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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 Numbers 50-413 and 50-414

Response to Request for Additional Information Regarding Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core cooling, Decay Heat Removal, and Containment Spray Systems"

Reference: Letter from Duke Energy to NRC, Catawba Nine Month (Post Outage) Response to NRC Generic Letter 2008-01, dated July 15, 2009 (ML092010132)

Letter from Duke Energy to NRC, Catawba, Unit 1 and 2, Response to Request for Additional Information Regarding Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", Dated March 4, 2010 (ML100640548)

On July 15, 2009, Duke Energy submitted the Final Response to Generic Letter 2008-01 for Catawba Nuclear Station. On December 4, 2009, Catawba received five Request for Additional Information (RAI) questions. Catawba responded on March 4, 2010.

On April 7, 2011, Catawba received two additional RAI questions. Catawba's response to these questions is contained in Attachment 1 to this letter.

Very truly yours,

James R. Morris

Attachment

A134
NRR

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

James R. Morris, Vice President

Subscribed and sworn to me: 5-6-2011
Date

Notary Public

My commission expires: 7-10-2012
Date

SEAL

xc (with attachments)

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Reference 3 section 1.4.3 states, "At NFR </= 0.65, some gas may be transported and if NFR >/= 2.0, all gas will be carried out of a pipe with the flowing water. Time to clear gas from a pipe for 0.8 < NFR < 2.0 is a function of flow rate. Dynamic venting may not be assumed effective for NFR < 0.8. Time to clear gas as a function of time will be addressed in a later revision of this document when we have received and evaluated test data that supports clearance behavior."

Reference 1 states, "Dynamic venting is credited (Froude number of > 0.55 for horizontal piping runs and > 1.0 for vertical piping runs)."

Reference 2 clarifies this by stating, "The criteria used was derived from WCAP-16631-NP." Reference 2 went on to say, "It is acknowledged that gas may be removed from piping at lower Froude numbers. In the end, ultrasonic test (UT) was conducted at numerous points on the subject systems and the piping was found to be full with the one exception mentioned above."

The NRC staff has the following questions:

1. Please provide justification for crediting dynamic venting with Froude numbers between 0.55 and 0.8.

The evaluations performed to respond to Generic Letter 2008-01 utilized guidance contained within Section 3.3.1 of WCAP-16631-NP, Volume 1. Specifically, the following criteria from the referenced document were utilized:

> Since most of the available literature correlates air transport out of horizontal pipes on the basis of Froude number (NFR), this is expected to be the primary correlating parameter. Based on the current state of knowledge, the following transport characteristics can be expected:
>
> 1. For NFR < 0.35 no air will be transported downwards towards the pump suction.
>
> 2. For NFR > 0.55 all of the air can be flushed out of a horizontal pipe into a plenum. The ability to transfer air through a piping system depends on the layout of piping downstream of the horizontal local high point. It is reasonable to expect that NFR=0.55 will not be sufficient to purge all of the air out of the local high point.
>
> 3. For NFR > 1.0 all of the air will be transported downwards towards the pump suction.
>
> 4. For 0.35 < NFR < 1.0 at least a portion of the air can be expected to be discharged from the local highpoint.

5. The rate of air entrainment is expected to be a function of the Froude number (NFR) in the horizontal pipe.

These criteria were published prior to the October 2008 response date required by Generic Letter 2008-01. Criteria specified within Reference 3 and its original revision were not issued until after the response date and completion of the required evaluations. System evaluations consisted of determining Froude numbers that were applicable to each unique horizontal span and judging against WCAP-16631-NP criteria. For locations at which the potential for gas formation existed and the Froude number was not sufficient to ensure adequate flushing as defined in the WCAP, a UT monitoring location and/or vent installation was specified to verify that the piping remained sufficiently filled. Catawba system evaluations do not credit dynamic venting in any horizontal span with Froude numbers between 0.55 and 0.8 unless the piping arrangement is such that entrained gas would be transported upward to another section of piping where it can be vented. As part of the initial licensee activities related to GL 08-01 evaluations, confirmatory UT inspections were performed at numerous locations to evaluate the effectiveness of dynamic venting.

