



Kelvin Henderson
Vice President
Catawba Nuclear Station
803-701-4251

Duke Energy
CNO1VP | 4800 Concord Rd.
York, SC 29745

July 31, 2013

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

Subject: Duke Energy Carolinas, LLC (Duke Energy)
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413 and 50-414
Catawba Nuclear Station Closure Option 1 Response to In-Vessel Downstream Effects Request for Additional Information for Generic Safety Issue (GSI) 191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance" in Resolution of Final Issues Related to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

On May 13, 2013, Catawba Nuclear Station submitted a letter of intent per SECY-12-0093, "Closure Options for Generic Safety Issue – 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance", indicating Catawba would pursue Closure Option 1 of the SECY recommendations (Compliance with 10 CFR 50.46 Based on Approved Models). The final outstanding issue for Catawba with respect to GSI-191 (identified as RAI question #29) is the in-vessel downstream effects evaluation, which addresses whether long term core cooling (LTCC) can be adequately maintained for all postulated accident scenarios.

On April 8, 2013, the NRC issued a safety evaluation relating to WCAP-16793-NP, Revision 2, "Evaluation of Long Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid". As the WCAP-16793-NP, Revision 2 methodology represents an NRC-approved model, successful completion of the in-vessel downstream effects analysis in accordance with the associated NRC safety evaluation shows compliance with 10 CFR 50.46, and resolves the final outstanding RAI question for Catawba Nuclear Station.

The in-vessel downstream effects evaluation has been successfully completed for Catawba Nuclear Station, and is documented in the attachment to this letter. This satisfies the final GSI-191 commitment identified in the May 13, 2013 Closure Option letter.

If any questions arise or if additional information is needed, please contact L.J. Rudy at (803) 701-3084.

A 116
MLL

U.S. Nuclear Regulatory Commission
Page 2
July 31, 2013

I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 31, 2013.

Very truly yours,

A handwritten signature in black ink, appearing to read "K. Henderson", written in a cursive style.

Kelvin Henderson

Attachment

U.S. Nuclear Regulatory Commission
Page 3
July 31, 2013

xc (with attachment):

V.M. McCree, NRC Region II Administrator
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, GA 30303-1257

J.C. Paige, NRC Project Manager
11555 Rockville Pike
Mail Stop 8 G9A
Rockville, MD 20852-2738

G.A. Hutto, III, NRC Senior Resident Inspector
Catawba Nuclear Station

S.E. Jenkins, Manager
Radioactive and Infectious Waste Management
Division of Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull St.
Columbia, SC 29201

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

29. The NRC staff considers in-vessel downstream effects to not be fully addressed at Catawba, as well as at other pressurized-water reactors. The supplemental response for Catawba refers to the evaluation methods of Section 9 of Topical Report (TR) WCAP-16406-P, Revision 1, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191", for in-vessel downstream evaluations and makes reference to a comparison of plant-specific parameters to those evaluated in TR WCAP-16793-NP, Revision 0, "Evaluation of Long Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The NRC staff has not issued a final Safety Evaluation (SE) for TR WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for Catawba by showing that the licensee's plant conditions are bounded by the final TR WCAP-16793-NP and the conditions and limitations identified in the final NRC staff's SE. The licensee may also resolve this item by demonstrating without reference to TR WCAP-16793 or the NRC staff's SE that in-vessel downstream effects have been addressed at Catawba. In any event, the licensee should report how it has addressed the in-vessel downstream effects issue within 90 days of issuance of the final NRC staff's SE on TR WCAP-16793. The NRC staff is developing a Regulatory Issue Summary to inform the industry of the NRC staff's expectations and plans regarding resolution of this remaining aspect of GSI-191.

