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April 30, 2008

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

SUBJECT: Duke Energy Carolinas, LLC
McGuire Nuclear Station, Units 1 and 2
Docket Nos. 50-369 and 50-370
Response to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

On September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02. The GL requested that all pressurized-water reactor (PWR) licensees (1) evaluate the adequacy of the emergency sump recirculation function with respect to potentially adverse effects associated with post-accident debris, and (2) implement any plant modifications determined to be necessary.

By letter dated March 1, 2005, as supplemented by letters dated September 1, 2005, June 28, 2006, and February 28, 2008, Duke Energy Carolinas, LLC (Duke) provided responses to GL 2004-02. As stated by Duke's letter of November 6, 2007, as amended by letter dated December 13, 2007, any additional or revised information resulting from the Integrated Prototype (chemical effects) Testing was to be provided as an amended response to GL 2004-02 by April 30, 2008. This extension was approved by the staff in a letter dated December 28, 2007.

The purpose of this letter is to provide the amended response to Generic Letter 2004-02 discussed in the February 28, 2008 submittal, as well as a summary level description of Duke's approach to resolution of issues related to Generic Letter 2004-02.

The NRC Revised Content Guide for Generic Letter 2004-02 Supplemental Responses, dated November 21, 2007 requested a summary level description of the approach taken to provide reasonable assurance that long-term core cooling is maintained. Attachment 1 to this letter provides the requested summary.

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Attachment 2 provides the amended response as discussed in the February 28, 2008 submittal (results of the McGuire Integrated Prototype (chemical effects) Testing).

As stated by GL 2004-02 Supplemental Response dated February 28, 2008, Duke also agreed to provide additional information related to the NRC staff-requested re-evaluation of downstream effects, to be performed using WCAP-16406, Revision 1, dated August 2007 and the associated NRC SER. The re-evaluation determined that all affected single and multistage pumps, heat exchangers, instrument tubing, valves, spray nozzles and orifices are not expected to fail or become blocked during the 30-day mission time following a LOCA event using the methodologies and acceptance criteria of WCAP-16406-P, Revision 1. The wear evaluation of all Emergency Core Cooling and Containment Spray system piping containing recirculated containment sump pool fluid during and after an accident determined that system piping is not expected to fail under the methodology and acceptance criteria provided in WCAP-16406-P, Revision 1. In addition, the previous acceptable downstream effects evaluations performed addressing the nuclear fuel and reactor internals have been determined to still be bounding with respect to the new requirements of WCAP-16406-P, Revision 1.

Consistent with the GL 2004-02 Supplemental Response dated February 28, 2008, the results of the McGuire downstream debris effects evaluations on the critical ECCS/CS components, reactor internals and the nuclear fuel, performed in accordance with WCAP-16406-P, Revision 1 criteria and the associated NRC SER, demonstrate that the currently installed components are acceptable for the expected ECCS mission time. No design or operational changes are required.

Duke understands that the NRC staff will consider the enclosed information and will issue a letter to Duke Energy assessing the overall adequacy of the McGuire Nuclear Station's GL 2004-02 corrective actions.

If any questions arise or additional information is needed, please contact K. L. Ashe at (704) 875-4535.

Very truly yours,

Bruce Hamilton

Bruce H. Hamilton

Bruce H. Hamilton affirms that he is the person who subscribed his name to the foregoing statement, and that all the matters and facts set forth herein are true and correct to the best of his knowledge.

Bruce Hamilton

Bruce H. Hamilton, Vice President, McGuire Nuclear Station

Subscribed and sworn to me: 4-30-2008
Date

Kay L Crane
Kay L Crane, Notary Public

My commission expires: 4-1-2012
Date

SEAL

KAY L. CRANE
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xc: w/attachments

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Attachment 1

Summary of Approach Taken

The NRC Revised Content Guide for Generic Letter 2004-02 Supplemental Responses, dated November 21, 2007 requested a summary level description of the approach taken to provide reasonable assurance that long-term core cooling is maintained. The following discussion provides the requested summary.

