

December 23, 2005

Mr. Ronald A. Jones, Vice President
Oconee Nuclear Station
Duke Energy Corporation
7800 Rochester Highway
Seneca, South Carolina 29672

SUBJECT: HIGH ENERGY LINE BREAKS OUTSIDE CONTAINMENT AT OCONEE
NUCLEAR STATION, UNITS 1, 2 AND 3

Dear Mr. Jones:

This responds to your letters of August 18 and November 21, 2005 in which you committed to certain actions to address high energy line break (HELB) issues for Oconee Nuclear Station, Units 1, 2, and 3. In your November 21, 2005 letter, you stated that you expected to provide additional information regarding modifications and schedules associated with these issues by January 31, 2006.

The NRC staff has reviewed your letters in light of the HELB issues that have been identified at Oconee. These issues include, in part, the inspection findings listed in Enclosure 1. Further, the NRC staff has reviewed the Oconee licensing basis with regard to HELB, including your detailed analysis included in your August 18, 2005 letter. The NRC staff's analysis of the licensing basis with regard to certain key issues is included as Enclosure 2. In particular, the NRC staff has evaluated the question of the licensing basis regarding plant end state following a HELB and have concluded that the existing licensing basis includes achievement of cold shutdown following all HELB events and that the conclusion is not scenario specific as you postulated in your August 18, 2005 letter.

With regard to the issue of the licensing basis regarding jet impingement, we agree with your assessment in the August 18, 2005 letter that the original licensing documents for HELB do not include well-defined characteristics of the physical attributes of a jet from a critical crack. You further reference NUREG/CR-2193, "Two-Phase Jet Loads" and assert that, using a NUREG/CR-2193 approach, safe shutdown equipment in the East Penetration Room would be adequately protected from jet impingement. However, you further offered that jet impingement effects are addressed in the existing licensing basis in so far as they lead to temperature, pressure and humidity effects. It is not clear whether you are proposing that NUREG/CR-2193 be considered as a licensing basis approach to characterizing jet physical characteristics in support of the existing licensing basis for jet impingement effects. If so, you should further justify its use, including a description of its applicability to the Oconee Nuclear Station design. The consideration of dynamic effects of jet impingement are considered part of the licensing basis.

With regard to your plans to submit further information on plans and schedules for the modifications referred to in your November 21, 2005 letter, it is important that you provide information that describes how your intended actions (whether modifications, inspections or proposed changes to the licensing basis) are consistent with the both the specific licensing

R. Jones

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basis positions articulated above regarding plant end state and jet characteristics and the overall Oconee licensing basis for HELB. It would also be beneficial if you described the extent of the condition of these issues you considered in formulating these planned actions, especially in light of the wide range of HELB related issues identified in Enclosure 1.

You should also provide additional detail on any of the actions you proposed in your November 21, 2005, letter, including detail on inspections (e.g., identification of specific welds (girth and attachment welds, shop and field welds, percentage of piping to be inspected) or modifications (e.g., design standards (such as NEMA 4) for electrical penetration termination enclosures).

We anticipate that your January 2006 submittal will provide information that will demonstrate your commitment to making significant progress on these complex and important issues. The NRC staff's expectation is that your actions (inspections, modifications, etc.) on this issue should be complete no later than December 31, 2007. If you have any questions on this, please do not hesitate to call me at 301-415-3037.

Sincerely,

/RA/

Edwin M. Hackett, Deputy Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-269, 50-270, 50-287

Enclosures: As stated

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**Review of High Energy Line Break Licensing Basis
Oconee Nuclear Station, Units 1, 2 and 3**

By letter dated December 15, 1972, as modified by letter dated January 17, 1973, the Atomic Energy Commission (AEC), predecessor to the NRC, requested that Duke provide information sufficient to demonstrate that Oconee Units 1, 2, and 3 can be shut down and maintained in a safe shutdown condition in the event of a postulated rupture, outside containment, of a pipe containing a high energy fluid (including the double-ended rupture of the largest pipe in the main steam (MS) and main feedwater (MFW) systems) consistent with Criterion 4 of the Commission's General Design Criteria listed in Appendix A of 10 CFR Part 50, which specified the following:

Structures, systems, and components (SSC) important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents (including loss-of-coolant accidents). These SSCs shall be appropriately protected against dynamic effects (including the effects of missiles, pipe whipping, and discharging fluids) that may result from equipment failures and from events and conditions outside the nuclear power unit.