Catawba Response:

In accordance with the SECY-12-0093 letter recommendation and as identified in Duke Energy letter to NRC dated May 13, 2013, Catawba Nuclear Station elected to pursue GSI-191 Closure Option 1 since both Units 1 and 2 meet the requirements of 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," based on approved models for analyses, strainer head loss testing, and in-vessel downstream effects. As the WCAP-16793-NP, revision 2 methodology represents an NRC-approved model, successful completion of the analysis in accordance with the associated SER shows compliance with 10 CFR 50.46 as it relates to in-vessel downstream effects, and resolves this final outstanding RAI question for Catawba Nuclear Station.

Compliance with WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid", Rev. 2 and the associated NRC Safety Evaluation issued on April 8, 2013 can be demonstrated by examining ECCS strainer bypass testing results, scaling the results to overall debris quantities predicted to be transported to the reactor vessel, evaluation of in-core response based on application of the LOCADM models, and successful application of the limitations and conditions imposed in the Safety Evaluation issued by the staff.

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

Background

As stated in Catawba Supplemental response dated February 29, 2008 and amended on April 30, 2008 as well as subsequent RAI responses submitted on August 13, 2012, the Catawba Replacement ECCS sump strainer utilizes a modular "Top Hat" design with the individual Top Hats mounted to a suction plenum structure. The sump strainer structure is mounted to the containment floor (no sump pit) with the Top Hats mounted horizontally. Each Top Hat module consists of two concentric perforated plates (3/32" diameter holes) with a debris bypass eliminator stainless steel knitted wire mesh sandwiched between them. The Top Hats range in length between 24 and 45 inches. The gross and net surface areas for the Unit 1 and Unit 2 ECCS sump strainers are shown below in Table 29S-1.

Table 29S-1

Replacement ECCS Sump Strainer Surface Area

	Gross Surface Area (ft ²)	Net Surface Area (ft ²)
Unit 1	2540	2298
Unit 2	2418	2181

ECCS Sump Strainer Bypass Testing

Catawba and McGuire contracted with Alion Science and Technology to perform strainer bypass testing in 2006 while designing the Replacement ECCS Sump Strainers and compiling information required to address the Generic Letter 2004-02 supplemental response. The purpose of the testing was to determine the volume and characteristics of fibrous material that might bypass the Top Hat module perforated plate surfaces, both with and without the debris bypass eliminator mesh. The testing apparatus and protocol were developed to ensure a robust and conservative test. The following sections will detail pertinent aspects of the strainer bypass testing series:

- Test Flume Design
Alion's test flume design consisted of a clear plexiglass tank/flow loop built around a plywood mount for a single 36" long Top Hat module. The plywood mount was

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

constructed with side walls to simulate the proximity of adjacent Top Hats and provide a representative interstitial volume for debris collection around the test module.

A filtering system was incorporated into the flow loop to capture all the fibrous debris that bypassed the test Top Hat module. The entire flow downstream of the Top Hat test module passed through the filter assembly with the required full flow capacity and a capture efficiency of at least 90% at 5 μ m.

- Test Flowrate

It is known that higher approach velocities produce more debris bypass; the flow rate chosen for the bypass tests was therefore representative of the highest flowrates predicted to exist at the start of post-LOCA sump recirculation. At the time of testing, this flow rate was representative of two Residual Heat Removal pumps and two Containment Spray pumps taking suction from the ECCS containment sump. In addition, the area of the strainer available for flow was based on the smallest designed strainer reduced by sacrificial strainer area predicted to be lost to miscellaneous latent debris (i.e., tags and labels), and the effect of the inherent non-free flow areas of the Top Hat itself (i.e., the longitudinal seams and stiffener rings). After this base approach velocity was determined, it was increased by approximately a factor of two to accommodate the "inrush" flow that will occur in the Top Hat modules located hydraulically closest to the ECCS suction inlet piping (reference also Catawba GL 2004-02 RAI Response submittal dated August 13, 2012).

Since 2006, several changes have been made in the plant that provide additional conservatism with respect to the test approach velocity. Most impactful, is the implementation of an ECCS Water Management Initiative. This results in only one train of containment spray being operated at a time while taking suction from the ECCS sump pool, thus reducing the overall flow through the ECCS strainer by approximately 25%. Additional conservatisms are noted in that the area calculations performed during testing were based on the as-designed ECCS Sump Strainers; the as-built configurations have a greater surface area than the original design. Also, compared to the initial containment debris evaluation, the quantity of tags and labels that transport to the ECCS Sump Strainer has been reduced.