MAJOR ACTIVITIES

The following major activities have been completed in support of GL 2004-02:

- Baseline evaluation, performed by Enercon Services, Inc.
- Refined evaluation using the guidance of NEI 04-07, completed by Enercon Services, Inc.
- Downstream effects evaluation using the WCAP-16406-P, Rev. 0 methodology. A re-evaluation using Revision 1 of the WCAP and the associated NRC SER was also completed.
- Containment walkdowns using the guidance of NEI 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments".
- The modification process and the plant labeling process have been enhanced relative to GL 2004-02 controls.
- Replacement of the Microtherm® insulation, previously installed on portions of the reactor vessel heads, with RMI.
- Installation of a new ECCS sump strainer in Unit 1 and Unit 2 (~1700 ft^2).
- Completion of the Integrated Prototype (chemical effects) Test.

The McGuire ECCS Sump strainer was initially sized using Enercon Baseline analyses in an attempt to install as large a strainer area as possible in each Containment. Refined analyses were then performed along with testing to validate the final design. These input activities are listed below. The details of the initial inputs are contained in the February 28, 2008 Duke response (Enclosures 1 and 2). A description and quantification of the refined inputs is finalized in Attachment 2 of this letter. Additionally, final ECCS Strainer head loss and ECCS recirculation pump NPSH margins are reported in Attachment 2 of this letter.

KEY ELEMENTS

The key elements of the design validation process are illustrated on Figure 1. The key elements align with the "NRC Revised Content Guide for Generic Letter 2004-02 Supplemental Responses," dated November 21, 2007.

1. Break Selection
2. Debris Generation
3. Latent Debris
4. Debris Transport
5. Head Loss
6. Sump Structural Design
7. Chemical Effects (Post-Accident Environment Determination)
8. Integrated Prototype Testing (IPT)
9. Downstream Effects
10. Additional Design Considerations/Modifications

CONSERVATISMS

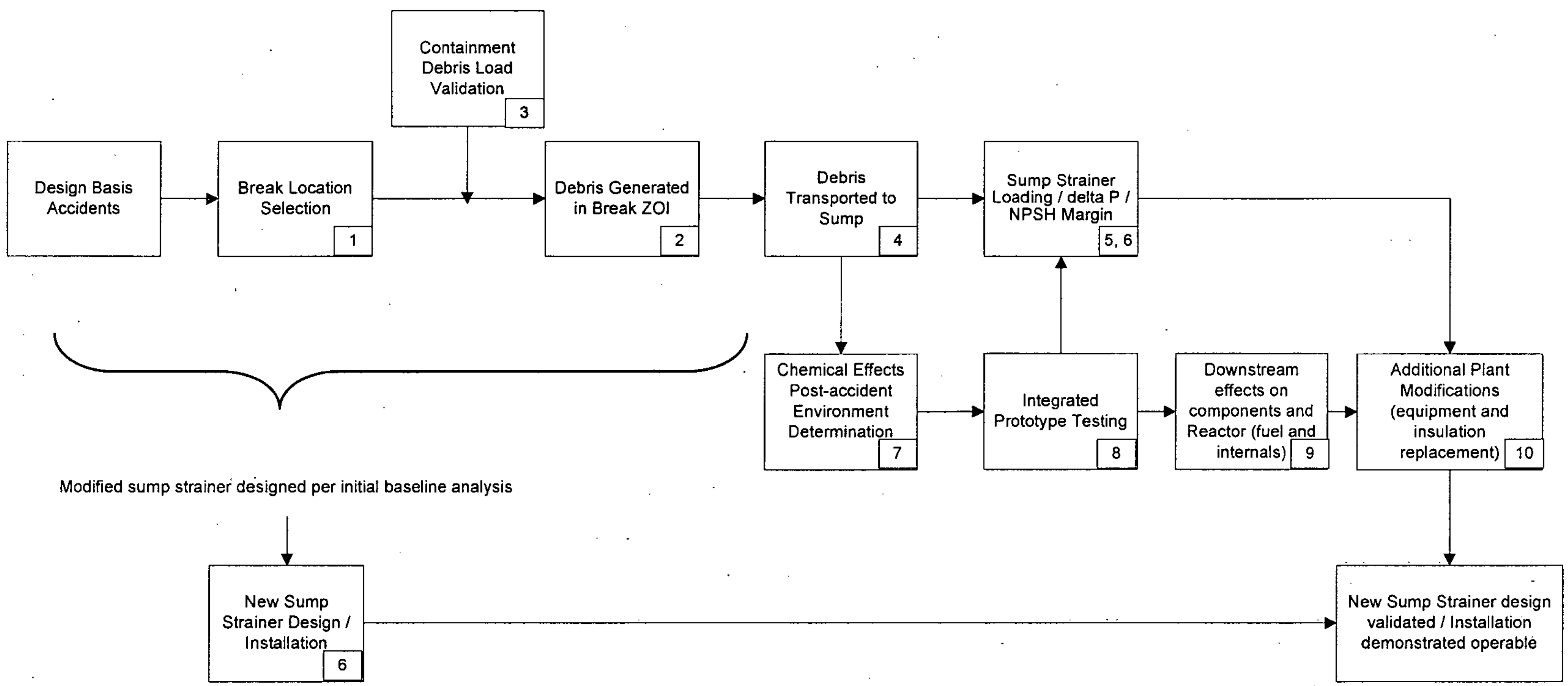
Conservatisms in each area are described in the February 28, 2008 submittal related to each of the analyses described above as appropriate.

