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February 29, 2008

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Serial No. 08-0017
NLOS/GDM R3
Docket No. 50-305
License No. DPR-43

DOMINION ENERGY KEWAUNEE, INC. (DEK)
KEWAUNEE POWER STATION
NRC GENERIC LETTER 2004-02 SUPPLEMENTAL RESPONSE
POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS

In a letter dated September 13, 2004, the NRC issued Generic Letter (GL) 2004-02, *Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors* (GL 2004-02. The purpose of the GL was to resolve NRC Generic Safety Issue (GSI) 191, *Assessment of Debris Accumulation on PWR Sump Performance*. GL 2004-02 identified a potential susceptibility of recirculation flow paths and sump screens to debris blockage. GL 2004-02 requested that addressees perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions to assure system function is preserved. Additionally, addressees were requested to submit the information specified in the letter to the NRC.

A 90-day response to GL 2004-02 was submitted for Kewaunee Power Station (Kewaunee) by letter dated March 7, 2005 (Reference 1). This response was supplemented by letters dated July 6, 2005 (Reference 2) and September 1, 2005 (Reference 3). In the September 1, 2005 letter, DEK committed to completing the corrective actions for Kewaunee required by GL 2004-02 by December 31, 2007. In a letter dated February 9, 2006, the NRC forwarded a request for additional information (RAI) regarding DEK's response to GL 2004-02 (Reference 4). The NRC requested DEK's response to the RAI within 60 days. However, in a subsequent letter dated March 28, 2006 (Reference 5), as supplemented by a letter dated January 4, 2007 (Reference 6), the NRC agreed to an alternative approach and timetable that allowed licensees to submit their responses to the RAIs no later than December 31, 2007, as part of their supplemental responses to GL 2004-02. In a letter dated November 30, 2007 (Reference 7), the NRC extended the due date for supplemental responses to February 29, 2008.

This letter provides DEK's supplemental response to GL 2004-02 for Kewaunee and includes the necessary information to appropriately address the questions included in the NRC RAI noted above. By letter dated November 15, 2007 (Reference 8), DEK requested an extension of the completion date for certain GL 2004-02 corrective actions until June 30, 2008. By letter dated December 13, 2007 (Reference 9), NRC granted an

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extension for Kewaunee to May 31, 2008. The corrective actions affected by the extension are noted in the applicable sections of this supplemental response.

In a letter dated August 15, 2007 (Reference 10), revised by letter dated November 21, 2007 (Reference 11), the NRC provided a content guide to the Nuclear Energy Institute (NEI) for responding to GL 2004-02. DEK's supplemental response to GL 2004-02 follows the guidance included in the November 21, 2007 revised content guide and is provided in the attachment.

Should you have any questions regarding this supplemental response, please contact Mr. Jerry Riste at (920) 388-8424.

Sincerely,

Gerald T. Bischof
Vice President – Nuclear Engineering

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. Gerald T. Bischof, who is Vice President – Nuclear Engineering of Dominion Energy Kewaunee, Inc. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 29th day of February, 2008.

My Commission Expires: August 31, 2008.

MARGARET B. BENNETT
Notary Public 354302
Commonwealth of Virginia
My Commission Expires Aug 31, 2008

Margaret B. Bennett
Notary Public

Summary of Commitments

1. Kewaunee will revise the containment recirculation sump minimum water level calculation to include, as appropriate, holdup volumes associated with condensed films on heat structures, water holdup on equipment and structures, water volume in containment spray piping, and water/condensation in the containment atmosphere. This calculation revision will be complete by May, 31, 2008.

2. The Kewaunee Updated Safety Analysis Report will be modified upon final resolution of GSI-191 and response to Generic Letter 2004-02.

Attachment: Supplemental Response to Generic Letter 2004-02

References

1. Letter from Edward J. Weinkam (NMC) to Document Control Desk (NRC), "Nuclear Management Company 90-Day Response to Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors,'" dated March 7, 2005, (ADAMS Accession No. ML050670014).

2. Letter from Michael G. Gaffney (NMC) to Document Control Desk (NRC), "Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation During Design-Basis Accidents at Pressurized-Water Reactors - Response to Request for Additional Information," dated July 6, 2005, (ADAMS Accession No. ML051940428).

3. Letter from David A. Christian (DEK, DNC, VEPCO) to Document Control Desk (NRC), "Response to NRC Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors," dated September 1, 2005, (ADAMS Accession No. ML052500378).

4. Letter from David H. Jaffe (NRC) to Michael G. Gaffney (DEK), "Kewaunee Power Station - 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' (TAC NO. MC4691)," dated February 9, 2006, (ADAMS Accession No. ML060370440).

5. Letter from Catherine Haney (NRC) to PWR Licensees, "Alternate Approach for Responding to the Nuclear Regulatory Commission Request for Additional Information Letter RE: Generic Letter 2004-02 (TAC NOS. see enclosure)," dated March 28, 2006, (ADAMS Accession No. ML060870274).

6. Letter from Catherine Haney (NRC) to PWR Licensees, "Alternate Approach for Responding to the Nuclear Regulatory Commission Request for Additional Information Letter RE: Generic Letter 2004-02 (TAC NOS. see enclosure)," dated January 4, 2007, (ADAMS Accession No. ML063460258).

7. Letter from William H. Ruland (NRC) to Anthony Pietrangelo (NEI), "Supplemental Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," dated November 30, 2007, (ADAMS Accession No. ML073320176).

8. Letter from William R. Mathews (DEK, DNC, VEPCO) to Document Control Desk (NRC), "NRC Generic Letter (GL) 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors, Request for Extension of Completion Dates for Corrective Actions," dated November 15, 2007, (ADAMS Accession No. ML073190553).

9. Letter from Siva P. Lingam (NRC) to William R. Matthews (Dominion), "Kewaunee Power Station, Millstone Power Station, Units 2 and 3, North Anna Power Station, Units 1 and 2, and Surry Power Station, Units 1 and 2, Requests for Extension of Completion Dates for Generic Letter 2004-02 Corrective Actions," dated December 13, 2007, (ADAMS Accession No. ML073450594).

10. Letter from William H. Ruland (NRC) to Anthony Pietrangelo (NEI), "Content Guide for Generic Letter 2004-02 Supplemental Responses," dated August 15, 2007, (ADAMS Accession No. ML071060091).

11. Letter from William H. Ruland (NRC) to Anthony Pietrangelo (NEI), "Revised Content Guide for Generic Letter 2004-02 Supplemental Responses," dated November 21, 2007, (ADAMS Accession Nos. ML073110269 and ML073110278).

cc: U.S. Nuclear Regulatory Commission
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Kewaunee Power Station

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ATTACHMENT

SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02

DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION

SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02 KEWAUNEE POWER STATION

SUMMARY OF RESOLUTION APPROACH

The approach taken by Dominion Energy Kewaunee, Inc. (DEK) for resolution of Generic Safety Issue (GSI) 191, *Assessment of Debris Accumulation on PWR Sump Performance,* for Kewaunee Power Station (Kewaunee) is summarized as follows:

- Determine postulated break locations generating the most detrimental mixture of post-accident debris (complete)
- Determine the quantity of debris that is postulated to transport to the Emergency Core Cooling System (ECCS) recirculation strainer (complete)
- Calculate the minimum water level at the onset of recirculation to ensure the replacement strainer will be fully submerged at the start of recirculation (complete; however, see new commitment in this letter)
- Redesign the ECCS recirculation strainer (complete)
- Perform flume testing to confirm the new strainer design (complete)
- Replace the recirculation strainer and perform related field work (complete)
- Evaluate downstream effects (evaluation revisions in progress)
- Evaluate chemical effects to identify precipitants and quantity (complete)
- Perform additional flume testing to determine fiber transport with the debris interceptors modeled (complete)
- Conduct fiber erosion test in support of additional flume testing (complete)
- Document updated strainer performance (in progress)

Process changes were made to ensure the evaluations completed in support of GSI-191 resolution will remain valid or will be revised in the future when necessary. For example:

- A GSI-191 program and procedures have been developed to ensure that future modifications in containment are appropriately reviewed for any potential impact on containment sump strainer performance.
- The procedures for the Coating Program were updated to indicate the analyzed quantity of post-accident coating debris.
- Procedures were issued to perform routine latent debris sampling and evaluation.
- Equipment labeling procedures were enhanced to ensure equipment labels and signage placed in containment are appropriate for the environment.
- Procedures for performing routine inspections of containment were enhanced.

Significant conservatisms and margins contained in analyses include, but are not limited to, the following:

- Margin was added to the design basis debris load when sizing and evaluating the design of the replacement strainer.

- Recent fiber transport flume testing confirms the fiber debris load assumed for the design of the replacement strainer is very conservative.
- Kewaunee's strainer design and performance was based on a qualified coating Zone of Influence (ZOI) radius equal to 10D. Subsequently, a plant-specific evaluation using the Florida Power & Light JOGAR tests was conducted that determined the qualified coating systems in Kewaunee's ZOI could be reduced to a ZOI radius equal to 4D. Therefore, there is significant margin in the coating debris inventory used to size the ECCS strainer.
- The NPSH margin calculation for the Residual Heat Removal (RHR) pumps operating in the recirculation mode has several embedded conservatisms.
- The maximum strainer head loss observed during flume testing was 3.7915 ft of water (debris-laden strainer head loss temperature-corrected to reflect 65 degree F water, plus clean strainer losses), which is significantly below the allowable strainer head loss of 10 ft of water.

1. OVERALL COMPLIANCE

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Kewaunee's ECCS is capable of providing long-term cooling of the reactor core following a LOCA.

The evaluation of the ECCS as required by Generic Letter 2004-02 is near completion:

- Analyses to determine the post-accident debris source term and the quantity of debris potentially able to transport to the ECCS recirculation strainer have been completed.

- An evaluation to determine the type and quantity of chemical precipitants that can form in the post-accident sump pool is complete.

- Evaluations to support the conclusion that there will be no increased head loss from chemical precipitants will be completed by April 30, 2008.

- Evaluations to determine the long term impact of debris laden fluid (downstream effects) on ECCS and Internal Containment Spray (ICS) system operation have been completed. However, these evaluations are currently being revised to reflect recent revisions to the industry evaluation guidance. The revisions are scheduled to be complete May 31, 2008.

The physical changes identified for resolution of GSI-191 have been implemented. Kewaunee has installed an improved ECCS recirculation strainer designed by Performance Contracting, Incorporated (PCI). Safety related strainer flume testing has been completed to verify the strainer's performance during post-accident conditions. PCI is in the process of updating the strainer performance documentation to integrate recent flume testing and plant-specific fiber erosion tests performed in 2007.

Programmatic enhancements have been made to ensure the assumed post-accident debris load and evaluated conditions are not invalidated by future activities.

2. DESCRIPTION OF CORRECTIVE ACTIONS AND SCHEDULE

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

As indicated in Item 1 above, Kewaunee has two outstanding activities to complete the analyses required by Generic Letter 2004-02 for resolution of GSI-191. Those activities are:

a. Update Kewaunee's ECCS recirculation strainer performance documentation to integrate recent flume and fiber erosion tests performed in 2007. This activity is required for final resolution of the chemical effects issue. This activity is scheduled to be complete by April 30, 2008.

b. Update Kewaunee's downstream effects evaluations to use the revised industry evaluation guidance provided in WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191, Revision 1," and WCAP-16793-NP, "Evaluation of Long Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid, Revision 0." This activity is scheduled to be complete by May 31, 2008. The revised downstream effects evaluations are expected to confirm that no additional physical modifications are required for Kewaunee.

