Duke Energy®

D.M. JAMIL
Vice President

Catawba Nuclear Station
4800 Concord Rd. / CN01VP
York, SC 29745-9635

803 831 4251
803 831 3221 fax

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Subject: Duke Power Company, LLC d/b/a Duke Energy Carolinas, LLC
McGuire Nuclear Station (MNS), Units 1 and 2
Docket Numbers 50-369 and 50-370
Catawba Nuclear Station (CNS), Units 1 and 2
Docket Numbers 50-413 and 50-414

Response to an RAI for an Amendment to Allow an Additional Operator Action to Manually Start One Containment Air Return Fan in Response to NRC Bulletin 2003-01

Please find the Duke Energy Carolinas (Duke) response to a Request for Additional Information (RAI) concerning the license amendment request (LAR) to allow an additional operator action to manually start one containment air return fan in response to NRC Bulletin 2003-01. This LAR was originally submitted by a Duke letter to the NRC dated June 29, 2005 and the RAI was originally discussed via a teleconference with the NRR Project Manager on November 7, 2005. The RAI responses are included in Attachment A to this letter.

There are no regulatory commitments contained in this letter or the associated attachment.

If you have any questions concerning this material, please call A.P. Jackson at (803) 831-3742.

Very truly yours,

Dhiaa M. Jamil

APJ/s

A103

Dhiaa M. Jamil 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.

Dhiaa M. Jamil, Site Vice President

Subscribed and sworn to me: 5/1/06
Date

Notary Public

My commission expires: 7/2/2014
Date

SEAL

xc (with attachments):

W.D. Travers
U.S. Nuclear Regulatory Commission
Regional Administrator, Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, GA 30303

J. B. Brady
Senior Resident Inspector (McGuire)
U.S. Nuclear Regulatory Commission
McGuire Nuclear Station

E.F. Guthrie
Senior Resident Inspector (CNS)
U.S. Nuclear Regulatory Commission
Catawba Nuclear Station

J.F. Stang, Jr.(Addressee only)
NRR Project Manager (CNS and MNS)
U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mail Stop 8-H 4A
Rockville, Md 20852-2738

H. J. Porter, Director
Division of Radioactive Waste Management
Bureau of Land and Waste Management
Department of Health and Environmental Control
2600 Bull St.
Columbia, SC 29201

Beverly O Hall, Section Chief
Radiation Protection Section
1645 Mail Service Center
Raleigh, NC 27699-1645

ATTACHMENT A

REQUEST FOR ADDITIONAL INFORMATION
DUKE ENERGY CAROLINAS
MCGUIRE NUCLEAR STATION, UNITS 1 and 2
DOCKET NUMBERS 50-369 AND 370
CATAWBA NUCLEAR STATION, UNITS 1 AND 2
DOCKET NUMBERS 50-413 AND 50-414

Duke Energy Carolinas License Amendment Request to Allow an Additional Operator Action to Manually Start One Containment Air Return Fan in Response to U.S. Nuclear Regulatory Commission Bulletin 2003-01

Background Information:

On August 7, 2003 Duke Energy Carolinas (Duke) responded to Bulletin 2003-01. One of the questions in the bulletin suggested that we study the impact of manually starting a containment air return fan early in a small break LOCA event to avoid the auto-start of containment spray. Duke agreed to study the proposal and realized that an amendment would be required to implement this additional operator action.

The license amendment request (LAR) dated June 29, 2005 proposed the manual start of one containment air return fan. This proposed action will have the effect of delaying or preventing the transfer to sump recirculation for a limited range of small break loss of coolant (SBLOCA) events.

The containment air return fans receive an auto-start signal upon receipt of a high-high containment pressure signal (nominally 3 psig) with a 9 minute (+/- 1 minute) timer delay. The proposed manual action is to start one containment air return fan following receipt of a high containment pressure signal (nominally 1 psig) with an operator action time delay (nominally 10 minutes). Thus, the SBLOCA break sizes where this proposed action could occur would be limited to containment pressurization rates slow enough such that the automatic actuation would not have occurred when operator action is taken.

The calculations performed to support the June 29, 2005 submittal focused on the set of conditions expected for SBLOCAs that reached a containment pressure of 1 psig but remained below a containment pressure of 3 psig (the automatic actuation setpoint) for a sufficient length of time to allow for operator action to be taken. The SBLOCAs being considered for this proposed manual action do not present a design basis challenge as they are not of sufficient size to actuate the containment engineered safeguards in the first few seconds of the transient. SBLOCAs that cause containment pressure to increase to 3 psi will actuate both the containment air return fans and the containment spray pumps, which results in a high likelihood of transferring to sump recirculation mode.

