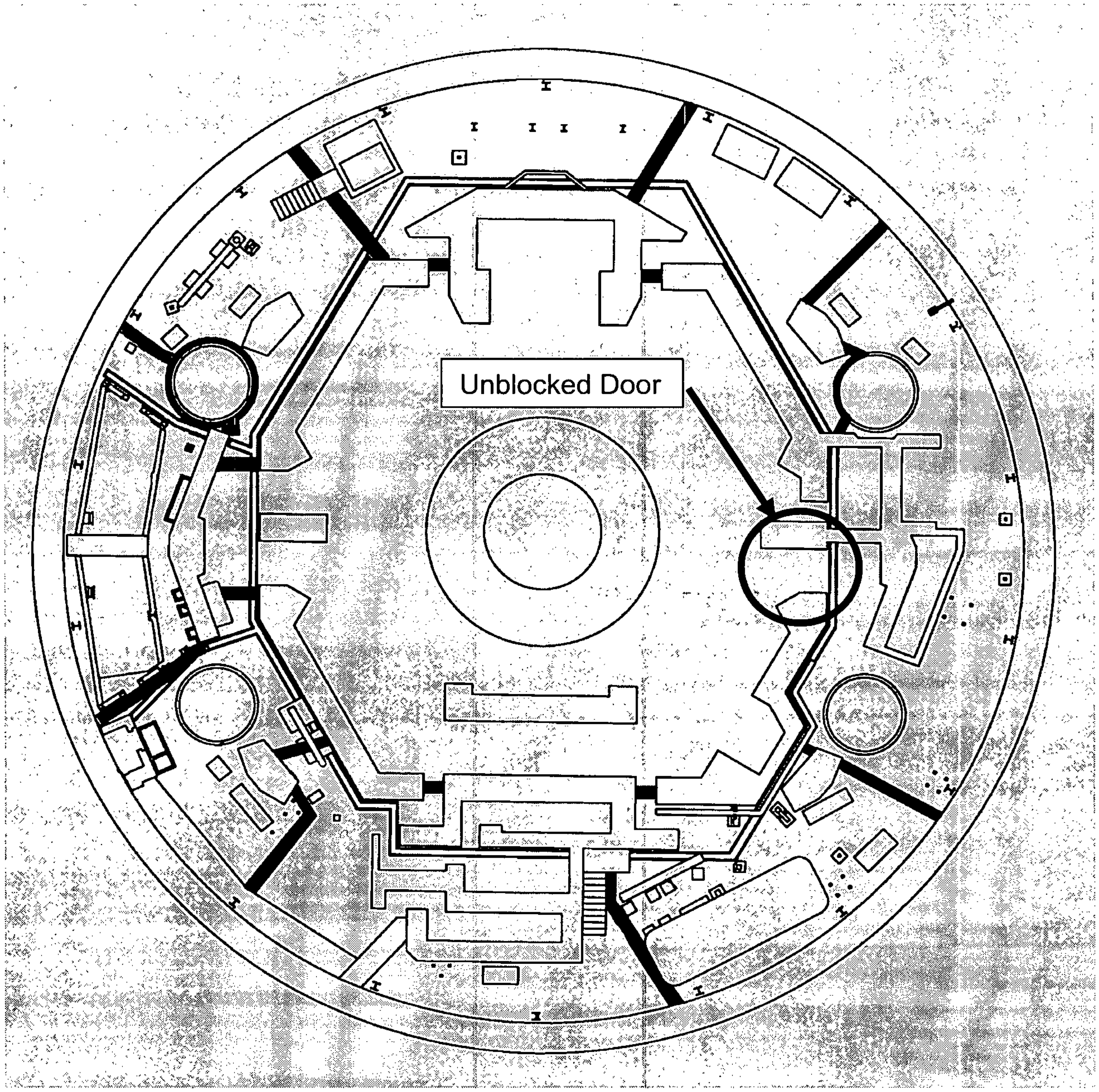
- Accumulator Skirt Debris Interceptors

  Where an annulus debris interceptor adjoins the support structure for an accumulator, (accumulator skirt) the skirt serves as part of the debris interceptor span. The location is shown in Figure 3.j-1. Debris interceptor panels are installed on the accumulator skirt openings.