3. METHODOLOGY FOR DEMONSTRATING COMPLIANCE

3.A BREAK SELECTION

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Kewaunee relies on containment sump recirculation to respond to loss of coolant accidents (LOCA). Recirculation is not credited in response to Main Steam pipe breaks or Feedwater pipe breaks in containment.

Kewaunee performed walkdowns to identify the various post-LOCA debris sources in containment using NEI 02-01, *Condition Assessment Guidelines: Debris Sources Inside PWR Containments, Revision 1.* The walkdowns documented potential debris sources in the RCS Loop compartments, other postulated break locations outside the compartments, the area submerged post-LOCA, and the areas subject to impingement from containment spray or drainage flow.

Kewaunee contracted with Sargent & Lundy to perform the RCS pipe break selections for the purpose of determining debris generation. Kewaunee is a two-loop pressurized water reactor (RCS Loop A and RCS Loop B). RCS Loop B was identified as having the largest quantity of potential post-LOCA debris and the largest mixture of debris types. Loop B is also closest in proximity to the ECCS recirculation sump strainer. Three pipe break locations in Loop B were selected to determine the quantity of debris generated from each break (cold leg, intermediate leg, hot leg). The Loop B hot leg break, while not having the largest ZOI, produces the largest quantity of debris and the largest variety of debris types. The Loop B hot leg pipe has an inside diameter of 29 inches, which equates to a ZOI radius from 13' 2" (5.45D) to 69' 1.5" (28.6D), dependent upon the debris type. The pipe break selection used in the evaluation performed by Sargent & Lundy deviates from the pipe break selection methodology in NEI 04-07, *Pressurized Water Reactor Sump Performance Evaluation Methodology*, as stated in Kewaunee's September 1, 2005 response to GL 2004-02. However, the pipe breaks selected provide an accurate assessment of the bounding breaks to ensure the ECCS recirculation strainer is designed for the most detrimental debris load.

3.B DEBRIS GENERATION/ZONE OF INFLUENCE

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

As noted in item 3.A above, the RCS hot leg break is the postulated break producing the largest quantity and largest variety of debris. Kewaunee is a low-fiber plant. The majority of insulation in containment is reflective metal insulation (RMI). Additionally, Kewaunee's containment is clean and has a very low latent debris quantity.

The methodology specified in NEI 04-07 was used to determine the quantity of debris generated from each source and the ZOI size.

Refer to Section 3.D for an explanation of latent debris quantity determination.

Refer to Section 3.H for an explanation of the coating quantities stated in Table 3.B-1 below.

Table 3.B-1 displays the debris sources and quantities determined to potentially exist from the limiting break location (RCS Loop B hot leg break). Note that the data reflected in the table below does not subtract assumed quantities of debris that will not transport to the ECCS recirculation strainer, and it does not add

debris for debris inventory margin. Those subtractions and additions are addressed in Section 3.E.

Table 3.B-1

DEBRIS TYPE	ZOI RADIUS R/D HOT LEG BREAK	LOOP B HOT LEG BREAK MAXIMUM QUANTITY DEBRIS GENERATED (WITHOUT TRANSPORT REDUCTIONS)
Reflective Metal - intact pieces	28.6D	18,133 ft^2
Reflective Metal - foils	28.6D	31,660 ft^2
Fibrous - jacketed TempMat	17D	41.2 ft^3
Fibrous - jacketed pipe cover	17D	6.9 ft^3
Fibrous - cable insulation	17D	0.6 ft^3
Fiber/particulate mix - jacketed Thermobestos (1)	5.45D	5.8 ft^3
Fibrous - latent debris	N/A	1.7 lbm
Particulate - latent debris	N/A	9.6 lbm
Coating - inorganic zinc	10D (2)	385 lbm (2)
Coating - phenolic epoxy	10D (2)	540 lbm (2)
Coating - enamel	10D (2)	250 lbm (2)
Coating - factory coatings	10D (2)	150 lbm (2)
Miscellaneous debris (3)	N/A	60 ft^2 (4)

(1) Johns Manville Thermobestos insulation is calcium silicate insulation bonded with asbestos fibers.
(2) Analyzed quantity for both qualified and unqualified coatings (with margin included). The ZOI for qualified coatings will be reduced from 10D to 4D which results in debris inventory margin; see Section 3.H.
(3) Ty-wraps, electrical tape, paper or plastic stickers, for example.
(4) An initial inventory of 60 ft^2 was recorded, however, during the 2006 Refueling Outage most paper and plastic signage was removed from containment.

Table 3.B-2 displays the quantities of debris generated from the non-limiting analyzed breaks (without transport reductions or margin added). Due to the large ZOIs, many debris quantities are the same as those listed in Table 3.B-1.

Table 3.B-2

DEBRIS TYPE	ZOI RADIUS R/D HOT LEG BREAK	LOOP B COLD LEG BREAK MAX. QTY. DEBRIS GENERATED	LOOP B INTERM. LEG BREAK MAX. QTY. DEBRIS GENERATED
Reflective Metal - intact pieces	28.6D	16,080 ft^2	16,080 ft^2
Reflective Metal - foils	28.6D	25,501 ft^2	25,501 ft^2
Fibrous - jacketed TempMat	17D	41.2 ft^3	41.2 ft^3
Fibrous - jacketed pipe cover	17D	6.9 ft^3	6.9 ft^3
Fibrous - cable insulation	17D	0 ft^3	0.6 ft^3
Fiber/particulate mix - jacketed Thermobestos	5.45D	4.9 ft^3	4.9 ft^3
Fibrous - latent debris	N/A	1.7 lbm	1.7 lbm
Particulate - latent debris	N/A	9.6 lbm	9.6 lbm
Coating - inorganic zinc	10D (1)	385 lbm (1)	385 lbm (1)
Coating - phenolic epoxy	10D (1)	540 lbm (1)	540 lbm (1)
Coating - enamel	10D (1)	250 lbm (1)	250 lbm (1)
Coating - factory coatings	10D (1)	150 lbm (1)	150 lbm (1)
Miscellaneous debris	N/A	60 ft^2	60 ft^2

(1) Analyzed quantity for both qualified and unqualified coatings (with margin included). The ZOI for qualified coatings will be reduced from 10D to 4D which results in debris inventory margin; see Section 3.H.

3.C DEBRIS CHARACTERISTICS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

1. Size Distribution

The size distribution for materials that are not assumed to have a transport fraction equal to 100% (see Table 3.E-1) is listed below.

a. RMI

Diamond Power mirror insulation with standard bands has a large ZOI, 28.6. However, a small fraction of fines is generated. See Table 3.E-1 for size distribution.

b. Fiber

See Table 3.E-2 for fiber size distribution.

2. Density of Debris

The following are the as-fabricated densities for the materials in Kewaunee's debris inventory:

Table 3.C-1

DEBRIS TYPE	AS-FABRICATED DENSITY (lbm/ft^3)
Fibrous - TempMat	11.8
Fibrous - pipe cover	3.3
Fibrous - cable insulation	11.8
Fibrous - Thermobestos	10
Particulate - Thermobestos	10
Fibrous - latent debris	2.4
Particulate - latent debris	100
Coating - inorganic zinc	91.68
Coating - phenolic epoxy	18.06
Coating - enamel	19.66
Coating - factory coatings	19.66

3. Specific Surface Areas for Debris

The specific surface area (S_v) of debris was used when performing the preliminary analysis using NUREG/CR-6224, *Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris, Revision 0*, to determine the size (surface area) of the replacement ECCS recirculation strainer.

The specific surface area was calculated using the NUREG/CR-6224 correlation. Fibrous debris was assumed to have a cylindrical shape and particulate debris was assumed to have a spherical shape.

Table 3.C-2

DEBRIS TYPE	CALCULATED S_v (ft^2/ft^3)
Fibrous - TempMat	133,332
Fibrous - pipe cover	173,913
Fibrous - cable insulation	173,913
Fibrous - Thermobestos	266,667
Particulate - Thermobestos	457,200
Fiber - latent debris	173,913
Particulate - latent debris	462,000
Coating - inorganic zinc	183,000
Coating - phenolic epoxy	183,000
Coating - enamel	183,000
Coating - factory coatings	183,000

Absent from the above list is reflective metal insulation and foreign materials, which are not inputs to the NUREG/CR-6224 correlation, but were added to the flume during strainer performance testing.

Although the above data was used for the preliminary replacement strainer size determination, the strainer size was subsequently verified by safety related flume testing.

3.D LATENT DEBRIS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Containment walkdowns to assess the quantity of latent debris in Kewaunee's containment were performed during the fall 2004 Refueling Outage. Latent debris sampling and evaluation was performed following the guidance provided in NEI 04-07. The latent debris sampling was performed in the midst of outage maintenance activities (including reactor head replacement), well after the initial containment cleaning and prior to final post-outage cleaning activities.

Latent debris samples were obtained from areas subject to submergence and containment spray post-accident. Sample locations were selected with consideration given to maintaining personnel safety. Electrical and moving equipment hazards were avoided and areas at extreme heights were avoided. The sample locations were representative of floors, walls, ductwork and equipment surfaces where latent debris could collect.

Fifteen latent debris samples were collected using a vacuum with a removable high efficiency particulate filter. The filter and sample bag were weighed prior to and after sample collection to determine the quantity of latent debris collected. Several samples from horizontal, vertical and equipment surfaces were obtained.

Mechanical, electrical, and structural drawings were reviewed to determine the overall quantity of surface areas in containment for various surface categories. The results of the sample collection were applied to the surface categories to determine the total quantity of latent debris in Kewaunee's containment. The total latent debris calculated in Kewaunee's containment building was 11.3 lbs. As noted in Section 3.I.4 below, Kewaunee's containment building is routinely cleaned which minimizes latent debris collection. For the purpose of designing the replacement ECCS recirculation strainer, a quantity of 100 lbs. of latent debris was conservatively assumed. The latent debris was assumed to consist of 15 lbs. fibrous debris (15% per NEI 04-07 Safety Evaluation, paragraph 3.5.2.3) and 85 lbs. particulate debris.

In August 2006, Kewaunee issued new procedures to provide guidance for routine latent debris sample collection and for analyzing the sample results. The procedures are scheduled with a frequency of every four plant operating cycles due to the high margin available in the debris inventory and due to routine cleaning activities in containment. The latent debris evaluation procedure contains steps to adjust the sample collection and analysis to be more or less frequent based on available margin in the latent debris inventory.

Kewaunee's new strainer design was flume tested with PCI's latent debris mixture, equivalent to Kewaunee's 100 lbs. specification. Sacrificial strainer surface area was not added for latent or miscellaneous debris when designing the strainer. Kewaunee's initial plant walkdowns identified 60 ft^2 of miscellaneous debris, such as paper and plastic labels, tape and ty-wraps. This quantity was increased to 90 ft^2 to add margin. Samples of the identified miscellaneous debris sources were provided to PCI, and an equivalent of 90 ft^2 of miscellaneous debris was placed in the flume during head loss testing in February 2006. Therefore, Kewaunee's replacement ECCS strainer is designed for the maximum latent and miscellaneous debris load. Subsequent to the strainer head loss flume testing, the majority of the paper and plastic labels were removed from containment, resulting in additional debris load margin.