- Fibrous Debris Preparation

To reproduce the conditions that would be experienced by fiber insulation within a break zone of influence in the plant, the fiber insulation was pre-baked and was double

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

shredded by two passes through a leaf shredder. This insulation was then boiled for a minimum of ten minutes to simulate the predicted residence time in the hot sump pool as the fiber transports to the strainer. This process was effective at producing fiber sizes that readily transported in the test flume and were capable of bypassing the perforated plate of the straining surface area.

- **Fibrous Debris Introduction**

The prepared fibrous debris was added to the test flume in small batches over a period of time; each batch was weighed and mixed with water prior to introduction. This strategy built a debris bed on the Top Hat test module in controlled increments so that the test loop and downstream filter system head loss limits were not exceeded. Upon the introduction of each batch of fibrous debris, the next batch was added only after it was visually confirmed that the previous batch had completely transferred to the test module. The point at which the Top Hat test module was completely covered with fibrous debris was noted in the test log but the test continued until the interstitial volume of the test module was completely filled with debris.

- **Fibrous Debris Transport Efficiency**

Care was taken in the test procedure to avoid the settling of the debris in the test flume. This was accomplished by periodically stirring the test flume to keep the fibrous debris suspended. The design of the plywood enclosure prevented the disturbance of the debris bed during stirring.

- **Capture/Quantification of Bypassed Debris**

Following each bypass test, the control filter bag and test filter bags from the cartridges were dried using a minimum of two drying/weighing cycles to ensure that residual moisture content was minimal. Following the drying/weighing cycles, the final weight of the control filter bag and test filter bags were compared to the previously recorded clean weight in order to determine the amount of fibrous debris captured by the filter bags.

- **Characterization of Captured Downstream Fibrous Debris**

Fibers collected in the filter bags during strainer bypass testing were examined using both optical microscopy and scanning electron microscopy (SEM). It was concluded that over 84% of the fibers collected inside the filter bags were shorter than 500 μm in length. Additionally, over 98% of the fibers collected inside the filter bag were shorter than 1000 μm in length. The SEM observation also determined that 100% of the fibers stuck inside the weave of the filter bags were shorter than 1000 μm .

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

- **Bypass Testing Results**
Results of the Duke Top Hat Module Bypass Testing are provided in the following section which outlines the post processing of the testing results as well as determination of overall fiber bypass quantity that can be expected at Catawba.

Post Processing Bypass Test Results and Determination of In-Vessel Debris Quantities

The fiber bypass testing described above determined the quantity of fiber that can be expected to bypass the Top Hat modules and Debris Bypass Eliminators used in the Catawba replacement ECCS sump strainers. This information, in conjunction with a series of experiments sponsored by the NRC performed by Los Alamos National Laboratory (LANL) to determine the type and quantity of debris that will pass through sump screens and openings of various sizes, are utilized to determine the bypass of the overall ECCS sump strainer. In order to correlate the bypass testing results to an overall quantity of fibrous debris, it was necessary to determine the maximum potential area of gaps and openings within the ECCS Sump Strainer assembly, determine the total quantity of fibrous debris expected to arrive at the ECCS sump strainer, and determine bypass fraction based on both LANL Bypass testing and Top Hat Bypass testing.