The Integrated Prototype Test (IPT) takes design inputs from the different analyses and conservatively simulates the environmental conditions of the containment sump pool over the ECCS mission time. IPT conservative assumptions include:

- Using conservatively small strainer areas for determining debris bed thicknesses.
- Providing conservative scaling of debris to both strainer surface area and to Containment sump volume to ensure close but conservative chemical concentrations in the test apparatus.
- Applying conservatively high chemical loads to compensate for the brief period when the test could not mimic the elevated post-LOCA temperatures.
- Operating in test startup mode for over 12 hours at elevated temperatures, ensuring debris bed formation, head loss stabilization, and conservative pool chemistry prior to data acquisition.
- Applying conservatively high aluminum loads as soluble material so that silicate inhibition would not limit the aluminum in the test.
- Following a temperature profile that exceeds the maximum expected temperatures early in the test to promote excess corrosion products, and descends below the minimum temperature late in the test to promote excessive dissolution of potential precipitation products.
- Providing temperature and flow correction that conservatively decreases the amount of temperature compensation with increasing temperature.

Attachment 1
Summary of Approach Taken

Figure 1
Key Elements of the Design Validation Process for the ECCS Sump Strainer



Key Element Numbers (Refer to Key Element Listing, Attachment 1, Page 2 of 4)

Attachment 2

Amended Response to Staff Request for Additional Information #12 Identified on February 9, 2006

McGuire Integrated Prototype (Chemical Effects) Testing Refinements and Conclusions

<u>Request for Additional Information 12</u>
For your plant-specific environment, provide the maximum projected head loss resulting from chemical effects (a) within the first day following a LOCA, and (b) during the entire ECCS recirculation mission time. If the response to this question will be based on testing that is either planned or in progress, provide an estimated date for providing this information to the NRC.

General Note:
Duke's Integrated Prototype Test (IPT) for chemical effects was conducted in the fall of 2007 at Wyle Laboratories in Huntsville, Alabama. A description of the design of the IPT and the associated input parameters was submitted in the McGuire GL 2004-02 Supplemental Response dated 2/28/08 (RAI #11). Due to the timeframe and the logistics involved in generating the final test report and supporting documentation, Duke requested and received NRC approval for an extension of the date to submit details of this documentation until April 30, 2008.

The original response to RAI #12 in the McGuire GL 2004-02 Supplemental Response dated 2/28/08 indicated that the maximum projected head loss (including chemical effects) across the McGuire ECCS sump strainer, the refined limiting NPSH margins on the ECCS sump recirculation pumps, and supporting information regarding refinements made to the initial ECCS sump strainer sizing evaluations would be provided once the documentation was complete.

Those details are provided herein.