As ongoing validation, post-dynamic flush venting or UTs and/or program monitoring venting or UTs are conducted at numerous points within the GL-addressed systems to verify dynamically flushed piping remains sufficiently filled.

As a result of this request for additional information, a review has been conducted of the evaluations to re-examine any locations where Froude numbers between 0.55 and 0.80 were used to credit dynamic venting. These are evaluated below:

1. Safety Injection (NI) which is considered intermediate head safety injection had statements in both units' evaluations where it stated that a Froude number of 0.61 was sufficient to ensure some 6 inch piping was dynamically vented. These portions of piping also receive Residual Heat Removal (RHR) system flow which results in Froude numbers greater than 2. The procedures were revised as a result of the Generic Letter to ensure that these piping segments receive RHR flow as part of the process of filling and venting of the system.
2. The evaluation for the Chemical and Volume Control System (CVCS) which also performs the High Head Safety Injection function contains a statement that a Froude number of 0.6 with a flow of 450 gpm would be sufficient to sweep a small gas void from a high point in the piping due to some slight pipe slope. The void of concern is a small void of only 0.05 cubic feet which would undergo some compression when RHR is supplying suction to the charging pumps. The evaluation has been revised to show that this piping segment is subjected to a higher flow of approximately 650 gpm during testing which will sweep the gas out of the system. Ultrasonic Testing (UT) has shown the piping to be full. In addition, due to the downstream piping geometry consisting of numerous elbows and elevation changes and the extremely small void size, the potential 0.05 cubic

foot void (prior to any compression) would not be expected to adversely impact the pumps if it were to be ingested by the charging pumps.

3. The evaluation for the Residual Heat Removal (RHR) system makes reference to a Froude number of 0.59 being sufficient to sweep gas. All of these references apply to a sweeping gas out of a horizontal segment into another horizontal segment or a vertical riser. It never applies to sweeping gas out of a horizontal segment into a downcomer. The Froude number of 0.59 only applies if gas were to be found online where the only available flow path is minimum flow. During fill of the system, all of these segments are swept with flows sufficient to achieve a Froude number of 2.0 or higher.
4. The evaluation for the Containment Spray System (NS) takes credit for a Froude number of 0.67 to sweep gas from four horizontal segments where an orifice could "act" as a dam. These are horizontal segments that lead to a riser. UT verified these segments to be full. Only a small portion of the system can be subjected to high flows since the recirculation piping used for the comprehensive IST tests is from the discharge of the pumps back to the pump suction and does not encompass the heat exchanger. Due to this piping arrangement, it is of no benefit in sweeping gas out of the system. The normally isolated recirculation path to the Refueling Water Storage Tank (FWST) has a maximum flow rate that results in a Froude number of 0.67 in the main process piping. This flow path would flush any air present in the process piping back to the FWST or to sections of piping where it can be vented.

2. Please verify the statement that UT is used to verify that dynamically flushed piping remains sufficiently full with respect to such areas as vertical U-tube heat exchangers and valve internal configurations where UT cannot be used if dynamic flushing involves these locations. If dynamic flushing is not used for these areas, then describe how they are determined to be sufficiently full.

The Residual Heat Removal (RHR) Heat Exchangers (Hx) at Catawba Nuclear Station are vertical U-tube heat exchangers. The heat exchangers are dynamically vented in a residual heat removal system alignment that passes a flow rate of greater than 3000 gpm through the heat exchanger to the Reactor Coolant System (RCS) cold legs. After the heat exchanger has been flushed, the piping branches downstream of the RHR Hx's are re-vented to remove any gas that may have accumulated in the non-flowing branch high points. Once the re-venting of downstream piping is complete, the RHR Hx and RHR system piping is considered sufficiently full. UT cannot be used to verify gas voids in the RHR Heat Exchangers. As described in Reference 2, a gas volume estimate of the RHR system is obtained and trended. In addition, as described in Reference 2, the RHR discharge header is continuously monitored by the Operator Aid Computer for pressurization.