The proposed manual action is only applicable to a limited range of SBLOCAs that do not present a fundamental challenge to the plant design basis. The primary function of the proposed manual action is to preclude the actuation of the containment spray pumps for a limited range of SBLOCAs. Given that the objective of NRC Bulletin 2003-01 is to explore the available avenues for reducing the possibility of requiring a transfer to sump recirculation, the proposed manual action is appropriate.

The Duke Topical Report DPC-NE-3004-PA describes the NRC approved methodology for evaluating the large break LOCA mass and energy release and containment response. This methodology uses RELAP5/MOD3.1DUKE to determine the mass and energy release, and GOTHIC Version 4.0/DUKE (GOTHIC) to determine the associated containment response. The June 29th submittal is based upon this methodology. The portion of the calculations required to evaluate the containment response is described in detail. The mass and energy release input is based upon RELAP5/MOD3.1DUKE results. However, given the limited range of applicability of the submittal, the mass and energy release analysis is not described in detail.

For the GOTHIC analyses of the SBLOCA scenarios in question, there were three different possibilities with respect to the containment response. The first was that containment pressure would never reach 1 psig, and that there would be no manual initiation of a containment air return fan. The second was that containment pressure would reach 1 psig, but that the differential pressure across the Intermediate Deck Doors (IDDs) would be insufficient to force any of these doors to open. For this scenario, the existing flowpath provided by the vent curtains would allow for the containment air return fan flow to reach upper containment and prevent a substantial differential pressure from building across the divider deck. The third possibility was that containment pressure would reach 1 psig, and that the pressure pulse across the IDDs would force some of these doors to open, establishing additional flow area for the containment air return fan flow to reach upper containment.

The range of SBLOCAs to produce these results is a narrow portion of the break spectrum. The approximate break size, which does not reach 1 psig in containment, is identified as 0.0025 ft^2, or a break diameter of about 0.7 inches. The approximate break size which forces enough air into the ice condenser to open the IDDs, is identified as 0.005 ft^2, or a break diameter of about 1 inch. Break sizes of this magnitude would not be anticipated to result in phenomena such as jetting, asymmetric ice melt, or significant leakage of steam through the deck leakage flow areas. Also, the pressure and temperature responses for breaks of these sizes change very slowly, when compared with larger breaks.

RAI Questions and Responses:

1. **Provide a summary of the Duke Energy Corporation (Duke) evaluation and disposition of the Numerical Application Incorporated GOTHIC condition reports. Have any errors been identified that required Duke to revise the GOTHIC Version 4.0/DUKE computer program? What was the impact of these changes on licensing analyses? How are these revisions documented?**

Response: All of the GOTHIC Error Reports issued by EPRI/NAI (on a quarterly basis) are reviewed to determine if any of the errors are applicable to GOTHIC Version 4.0/DUKE. Only a very small number of errors have been applicable to GOTHIC versions which date as far back as Version 4.0; none has ever resulted in a change to any of Duke's models.

2. **Clarify the meaning of "representative [small-break loss-of-coolant accident (SBLOCA)] mass and energy(M&E)release information."**

Response: These questions focus on the mass and energy release input data used in the GOTHIC containment response calculations. For the subject LAR, representative tables were used as input to GOTHIC for the M&E release. These tables were taken based on cases performed using RELAP5 and were listed as assumptions in the calculations. The important aspects of this submittal are the containment response for SBLOCAs that do not result in automatic actuation of the containment engineered safeguards. The details of the SBLOCA mass and energy releases to obtain such containment pressures are not significant. Thus, approximations to the RELAP5 results were used as input.

2a. **It is stated that the mass releases were estimated based on a previous RELAP5/MOD3.DUKE computer program (used for the long-term updated final safety analysis report (UFSAR) containment response evaluations) calculations and the energy releases correspond to the reactor system coolant (RCS) inventory at hot full power (not defined, hot full power assumed). If the analyses are intended to address the design base then the RCS parameters should be consistent with design base analyses assumptions (for example, full power plus measurement uncertainty, etc.). Address this concern, and verify that the subject evaluation adequately covers the expected range of conditions for the breaks of interest.**

Response: The analyses in the submittal are not intended to address any accident which challenges the containment design basis. This submittal focuses on SBLOCA break sizes that do not result in automatic actuation of the containment engineered safeguards, except for credit for containment isolation. These cases do not represent an evaluation of the containment design basis response.