3.E DEBRIS TRANSPORT

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Kewaunee contracted with Sargent & Lundy to perform the initial debris transport study for resolution of GSI-191. Kewaunee is a Westinghouse two loop unit with robust structures (referred to as "vaults") surrounding the steam generators, reactor coolant pumps and pressurizer. Therefore, the transport analysis used the methodology presented in NEI 04-07, Section 3.6.3.1, for a highly compartmentalized containment. No inactive volumes were modeled in the transport logic trees for Kewaunee. Kewaunee's inactive volumes are the waste sump (Sump A), the area under the reactor vessel (Sump C) and a volume of water held up in the bottom of the refueling cavity due to the presence of a standpipe in the cavity's floor drain. Minimal post-accident debris is postulated to reach the inactive pools. Therefore, as a conservative measure, the inactive pools were not utilized in the transport logic trees.

The following Tables 3.E-1 and 3.E-2 show the postulated transport of post-accident debris in Kewaunee's containment from the bounding pipe break (RCS Loop B hot leg break), and the resultant analyzed post-accident debris assumed when sizing the replacement ECCS strainer.

Table 3.E-1

DEBRIS TYPE	DEBRIS SIZE	QUANTITY GENERATED	TRANSPORT FRACTION	QUANTITY AT SUMP SCREEN	QUANTITY INPUT TO STRAINER DESIGN
Reflective Metal (Diamond Power)	Foils (fines)	31,660 ft^2	1.2% (Note 1)	380 ft^2	450 ft^2
	Large/Intact	18,133 ft^2	0% (Note 2)	0 ft^2	0 ft^2
TempMat	Note 3	41.2 ft^3	62% (Note 3)	25.5 ft^3	30 ft^3
Fiberglass Pipe Cover	Note 3	6.9 ft^3	62% (Note 3)	4.3 ft^3	5 ft^3
Fibrous - latent debris	Fines	1.7 lbm	100%	1.7 lbm	15 lbm
Fibrous - cable insulation	Smalls/Fines	0.6 ft^3	100%	0.6 ft^3	0.7 ft^3
Thermobestos	Smalls/Fines/ Particulates	5.8 ft^3	100%	5.8 ft^3	6 ft^3 (Note 4)
Particulate -latent debris	All	9.6 lbm	100%	9.6 lbm	85 lbm
Coating - inorganic zinc	All	Note 5	100%	Note 5	385 lbm (Note 5)
Coating - phenolic epoxy	All	Note 5	100%	Note 5	540 lbm (Note 5)
Coating - enamel	All	Note 5	100%	Note 5	250 lbm (Note 5)
Coating - factory coatings	All	Note 5	100%	Note 5	150 lbm (Note 5)
Miscellaneous Debris	All	60 ft^2	100%	60 ft^2	90 ft^2

Note 1: Ref. NEI 04-07 SER, Table II-8. 75% of the 1.6% fines generated are assumed to transport.

Note 2: The ECCS recirculation strainer is surrounded by debris interceptors that will prevent the transport of large RMI pieces to the strainer. Intact RMI debris consists of those panels indirectly affected by the pipe break jet. Intact debris falls to the floor or vault shelf but the RMI cassette remains intact, not releasing its inner foils.

Note 3: Refer to Table 3.E-2 for fibrous debris size distribution and transport fractions.

Note 4: For the purpose of strainer sizing using NUREG/CR-6224 and flume testing, Thermobestos was conservatively assumed to be 90% particulate and 40% fibrous, for a total of 130% of the assumed value.

Note 5: The ECCS recirculation strainer was analyzed for an assumed coating quantity corresponding to plant-specific coating types and quantities, with margin added. The Coating Program ensures the quantity of qualified coatings in the bounding case ZOI and the unqualified coatings, in total, remain below the analyzed value.

The following Table 3.E-2 reflects the size distribution and overall transport fraction for fibrous debris.

Table 3.E-2

FIBROUS DEBRIS TYPE	FIBER SIZE DISTRIBUTION (FRACTION)	DEBRIS TRANSPORT FRACTION	FRACTION OF FIBROUS DEBRIS ASSUMED AT SUMP SCREEN
Fines	8%	100%	8%
Smalls	25%	100%	25%
Large	32%	90% (Note 1)	29%
Intact	35%	0%	0%
Total	100%	N/A	62% (Note 1)

Note 1: The strainer is surrounded by debris interceptors. Although large debris will not transport to the strainer, in accordance with NEI 04-07 Safety Evaluation, Appendix III, 90% of the large debris was assumed to erode over time and transport to the strainer. See also Section 3.O for discussion of more recent testing related to fiber transport and fiber erosion.

In 2007, Kewaunee performed additional flume testing to evaluate the transport of fiber in the Kewaunee sump pool (see Section 3.O). This testing confirmed minimal transport of fiber in the Kewaunee sump pool due to low sump pool velocities and the presence of the debris interceptor around the recirculation strainer.

3.F HEAD LOSS AND VORTEXING

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Schematic diagrams of the ECCS and ICS systems are provided in Figures 1 and 2 attached.

1. Vortexing and Void Fraction

As stated in Section 3.G below, the minimum containment sump water level at the onset of recirculation is 40.5 inches. This is a bounding value for either a small break or large break LOCA. The minimum water level would be increased by approximately four inches if the water contribution from the safety injection (SI) accumulators is included for the large break LOCA scenario. At the minimum sump level, the ECCS recirculation strainer is fully submerged. The height of the new strainer is 37.25 inches. Therefore, there is a minimum of 3.25 inches water level above the top of the strainer's perforated material at the onset of recirculation.

Also, as noted in Section 3.G below, there are several conservatisms in the minimum water level calculation. For example, no credit is taken for additional sump volume due to operator response time to line up the RHR and SI train and manually initiate recirculation.

Kewaunee contracted with PCI to perform an evaluation of the potential for vortexing with the new ECCS recirculation strainer design. The evaluation, using the guidance of USNRC Regulatory Guide 1.82, Revision 3, *Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident*, concluded that vortex formation is precluded by the PCI Sure-Flow™ strainer design and Kewaunee's strainer configuration. The evaluation also verified that vortex formation is not a concern for the perforated recirculation sump pit maintenance hatch, described in Section 3.J below.

PCI also evaluated the potential for void formation (flashing) at the strainer. The evaluation used two methodologies, a conventional approach using classical hydraulic and fluid flow calculations, and an analysis using the NUREG/CR-6224 correlation. The evaluation used the post-accident containment pressure at the time of switchover to recirculation. The pressure was derived from the Kewaunee GOTHIC containment analysis. Using the conventional methodology, 0% void fraction was calculated for the strainer discharge flow before it leaves the Kewaunee containment sump. Using the NUREG/CR-6224 correlation, a void fraction of 0.052% was determined at the strainer, before the strainer discharge fluid enters the ECCS pump suction pit. In both cases, the void fraction is significantly less than the 3% acceptance criteria specified by Kewaunee's calculation.

2. Strainer Head Loss

Kewaunee's replacement ECCS recirculation strainer was designed for a maximum 10 ft head loss across the debris-laden strainer (see Section 3.G below). The strainer was designed for a flow rate of 4,000 gpm (two RHR pumps in operation). In the recirculation mode, however, only one RHR pump will operate and the RHR flow is throttled to 1500 gpm. Kewaunee does not credit ICS operation in the recirculation mode, however, it is not procedurally prohibited. If ICS operation in the recirculation mode is desired, such as in response to a beyond-design-basis accident, the standby RHR pump would be placed in operation with the containment sump as its suction source and that RHR pump would feed the ICS system.

PCI performed head loss calculations for Kewaunee's replacement ECCS recirculation strainer using NUREG/CR-6224. The head loss predictions are presented below:

Table 3.F-1

PARAMETER	RESULT	NOTES
Maximum head loss from debris laden strainer	8.5 ft of water	Design basis debris load - see Table 3.E-1 (fiber quantity 45.1 ft^3); clean strainer losses are included (Note 1); 8.5 ft is less than the 10 ft allowed
Fiber quantity required to achieve 10 ft head loss (debris bed + clean strainer losses)	200 ft^3 fiber	Using the NUREG/CR-6224 correlation, there is significant margin between the design basis 45.1 ft^3 fiber and the fiber quantity to achieve the maximum strainer loss of 10 ft of water

Note 1: Clean strainer head loss is calculated as 1.451 ft of water. This is the total corrected clean strainer loss calculated at 4,000 gpm flow, assuming 65 degree F water. The calculation includes 6% uncertainty, and the head losses associated with the strainer piping length, strainer module-to-module transition (with 10% conservatism), attached piping and fittings (with 10% conservatism), and expansion of the flow of water entering the sump pit.

Safety related flume testing for the replacement ECCS recirculation strainer was conducted the week of February 13, 2006, at Alden Research Laboratories (ARL). For Kewaunee's tests, PCI contracted with AREVA NP, Inc. (AREVA) to prepare the test plan and conduct the tests at ARL. The following tests were conducted:

a. Design Basis Debris Load; Coatings Failed as Powder

This test was conducted with the design basis debris load, which is the quantity of debris postulated to transport to the sump, with margin added. Coatings were simulated in the test flume by use of tin powder and walnut shell powder. Chemical debris was simulated by adding an equivalent of 665.53 mg/L sodium aluminum silicate ($NaAlSi_3O_8$) to the flume (see Section 3.O). The test was conducted at 63.5 gpm, equivalent to a recirculation flow rate of 4,000 gpm. The maximum measured strainer head loss during this test was 0.017 ft of water.

b. Design Basis Debris Load; Coatings Failed as Chips and Powder

This test was conducted with the design basis debris load, which is the quantity of debris transported to the sump, with margin added. Coatings were simulated in the test flume by use of a combination of tin powder, walnut shell powder, Carboline Carboguard 890 paint chips, Carboline 2011S paint chips, DuPont Dulux paint chips and Richardson Enamel paint chips. Chemical debris was simulated by adding an equivalent of 665.53 mg/L sodium aluminum silicate ($NaAlSi_3O_8$) to the flume (see Section 3.O). The test was conducted at 63.5 gpm, equivalent to a recirculation flow rate of 4,000 gpm. The maximum measured strainer head loss during this test was 0.089 ft of water.

c. Thin Bed of Fiber

This test was conducted with a quantity of fiber required to obtain a 1/8 inch thin bed of fiber on the test strainer module. RMI foils, coatings in powder form, latent debris particulate, calcium silicate, and miscellaneous tags and labels debris were added to the flume. Chemical debris was simulated by adding an equivalent of 665.53 mg/L sodium aluminum silicate ($NaAlSi_3O_8$) to the flume (see Section 3.O). The test was conducted at 63.5 gpm, equivalent to a recirculation flow rate of 4,000 gpm. The maximum measured strainer head loss during this test was 3.15 ft of water.

During the tests, the debris was thoroughly mixed, suspended, and located at the strainer. These tests were highly conservative as the recirculation flow and strainer design does not result in depositing all of the debris at the strainer (see Section 3.O).