- Bioshield Scupper Debris Interceptors

  Bioshield scupper debris interceptors will be installed on one end of nineteen (19) scuppers in the bioshield wall. The scuppers are small passageways (approximately 4-inches square) through the bioshield wall that allow water leaking inside the bioshield to pass through the wall to the floor drains located outside the bioshield. Installing debris interceptors on the scupper openings prevents potential fiber bypass around the annulus debris interceptors.

With the exception of the Bioshield scupper debris interceptors, the debris interceptors are constructed from stainless steel bar grating overlaid with a stainless steel wire cloth with 0.38-inch square openings. The scupper debris interceptors, although of a different construction (because of their smaller size) have a similar hole size, 0.375-inch nominal diameter round holes.



Debris Interceptor ▬▬▬
The unblocked door does not have a debris interceptor.
The debris Interceptors on the bioshield scuppers are not shown.

Figure 3.j-1: Seabrook Unit 1 Debris Interceptor Locations

Topic 3.k: Sump Structural Analysis

FPL Response

The previous sump strainers will be completely replaced by new strainer modules and debris interceptors. The discussion that follows describes the corrective actions associated with the strainers that are currently scheduled for outage OR12 (spring 2008).

Each strainer assembly and each debris interceptor is a passive unit (i.e., there are no active components and the strainers do not utilize backflushing). They are described in the response to NRC Topic 3.j, *Screen Modification Package*. Assurance that strainer modules and debris interceptors are inspected for adverse gaps or breaches prior to concluding an outage is discussed in the response to NRC Topic 3.p, *Foreign Material Control Programs*.

The Seabrook Unit 1 containment has two independent sumps. Each sump has its own strainer module consisting of twenty (20) strainer disk sets. Each disk set is composed of four (4) individual strainer disks with two side by side and an additional two mounted above the lower disks. The disks are bolted vertically to each other and to a bottom plenum by means of flanged connections. The disk sets are bolted to those in adjoining vertical planes by means of connector plates attached to the flanges. All strainer components are fabricated from stainless steel and the anchorage details are designed to accommodate thermal expansion. Therefore, there are no internal component thermal stresses.

The trash rack function is incorporated into the debris interceptors and strainer module design. Separate trash racks are not required.

The strainers and their components were analyzed using a detailed ANSYS structural analysis model. The strainers and their supports are designed and analyzed using the ASME BP&V Code, Section III, Subsection NC, Class 2 (for the components) and Subsection NF (for the supports) as a guide. The capability of the strainer perforated plate disks as structural members is based on an equivalent plate approach similar to that presented in ASME III, Appendix A, Article A-8000. ASME Service Level B allowables are used as a guide for the stress evaluation of both normal and accident conditions. Thus, ASME III Subsection NF paragraph NF-3251.2 is used for Class 2 plate and shell type components; and NF-3350 for Class 2 linear type supports. For bolts, the stress limits of NF-3324.6, increased by values provided in Table NF-3225.2-1, are used. Welds are evaluated per paragraph NF-3324.5. Expansion anchors are evaluated using the ultimate capacity values with a safety factor of four (4).

The new strainer modules are in the same location as the original strainers, which is outside the bioshield wall. The new strainers are not subject to missiles, pipe whip, or jet impingement.

The strainer structural loads and load combinations are summarized in Table 3.k-2 and the structural qualification results are summarized in Table 3.k-4 below.

The debris interceptors and supports are fabricated from stainless steel. The bioshield and annulus debris interceptors are constructed from stainless steel bars (1-inch by 3/16-inch) overlaid with stainless steel wire cloth and are supported by a combination of vertical floor-mounted support posts and wall mounts. The accumulator skirt debris interceptors are similar in design, but are bolted to the accumulator skirt without physically modifying the skirt. The scupper debris interceptors are constructed from perforated stainless steel sheet approximately 5.34-inch by 4.38-inch and 0.12-inch thick.

The structural adequacy of the debris interceptors and their components was confirmed using hand analysis methods. Seismic adequacy was confirmed using an equivalent static analysis. The debris interceptor acceptance criteria used the guidance in the AISC Manual of Steel Construction, 9th Edition and the ASME BP&V Code Section II, part D. Expansion anchors were evaluated using the ultimate capacity values with a safety factor of four (4).

The locations of the debris interceptors have been analyzed for susceptibility to missiles, jet impingement and pipe whip. Postulated missiles will not strike the debris interceptors. None of the bioshield or annulus debris interceptors are in the path of a postulated pipe whip or jet spray.