<u>McGuire Response</u>:

Analytical Refinements to Initial Strainer Sizing Evaluation
As noted in the 2/28/08 McGuire GL 2004-02 Supplemental Response to RAI #11, Duke's ECCS sump strainer IPT for chemical effects included refinements to the low density fiberglass (LDFG) insulation and failed coatings debris input parameters to more accurately represent the debris bed on the top-hat strainer module. The specific debris load refinements made to the initial strainer sizing values are listed below:

- The break Zone of Influence (ZOI) for jacketed Nukon® and jacketed Thermal-Wrap® fiber insulation was reduced from 17D (as recommended per NEI 04-07 guidance) to 7D, using the methodology outlined in WCAP-16710-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) of Min-K and NUKON® Insulation for Wolf Creek and Callaway Nuclear Operating Plants", dated October 2007. The WCAP methodology in this report was evaluated and determined to apply to McGuire, and as such was implemented. The quantity of fiber transported to the McGuire ECCS sump for the limiting break reported in the 2/28/08 McGuire submittal (reference response to RAI #1) reflects the initial 17D ZOI fiber load used for sizing the modified ECCS sump strainer.

- Unqualified epoxy coatings debris quantities and transport metrics are refined based on analysis of OEM coatings performed by EPRI. Duke revised the initial statistical assessment and incorporated a more conservative unqualified particulate refinement based upon applying a 2 standard deviation correction from the mean. It was assumed that Duke-applied coatings inside containment are similar to the manufacturer-applied coatings used in the analysis. Unqualified alkyd coatings debris and qualified coatings debris were not affected by this refinement. The quantity of failed unqualified epoxy coating debris transported to the McGuire ECCS sump for the limiting break reported in the 2/28/08 McGuire submittal already reflects this refinement.

Table 12-1 and Table 12-2 show the initial and refined quantities for LDFG and unqualified coatings at McGuire.

Table 12-1
McGuire LDFG Initial and Refined Debris Loads - Limiting Break

Nukon® and Thermal-Wrap® Low Density Fiberglass (LDFG)	**Initial Debris Quantity Generated (17D ZOI)***	**Refined Debris Quantity Generated (7D ZOI)***	**Debris Transport Fraction (DTF)**	**Initial Quantity At Sump Pool**	**Refined Quantity At Sump Pool**
Fines (constituent fibers)	272.7 ft^3	125.0 ft^3	100%	272.7 ft^3	125.0 ft^3
Small Pieces (<6" on a Side)	891.9 ft^3	500.2 ft^3	21%	187.3 ft^3	106.5 ft^3
Large Pieces (>6" on a Side)	444.9 ft^3	0 ft^3	10%	44.5 ft^3	0 ft^3
Intact Blankets	476.4 ft^3	0 ft^3	0%	0 ft^3	0 ft^3

* The break ZOIs evaluated include those defined by NEI 04-07 guidance, and also a 7D ZOI defined by WCAP-16710-P for LDFG insulation. 7D ZOI debris quantities represent the conservative 7D fiber debris size distribution described in the 2/28/08 McGuire submittal. Limiting break is on the "B" Loop Hot Leg.

Table 12-2
McGuire Initial and Refined Unqualified Coatings Characteristics

Coating Material	Total Area (ft^2)	DFT* (mils)	Initial Volume** (ft^3)	Refined Volume** (ft^3)	Density (lb/ft^3)	Initial Weight** (lb)	Refined Weight** (lb)
Epoxy	13,917	6	6.96	3.8	94	654.2	357.1
Alkyd	1,213	1.5	0.16	0.16	98	15.7	15.7
Total	15,130	NA	7.12	3.96	NA	669.9	372.8

* DFT: Dry Film Thickness
** Unqualified epoxy coatings debris quantities and transport metrics are refined based on analysis of OEM coatings performed by EPRI. Unqualified alkyd coatings debris (and qualified coatings debris) is not affected by this refinement.