The tests concluded that the maximum strainer debris bed losses, when added to the clean strainer losses (1.451 ft of water), remain well below the specified maximum 10 ft of water allowed. The maximum head loss observed during testing was 3.7915 ft of water (debris-laden strainer head loss temperature-corrected to reflect 65 degree F water, plus clean strainer head loss). See also Section 3.O for discussion regarding additional flume testing performed in June 2007.

3.G NET POSITIVE SUCTION HEAD (NPSH)

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

The ECCS includes two trains of emergency core cooling pumps (see Figure 1). Each train consists of one high pressure SI pump and one low pressure injection

RHR pump. Both ECCS trains are aligned to the refueling water storage tank (RWST) and then are realigned to the recirculation sump by manual operator actions once pre-determined water levels in the RWST have been reached. The ICS pumps are aligned to take suction from the RWST.

System response is determined by the RCS and containment pressure characteristics. The SI pumps and RHR pumps are actuated upon an SI signal when RCS pressure decreases to 1815 psig. The ICS pumps are actuated when containment pressure increases to 23 psig.

During a small break LOCA, the rate of RCS depressurization will be slower and therefore, create a delay between high pressure SI and low pressure injection using the RHR pumps. Due to the relatively low shutoff head of the RHR pumps, low pressure injection flow to the RCS will not begin until the RCS depressurizes to approximately 150 psig. During a large break LOCA, rapid RCS depressurization and concurrent containment pressurization will cause high pressure injection, low pressure injection, and containment spray actuation early in the event. For the bounding large break LOCA, RCS pressure will be sufficiently low to allow high pressure and low pressure injection, resulting in the most rapid depletion of the RWST and therefore earliest switchover to ECCS sump recirculation. As noted above, ICS utilizes the RWST as its suction source. The Kewaunee safety analyses do not credit ICS operation in the recirculation mode.

When two trains of emergency core cooling pumps are available, at 37% RWST level one ECCS train is manually aligned for containment sump recirculation. The second train continues to draw suction from the RWST until the minimum RWST level is reached. Upon reaching the minimum RWST level, the second train is manually aligned for containment sump recirculation in standby mode. The RHR pumps take suction from a common ECCS recirculation sump. One SI/RHR train supplies recirculation flow to the reactor core.

When only one train of emergency core cooling pumps is available, at 10% RWST level the operable train is manually aligned for containment sump recirculation.

The minimum containment sump level for recirculation exists at the 37% RWST level (63% depleted), when both ECCS trains are available. The minimum containment sump water level at 37% RWST level is 40.5 inches above the containment basement floor elevation. The ECCS recirculation strainer modules are mounted to the containment basement floor. The minimum sump level calculation determined the quantity of water from the RWST to be 21,300 ft^3, including consideration for instrument accuracy. The water height is determined taking into account water holdup volumes in the containment that affect the sump level at the onset of recirculation (Sump A, Sump B recirculation sump suction pit, Sump C, and the refueling cavity holdup volume; see Section 3.E). The calculation also accounts for displacement of water from concrete walls and columns, the Pressurizer Relief Tank, the Reactor Coolant Drain Tank, and the lower Reactor Vessel.

Kewaunee's minimum sump water level calculation was created with several conservatisms to bound the small break and large break LOCA scenarios (see discussion following Table 3.G-1 below). Upon review of the NRC GL content guide (References 10 and 11), it was determined that the calculation should be improved to include, as appropriate, holdup volumes associated with condensed films on heated structures, water holdup on equipment and structures, water volume in the containment spray piping, and water/condensation in the containment atmosphere. This calculation revision will be completed by May 31, 2008. In the interim, a preliminary analysis indicates that there is no impact on the minimum containment sump level due to the significant conservatisms in the existing calculation.

At the minimum containment sump water level, the ECCS recirculation strainer is fully submerged. The height of the new strainer is 37.25 inches. The minimum containment sump water level is 40.5 inches.

A net-positive suction head (NPSH) calculation was performed for the RHR pumps when taking suction from the containment recirculation sump, assuming a RWST level of 37%. The results of the calculation are displayed in Table 3.G-1.

Table 3.G-1

PARAMETER	HEAD (FT)	COMMENT
NPSH Available	23.813	Total water height at the onset of recirculation, minus piping friction losses
Maximum debris laden strainer head loss	10	Includes clean strainer head loss and debris laden strainer head loss combined (Note 1)
NPSH Required	8	At design flow rate 2000 gpm/pump
NPSH Margin	5.813	

Note 1: The ECCS recirculation strainer is limited to 10 ft head loss unless the structural integrity of the strainer is analyzed to exceed that value. See item e below for margin discussion.

The following conservatisms in the NPSH calculation should be noted:

a. No credit is given for the operator response time to manually align the first RHR pump to the recirculation sump. If the time delay is credited, the RWST level will be lower and the resultant sump level will be higher when the RHR pump is started in the recirculation mode.

b. No credit is given for the SI accumulators' volume in the sump. Without crediting the additional water from SI accumulator injection during a large break LOCA, the NPSH calculation bounds the small break LOCA scenario where the accumulators may not inject. Similarly, no credit is given for additional water volume from spilled RCS fluid or injection of sodium hydroxide (NaOH) into containment.

c. Containment accident pressure is not credited in the calculation.

d. A sump fluid temperature of 70 degree F is assumed to ensure friction losses in the RHR pump suction piping are conservative.

e. Margin exists in the 10 ft. recirculation sump strainer head loss value. The actual strainer head loss is less than 10 ft., and margin was factored into the debris inventory that was assumed to determine the strainer head loss. Additionally, margin was factored into the clean strainer head loss calculation. The maximum debris bed head loss calculated using NUREG/CR-6224 is 7.0498 ft., plus clean strainer head loss of 1.451 ft, for a total maximum head loss of 8.5008 ft. The maximum temperature-corrected head loss observed during strainer flume testing in February 2006, including clean strainer head loss, was 3.7915 ft. Recent flume testing completed in June 2007 with the debris interceptors modeled in the flume indicates there is insufficient fiber that will transport to the strainer to create a thin bed effect or thick bed. Therefore, the actual strainer head loss is much less than the February 2006 flume test values.

3.H COATINGS EVALUATION

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

As stated in Section 3.I.7 below, Kewaunee has a Coatings Program that routinely inspects and inventories coatings in containment. The inventory includes unqualified coatings in containment, and qualified coatings within a 10D ZOI in the limiting postulated RCS pipe break location, RCS Loop B hot leg break (also see 4D ZOI discussion in this Section below).

Kewaunee's post-accident coating debris load inventory is classified into four categories of coating types: inorganic zinc, phenolic epoxy, enamel and factory coatings.

The quantity of qualified coatings that could fail post-accident in the bounding RCS break location (RCS Loop B hot leg break) has been quantified as 5.6414 ft^3, consisting of 0.5597 ft^3 of inorganic zinc (Carbozinc 11) and the remainder is phenolic epoxy (Phenoline 305, Carboline 195, Carboguard 890). This is the coating applied to concrete walls, floors and ceilings, structural steel, and equipment in the Loop B vault.

The quantity of unqualified coatings in containment is tracked by Kewaunee's Coating Program Unqualified Coating Log. Unqualified coatings at Kewaunee currently include Carbozinc 11, Phenoline 305, Carboguard 890, DuPont Dulux, Richardson Enamel, and factory coatings. Some coatings are classified as unqualified due to having an unqualified application or substrate.

For the purpose of creating and maintaining the post-accident debris inventory, the coatings are classified as qualified (qualified coatings located in the limiting RCS break location), or unqualified (all containment locations) to determine the total post-accident coating debris load. The total analyzed quantity of postulated failed coatings is reported above in Table 3.B-1. The Coatings Program ensures the quantity of qualified coatings in the bounding case ZOI and the unqualified coatings remain, in total, below the analyzed value for each coating type (i.e., inorganic zinc, phenolic epoxy, enamel and factory coating).

Kewaunee's transport analysis and strainer head loss evaluations conservatively assume that the qualified coatings in the ZOI and all of the unqualified coatings fail as particulate fines. It is further assumed that 100% of those coatings transport to the ECCS recirculation strainer. Strainer head loss testing was performed with the coatings failed as 100% particulate, and with the coatings failed as a combination of particulate and chips (see Section 3.F.2 above). The following surrogate materials were used during Kewaunee's plant-specific strainer head loss tests.

Table 3.H-1

COATING	SURROGATE	NOTES
Inorganic Zinc	Tin Powder	50% size 1-5 microns 50% size 10-44 microns (Note 1)
Phenolic Epoxy	#325 Walnut Shell Flour	41 microns average size (Notes 2, 3)
Enamel		
Factory Coatings		

Note 1: Zinc is an environmentally hazardous material; therefore, it was replaced with tin powder as a surrogate. Tin powder is similar in size, shape and density. EPRI Report 1009750 identified that tested coatings failed in the 5 to 650 micron size range (83 micron average) for EPRI Test 1 and failed in the 5 to 1,025 micron size range (301 micron average) for EPRI Test 2. Particulates used in head loss tests that are < 83 microns are considered conservative and bounding for testing. Particles of smaller size bound particles of larger size as the smaller particles will fill more of the interstitial spaces between fibers in the debris bed.

Note 2: #325 walnut shell flour was found to be bounding and conservative as a surrogate for epoxies, enamels and other coatings with a density above 90 lbs/ft^3. Walnut shells have a specific gravity of 1.2 to 1.5, which is 74.9 to 93.6 lbs/ft^3. A lot-specific test of the surrogate confirmed a specific gravity of 1.44 and 1.45.

Note 3: Head loss testing with coatings failed as powder and paint chips (see Section 3.F.2) used tin powder as a surrogate for Carbozinc 11 and walnut shell powder as a surrogate for factory coatings. Epoxies and enamels were simulated by paint chips formed from the following coatings: Carboguard 890 (dry film thickness 5.1 - 6.3 mils), Carboline 2011S (dry film thickness 22.7 - 36.7 mils), DuPont Dulux (dry film thickness 1.6 - 2.8 mils) and Richardson Enamel (dry film thickness 4.6 - 5.7 mils).

Subsequent to the ECCS replacement strainer sizing and testing, Kewaunee contracted with AREVA to perform a review of Florida Power & Light Report, JOGAR-06-001, Revision 0. This is a ZOI test for design basis accident qualified coatings. AREVA's evaluation of JOGAR-06-001 and Kewaunee's coating systems concluded that Kewaunee's qualified coating systems listed in Table 3.H-2 may reduce the ZOI from 10D to 4D. Since the ECCS recirculation strainer was sized for failed qualified coatings with a ZOI equal to 10D, this reduction in zone size to 4D results in added debris inventory margin.

Table 3.H-2

SUBSTRATE	COATING SYSTEMS PRIMER / TOPCOAT(S)
Concrete	• Carboline 195 / Phenoline 305 • Phenoline 305 / Carboline 195 / Phenoline 305 • Phenoline 305 / Phenoline 305
Steel	• Carboline Carboguard 890 / Carboguard 890 • Carboline Carbozinc 11 / Phenoline 305

3.I DEBRIS SOURCE TERM

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

The following programs or processes will ensure the maximum postulated debris in containment does not exceed the analyzed quantities. This will ensure ECCS operability as future changes are made to the plant.

1. Dominion has implemented a Fleet GSI-191 Program. The Fleet Program designates a Fleet GSI-191 Lead Person, Site GSI-191 Program Owners, and delineates GSI-191 staff and management responsibilities to ensure the design and licensing bases and technical documents established for each site are maintained.