An attachment to the December 15, 1972, letter provided a general list of information that was required for AEC review. A portion of the items on this list are documented below:

- A. verification that failure of any structure, including nonseismic Category 1 structures, caused by the accident will not cause failure of any other structure in a manner to adversely affect mitigation of the consequences of the accidents and the capability to bring the unit(s) to a cold shutdown condition;
- B. verification that rupture of a pipe carrying high energy fluid will not directly or indirectly result in the following:
 - 1. loss of redundancy in any portion of the protection system (as defined in IEEE-279), Class 1E electric system (as defined in IEEE-308), engineered safety features equipment, cable penetrations, or their interconnecting cables required to mitigate the consequences of the steam line break accident and place the reactor(s) in a cold shutdown condition; or
 - 2. loss of the ability to cope with accidents due to rupture of pipes other than a steam line, such as the rupture of pipes causing a steam or water leak too small to cause a reactor accident but large enough to cause electrical failure;
- C. assurance that the control room will be habitable and its equipment functional after a steam line or feedwater line break or that the capability for shutdown and cooldown of the unit(s) will be available in another habitable area;
- D. an evaluation to assure that the onsite power distribution system and onsite sources (diesels and batteries) will remain operable throughout the event;

Enclosure 2

- E. a discussion of the potential for flooding of safety related equipment in the event of failure of a feedwater line or any other line carrying high energy fluid; and
- F. a summary of the emergency procedures that will be followed after a pipe break accident, including the automatic and manual operator actions required to place the reactor unit(s) in a cold shutdown condition. Among other things, the January 17, 1973, AEC letter modified this initial list to include the following additional guidance:

Design basis break locations should be selected in accordance with the following pipe whip protection criteria; however, where pipes carrying high energy fluid are routed in the vicinity of structures and systems necessary for safe shutdown of the nuclear plant, supplemental protection of those structures and systems shall be provided to cope with the environmental effects (including the effects of jet impingement) of a single postulated open crack at the most adverse location(s) with regard to those essential structures and systems, the length of the crack being chosen not to exceed the critical crack size. The critical crack size is taken to be half the pipe diameter in length and half the wall thickness in width.

In a letter dated April 25, 1973, Duke transmitted MDS Report No. OS-73.2, "Analysis of Effects Resulting From Postulated Piping Breaks Outside Containment for Oconee Nuclear Station Units 1, 2, and 3." The report indicated that high energy piping systems were examined by a detailed design drawing review for a postulated pipe break along their entire routing. The report also specifically indicated that all terminal ends and intermediate locations (minimum of two) between terminal ends were reviewed for the consequences of a pipe break and that all locations of consequence were reviewed. The report further indicated that protection from the consequences of postulated pipe breaks will be furnished such that mitigation of the accident and capability to safely shut down the reactor and maintain it in a safe shutdown condition are assured. The following types of breaks that were analyzed:

- double ended breaks and equivalent area longitudinal breaks occurring at terminal ends; butt weld joints of ells, tees, laterals, etc.; and nozzle weld joints; and
- critical cracks occurring at any location along straight sections of piping; and any location along curved members of piping.

Based on the evaluations that were completed, the report, in part, included the following findings:

- A. The failure of civil structures caused by postulated pipe breaks will not cause the failure of any other structure in a manner that will adversely affect the mitigation of the postulated accident or the capability to safely shut down the reactor and maintain it in a safe shutdown condition.
- B. The penetration room of the auxiliary building at elevation 809' 3" is the only area of the station which could experience appreciable pressurization in the event of a postulated pipe break. Only in the event of an MS or MFW break could the room be pressurized.
- C. The terminal end east MS line break in the penetration room results in a possible loss of low pressure (LP) injection piping (one redundant channel) and a possible loss of the cable for valve HP-26 (single failure criterion not met); a possible loss of concrete beams, columns, and roof in the immediate area of the auxiliary building; and no

consequential flooding.