The debris interceptor structural loads and load combinations are summarized in Table 3.k-3 below.

Table 3.k-1: Structural Load Symbols

Symbol	Load Definition
D	Dead Load, in air
D'	Dead Load Debris Weight plus Hydrodynamic Mass (Submerged)
L	Live Load
T_o	Normal Operating Thermal Load
T_a	Accident Thermal Load
E_{o1}	Earthquake Load, OBE in air
E_{o2}	Earthquake Load, OBE in water
E_{ss1}	Earthquake Load, SSE in air
E_{ss2}	Earthquake Load, SSE in water
P_{cr}	Differential (Crush) Pressure

Table 3.k-2: Strainer Loads and Load Combinations

Load	Strainer Load Combination
1	$D + L + E_{o1}$
2	$D + L + T_o + E_{o1}$
3	$D + L + T_o + E_{ss1}$
4	$D' + L + T_a + E_{o2} + P_{CR}$
5	$D' + L + T_a + E_{ss2} + P_{CR}$

Table 3.k-3: Bounding Debris Interceptor Loads and Load Combinations

Load	Bioshield and Annulus DI Load Combinations (Notes 1-4)
1	D + L
2	D + L + E_{o1}
3	0.63 (D + E_{ss1}) + P_{CR}

Notes:

1. Thermal expansion stresses, T_a, are negligible and therefore, are not included.
2. The differential pressure load is 500 lbs per panel. This is the hydrodynamic force during pool fill-up or recirculation.
3. The hydrodynamic effects during an SSE, E_{ss2}, are negligible and therefore, are not included.
4. Live load, L, is 0.0 for debris interceptors.

Table 3.k-4: Strainer Module Stress Ratio Results

Component	Stress/Load Value	Allowable	Ratio to Allowable
Disks			
Perforated Plate	28.6 ksi	31.0 ksi (2S)	0.92
Wire Cloth	25.8 ksi	31.0 ksi (2S)	0.83
Frame/Rib	8.5 ksi	12.3 ksi (1.33 x $0.4S_Y$)	0.69
Weld of Perf to End Channels	5.2 ksi	12.3 ksi (1.33 x $0.4S_Y$)	0.42
Weld of Perf to Flanges	4.8 ksi	12.3 ksi (1.33 x $0.4S_Y$)	0.39
Resistance Weld of Wire Cloth	36 lbs	750 lbs	0.05
Weld of Ribs to Frame	8 ksi	12.3 ksi (1.33 x $0.4S_Y$)	0.65
Disk to Disk Bolting	9.3 ksi	23.3 ksi ($0.345S_U$)	0.40
Disk to Plenum Bolting	3.3 ksi	23.3 ksi ($0.345S_U$)	0.14
Disk Connector Plates	10.2 ksi	23.05 ksi (1.33 x $0.75S_Y$)	0.44
Connector Plate Bolting (max single shear)	19.96 ksi	19.96 ksi ($0.1426S_U$)	1.00
Connector Plate Bolting (max double shear)	14.6 ksi	19.96 ksi ($0.1426S_U$)	0.73
Separator Wall Anchorage Detail			
Weld/bolt of Disk Flange to Intermediate Plate	17.3 ksi	23.3 ksi ($0.345S_U$)	0.74
Intermediate Plate	3.7 ksi	23.1 ksi	0.16
1-1/8 inch Diameter Stud	91.2 ksi	102.8 ksi (S_Y)	0.89
Clip Brackets	14.5 ksi	23.1 ksi	0.63
Weld of Brackets to Base Plate	3.5 ksi	12.3 ksi (1.33 x $0.4S_Y$)	0.29
Hilti Base Plate	13.7 ksi	23.1 ksi	0.59
Hilti Expansion Anchors-Tension	2.8 kips	3.1 kips	0.91
Supporting Base Frame and Plenum Roof			
Frame Tubing	14.6 ksi	31.0 ksi (2S)	0.47
Tube Splice Connection	7.8 ksi	9.63 ksi ($0.1426S_U$)	0.81
Plenum Roof Plates	<19.3 ksi	31.0 ksi (2S)	<0.62
Plenum Roof Bolts	15.3 ksi	19.96 ksi ($0.1426S_U$)	0.77
Floor Anchorage Detail			
Weld of Gusseted Bracket to Tube Member	2.7 ksi	12.3 ksi (1.33 x $0.4S_Y$)	0.22
Shoulder Bolts – Tension/shear interaction	N/A	N/A	0.52