2. Dominion has a fleet foreign material exclusion (FME) procedure used by the plant sites that prevents entry of foreign material into plant systems. The procedure directs the user to perform a work activity hazard determination and risk determination and establishes FME requirements.

3. Kewaunee has a containment inspection procedure that is implemented at the end of each outage, prior to reaching Hot Shutdown. The inspection identifies and removes inappropriate material and debris from containment, ensures portable equipment is seismically restrained or properly stored, confirms no structural damage to the recirculation strainer assembly or the recirculation sump pit perforated maintenance hatch, ensures the recirculation strainer debris interceptors are installed, and various similar activities to ensure the operability of the recirculation sump. A similar procedure is performed quarterly during containment entries during power operations.

4. During refueling outages, the Radiation Protection staff routinely performs cleaning of various areas in containment, such as the refueling cavity, reactor coolant pump vaults, etc. Routine cleaning reduces the amount of latent debris in containment.

5. Kewaunee controlled area maintenance staff clean the recirculation sump pit as needed during refueling outages to remove standing water and boric acid residue caused by periodic cycling of the recirculation sump suction containment isolation valves.

6. Kewaunee has established procedures to perform periodic latent debris sampling in containment and to quantify the total latent debris in containment to ensure the quantity remains below the analyzed limit. Refer to Section 3.D above and Section 3.O below for a discussion on latent debris thin bed.

7. Kewaunee has established procedures to apply, inspect, and quantify coatings in containment. An Unqualified Coating Log is maintained and updated each refueling outage. The inventoried quantity of qualified coatings in the worst case postulated LOCA pipe break location is also maintained. Changes to the qualified or unqualified coating inventories are evaluated to ensure the quantity of coatings assumed to fail post-accident remains below the quantity of coatings analyzed for potential impact on the recirculation sump strainer.

   Qualified coatings are visually examined on a routine basis to identify visible defects such as blistering, cracking, flaking, peeling, delamination, and physical damage. The inspection is performed in accordance with ASTM D5163, *Standard Guide for Establishing Procedures to Monitor the Performance of Service Level I Coatings in an Operating Nuclear Power Plant.* Coating repairs are made immediately or are evaluated for potential impact on the post-LOCA debris inventory if repairs are delayed to the next refueling outage.

   As indicated in the 2007 EPRI Report 1014883, *Plant Support Engineering: Adhesion Testing of Nuclear Coating Service Level I Coatings*, testing of aged, DBA-qualified coatings from various manufacturers, with no visual anomalies, resulted in pull-off adhesion at or in excess of the originally specified (ANSI N5.12-1972) value. Based on the EPRI testing, it was concluded that the containment coating monitoring approach contained in ASTM D5163 is valid. This approach is endorsed by the USNRC in RG 1.54, Revision 1, and NUREG-1801.

8. Dominion has a fleet guidance document for labeling plant equipment that includes labeling equipment in containment. The procedure ensures that equipment labels placed in the reactor containment building are appropriate for the environment and will not adversely affect the recirculation sump strainer.

9. Kewaunee has a maintenance procedure that provides guidance for applying and replacing insulation in containment. The procedure ensures the installation is performed with like materials appropriate for the containment environment and initiates a plant modification request if like materials are not desired. The modification process evaluates requested insulation changes and the potential impact on the containment sump recirculation system.

10. Kewaunee's plant modification process includes notification to the GSI-191 responsible engineer of modifications to the screen for potential impact relative to GSI-191 issues. Additionally, the modification process design input checklist used by the modification responsible engineer

contains a list of questions that will identify potential ECCS and ICS equipment impacts or technical document impacts, such as, but not limited to, post-accident debris inventory, chemical precipitation, sump water levels, and transport or drainage paths. This process applies to both permanent and temporary modifications.

In addition to programmatic activities to maintain the debris source term within analyzed quantities, the following maintenance activities were performed during the fall 2006 Refueling Outage to reduce Kewaunee's post-accident debris source term.

1. Equipment labels that have the potential to become post-accident debris were removed from the containment building. Specifically, plastic signage was removed (Gravoply II laminated signage, Dymo tape labels). A small quantity of nonmetallic equipment labels remain that are necessary to ensure safe and efficient plant operation (examples: color coded electrical tape to reflect train separation and instrument bus feeds, and small stickers to reflect snubber settings).

2. Jacketed fiberglass pipe insulation on the upper elevation of containment that can be subjected to containment spray impingement was replaced with like materials to improve its material condition.

3. Jacketed calcium silicate insulation in the submergence zone was repaired to eliminate gaps in the jacketing to improve its material condition and prevent the insulation outside a ZOI from becoming a debris source.

4. The wooden reactor vessel o-ring storage container was removed from containment. The spare o-rings were placed in a stainless steel container.

5. Four beams in the upper pressurizer vault were modified. Four 8WF67 beams coated with gypsum perlite plaster with metal lath were covered with 0.016 inch stainless steel jacketing and fastened with 1/2 inch stainless steel bands. The jacketing was overlapped by two inches, with the seams oriented away from the postulated break locations. The beams are located between 19.5 and 29.4 ft. from a postulated RCS pipe break location. The material was determined to have a ZOI of 6.6 pipe diameters for the purpose of debris generation. The beams are located between 8.1 and 12.2 pipe diameters from the postulated break location. However, it was conservatively decided to jacket the fire proofing material to ensure the material does not contribute to the debris source term.

6. As part of Kewaunee's Coatings Program, Kewaunee continues to reduce the quantity of unqualified coatings in containment by performing coating removal and replacement with qualified coatings, as needed. This activity

gains margin in the unqualified coating inventory assumed in the design basis debris load.

3.J SCREEN MODIFICATION PACKAGE

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Figure 3 shows the recirculation strainer arrangement prior to replacement during the fall 2006 Refueling Outage. The previous arrangement was a strainer arrangement consisting of two conical-shaped screen elements with a combined total surface area of approximately 39 ft^2. The screens were constructed from Johnson screen material with a mesh size measuring 1/8 inch x 15/32 inch. The screens emptied into a common sump. Access into the sump to perform inspection and cleaning activities was performed by removal of one screen element. The previous arrangement did not result in the screens being fully submerged at the onset of recirculation.

Figure 4 shows the modified recirculation strainer arrangement. The new strainer arrangement includes a passive, safety-related Sure-Flow™ Strainer assembly manufactured by PCI. The passive strainer design does not utilize an active approach, i.e., backflushing. The PCI strainer is a modular design and is comprised of fourteen strainer modules (elements), core tube, and mounting track. The strainer has 768.7 ft^2 of surface area and is fully submerged at the onset of recirculation. There are no vents or penetrations through the strainer surfaces.

Each strainer module is constructed from 18 gauge stainless steel sheets perforated with 0.066 inch diameter holes. The perforated sheets are riveted together along the outside edge and shop welded to a core tube along the inner edges. The core tube is 18 inch diameter, 16 gauge, stainless steel pipe. The core tubes of each module are connected together by means of a coupling sleeve fitted over the core tubes, secured by a latch. The core tube has flow holes cut in the wall to admit the flow of strained water from the inside of the perforated sheets.

The strainer modules are pin connected to a mounting track, which in turn is anchored to the containment 592 ft elevation. The mounting track is made of structural angles and flat bars. The strainer design allows for disassembly, replacement of modules, or addition of future modules, as needed. An 18 inch schedule 10 stainless steel pipe from the first module delivers the strained water into the containment recirculation sump (Sump B) pit by penetrating through the sump cover plate. The adjacent sump cover plate was redesigned to provide a maintenance access hatch to allow for inspection and cleaning of the sump pit and the RHR suction piping. The maintenance access hatch contains a two-disk strainer that is perforated with 0.066 inch holes. The maintenance hatch can admit water into the sump at a lower elevation than the recirculation strainer for non-design basis events. The maintenance hatch strainer element has the capability to support flow into the recirculation sump suction pit to support operation of one RHR pump without the presence of debris. It is not relied upon for LOCA mitigation. The maintenance hatch strainer was structurally designed for debris load deadweight and differential pressure to ensure it will not fail and cause bypass into the recirculation sump pit during a LOCA response.

Three debris interceptors were designed and strategically installed around the ECCS recirculation strainer to prevent debris from transporting along the basement floor and reaching the strainer. The debris interceptors are designed with removable sections to allow unobstructed access to the strainer area during maintenance activities. The debris interceptors are constructed from eight inch stainless steel channel material. The debris interceptors surround the new strainer, taking advantage of the containment walls (see Figure 4).

Two narrow range containment sump level indicators are mounted on the recirculation sump pit curb. The bottom plates in the float columns for the level indicators/switches are perforated and can allow water entry into the recirculation sump pit. The float column end plates' perforation size exceeded the new 0.066 inch strainer perforation size; therefore, the plates were modified to have a perforation size of 1/16 inch to prevent bypass of debris into the sump exceeding the strainer perforation size.

3.K SUMP STRUCTURAL ANALYSIS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

The new recirculation strainer arrangement is located on the containment basement elevation (592 ft elevation). The strainer is one floor elevation below the RCS loop piping that is contained within concrete vault structures. Although there are floor openings allowing the free flow of water out of the concrete vault structures, there are no direct impingement paths between the RCS or connected piping and the strainer arrangement. Backflushing is not credited.

Structural analyses were performed for the replacement strainer arrangement to qualify the strainer modules, piping, pipe supports, Sump B pit cover and Sump B pit maintenance hatch strainer.

STRAINER MODULES

The structural analysis for the strainer modules, including the Sump B maintenance hatch strainer, was performed using a combination of manual calculations and finite element analysis using the GTSTRUDL computer program, Version 25, and the ANSYS computer program, Version 5.7.1. The strainer modules are designed to withstand design basis conditions at full debris loading without collapse or structural damage. The analysis includes evaluation of the inertial effects of the added hydrodynamic mass due to the submergence of the strainer modules.

Strainer Module Seismic Loads

The strainer modules are qualified for a minimum submergence elevation of 595 ft 4.5 inches, which equates to 3.25 inches water level above the top of the strainer modules. The strainer is considered passive mechanical equipment. The damping values for seismic loads are taken from DEK's Updated Safety Analysis Report (USAR) as 1% for Operating Basis Earthquake (OBE). Where Design Basis Earthquake (DBE) accelerations are calculated, DBE is equal to double the OBE accelerations. Factors for torsional accelerations are also applied.

The strainer modules are analyzed for the independent occurrence of coincident X-Y or Z-Y earthquakes in accordance with the KPS earthquake analysis for the reactor building [X = east-west; Y = vertical; Z = north-south]. The analysis uses the enveloping horizontal response spectra for the lateral directions. The modal combination is performed by the use of the square-root-sum-of-the-squares (SRSS) method. Zero Period Acceleration (ZPA) is considered. The ZPA response is added to the response spectra analysis by the SRSS.

Strainer Module Operating Loads

Operating loads on the strainer modules are comprised of weight and pressure loads. The weight includes the strainer self weight and the weight of the debris that could accumulate on the strainer. The pressure load acting on the strainer is the differential pressure across the strainer perforated plates in the operating condition. This is taken as the hydrostatic pressure associated with the maximum allowed head loss through the debris-laden strainer. The maximum allowed head loss through the recirculation sump strainer is 10 ft at 4000 gpm.