2b. **(Question 2b was withdrawn per the teleconference.)**

2c. **It is also unclear if actual break studies were performed, covering what physical range of pipe break sizes, and break locations (cold leg, hot leg, steam line) and if a set of mass and energy releases are from a single break size study (for example a RELAP5/MOD3.DUKE computer run), Clarify and provide graphs of the mass and energy releases for each SBLOCA, include a discussion of the consistency of the mass and the energy releases since they appear to come from different assumptions. What is the break size range for which manual action is expected to be of benefit to Duke?**

Response: The subject LAR provides the break sizes that were evaluated in the GOTHIC containment response calculations. As discussed in the telecon between Duke and NRC, RELAP5 cases were performed to provide a basis for the initial investigations into the containment response. For the subject LAR, representative tables were used as input to GOTHIC for the M&E release. These tables were approximated based on cases performed using RELAP5 and were listed as assumptions in the calculations. As discussed in the teleconference, graphs of the representative tables are not provided. The important aspect of this submittal is the containment response for SBLOCAs that do not result in automatic actuation of the containment engineered safeguards. The details of the SBLOCA mass and energy releases to obtain such containment pressures are not significant. Thus, approximations to the RELAP5 results were used as input in the associated GOTHIC calculations.

3. **Provide justification that the GOTHIC containment model is adequate to simulate the phenomena associated with the SBLOCA transient. Address temperature**

stratification, small break jet dynamics, and ice condenser lower inlet door behavior. Give a qualitative description of the anticipated containment response for a SBLOCA for the range of break sizes discussed in the submittal, and assess whether the GOTHIC prediction matches this anticipated response. (This revised Question 3 encompasses the information desired from the original questions 3 and 4.)

Response: For the range of break sizes discussed in the submittal, it was anticipated that the containment response would be fairly slow-moving, with pressures and temperatures changing at fairly slow rates. The containment pressure for these breaks would reach 1 psig, but would not reach 3 psig in the time frame before the procedure step to manually start one VX fan would be reached by the plant operators (approximately 10 minutes into the transient). Some ice melting would be expected, but not a significant amount. It is likely that some ice condenser lower inlet doors on the opposite side of containment from the break would not open. The inlet doors in the vicinity of the assumed break location would crack open, providing adequate flow area to vent the steam from the pipe break into the ice bed.

The overall containment response as observed in the GOTHIC analyses was consistent with these expectations. The detail of nodalization within the lower containment region was adequate to capture the temperature profile resulting from the small pipe break. The warmer air/steam mixture rose to the top of lower containment, with much of the steam passing through the lower ice condenser inlet doors. The pressurization to 1 psig forced some of this air/steam mixture into the dead-ended compartments outside the crane wall, and a limited amount through the deck leakage flowpaths into upper containment, as well as into the ice condenser. Within the ice condenser, 100% of the steam was condensed on the ice surfaces, with the air passing through.

There would be no impact of varying flow distributions within the condenser. Also, there would be no melt-through of any ice bed for breaks of this size. The amount of ice melt is insufficient to open any of the ice condenser drains, and therefore the location of the ice melt has no impact on the containment response. The existing ice condenser heat transfer model is adequate to capture this 100% condensation of the steam entering the ice bed.

The pressurization caused by the air passing through the condenser, resulted in a force applied to the intermediate deck doors. For some breaks, this force was sufficient to cause some of these doors to open. For others, the air passed through the vent curtain flowpaths without opening any of the intermediate deck doors.

The forces associated with breaks in the range of sizes discussed in the LAR, are insufficient to cause any significant jetting effects. The overall containment response predicted with the GOTHIC containment model, as described in the submittal, is consistent with the expectations for this limited range of break sizes.