Component	Stress/Load Value	Allowable	Ratio to Allowable
Hilti Base Plate	17.8 ksi	23.1 ksi	0.77
Hilti Expansion Anchors – Tension/Shear	N/A	N/A	0.96
"Dog House"			
Side Walls	See "Disks"	N/A	N/A
Eastern End Plate	30 ksi	31.0 ksi (2S)	0.97
Eastern End Plate Clip Connection	10.1 ksi	23.05 ksi (1.33 x $0.75S_Y$)	0.44
East to West Section Bolted Connections	11.5 ksi	19.96 ksi ($0.1426S_U$)	0.58
Connections to Base Frame	15.6 ksi	19.96 ksi ($0.1426S_U$)	0.78
ECCS WALL Connections			
Interface Plate	15.9 ksi	31.0 ksi (2S)	0.51
Clamp Bolt	23.1 ksi	23.3 ksi ($0.345S_U$)	0.99
Hilti Expansion Anchors	2.1 kips	3.13 kips	0.66
Catch Basin Pan			
Hilti Expansion Anchors-Shear	107 lbs	1.26 kips	0.09

Topic 3.l: Upstream Effects

FPL Response

[RAI 38] Currently, water in the refueling canal is conservatively assumed to be held up. As a result, the water sequestered in the refueling canal is excluded from the determination of the minimum recirculation water level and the NPSH calculations that use the recirculation water level as an input parameter. However, the existing procedure for entering Mode 4 ensures that the refueling cavity drain path is open.

The debris interceptor design and layout ensures that the debris interceptors do not create new choke points. The debris interceptors in the annulus are designed so that there is a nominal 9 inches of clearance between the top of the debris interceptor and the minimum water level. The east-most bioshield doorway does not have a debris interceptor to ensure that there is at least one completely unobstructed pathway for water to flow from the break to the outer annulus. The unblocked doorway is noted on Figure 3.j-1.

With regard to other potential choke points, the walkdowns that were conducted during refueling outage OR09 (October 2003) surveyed recirculation and drainage flow paths for equipment or structures that could potentially prevent water from reaching the sumps. The flow path survey included curbs, ledges, gates, tool boxes, etc., but because of the timing, did not cover the debris interceptors or planned change to the refueling canal drains that are discussed above. However, the information for all other flow paths that was provided in the September 1 response remains applicable. It is repeated here for convenience.

> "A walkdown and analysis of the Seabrook containment was performed to assess potential chokepoints in the path from the RCS loops to the ECCS sump, including gates and screens. The walkdown confirmed that there are no potential chokepoints that would adversely affect operation of the ECCS and CBS in the recirculation mode or cause the sump water level and associated NPSH to be less than the design basis values."

Topic 3.m: Downstream Effects – Components and Systems

FPL Response

In the September 1 response it was noted that, at that time, the downstream evaluations identified instrumentation and twenty two (22) components that required further evaluation.

[RAI 31] These evaluations will be conducted using the methodologies of Revision 1 of WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," Revision 1, August, 2007. Results of this assessment will be provided with the supplemental response that is to be submitted within 90 days of the conclusion of outage OR12 (spring of 2008).

Topic 3.m: Downstream Effects – Fuel and Vessel

FPL Response

FPL is participating in the PWR Owners Group (PWROG) program to evaluate downstream effects related to in-vessel long-term cooling. The results of the PWROG program are documented in WCAP-16793-NP (WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in Recirculating Fluid," Rev. 0, May, 2007), which was provided to the NRC staff for review on June 4, 2007. The program was performed such that the results apply to the entire fleet of PWRs, regardless of the design (e.g., Westinghouse, CE, or B&W).

The PWROG program demonstrated that the effects of fibrous debris, particulate debris, and chemical precipitation would not prevent adequate long-term core cooling flow from being established. In the cases that were evaluated, the fuel clad temperature remained below 800 °F in the recirculation mode. This is well below the acceptance criterion of 2200 °F in 10 CFR 50.46, *Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors.* The specific conclusions reached by the PWROG are noted below.