There are no thermal expansion stresses on the strainer modules because the strainer design allows free expansion without restraint due to sufficient gaps built into the four pin connections that secure the modules to the floor mounting track. The sleeve connections to the piping and adjacent strainers allow the strainer to grow thermally. The strainer mounting track design also has tolerances that would allow for thermal growth.

STRAINER PIPING, PIPE SUPPORTS AND SUMP COVER

A structural analysis was performed for the strainer piping, pipe supports and the sump cover plate that attaches to the base of Sump B. The analysis used a combination of manual calculations and use of the AutoPIPE computer program, Version 8.50.

Seismic Loads

The strainer piping is subject to two operating conditions: the "dry" condition with no recirculation water inside or external water present, and the "wet" condition. The "wet" condition was analyzed as this presents the bounding condition. The inertial effect of the added hydrodynamic mass due to the submergence of the piping was considered.

The piping is located on the containment floor elevation. In accordance with the KPS USAR, 0.5% damping horizontal and vertical spectra were used in the analysis for both the OBE and DBE. Torsional accelerations were accounted for. The response spectra for the DBE were determined by multiplying the OBE spectra by a factor of 2.0.

The strainer piping was analyzed for the independent occurrence of coincident X-Y or Z-Y earthquakes [X = east-west; Y = vertical; Z = north-south]. The modal combination is performed by the use of the SRSS method. ZPA is considered. The ZPA response is added to the response spectra analysis by the SRSS.

Operating Loads

Operating loads are comprised of weight, thermal expansion and pressure loads. The self weight of the piping and flanges was used. The weight of the water inside the pipe was not used for the deadweight condition, but was used for the seismic evaluation. A thermal expansion analysis was based on the maximum sump water temperature during the recirculation phase of the event. The differential pressure load was calculated as the hydrostatic pressure associated with the maximum allowed head loss through the debris-laden strainer.

SUMMARY

The analyses cited above confirm the strainer arrangement will maintain its structural integrity during operating conditions and seismic events.

The strainer arrangement is routinely inspected to verify that no damage has occurred to the strainer due to outage maintenance activities.

3.L UPSTREAM EFFECTS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Water drainage in containment was evaluated. There are three sumps in containment and each will fill with water during the blowdown or recirculation phase of the LOCA event. Containment Sump A collects the contents from floor drains in containment. Sump A normally is pumped to the waste holdup tank, but it is isolated during the LOCA event. Sump A is located below the containment basement floor elevation. Sump A will fill with water and overflow onto the containment basement floor (the containment recirculation "sump"). Containment Sump B is the recirculation sump (containment basement elevation) and includes a pit below the floor elevation from which the RHR pumps take suction. Containment Sump C is located below the reactor cavity. Sump C will fill with water when the containment sump (basement elevation) reaches approximately 2.5 feet of water, which is prior to the onset of recirculation. The lower elevation of the refueling pool cavity will also contain a quantity of water due to the presence of a standpipe in the cavity drain. The standpipe will prevent dense debris from entering the cavity drain. The refueling cavity drains to containment Sump A.

The water volumes in Sump A, Sump B pit, Sump C, and the refueling pool cavity were considered when calculating the minimum water level in the containment basement elevation at the onset of recirculation. The minimum water level was calculated to ensure the new strainer arrangement will be fully submerged at the onset of recirculation for both the large break LOCA (LBLOCA) and small break LOCA (SBLOCA) events. The minimum water level calculation can be conservatively applied to both the LBLOCA and SBLOCA events, as the water inventory from the SI accumulators was not considered, and the operator time delay for manual switchover to recirculation was not considered. These conservative considerations add to the water inventory prior to starting a RHR pump in the recirculation mode.

Water drainage from the upper containment elevations to the containment sump (basement elevation) is routed to the basement via the unobstructed south stairwell. Floor penetrations on the elevation above the containment basement have two inch floor collars, and the north stairwell has weirs and a toe rail on the stairwell gate that will direct the majority of the drainage to the unobstructed south stairwell. The south stairwell is located approximately 40 ft. away from the recirculation strainer elements with a tortuous path; therefore, drainage flow or debris will not be deposited directly near the strainer.

3.M. DOWNSTREAM EFFECTS - COMPONENTS AND SYSTEMS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Kewaunee is in the process of completing its downstream effects evaluations. As indicated in References 1 and 2, this activity will be complete by May 31, 2008.

Kewaunee has already performed a series of evaluations to assess the impact on the ECCS and ICS systems due to operating with debris-laden fluid. Although operation of the ICS system in the recirculation mode is not credited in the Kewaunee LOCA safety analyses, the ICS system was not excluded from the downstream effects evaluations.

The first evaluation identified the components and internal system clearances in the recirculation systems (RHR, SI, and ICS). This activity was conducted by Sargent & Lundy and was performed by reviewing plant drawings, procedures and vendor manuals.

A second evaluation determined the impact on the RHR, SI and ICS pumps due to operating with debris-laden fluid. Hydraulic performance, pump vibration, and the potential for mechanical seal failures were evaluated. This evaluation was performed by AREVA. The method of evaluation stated in WCAP-16406-P, Revision 0, was used for this evaluation. As a conservative measure, the pumps were evaluated for a mission time of 60 days. The following is the result of this evaluation:

Table 3.M-1

PUMP	EVALUATION	RESULT
RHR Pump	Hydraulic Performance	No flow blockage expected. Debris induced wear will not significantly degrade the pump performance.
	Mechanical Seal	Blockage not expected. Seal failure not expected.
	Vibration	Not applicable to single-stage pump.
SI Pump	Hydraulic Performance	No flow blockage expected. Debris induced wear will not significantly degrade the pump performance.
	Mechanical Seal	Blockage not expected. Seal failure not expected.

	Vibration	Acceptable; does not exceed two times the design running clearance limit for each wear component over the diameter of the wear rings.
ICS Pump	Hydraulic Performance	No flow blockage expected. Debris induced wear will not significantly degrade the pump performance.
	Mechanical Seal	Twelve hour seal life if used for post-accident recirculation due to the Durametallic Type PTO seal design.
	Vibration	Not applicable to single-stage pump.

A third evaluation determined the impact on the remaining components in the RHR, SI and ICS systems due to operating with debris-laden fluid (valves, orifices, heat exchangers, containment spray nozzles, instruments). This evaluation was performed by Sargent & Lundy and uses the methodology provided in WCAP-16406-P, Revision 0. This evaluation did not identify any post-accident operation concerns for the subject equipment due to operating long term with debris-laden fluid.

Due to the recent issuance of WCAP-16406-P, Revision 1, in August 2007, the second and third downstream effects evaluations listed above will be revised to incorporate the revised industry guidance. As indicated in Reference 1, these evaluations will be complete and approved by May 31, 2008.

3.N DOWNSTREAM EFFECTS - FUEL AND VESSEL

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

In August 2006, Westinghouse completed an evaluation of Kewaunee's reactor vessel and nuclear fuel design using the methodology stated in WCAP-16406-P, Revision 0. The evaluation concluded that dimensions in the reactor vessel and fuel flow path are adequate to prevent blockage from ingested debris, and there is not a sufficient fiber concentration to create a thin bed of fiber on the top support grid of the core. Therefore, no core blockage or cooling concerns were identified.

Kewaunee will reassess the downstream effects evaluation of the reactor vessel internals and nuclear fuel due to the recent issuance of WCAP-16406-P, Revision 1, and WCAP-16793-NP, Revision 0, *Evaluation of Long Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid.* As indicated in References 1 and 2, this activity will be completed by May 31, 2008.

3.O CHEMICAL EFFECTS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Kewaunee is in the process of updating its strainer performance documentation following additional flume tests and fiber erosion tests that were conducted in 2007. Those tests are an input to final resolution of chemical effects, as indicated below. As indicated in Reference 1, this activity will be complete by the April 30, 2008.

The following chemical effects evaluations were completed for Kewaunee. Kewaunee contracted AREVA to perform the analyses.

A preliminary analysis was performed in February 2006 using the results from the NRC-sponsored Integrated Chemical Effects Tests (ICET) Program. ICET Tests #1 and #4 were selected as most closely matching Kewaunee's chemical debris configuration. The evaluation determined the chemical precipitants that will form in the post-accident recirculation sump pool, and the quantity of each precipitant. The evaluation conservatively concluded that 665 mg/L of precipitants could form. The precipitants likely to form were identified as a combination of sodium aluminum silicate ($NaAlSi_3O_8$) (542 mg/L) and aluminum oxyhydroxide (AlOOH) (123 mg/L). Sodium aluminum silicate ($NaAlSi_3O_8$) was selected as the representative precipitant for use in the initial strainer flume tests conducted at ARL in February, 2006, with a concentration of 665 mg/L.

In May 2006, and subsequently revised in October 2006, a new chemical precipitation analysis was completed for Kewaunee. The analysis utilized the evaluation methodology presented in WCAP-16530-NP, *Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191, Revision 0*. The revised analysis predicted that the chemical precipitant in Kewaunee's sump pool is sodium aluminum silicate ($NaAlSi_3O_8$) with a maximum concentration of 403 mg/L. No aluminum oxyhydroxide (AlOOH) was observed to precipitate. Therefore, this evaluation concluded that the quantity and type of precipitant used in the February 2006 flume tests remained bounding.

In October 2007, a revised chemical precipitation analysis was completed for Kewaunee. This was a revision to the October 2006 analysis using WCAP-16530-NP. The October 2007 analysis also used WCAP-16785-NP, *Evaluation of Additional Inputs to the WCAP-16530-NP Chemical Model, Revision 0.* The analysis performed by AREVA indicates that aluminum, silicon and calcium are the largest contributors to the dissolved solution and that any precipitates would likely form from these elements. Consequently, the following materials are modeled in Kewaunee's evaluation: aluminum, calcium silicate insulation, latent particulate, latent fiber, fiberglass insulation, concrete surfaces, and sodium hydroxide buffer solution. The sump pH profile input to the chemical precipitation analysis is as follows:

Table 3.O-1

	START OF LOCA (0 SEC.) pH	1,000,000 SECONDS (11.5 DAYS) pH	INPUT
Low pH Range	4.66	7.5	Minimum RWST and Accumulator Boron Concentration; RCS at 0 ppm boron (end of cycle)
High pH Range	5.13	7.8	Maximum RWST and Accumulator Boron Concentration; RCS at 1514 ppm boron (beginning of cycle)

Additional chemical evaluation parameters, as requested by the NRC letter dated February 9, 2006, include those shown in Table 3.O-2:

Table 3.O-2

PARAMETER	VALUE/BASIS
Time to recirculation initiation	Twenty-three (23) minutes after initiation of event. USAR Table 14.3.4-3 indicates 1443 sec. (24 min.) as the time for switchover to recirculation with maximum safeguards trains available. The value of 1443 sec. was conservatively reduced to 1431 sec. to account for additional instrument inaccuracy values.
Pool (sump) temperature	226 °F at the start of the LOCA event 115 °F at 35 days after the event The range of values used in the chemical analysis is derived from Kewaunee's LOCA analysis.
Pool volume	24,179 ft^3 minimum 38,153 ft^3 maximum Both minimum and maximum values are provided for the bounding case LBLOCA and include: SI accumulator volumes (min/max per Technical Specifications (TS)), RWST volume (min/max per TS with adjustment for level instrument accuracy), RCS volume, and subtraction of containment holdup volumes (Sumps A and C and Refueling Cavity).