4. **(The original Question 4 was included in the revised Question 3 shown above.)**

5. **The GOTHIC large break model has been revised to include additional plant features important to the subject analyses, including additional nodes, flow paths and doors/vents. These changes address features used in the sub-compartment model (TMD) and the new GOTHIC analyses now also address the compression ratio analysis described in the plant UFSAR, with GOTHIC only being used for the long-term containment response. (Questions 5a,5b,5c were withdrawn as a result of the teleconference.)**

5d. **Have there been any changes in vent sites or their modeling characteristics, for example flow area or flow resistance?**

Response: The Ice Condenser Intermediate Deck and Ice Condenser Top Deck Vent Curtain configuration and location is unchanged from original installation at

Catawba and McGuire Nuclear Stations. The intermediate deck, which is positioned immediately on top of the ice bed, is designed with flexible membranes at its periphery (i.e., along all 24 bays and at both end walls) to reduce vapor transport from the ice bed to the air handlers in the Upper Plenum (thus reducing sublimation). Along the containment wall side of the intermediate deck, eight bays out of 24 have an equalization vent curtain installed in lieu of a complete sealing strip membrane, designed to permit air flow in either direction and provide for momentary pressure imbalances during normal operation. This feature is described in Section 6.2.2.11.2 of the McGuire UFSAR, and Section 6.7.11.2 of the Catawba UFSAR. These curtains are only located along the containment wall edge of the deck, and are spaced equally (i.e., in Bays 2, 5, 8, 11, 14, 17, 20, and 23). The crane wall and end wall edges are completely sealed. During refueling outages, the Intermediate Deck panels, support beams, and sealing strips/vent curtains are disassembled and removed in order to gain access to the ice baskets and flow channels in the ice bed; after this maintenance is complete, these components are returned to their specific locations and re-assembled.

The ice condenser top deck is composed of a steel grating which supports 48 double-ply blanket panels (two per bay) arranged in a radial configuration on top of the upper plenum of the ice condenser. These blanket panels are hinged at their base along the crane wall, and all free edges between adjacent panels, bays, end walls and at the containment wall are sealed with tape to provide a vapor and moisture barrier. Along the containment wall periphery of the top deck, there is a vent curtain provided that is designed to permit air flow in either direction and provides for momentary pressure imbalances during normal operation. This top deck feature is described in Section 6.2.2.10.2 of the McGuire UFSAR, and Section 6.7.10.2 of the Catawba UFSAR. As with the intermediate deck sealing strips, the top deck vent curtain is sealed at the top and bottom in all but eight equally spaced bays out of 24, providing communication between the ice condenser upper plenum and the upper compartment of containment.

5e. **Provide a summary of the analysis used to determine the intermediate deck door opening dP and the dP to open the top deck blankets. Have these values been verified? How often are inspections performed to ensure these openings are not blocked or obstructed?**

Response: The ice condenser intermediate deck contains 192 doors, eight doors per bay. The doors are configured horizontally as they also provide a platform in the upper plenum for inspections and maintenance. The weight of the doors serves to keep them closed under normal operating conditions. Due to the curvature of containment, the doors have different sizes as the deck expands in the radial direction toward the containment wall from the crane wall; there are four sizes altogether.

In order to determine the pressure differential across the intermediate deck at which these doors would begin to lift off their seals, hand-calculations were performed for the range of door sizes based on the projected area underneath the deck and just inside the door seal. These doors are governed by a technical specification surveillance requirement test acceptance criteria that quantifies the maximum allowable lift force for each door size to ensure operability. This acceptance criteria is described in the Technical Specification Bases 3.6.13 for each site. This test acceptance criteria was used as the basis for the resulting pressure calculation since, once resolved to a pressure distribution, it is representative of the maximum pressure allowed before the doors begin relieving the design basis accident condition at the intermediate deck. The surveillance test is performed at every refueling outage (i.e., every 18 months), which serves to consistently verify that the doors are still capable of properly relieving lower compartment pressure.

Once the intermediate deck has relieved this pressure to the upper plenum of the ice condenser, the top deck blankets would also be required to open in order to relieve the pressure, if the top deck equalization vent curtains are insufficient to handle the transient. These blankets, also horizontally configured, are considerably larger than the intermediate deck doors and are of light, flexible design and construction, and as such are only required to pass a visual technical specification surveillance test every three months to verify operability. It was determined that the top deck doors would also lift away from the top deck grating under the same pressure condition that lifted the intermediate deck doors, since the resultant forces involved would be very large in relation to the top deck blanket and would break the sealing tape as a result of the lifting force.

In addition to the surveillance frequencies noted above for each of these sets of doors, there is a required weekly surveillance of the ice condenser upper plenum at the intermediate deck for anomalous conditions as well.