The system evaluation performed for Generic Letter 2008-01 evaluated the flush of the RHR Hx as described above. The evaluation determined that the 4 pass RHR Hx tubes can be cleared of gas at a flow-rate of 516 gpm corresponding to a Froude number of 1.0. The channel head region, at the exit of the RHR Hx tubes, is also evaluated. The channel head area is considerably larger than the combined area of the Hx tubes discharging into the channel head. Therefore, the velocities in the channel head are much lower than the tube velocities. The calculation assumed a 0.55 Froude number at 1400 gpm would transport gas laterally in the 14" horizontal outlet nozzle. Actual flow during the flush is 3000 gpm. The Froude number at the outlet nozzle is 1.2 with the 3000 gpm flush flow, therefore, lateral transfer of gas is assured during the Hx flush as concluded in the system evaluation.

With respect to valve internal configurations, the system evaluations performed in response to Generic Letter 2008-01 evaluated the volumes contained within check valve and gate valve bonnets on suction and discharge piping. Section 8.2 of the evaluation makes the following general statements concerning valve bonnets and the potential for gas to remain in these volumes.

- Unventable volumes within valve bonnets are above the flow stream. Only a portion of the gas within tall bonnets such as those on gate valves can be displaced due to the lack of a direct flow path through the upper portion of the bonnet.
- For gate valves, discs in the open position reduce the available volume for gas to collect in the bonnet. Many of the gates valves in the systems subject to the GL 2008-01 evaluations are open during the fill and vent of the systems. This minimizes the amount of gas that is present in the valves. In check valves, a large portion of the exposed volume is blocked from the flow path by the disc.
- For valves on the discharge of pumps, the gas volume will likely be compressed up into the bonnet, especially with the taller bonnets on gate valves.
- Globe valves within the subject systems have negligible internal volumes subject to gas accumulation
- Gate valves oriented horizontally will tend to self vent with minimal gas accumulation in the bonnet.

As such, the presence of residual gas pockets within valve bodies was not considered to be a significant contributor to overall system vulnerability. This position appears to be consistent with guidance documented in NRC Inspection Manual Temporary Instruction 2515/177.

The larger gate valves and check valves in the RHR system were evaluated. Evaluated were potential trapped volumes in relief valve risers, gate, and check valve bonnets on the suction of the RHR pumps. These un-ventable gas volumes are quantified and evaluated for expansion of gas volume at lower operating pressures. The evaluation determined that no additional vents were required for these volumes. Similar evaluation was performed for relief valve risers and gate and check valve bonnets on the RHR discharge piping. These volumes were judged to have insignificant impact on water hammer and would remain compressed during injection and recirculation operation.

REFERENCES

1 Harrall, T., "Duke Energy Carolinas, LLC (Duke); Oconee Nuclear Station, Units 1, 2 & 3, Docket Nos. 50-269, 50-270, 50-287; McGuire Nuclear Station, Units 1 & 2, Docket Nos. 50-369, 50-370; Catawba Nuclear Station, Units 1 & 2, Docket Nos. 50-413, 50-414; Generic Letter 2008-01, 9-Month Response," Letter to Document Control Desk, NRC, October 13, 2008 (ADAMS Accession No. ML082900490).

2 J. R. Morris, "Generic Letter 2008-01 RAI Response," Letter from Vice President Catawba Nuclear Station, March 4, 2010, (ADAMS Accession No. ML100640548).

3 "Guidance To NRC/NRR/DSS/SRXB Reviewers for Writing TI Suggestions for the Region Inspections," December 6, 2010 (ADAMS Accession No. ML103400347).