The refined analysis identifies the only chemical precipitant in Kewaunee's sump pool is sodium aluminum silicate ($NaAlSi_3O_8$) with a maximum concentration of 8 mg/L (5.674 kg). Therefore, this evaluation also concludes that the quantity and type of precipitant used in the February 2006 flume tests remained bounding. It also demonstrates that Kewaunee has an extremely low concentration of precipitant that will form in the post-accident sump pool.

Chemical Effects Resolution

Kewaunee has several positive attributes that prevent chemical effects concerns:

- Kewaunee has a low concentration of chemical precipitation in the post-accident sump pool (8 mg/L).
- Kewaunee has a very low quantity of fibrous debris in containment (45.1 ft^3, including margin), as most of the insulation in containment is RMI.
- Kewaunee's replacement ECCS recirculation strainer has a very low approach velocity (0.0116 ft/sec), i.e., quotient of strainer flow rate and total surface area conservatively calculated at a strainer flow rate of 4,000 gpm (see Section 3.F.2).
- Kewaunee's strainer design includes debris interceptors that limit the transport of debris to the strainer.

In June 2007, Kewaunee performed additional flume tests at ARL. The purpose of the June 2007 testing was to include the strainer's debris interceptor in the flume, model the flow rate across the debris interceptor and determine the quantity of fiber that is retained behind the debris interceptor.

The following is a summary of the June 2007 flume tests and their results:

The June 2007 flume tests were a series of safety related tests conducted and witnessed by ARL, AREVA and DEK. The purpose of the tests was to determine the quantity of fiber that collects on the recirculation sump strainer without artificially placing the debris directly on the strainer as was done in previous tests.

Tests were conducted with single train (2000 gpm) and two train (4000 gpm) flow rates (see Section 3.F.2). The flume test modeled the flow rate over the debris interceptor. The test flow rates were approximately 170 gpm (single train operation simulation) and 340 gpm (two train operation simulation). The use of overhead sprays provided sump mixing by simulating drainage and RCS break flows in containment.

The total fibrous debris introduced into the flume was weighed prior to each test. A plexiglass divider plate was installed in the flume during debris introduction to maintain the debris upstream of the debris interceptor, and was installed again upon test completion to capture, dry and weigh the debris that traveled downstream of the debris interceptor.

The time between debris addition to the flume and pump start was controlled to ensure the debris would not settle due to excessive time delays. A test was performed at each flow rate with 100%, 66% and 33% of the fiber debris load. The debris quantities used in the tests were based on the design basis debris load for the strainer design (see Table 3.E-1, Quantity Input to Strainer Design) and were scaled based on the ratio of the length of the debris interceptor section to the total length of the debris interceptor in the plant. Latent fiber was prepared as 100% fines. Okotherm cable insulation and Johns Manville Thermobestos was prepared as 40% fines and 25% smalls. The majority of the fiber, fiberglass pipe cover and TempMat fiberglass was prepared as 20% fines, 19% smalls and 26% larges (see fiber erosion test information that follows).

The test results identified that a very small amount of fiber transports to Kewaunee's recirculation strainer due to the low sump flow rates and the presence of the debris interceptors. A small amount of fiber was floating in the flume during each test, both upstream and downstream of the debris interceptor. This fiber was captured and weighed and was included as fiber that can travel downstream of the debris interceptor. The results of the tests are listed in the following Table 3.O-3.

Table 3.O-3

TEST	DEBRIS WEIGHT PRIOR TO TEST (LBS)	DEBRIS TRANSPORTED DOWNSTREAM OF DEBRIS INTERCEPTOR OR FLOATING (LBS)	DEBRIS TRANSPORTED DOWNSTREAM OF DEBRIS INTERCEPTOR OR FLOATING (% OF TOTAL)
1A (100% test debris quantity; single train simulation)	41.35	0.15	0.36 %
1B (100% test debris quantity; two train simulation)	41.35	0.7	1.7 %
2A (66% test debris quantity; single train simulation)	27.25	0.55	2.02 %
2B (66% test debris quantity; two train simulation)	27.25	0.35	1.28 %
3A (33% test debris quantity; single train simulation)	13.8	0.25	1.81 %
3B (33% test debris quantity; two train simulation)	13.8	0.7	5.07 %

In support of the June 2007 flume tests, Kewaunee contracted with Alion Science and Technology (Alion) to perform a fiber erosion test. The fiber erosion test was used to confirm the fiber size distribution used in the June 2007 flume tests for fiberglass pipe cover and TempMat was conservative.

The majority of Kewaunee's fiber is TempMat insulation. Alion performed a TempMat fiber erosion test and had previously performed a Nukon fiberglass erosion test. The Nukon fiberglass erosion test, ALION-REP-LAB-2352-77, Revision 1, *Test Report: Erosion Testing of Low Density Fiberglass Insulation*, tested small and large Nukon insulation pieces using its incipient tumbling velocities. The Nukon fiber erosion test concluded that the Nukon releases approximately 6% of its mass as fines over a period of 30 days; this value was conservatively increased to 10% to account for potential testing and analysis inaccuracies. The Alion TempMat insulation erosion test, ALION-REP-LAB-

2352-231, Revision 0, *Test Report: Erosion Testing of Temp-Mat Fiberglass Insulation*, tested small and large size samples at the incipient tumbling velocities for TempMat. The test durations ranged from two hours to sixteen (16) hours. After 16 hours, the TempMat was found to have released on average 0.25% of its mass as fines. The results of the Nukon tests and TempMat tests were analyzed by Alion, and it was concluded that the 10% erosion rate determined for Nukon over 30 days can be conservatively applied to TempMat as well. Consequently, the 90% erosion of large fiberglass pieces that was initially assumed in accordance with NEI 04-07 (see Table 3.E-2) can be reduced to 10%. Table 3.O-4 below shows the initial fiber size distribution for fiberglass pipe cover and TempMat, the new size distribution with the 10% erosion result applied, and the actual size distribution used for the June 2007 flume tests. As can be seen from the table below, the June 2007 flume tests used a conservative quantity of smalls and fines for the test, including a higher quantity of fines than required. The higher quantity of fines has the potential to increase the transport of the fibrous debris to the strainer. However, the flume test results (see Table 3.O-3) revealed that minimal transport actually occurs in Kewaunee's sump pool.

Table 3.O-4

FIBERGLASS PIPE COVER AND TEMPMAT	INITIAL SIZE DISTRIB. (FRACTION)	INITIAL TRANSPORT ASSUMP. (FRACTION)	DISTRIB. USING ALION EROSION TEST RESULTS (3)	TEST SIZE DISTRIB. JUNE 2007 (4)
Fines	8%	8%	13.7%	20%
Smalls	25%	25%	22.5%	19%
Large	32% (2)	29% (1) +3% (2)	28.8% (2)	26%
Intact	35% (2)	0% (2)	0% (2)	0%
Total Smalls & Fines	33%	62%	36.2%	39%

Note 1: Assumes 90% erosion of larges to smalls, fines. See Table 3.E-2.

Note 2: Large and intact pieces do not transport due to debris interceptors.

Note 3: 10% of small and large piece fiberglass and TempMat fiber erodes into fines.

Note 4: All debris is placed in the flume upstream of the debris interceptor.

To finalize resolution of chemical effects, Kewaunee retained PCI to integrate the results of the June 2007 flume tests with previous tests and analysis and provide an updated strainer performance document. Based on the flume tests performed in June 2007 and the behavior of Kewaunee's fibrous and particulate debris post-accident, the documentation is expected to show that, due to the low sump pool velocities and the presence of debris interceptors, a thin or thick debris bed will not form on the ECCS recirculation strainer and clean strainer surface will remain. A clean strainer surface, in conjunction with low chemical precipitation, results in no expected increased strainer head loss due to chemical effects. This evaluation will be complete by the April 30, 2008 (Reference 1).

In the interim, it should be noted that Kewaunee's current ECCS recirculation strainer design contains head loss margin for chemical effects in the design basis debris load. The updated strainer performance documents are expected to conclude that the margin available is significantly greater due to the results of recent testing.

The following additional information related to chemical precipitation is provided in response to the NRC Request for Additional Information dated February 9, 2006.

- Aluminum is a contributor to chemical precipitant generation. Kewaunee does not store aluminum scaffolding in containment. Kewaunee's Plant Cleanliness and Storage Procedure was modified to ensure aluminum scaffolding is not stored in containment during power operations.

- Kewaunee does not have non-stainless steel (i.e., aluminum) insulation jacketing in containment.

- Kewaunee is not susceptible to a thin bed effect from latent fiber only. As indicated in Table 3.B-1, Kewaunee's latent debris sampling resulted in quantifying 11.3 lbs. of latent debris in containment. As indicated in Section 3.D and Table 3.E-1, Kewaunee's latent fiber debris is very conservatively assumed to be 15 lbs. for the purpose of analysis. 15 lbs. of latent fiber will not result in a thin bed of fiber on the recirculation strainer with a surface area of 768.7 ft^2.

  During strainer flume testing in February 2006, 0.8 lbs. of Nukon fiber was used to create a 1/8 inch thin bed of fiber on the Kewaunee test strainer with a surface area of 12.2 ft^2. Therefore, a strainer with a surface area of 768.7 ft^2 would require 50.4 lbs. of Nukon fiber to create a 1/8 inch thin bed (768.7 X 0.8 / 12.2 = 50.4). Conservatively assuming the Nukon fiber and latent fiber are both equivalent to 2.4 lbs/ft^3, there is insufficient latent fiber in Kewaunee's containment to create a 1/8 inch thin bed of fiber on the recirculation strainer (50.4 lbs. required to create a 1/8 inch thin bed vs. 15 lbs. in the debris inventory, with margin).

3.P LICENSING BASIS

This response supplements the previous response to GL 2004-02 for Kewaunee submitted on September 1, 2005.

Following modification of the Kewaunee recirculation sump strainer, the Kewaunee Updated Safety Analysis Report was revised to modify the description of the recirculation strainer assembly, the NPSH available to the RHR pumps in the recirculation mode, and the methods of evaluation used to analyze the ECCS and ICS systems for GSI-191 concerns. The USAR will be revised upon final resolution of GSI-191 and response to Generic Letter 2004-02 to update the methods of evaluation, including use of the 4D ZOI for applicable qualified coatings, and other changes as necessary.

There was no impact on the Kewaunee Technical Specifications or Technical Requirements Manual.

CONCLUSION

In summary, DEK has performed the required analyses to determine the maximum post-accident debris load and its impact on the ECCS recirculation strainer. DEK replaced the recirculation strainer with an improved design during the fall 2006 Refueling Outage. The replacement sump strainer will be fully submerged at the onset of recirculation and is sized for the maximum post-accident debris load, with margin available. Strainer flume testing has been completed to verify the strainer design. Downstream effects evaluations have been completed per WCAP-16406-P, Rev. 0, and no modifications were required as a result of those evaluations. Due to recent revised industry guidance, Kewaunee is in the process of updating its downstream effects evaluations per WCAP-16406-P, Rev. 1. Kewaunee is also in the process of revising the overall strainer performance documents to incorporate inputs from recent flume tests and to provide closure to the issue of chemical effects. In the interim period until the revised evaluations are complete, no issues have been identified that would prevent the ECCS and containment spray system from performing their required design functions.