1. Mitigation of this event relies upon high pressure (HP) and LP injection, the core flooding system, the reactor protective system (LP trip), and the turbine stop valve closure signals and actuation system. MFW to the unaffected steam generator is used to control plant cooldown, and the HP injection system is operated manually to control pressurizer level and boron concentration.
 2. Permanent corrective actions include installation of light weight blowout panels in the north and east wall of the east penetration room, reinforcement of the battery room walls, removal of the existing restroom, shield the LP injection line, and reroute electrical cable in the east penetration room.
 3. Interim measures to leave valve HP-27 open (to minimize the single failure vulnerability) will be taken until remedial action is completed to protect valve HP-26.
- D. The terminal end MFW pipe break in the east penetration room results in a possible loss of HP injection piping (one redundant channel); possible loss of the electrical cable for valve HP-26; and the possible loss of concrete beams, columns, and collapse of the floor above the immediate area of the auxiliary building. Flooding is negligible because the north wall of the east penetration room will fail due to pressure, thereby, relieving water to outside of the auxiliary building.
1. Mitigation of the feedwater line break is the same as for the MS line break. Feedwater can continue to be supplied to the unaffected steam generator by using the hotwell and condensate booster pumps. Long-term cooling can be accomplished by using the low pressure injection system. Pressurizer level and reactor coolant system boron control can be accomplished by using the HP injection system. Because jet impingement from the feedwater break can disable valve HP-26 and its associated flowpath, the single failure criterion for this event is not satisfied.
 2. Interim measures to leave valve HP-27 open (to minimize the single failure vulnerability) will be taken until remedial action is completed to protect valve HP-26.
 3. Permanent corrective measures include the installation of MFW restraints between the reactor building anchor and the MFW isolation check valves to prevent the loss of HP injection.

The report provided a schedule for completing the design modifications that were necessary to fully comply with the AEC criteria. Additionally, where the required modifications could not be completed prior to unit operation, the report indicated that appropriate interim measures would be implemented.

A supplement to the MDS report was submitted on June 22, 1973, to provide additional information as requested by the AEC during a meeting that was held between the AEC and

Duke on June 12, 1973. Included with the information provided in response to Question 5 was the following listing of the design criteria that would be applied for the MFW reactor building terminal end break:

1. Restrain the lines to prevent pipe whip.
2. Limit the double ended break gap to a zero-inch gap insofar as possible based on thermal expansion tolerances.
3. Prevent jet impingement from a terminal end break.
4. Limit and direct the flow of leakage away from vulnerable mechanical and electrical equipment.
5. The following are related mechanical loading and stress analysis aspects:
 - a. The guard pipe will be designed for full system design pressure and temperature.
 - b. All load bearing members will be designed to 9.0 yield stress for primary stresses.
 - c. A dynamic load factor of 3.0 will be used for applicable load bearing members of the restraint.

Also, in response to Question 7, Duke provided additional information to qualify the remote probability of a reactor building terminal end pipe break for the east MS line and among other things, indicated the following:

- Pressure relief of the penetration room is assured by replacing existing walls with light blowout panels of one pound per square foot or less for all vent areas.
- Inservice inspection of the postulated break area, to include metal surface inspection, will be completed every 5 years to detect any surface defects.

In response to Question 8, which asked if the effects of critical crack impingements have been analyzed, the licensee affirmed that the consequences of critical cracks had been analyzed and accounted for in the MDS report.

Finally, the licensee's response to Question 6 provides clear recognition and acceptance of the AEC criteria for being able to not only safely shut down the plant but also to achieve cold shutdown conditions following postulated high energy pipe failures (including the assumed single failure of protected equipment). The response to Question 6 states, "... an orderly cooldown to cold shutdown condition is accomplished ..."

In a letter dated July 26, 1973, with respect to Oconee Unit 1 the AEC accepted the licensee's analysis and resolution of postulated high energy line breaks (HELB) outside the reactor building as described in the submittal dated April 25, 1973, as supplemented by letter dated June 22, 1973. The AEC acceptance for Oconee Units 2 and 3 is documented in a safety

evaluation dated July 6, 1973.

During a meeting on January 26, 1999, the NRC was notified that the licensee was initiating a project to reconstitute the design and licensing basis for HELBs outside the reactor building. By letters dated October 15, 2001, supplemented by letters dated July 3, 2002, and August 20, 2003, the licensee requested NRC review and approval of the methodology that the licensee proposed to use in its HELB project. This methodology would be used by the licensee to modify the licensing basis for HELB. By letter dated January 14, 2004, the NRC stated that while it did not object to the use of the licensee's proposed assumptions, these assumptions may require further NRC review and approval pursuant to 10 CFR 50.59. For example, the proposed assumptions tended to allow a relaxation in the ability to achieve and maintain cold shutdown conditions. At a June 29, 2004, meeting the licensee informed the NRC of the project's status and schedule, including a plan to submit license amendment requests in 2006 and 2007. On June 30, 2005, the licensee met with the NRC staff to provide an update of the ongoing Oconee HELB revalidation project and to discuss the current HELB licensing basis for the Oconee units.