- **Area of Gaps/Openings within ECCS Sump Strainer Plenums**
Potential gaps can exist between the strainer plenums and sealing plates, between the Top Hat base plates and the plenums, and inspection ports and vent holes in the strainer plenum. The replacement ECCS sump strainer was designed such that any gaps or openings between connecting parts of the strainer that provide entry into the strainer internals shall not exceed 3/32" diameter or be larger than 1/16" in characteristic dimension. Therefore, the evaluation assumed 1/16" gaps at all bolted connections and a 3/32" diameter for all vent holes. This is considered conservative as this is the maximum allowable clearance and the majority of these connections have little or no gaps present, and the existence of a continuous peripheral gap around each joint is also not credible. In addition, even if a small gap does exist, debris would have to travel a torturous path to pass through the gap, thus increasing the likelihood of the fiber being trapped. Although not credited in the evaluation, it is expected that after a short period of time, the build-up of debris would clog the gaps and prevent further bypass. It should also be noted that all accessible bolted connections are inspected with feeler gauges during refueling outage to ensure compliance with design tolerances. A review of design drawings in conjunction with the assumptions stated above result in a total gap/opening area available for debris to bypass the strainer surfaces is 8.29 ft² for the limiting Catawba ECCS sump strainer.
- **Fiber Bypass Through Strainer Gaps/Openings**
A series of tests to address the tendency of different types of insulation debris to penetrate sump screens with various size openings were performed under the direction

Catawba Nuclear Station
 Generic Letter 2004-02 Supplemental Response
 11/21/08 NRC RAI #29
 Final Response

of LANL to generate data needed to support the resolution of GSI-191. A test case from the LANL testing utilized a screen size of 1/16" and an approach velocity of 0.208 ft/sec and resulted in a bypass fraction of 3.92%. This test case will serve as the basis for determining the bypass through the gaps/openings in the Catawba ECCS strainer design. The 1/16" screen size is equivalent to the maximum allowable width of gaps in the Catawba strainer and very close to the 3/32" drain/vent holes. The 0.208 ft/sec approach velocity is much larger than the maximum approach velocity of 0.051 ft/sec expected for the Catawba ECCS Sump Strainer. Given that the LANL testing determined a direct relationship between approach velocity and bypass fraction, the use of this test case is considered conservative.

- **Fiber Bypass through the Top Hat Module**
 The results of the Duke ECCS sump strainer bypass testing described previously are provided below in Table 29S-2. For Catawba, the bypass test of record is Test #2 due to the higher bypass fraction.

Table 29S-2

Results of Duke Top Hat Module Bypass Testing

Test Number*	Strainer Approach Velocity (ft/s)	Total Fiber Load Used for Testing (lbm)	Fiber Bypass (grams)	Fiber Amount for Full Coverage** (lbm)	Fiber Bypass Fraction
2	0.045	13.44	23.45	2.88	1.80%
3	0.075	8.64	26.94	7.68	0.77%

* Note: Test #1 was a bypass test without the knitted steel Debris Bypass Eliminator (DBE) installed and the results of this test are not applicable to the as installed Catawba ECCS Sump Strainer configuration.

**Note: "Full coverage" is the fiber volume required to just cover the Top hat surface. For Test #2 this occurred after the value shown in the table, but prior to the value shown for Test #3.

The fiber bypass fraction presented above is the ratio between the fiber bypass quantity and the minimum fiber quantity required for full Top Hat coverage. As stated earlier, this testing was performed in 2006 before guidance was widely available for performing Sump Strainer Bypass testing. As a result, determining the exact point at which the

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

Top Hat became covered was not an objective of the testing. However, a review of the test logs identified notes indicating when the Top Hat module surface was covered, and allowed conservative determination of the fiber quantity that had been introduced.

As identified in previous submittals, plant modifications have been performed to remove a large portion of the fibrous insulation in the Catawba containment, and also to reduce the ECCS recirculation flow rate. The fiber loads and test velocities used in the original strainer bypass tests therefore reflect plant fibrous debris loads and flow rates significantly higher than the existing Catawba configuration. In the bypass test of record in Table 29S-2, the amount of fiber bypass was measured to be 23.45 grams, which was generated by introducing 13.44 lbm of fiber into the test tank. This total fiber load was originally designed to fill the interstitial volume of the strainer test rig (which it did), and as a result there was likely continued bypass beyond Top Hat module coverage alone due to increased compression of the debris bed. The fiber quantity replicating current transported fibrous debris loads would be much less than the 13.44 lbm used in the original test; as a result the 23.45 grams of fiber bypass measured in the test of record is considered bounding.