- Adequate flow to remove decay heat will continue to reach the core even with debris from the sump reaching the RCS and core. Test data has demonstrated that any debris that bypasses the screen is not likely to build up an impenetrable blockage at the core inlet. Any debris that collects at the core inlet will provide some resistance to flow. In the case where large blockage does occur, numerical analyses have demonstrated that core decay heat removal will continue. Per WCAP 16793-NP, Revision 0, no plant specific evaluation is recommended. This conclusion thus applies to Seabrook Unit 1.

- Decay heat will continue to be removed even with debris collection at the fuel assembly spacer grids. Test data has demonstrated that any debris that bypasses the screen is small and consequently is not likely to collect at the grid locations. Further, any blockage that may form will be limited in length and not be impenetrable to flow. In the extreme case that a large blockage does occur, numerical and first principle analyses have demonstrated that core decay heat removal will continue. Per WCAP 16793-NP, Revision 0, no plant specific evaluation is recommended. This conclusion thus applies to Seabrook Unit 1.

- Should fibrous debris enter the core region, it will not tightly adhere to the surface of fuel cladding. Thus, fibrous debris will not form a "blanket" on clad surfaces to restrict heat transfer and cause an increase in clad temperature. Therefore, adherence of fibrous debris to the cladding is not plausible and will not adversely affect core cooling. Per WCAP 16793-NP, Revision 0, no plant specific evaluation is recommended. This conclusion thus applies to Seabrook Unit 1.

- Using an extension of the chemical effects method developed in WCAP-16530-NP to predict chemical deposition of fuel cladding, two sample calculations using large debris loadings of fiberglass and calcium silicate, respectively, were performed. The cases demonstrated that decay heat would be removed and acceptable fuel clad temperatures would be maintained.

WCAP-16530-NP, Revision 0, evaluated the potential for chemical precipitation to form on the cladding surface as summarized in the preceding bullet, which is demonstrated in WCAP-16793, Revision 0, to produce acceptable fuel clad temperature results for two sample cases. As recommended in the WCAP-16793-NP, Revision 0, FPLE has decided to perform a plant-specific calculation using plant-specific parameters and the recommended WCAP methodology to confirm that chemical plate-out on the fuel does not result in the prediction of fuel cladding temperatures approaching the 800 °F value. We plan on having this assessment completed in accordance with the schedule provided to the NRC staff in Letter L-2007-155. Results of this assessment will be provided with the supplemental response that is to be provided 90 days after completion of outage OR12 (spring 2008).

Topic 3.n: Chemical Effects

FPL Response

It is anticipated that chemical testing and analyses will be completed by April, 2008. In the meantime, a new strainer system will be installed during outage OR12 (spring 2008) that will increase the strainer surface area to approximately 2,412 ft^2 in each sump. After accounting for head losses due to debris and temperature dependent effects, the minimum NPSH margin is expected to be approximately 0.4 feet, excluding chemical effects. Pending resolution of chemical effects issues, this margin is available to accommodate strainer head loss due to chemical effects at the sump strainers. Upon completion of the chemical effects tests and analyses, the available NPSH margin will be updated.

The impact of chemical effects on full implementation of GSI-191 corrective actions will not be fully assessed until completion of the chemical tests and analyses in April of 2008. Therefore, the responses to the staff's RAI items related to chemical effects in the NRC RAI dated February 9, 2006 (TAC No. MC4716) will be provided with the supplemental response that is due 90 days after completion of outage OR12 (spring 2008).

Topic 3.o: Licensing Basis

FPL Response

FPL Energy does not anticipate that any license amendments will be requested as a result of the implementation of the GL 2004-02/GSI-191 modifications. However, it is anticipated that the technical specification bases may be updated to incorporate the new strainer design basis. It is expected that these changes will not affect the plant licensing basis or existing UFSAR analyses, and will be made in accordance with the requirements of 10 CFR 50.59. The UFSAR will be updated as necessary, consistent with the requirements of 10 CFR 50.71(e), to reflect the modifications and other changes made to resolve GL 2004/GSI-191.

Topic 3.p: Foreign Material Control Programs

FPL Response

Information related to programmatic controls for foreign materials was provided to the NRC in previous submittals. Such information was provided in letter L-2003-201 which responded to Bulletin 2003-01, and most recently in letter L-2005-181, which responded to GL 2004-02. In general, the information related to programmatic controls that was supplied in these responses remains applicable. However, since the September 1 response, a modification, tests, and walkdowns have been completed, and these have been used to inform and update the programmatic controls that support the new sump strainer system design basis.