6. **Please provide a qualitative assessment of the existing containment model with respect to overall uncertainty. (Original questions 6a, 6b, and 6c were all incorporated into this single question 6.)**

Response: Individual sensitivity studies involving any of various parameters such as initial temperatures, pressures, and heat transfer correlation assumptions for the passive heat structures, would be of little added value due to the nature of the analysis. This is due to the relative insensitivity already demonstrated to a key parameter in this particular analysis: form loss coefficients through the vent curtain flowpaths. The conclusions of the original GOTHIC analyses would not be impacted, nor the acceptable margin to the VX fan shutoff head.

The timing of reaching a containment pressure of 1 psig is not a critical piece of the analysis. Some breaks will reach this pressure at varying times, depending on lower containment ventilation capabilities, initial conditions, etc. It is not critical to assign a certain break with a certain time at which 1 psig is reached. Likewise, the timing of the opening of the intermediate deck doors is not a critical result. If they do open, either partially or completely, extra flow area is provided through the ice condenser. If they do not open, the vent curtain flowpaths are sufficient to provide the needed flow area to prevent high divider deck differential pressures. This is discussed in the LAR.

Given the extensive number of sensitivity cases performed, and the relative insensitivity of the containment pressure response to changes in the various parameters mentioned above, it is concluded that the uncertainty in the GOTHIC models, or individual cases, is small enough to address the range of pressure differentials demonstrated in these analyses. The margin with respect to the shutoff heads of the VX fans for McGuire and Catawba, are discussed in Question 9 below.

7a. **(The original question 7 was broken into parts a - f.)Why is it necessary to bypass the 0.5 psi differential pressure switch permissive on the air return system?**

Response: The isolation damper open circuitry is currently designed to bypass the 0.5psi dP switch only during manual damper operation. This feature will be incorporated into the "Reactor Trip or Safety Injection" emergency procedure as a defense-in-depth strategy to allow the operator to manually start one air return system fan, if necessary. If the isolation damper fails to automatically open after the ten second time delay, manual operation of the isolation damper is performed

7b. **What are the consequences of the failure of the isolation damper actuator?**

Response: The failure of one isolation damper actuator will result in loss of one air return system train as described in CNS or MNS UFSAR Table 6-68. The redundant air return system train will be available to delay or prevent the NS System actuation and the subsequent transfer to ECCS sump recirculation.

7c. What are the consequences of operating the air return fan in an unstable region?

Response: As stated in Attachment 5, Page 1, of the June 29, 2005 Duke submittal, unstable fan operation would begin at total pressures of 2.4 inches water (0.0866 psid for MNS) and 4.85 inches water (0.1751 psid for CNS) for the air return fans.

Under these conditions, the air return fans would be operating with flow and static pressure surges or pulsations and increased noise and vibration. Brake horsepower would initially decrease then increase as the fan total pressure increases to the shutoff point of the performance curve. The brake horsepower at the shutoff point of the fan performance curve is less than the nominal horsepower rating for the fan-motor.

The CNS air return fan performance curve is shown in UFSAR Figure 6-106 and the MNS air return fan performance curve is shown in UFSAR Figure 6-109 for operation under LBLOCA conditions.

No adverse consequences to the fans or dampers are expected for these size SBLOCA events.

7d. Have the malfunction of the actuator and operation of the air return fan in an unstable region been included in previous plant safety evaluations?

Response: No. The dP switch is designed to prevent operation of the damper actuator until the differential pressure between lower and upper containment decreases below 0.5 psid. The safety analyses show the air return fans operate in stable regions of the fan performance curves. Operation of the air return fans in an unstable region has never been part of the design bases.

7e. How does this action relate to the 0.5 psi divider deck dP for safe air return fan operation?

Response: The 0.5 psid divider deck dP is only a design limitation imposed upon the isolation damper actuator within each air return system train to ensure the damper is capable of opening. The calculated differential pressures between the lower and upper containment in the limiting cases for these break events (0.069 psid for MNS and 0.081 psid for CNS) are less than the air return fan point of unstable operation (0.0866 psid for MNS and 0.1751 psid for CNS) and the shut-off head for both the CNS and MNS (0.108 psid for MNS and 0.249 psid for CNS) air return fans.

7f. How does this relate to the proposed technical specification insert that, "During an SBLOCA event, the differential pressure between the upper and lower containment remains below the isolation damper actuator and air return fan design limits?"