By determining the bypass fraction as a ratio between the fiber bypass quantity and the minimum fiber amount required for full Top Hat coverage during testing, no credit is taken for additional filtering from the debris bed itself. This also increases the computed bypass fraction by nearly a factor of five over a proportion based on the total test fiber debris load introduced to the test tank.

For the reasons stated above, the use of a Top Hat bypass fraction of 1.80% is considered a valid and conservative value.

- **Total Fiber Bypass**
Using the information presented previously for strainer plenum gap/opening bypass (3.92%) and also for Top Hat module bypass (1.8%), the overall amount of fiber that passes through the Catawba ECCS sump strainer can be determined. For each flow path (plenum gap/opening bypass and Top Hat module bypass) the quantity of entrained fibrous debris is first calculated by correlating the free flow area of the plenum gaps/openings and Top Hat module perforated plate. Overall fibrous debris load is then split between the two flow paths and then multiplied by the fiber bypass fraction associated with the flow path to determine the amount of fiber bypass. The fiber bypass quantities of the two flow paths are then combined to obtain the total fiber bypass for the ECCS strainer.

Following this process, the bounding fiber bypass volume for Catawba is 1.227 ft³, generated by a total expected fibrous debris load transporting to the strainer of 67.25

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

ft³. This corresponds to 6.9 g/fuel assembly based on a density of 2.4 lb/ft³ for the fibrous debris and the total number of fuel assemblies of 193.

Analysis of In-Vessel Downstream Effects

The Pressurized Water Reactor Owners Group (PWROG) and Westinghouse have developed a methodology for evaluating the effect of debris and chemical products on core cooling for Pressurized Water Reactors, as documented in report WCAP-16793-NP, Revision 2. Catawba committed to demonstrating compliance with the staff's Safety Evaluation (Reference letters from Catawba dated 8/13/2012 and 5/13/2013). Thus far, the information contained in this RAI response has outlined the basis for one of three success criterion (Fibrous debris in the core) outlined within the SE.

The remainder of the acceptance criterion associated with the WCAP report is met by use of the LOCA Deposition Model (LOCADM) contained as part of WCAP-16793-NP, Rev. 2. This model predicts the scale thickness due to deposition of bypass debris on the fuel rod surfaces and then evaluates the resulting peak cladding temperature. The resulting scale thickness is combined with the thickness of existing fuel cladding oxidation and crud build-up to calculate the total deposition thickness.

The results of the WCAP-16793-NP, revision 2 evaluation conclude the accumulation and deposition of fibrous and chemical precipitate debris at the reactor core will not challenge the ability to maintain post-LOCA Long Term Core Cooling (LTCC) at Catawba.

- Application of the bypass testing performed specifically for the Top Hat modules in use at Catawba as well as LANL testing concluded that the amount of fibrous debris at the reactor core translates to 6.9 grams per fuel assembly. This debris load is smaller than the 15 gram per fuel assembly limit given in the WCAP report. Therefore, accumulation of fibrous debris at the reactor core spacer grid will not block long term core cooling flow.
- Utilizing the methodology outlined in WCAP-16793-NP, LOCADM runs were performed for two different cases: minimum initial ECCS sump volume (Case 1) and maximum initial ECCS sump volume (Case 2). Table 29S-3 below summarizes the peak cladding temperature, scale thickness and deposition thickness of the two cases.

Catawba Nuclear Station
 Generic Letter 2004-02 Supplemental Response
 11/21/08 NRC RAI #29
 Final Response

Table 29S-3

Catawba LOCADM Model Results

Case	Peak Cladding Temperature PCT (°F)	Scale Thickness ST (microns)	Deposition Thickness DT (mils)
1 (Min ECCS Sump Volume)	350	17.4	12.2
2 (Max ECCS Sump Volume)	350	6.2	11.7

For either case, the PCT is much lower than the acceptance criterion of 800°F and the DT value is well within the acceptance criterion of 50 mils. Therefore, deposition of post-LOCA debris and chemical precipitate product on the fuel rods will not block the long term core cooling flow through the core or create unacceptable local hot spots on the fuel cladding surfaces.