The results of the recently completed walkdowns to assess the quantities of latent and miscellaneous debris are discussed in the response to NRC Topic 3.d, *Latent Debris*. These walkdowns were conducted without any preconditioning or pre-inspections. Consequently, the debris found during the walkdowns is characteristic of approximately 16 years of operation under the existing housekeeping programs. Given the small quantity of latent and miscellaneous debris after 16 years of operation under the current housekeeping program, combined with the label reduction program, it is concluded that the current housekeeping programs are sufficient to ensure that the new strainer system design bases will not be exceeded.

The surveillance procedure that inspects the containment recirculation sumps will be revised to include all of the debris interceptor and strainer system components. The update will require that there is no visible damage or corrosion to the debris interceptors or accessible strainer panels and that no debris is present on the debris interceptors or accessible strainer panels.

Note that programmatic controls related to coatings are provided in the response to NRC Topic 3.h, *Coatings Evaluation*.

Attachment 2

Regulatory Commitments

List of Regulatory Commitments

The following table identifies the regulatory commitments in this document. Any other statements in this submittal represent intended or planned actions. They are provided for information purposes and are not considered regulatory commitments.

Commitment	Scheduled Completion Date
1. It is anticipated that upon completion of the planned corrective actions and confirmatory tests and analyses, Seabrook Unit 1 will be demonstrated to be in compliance with the regulatory requirements listed in Applicable Regulatory Requirements section of GL 2004-02. In the case that additional corrective actions are required, FPL Energy will contact the NRC.	Upon identification of the need for additional corrective actions.
2. The estimated quantities in Table 3.d-1 (Estimated Miscellaneous (Foreign) Debris in Containment prior to Debris Reduction Program) will be updated when the results of the label reduction program are available, and will be provided with the supplemental response that is to be submitted 90 days after completion of outage OR12 (spring 2008).	Within 90 days after completion of outage OR12 (spring 2008).
3. The quantity estimated in Table 3.e-1 (Test Debris at Sump Strainer Modules for Limiting Case) will be updated when the results of the reduction program are available, and will be provided with the supplemental response that is to be submitted within 90 days of the conclusion of outage OR12 (spring of 2008).	Within 90 days of the conclusion of outage OR12 (spring of 2008)
4. Additional debris interceptors will be installed on the scuppers in the bioshield wall to further reduce the debris that can be transported to the sump strainers from a postulated LOCA.	Outage OR12 (spring of 2008)

Commitment	Scheduled Completion Date
5. FPL Energy Seabrook intends to perform additional vortexing and air ingestion testing as part of the chemical effects testing. The results of the testing will be provided in the follow-on supplemental response that is to be submitted within 90 days of the conclusion of outage OR12 (spring of 2008).	Within 90 days of the conclusion of outage OR12 (spring of 2008)
6. The results of the downstream analyses will be provided with the supplemental response that is to be submitted within 90 days of the conclusion of outage OR12 (spring of 2008).	Within 90 days of the conclusion of outage OR12 (spring of 2008)
7. As recommended in the WCAP-16793-NP, Revision 0, FPLE has decided to perform a plant-specific calculation using plant-specific parameters and the recommended WCAP methodology to confirm that chemical plate-out on the fuel does not result in the prediction of fuel cladding temperatures approaching the 800 °F value. Results of this assessment will be provided with the supplemental response that is to be provided 90 days after completion of outage OR12 (spring 2008).	Within 90 days of the conclusion of outage OR12 (spring of 2008)
8. The responses to the staff's RAI items related to chemical effects in the NRC RAI dated February 9, 2006 (TAC No. MC4716) will be provided with the supplemental response that is due 90 days after completion of outage OR12 (spring 2008).	Within 90 days of the conclusion of outage OR12 (spring of 2008)

Commitment	Scheduled Completion Date
9. The surveillance procedure that inspects the containment recirculation sumps will be revised to include all of the debris interceptor and strainer system components. The update will require that there is no visible damage or corrosion to the debris interceptors or accessible strainer panels and that no debris is present on the debris interceptors or accessible strainer panels.	Outage OR12 (spring of 2008)