Response: The SBLOCA analyses for these break events show that the limiting divider deck dP is 0.069 psid for MNS and 0.081 psid for CNS. These divider deck differential pressures are significantly less than the 0.5 psid design limitation required for proper damper operation. The limiting divider deck differential pressures for the MNS and CNS SBLOCA events are also within the air return fan design limitations described in the responses for Questions 7c, 7e, 9b and 9c.

8. The GOTHIC model includes the lower containment ventilation system, used to maintain the containment temperature within limits during normal operation. Its use for design base analyses needs to be justified. For the breaks of interest, would the system be isolated by a containment isolation signal, if so when? Is the system capable of functioning as designed for the accident environment? What assumptions concerning onsite/offsite power availability were used for the subject evaluation? What is the effect of this system on the air density used to determine that the air return fans are operable?

Response: This question relates to the non-safety related lower containment ventilation systems. These systems are not qualified for operation in an environment that requires the actuation of the containment engineered safeguards. However, since the range of SBLOCAs is such that the containment pressure will remain below this setpoint, their availability should be considered, especially if their operation may lead to more limiting results. Such consideration does not credit their operation for design basis events. The non-safety lower containment ventilation systems are isolated on a high-high containment pressure signal (nominally 3 psig). No assumptions with regard to offsite power availability are made, since cases with no lower containment ventilation modeled have already been conducted. The system is capable of functioning in this environment; however, a loss of the system has only a minor impact on the analysis results.

With regard to air density impact: if the lower containment ventilation system is functioning, it serves to lower the temperatures within lower containment, and aids in maintaining the air density. (Following a high energy line break, containment air densities will typically increase with the elevated building temperatures.) The condensation of steam on the cooler coils reduces lower containment pressure, therefore reducing the differential pressure against which the VX fan would be operating.

9a. **Provide the numerical values for the calculated differential pressure for the limiting case for both plants. (Question 9 was separated into sections a - d.)**

Response: The calculated differential pressure between the lower and upper containment in the limiting cases was 0.069 psid for MNS and 0.081 psid for CNS. The limiting analyzed case for MNS is for a break size of 0.0025 ft^2 with containment ventilation assumed in operation. The limiting analyzed case for CNS is also for a break size of 0.0025 ft^2 with containment ventilation assumed in operation.

9b. **Provide the numerical value of the shutoff head for the limiting case for both plants.**

Response: MNS Air Return Fan Shutoff Head at 0.075 lbm/ft^3 is approximately 0.108 psid. CNS Air Return Fan Shutoff Head at 0.075 lbm/ft^3 is approximately 0.249 psid.

9c. **Provide the numerical value for the point of unstable operation of the air return fan for the limiting case for both plants.**

Response: As stated in Attachment 5, Page 1, of the June 29, 2005 Duke Submittal, unstable fan operation would begin at total pressures of 2.4 inches water (0.0866 psid for MNS) and 4.85 inches water (0.1751 psid for CNS) for the air return fans for the air densities in containment following a SBLOCA.

9d. **Compare the margins to the uncertainties in the GOTHIC calculations, based on the sensitivity studies performed as well as the uncertainty in the GOTHIC modeling of containment.**

Response: As stated in Attachment 5, Page 3, of the subject LAR, none of the factors assessed in the sensitivity studies resulted in a substantial impact on the calculated divider deck differential pressures. There is no overall quantitative analysis of the uncertainties associated with the GOTHIC calculations. The margins between the calculated differential pressures given in the response to Question 9a, and the acceptance criteria given in the responses to Questions 9b and 9c, represent the analyzed margins allowing for manual operation of a VX fan for these SBLOCA scenarios.

10. Describe the approximate, calculated break size that reaches 3 psig of pressure in Containment within 10 minutes. (This was an additional reviewer question.)

Response: The expected break size to reach the hi-hi containment pressure setpoint of 3 psig within 10 minutes, is approximately 0.01 ft^2 or a break diameter of about 1.4 inches for both Catawba and McGuire. This is consistent with previous SBLOCA scoping studies using the GOTHIC code; it is expected that breaks in this size range should reach the 3 psig setpoint in about 7 - 8 minutes. This assumes no cooling from the lower containment ventilation units. If some lower containment cooling were assumed, the break size required to reach the hi-hi containment pressure setpoint within 10 minutes would be slightly larger.