Compliance with Limitations and Conditions

The NRC Safety Evaluation dated April 8, 2013 provides analysis and recommendations on the usage of Westinghouse's WCAP-16793-NP, revision 2 evaluations. Specifically, the SE points out 14 Limitations and Conditions that must be addressed when applying the WCAP methodology. These 14 Limitations and Conditions are addressed for the Catawba configuration below.

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

WCAP-16793-NP, Revision 2 Safety Evaluation

Limitations and Conditions

1. Assure the plant fuel type, inlet filter configuration, and ECCS flow rate are bounded by those used in the FA testing outlined in Appendix G of the WCAP. If the 15 g/FA acceptance criterion is used, determine the available driving head for a HL break and compare it to the debris head loss measured during the FA testing. Compare the fiber bypass amounts with the acceptance criterion given in the WCAP.

Catawba Response:

- Utilizing the methodology identified in RAI #18 of PWROG letter OG-10-253, "PWROG Response to Request for Additional Information Regarding PWROG Topical Report WCAP-16793-NP, Revision 1", dated August 2010, the available driving head for a hot leg break at Catawba is 13.7 psi. This driving head is favorably higher than the appropriate head losses measured for both AREVA (2.7 psi) and Westinghouse (6.26 psi) fuels in the FA testing.
 - The maximum ECCS injection flow rate expected for a cold leg break at Catawba is 8041 gpm. This corresponds to a flow rate of 41.7 gpm/FA which is within the bounds of the FA testing flow rate of 44.5 gpm/FA. In a cold leg break scenario some coolant flow would be expected to exit the break in the faulted RCS loop, but no reduction in ECCS flow is assumed for this evaluation which ensures conservatism by forcing maximum downstream debris flow through the reactor core.
 - The Catawba fuel type (17x17 Westinghouse) and inlet filter configuration (standard Westinghouse P-Grid) are covered by the FA testing program in Appendix G of WCAP-16793-NP, revision 2.
 - As determined earlier, the amount of fiber bypass at Catawba translates to 6.9 g/FA, which is within the bounds of the 15 g/FA acceptance criterion limit identified in WCAP-16793-NP, revision 2.
2. Each licensee's GL 2004-02 submittal to the NRC should state the available driving head for a HL break, ECCS flow rates, LOCADM results, type of fuel and inlet filter, and amount of fiber bypass.

Catawba Response:

See the Analysis of In-Vessel Downstream Effects Section of this RAI response for the plant-specific LOCADM results. For the available hot leg break driving head, ECCS flow rate, type of fuel and inlet filter, and the amount of fiber bypass, see the response to Limitations and Conditions item #1 above.

3. If a licensee credits alternate flow paths in the reactor vessel in their LTCC evaluations, justification is required through testing or analysis.

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

Catawba Response:

Catawba is not crediting alternate flow paths. Therefore, no additional justification is required.

4. The numerical analysis discussed in Section 3.2 and 3.3 of the WCAP should not be relied upon to demonstrate adequate LTCC.

Catawba Response:

Catawba does not use any of the conclusions drawn based on the fuel blockage modeling discussed in Sections 3.2 and 3.3 of the WCAP-16793-NP, revision 2 report. Instead, the fibrous debris amount at the core obtained from Catawba strainer bypass testing and evaluation (discussed previously) is compared with the reactor core fibrous debris acceptance criterion established from the FA testing to show that the debris will not form impenetrable blockage at the core spacer grid, thereby demonstrating adequate LTCC.

5. Assure the plant meets the 15 g/FA fiber bypass acceptance criteria limit.

Catawba Response:

See the Post Processing Bypass Test Results section of this RAI response for derivation of the 6.9 g/FA expected for the Catawba reactor core. As noted, this bypass quantity meets the 15 g/FA acceptance criteria limit identified in the SE.