REFERENCES

1. Letter from William R. Mathews (DEK, DNC, VEPCO) to Document Control Desk (NRC), "NRC Generic Letter (GL) 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors Request for Extension of Completion Dates for Corrective Actions," dated November 15, 2007 (ADAMS Accession No. ML073190553).

2. Letter from Siva P. Lingam (NRC) to William R. Matthews (Dominion), "Kewaunee Power Station, Millstone Power Station, Units 2 and 3, North Anna Power Station, Units 1 and 2, and Surry Power Station, Units 1 and 2, Requests for Extension of Completion Dates for Generic Letter 2004-02 Corrective Actions," dated December 13, 2007 (ADAMS Accession No. ML073450594).

FIGURE 1
ECCS SCHEMATIC DIAGRAM

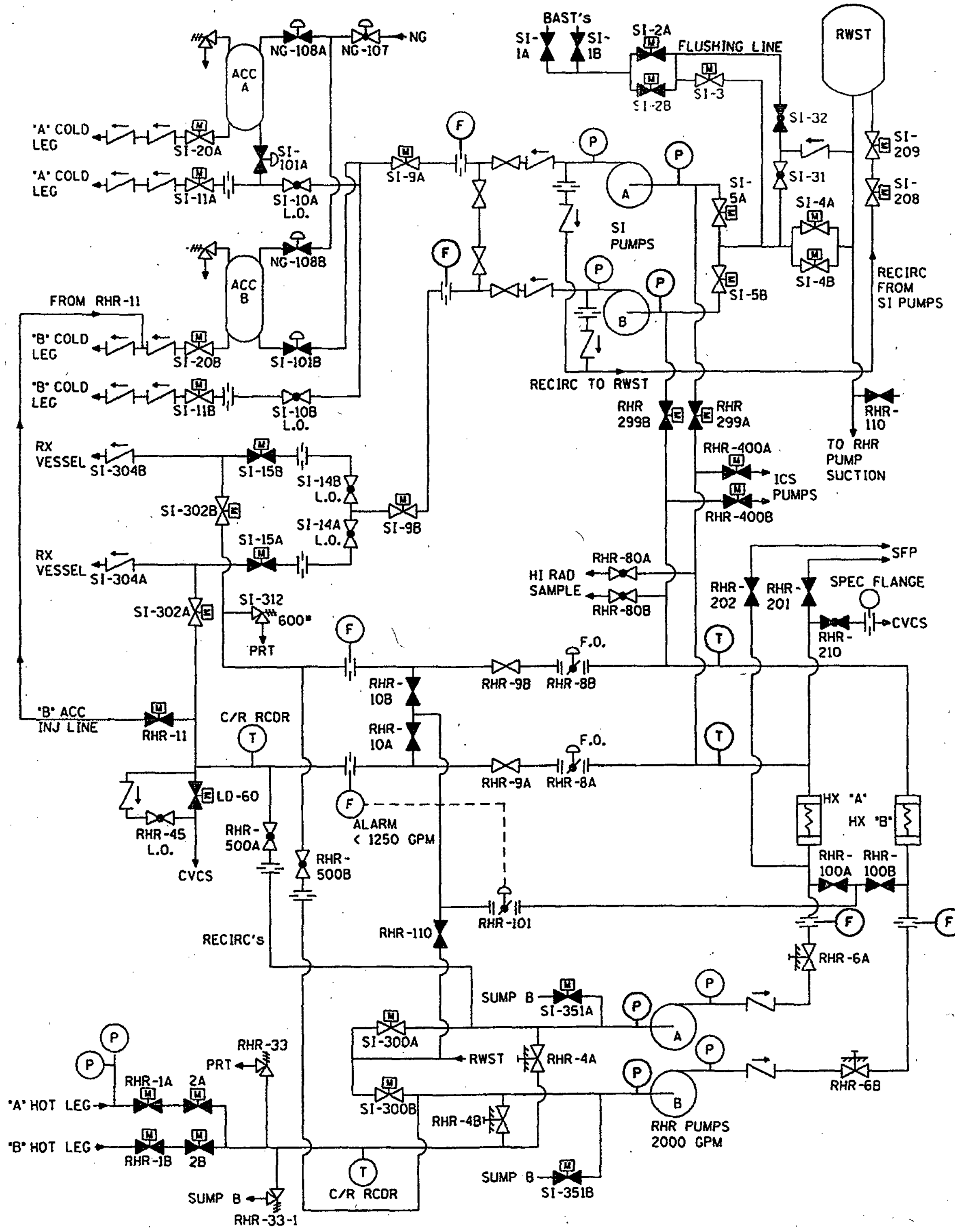

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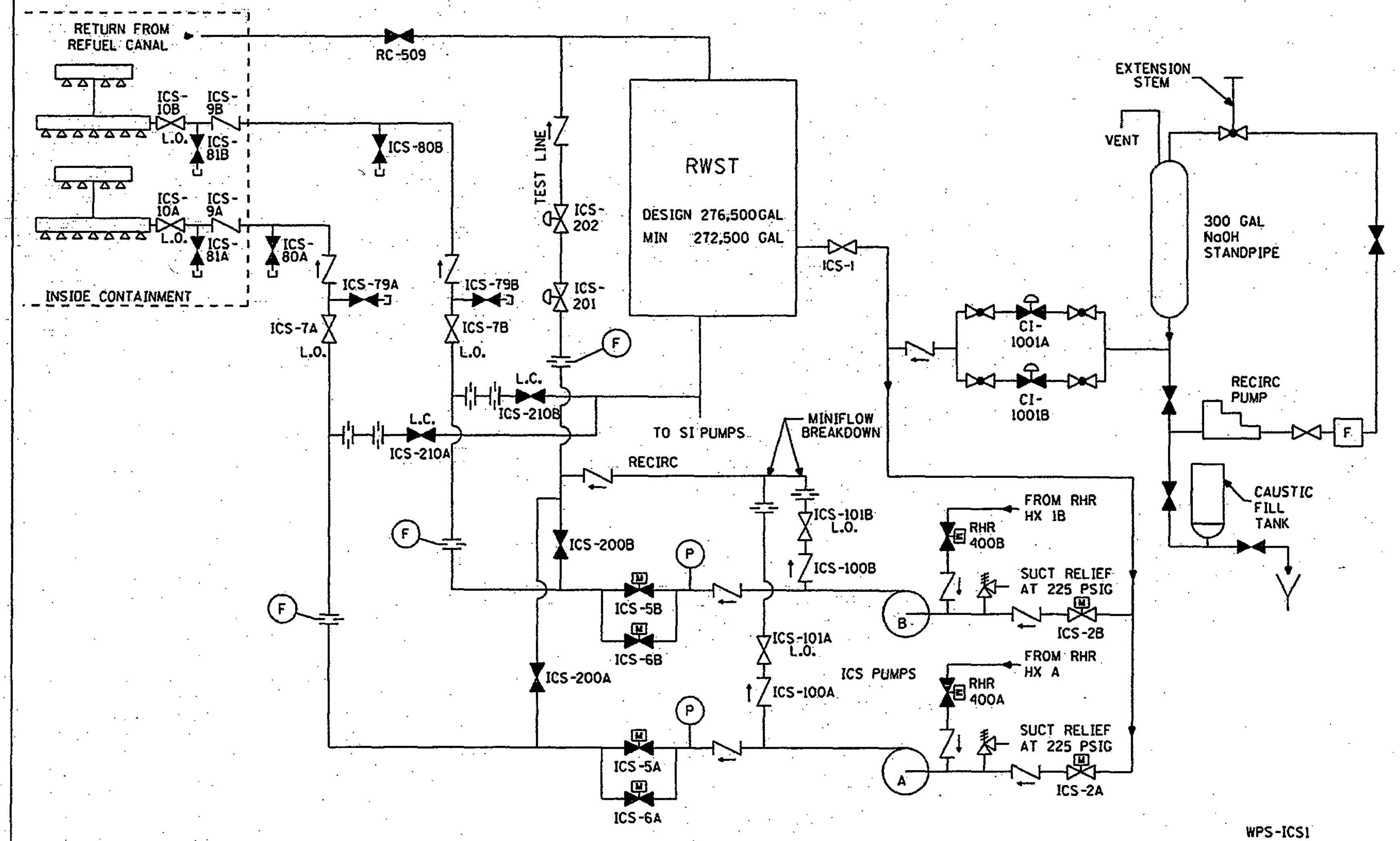
FIGURE 2
INTERNAL CONTAINMENT SPRAY SCHEMATIC DIAGRAM



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WPS-ICS1
OPERM-217
REV. AH

Serial No. 08-0017
Docket No. 50-305
Attachment
Page 40 of 42

FIGURE 3
KEWAUNEE RECIRCULATION STRAINER
ARRANGEMENT PRIOR TO MODIFICATION

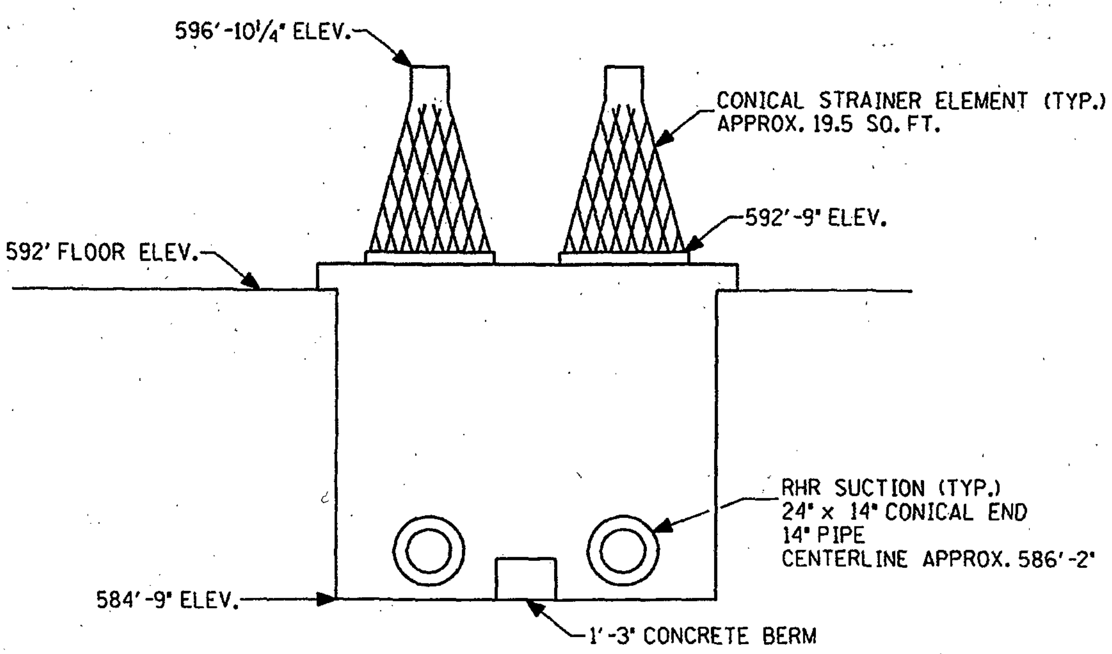

FIGURE 4
KEWAUNEE REPLACEMENT
RECIRCULATION STRAINER ARRANGEMENT