Strainer Head Loss, NPSH Margin, and ECCS Strainer Structural Limitations

After a LOCA, early in the event the sump pool temperature (and therefore the pool vapor pressure) determines the limiting conditions for operation of the ECCS sump strainer in the recirculation phase. Since the strainer head loss has not yet reached its maximum, the available NPSH margins for the RHR and CS pumps are minimized because the pool temperature is high (and vapor pressure is high). As the event continues and the head loss across the strainer increases over time (i.e., due to chemical effects, increases in pool density and changes in the debris bed morphology), the strainer structural margin becomes more limiting, since the NPSH available for the ECCS recirculation pumps increases substantially. For this reason, the limiting NPSH margins for the RHR and CS pumps exist early in the event, at the time of pump suction realignment to the ECCS sump pool.

Maximum Projected Strainer Head Loss

The maximum projected head loss across the McGuire ECCS Sump Strainer within the first day following a LOCA is shown in Table 12-3. At this time interval (i.e., about 24 hours), the sump pool temperature is predicted to be approximately 114°F (maximum safeguards/maximum flowrate).

Table 12-3
Head Loss Across McGuire ECCS Sump Strainer (at 24 hours/114°F)

Recirculation Flow Condition	Average Approach Velocity (ft per sec)	Clean Strainer Head Loss* (ft of water)	Debris-Loaded Strainer Head Loss (ft of water)
Maximum (16,000 gpm)	0.028	5.8	13.0

* Clean strainer head loss reported for limiting Unit (McGuire Unit 2) at 60°F

The maximum projected head loss across the McGuire ECCS Sump Strainer during the entire ECCS mission time (i.e., 30 days) is shown in Table 12-4. At this time interval, the sump pool temperature is predicted to be approximately 90°F.

Table 12-4
Head Loss Across McGuire ECCS Sump Strainer (at 30 days/90°F)

Recirculation Flow Condition	Average Approach Velocity (ft per sec)	Clean Strainer Head Loss* (ft of water)	Debris-Loaded Strainer Head Loss (ft of water)
Maximum (16,000 gpm)	0.028	5.8	15.7

* Clean strainer head loss reported for limiting Unit (McGuire Unit 2) at 60°F.

Limiting ECCS Sump Recirculation Pump NPSH Margins

The McGuire ECCS sump recirculation pump NPSH margins are shown in Table 12-5 and Table 12-6. For conservatism, the NPSH margins are given at the maximum ECCS sump pool temperature of 190°F and the maximum recirculation flow condition (the NPSH margins at 190°F are bounding). At the time of pump suction realignment to the ECCS sump pool, the debris-loaded head loss across the McGuire ECCS sump strainer is conservatively predicted to be 9.8 feet of water.

Table 12-5
Limiting NPSH Margin for McGuire Containment Spray Pumps (190°F)

Recirculation Flow Condition	NPSH Required (ft of water)	NPSH Available *No Strainer** (ft of water)	NPSH Available *Debris-loaded Strainer** (ft of water)	NPSH Margin (ft of water)
Maximum (16,000 gpm)**	19	29.8	>20.0	>1.0

* NPSH available is referenced to the McGuire ECCS Sump floor elevation (zero submergence) and does not credit containment overpressure.
** Limiting NPSH occurs on "B" train CS pump, when 2 train RHR/CS recirculation is aligned with SI to the RCS Hot Leg, and the RHR to Charging/SI Isolation valve closed.

Table 12-6
Limiting NPSH Margin for McGuire Residual Heat Removal Pumps (190°F)

Recirculation Flow Condition	NPSH Required (ft of water)	NPSH Available *No Strainer** (ft of water)	NPSH Available *Debris-loaded Strainer** (ft of water)	NPSH Margin (ft of water)
Maximum (16,000 gpm)**	19	33.4	>23.6	>4.6

* NPSH available is referenced to the McGuire ECCS Sump floor elevation (zero submergence) and does not credit containment overpressure.
** Limiting NPSH occurs on "B" train RHR pump, when 2 train RHR/CS recirculation is aligned with SI to the RCS Hot Leg, and the RHR to Charging/SI Isolation valve closed.

The McGuire ECCS sump strainer meets the ECCS sump recirculation pump NPSH requirements with the predicted debris loading, and, as reported in the 2/28/08 McGuire submittal, meets all AISC, AWS, and ASME code allowable stresses at the maximum predicted head loss condition (highest flowrate and lowest temperature).