6. The Debris acceptance criterion can only be applied to fuel types and inlet filter configurations evaluated in the WCAP FA testing.

Catawba Response:

As stated in the response to Limitations and Conditions item #1, Catawba's fuel type (Westinghouse 17x17) and inlet filter configuration (standard Westinghouse P-grid) are covered by the Westinghouse FA testing described in WCAP-16793-NP, revision 2. Therefore, the in-vessel fibrous debris acceptance criterion given in the WCAP is applicable to the Catawba fuel type and inlet filter configuration.

7. Each licensee's GL 2004-02 submittal to the NRC should compare the PCT from LOCADM with the acceptance criterion of 800°F.

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

Catawba Response:

The Catawba PCT is determined to be 350°F as described in the Analysis of In-Vessel Downstream Effects Section of this RAI response, which is well within the acceptance criterion of 800°F.

8. When utilizing LOCADM to determine PCT and DT, the aluminum release rate must be doubled to more accurately predict aluminum concentrations in the sump in the initial days following a LOCA.

Catawba Response:

The appropriate modeling methodology was followed, including the doubling of the aluminum release rate, in the LOCADM analysis.

9. If refinements specific to the plant are made to the LOCADM to reduce conservatism, the licensee should demonstrate that the results still adequately bound chemical product generation.

Catawba Response:

Catawba did not credit any refinements provided in the model.

10. The recommended value for scale thermal conductivity of 0.11 BTU/(h-ft-°F) should be used for LTCC evaluations.

Catawba Response:

The recommended scale thermal conductivity was used in the Catawba LTCC evaluation. This represents the lowest (and most limiting) value as discussed in Appendix E of WCAP-16793-NP, revision 2. Lower thermal conductivities inhibit heat transfer from the fuel rods and increase PCT.

11. The quantity of fiber bypass should be determined by strainer bypass testing using information specific to the plant.

Catawba Response:

See the ECCS Sump Strainer Bypass Testing section of this RAI response for discussion of the plant-specific strainer bypass testing that was performed for Catawba.

Catawba Nuclear Station
Generic Letter 2004-02 Supplemental Response
11/21/08 NRC RAI #29
Final Response

12. If a licensee intends to increase the 15 g/FA acceptance criterion for fiber bypass, additional justification is required.

Catawba Response:

As stated previously in this RAI response, the Catawba in-vessel fibrous debris quantity is within the bounds of the 15 g/FA acceptance criterion limit. No increase in the stated acceptance criteria limit is being pursued.

13. The size distribution of fibrous debris that passes through the sump strainer at the plant must represent the size distribution of the debris used in the FA testing.

Catawba Response:

The fibers collected in the filter bags during the strainer bypass testing were examined using both optical microscopy and scanning electron microscopy (SEM). Over 84% of bypassed fibers were shorter than 500 microns in length, 14% were between 500 and 1000 microns, and 2% were longer than 1000 microns. For the WCAP-16793-NP, revision 2 FA tests, 67%-87% of the fibers were shorter than 500 microns, 8%-28% were between 500 microns and 1000 microns, and between 0%-15% were longer than 1000 microns. Therefore, the size distribution of the fibrous debris predicted to bypass the Catawba ECCS strainers is consistent with that of the fibers used in the FA testing. This provides assurance that the fibrous debris bypass acceptance criterion developed from the FA testing is applicable to Catawba.

14. Each licensee's GL 2004-02 submittal to the NRC should not utilize the "Margin Calculator" as it has not been reviewed by the NRC.

Catawba Response:

The Catawba in-vessel downstream effects evaluation does not utilize the "Margin Calculator".

Summary

The preceding evaluation of the Catawba in-vessel downstream effects issue described in RAI question 29 of the NRC letter dated November 21, 2008 verifies that long term core cooling can be adequately maintained in the predicted post-accident scenarios.