In a letter dated August 18, 2005, the licensee provided information regarding the licensing basis associated with the plant state subsequent to a HELB event and the licensing basis associated with consideration of the effects of jet impingement. The staff has reviewed the licensee's analysis and concluded:

- (1) Consistent with the response to Question 6 from the June 22, 1973 letter, the existing licensing basis includes achievement of cold shut down following all HELB events and that the conclusion is not scenario specific as postulated in the August 18, 2005 letter. In the discussion of the safe-end state, your August 18, 2005, letter included portions of the letter dated December 15, 1972, from Angelo Giambusso of the Atomic Energy Commission Commission (predecessor to the NRC). These portions clearly state the requirement that plants should be able to achieve cold shutdown following an HELB. Your April 25, 1973, response, which contained MDS Report No. OS-73.2, did not take exception to this requirement. Furthermore, your August 18, 2005, letter states, "A number of high energy systems with their associated postulated breaks were found to have no adverse effect on the operation of the reactor coolant system. As such, no discussion was provided to describe how the reactor was brought to a safe shutdown condition followed by a plant cooldown to a cold shutdown condition." The fact that there are no adverse effects on the operation of the reactor coolant system does not mean that there are no adverse effects on the operation of systems that are needed to achieve cold shutdown.
- (2) The consideration of dynamic effects of jet impingement are considered part of the licensing basis.

Recent High Energy Line Break Inspection Findings Oconee Nuclear Station

Since January 1, 2000, the following related HELB issues have also been documented in various NRC inspections reports:

- Violation (VIO) 1998-552-01014 – Emergency Procedure not Adequate to Mitigate Secondary Pipe Breaks. (This item was closed in NRC Inspection Report No. 2000-04.)
- Non-Cited Violation (NCV) 50-269,270,287/00-05-14 – Past Emergency Feedwater System Design was not Functional for a MFW Line Break and was not Reported or Adequately Corrected. (This item was documented in NRC Inspection Report No. 2000-05.)
- Unresolved Item (URI) 50-269,270,287/00-05-19 – Potential Vulnerability of a HELB Causing a Loss of the Three 4-KV Safety-Related Electrical Busses. Opened in NRC Inspection Report No. 2000-05. (This item was closed in NRC Inspection Report No. 2001-05.)
- URI 50-269,270,287/00-08-04 – Risk Significance of Uncontrolled Design Changes to Penetration Room Blowout Panels. (This item was opened in NRC Inspection Report No. 2000-08.)
- NCV 50-269,270,287/02-04-02 – Unauthorized Design Changes to the East Penetration Room Blowout Panels. (This item was documented in NRC Inspection Report No. 2002-04.)
- URI 50-270/02-05-05 – Determination of Consequences for not Maintaining Design Clearances on Feedwater Piping Whip Restraints and Corresponding Risk. (This item was documented in NRC Inspection Report Nos. 2002-05 and 2004-05.) (Refer to NCV 50-270/04-05-03.)
- URI 50-269,270,287/03-03-02 – HELB Accident Scenario Review, Updated Final Safety Analysis Report Change Associated with HELB on a Feedwater Line. (This item was documented in NRC Inspection Report No. 2003-03.)
- NCV 50-269,270,287/04-02-01 – Inadequate Inservice Inspection Program for Inspections of Feedwater System and Steam Line System Supports. (This item was documented in NRC Inspection Report No. 2004-02.)
- NCV 50-270/04-05-03 – Failure to Maintain Design Clearances on Feedwater Piping Whip Restraints. This item was documented in NRC Inspection Report No. 2004-05.) (Refer to URI 50-270/02-05-05.)

- VIO 50-269,270,287/04-07-01 – Failure to Obtain Prior NRC Approval to a Change to the Facility Involving Unreviewed Safety Questions on HELB Analysis. (This item was discussed in NRC Inspection Report Nos. 2004-05 and 2005-02, and it currently remains open.)
- Licensee Event Report (LER) 05000269/200402-(00)-(01) – MS Line Break Mitigation Design/Analysis Deficiency. (This item was discussed in NRC Inspection Report No. 2005-03.)
- GREEN NCV 50-269/05-03-03 – Failure to Maintain Equipment Qualification of Reactor Coolant Pump Seal Return Line Containment Isolation Valve HP-21.

Additionally, the following ongoing HELB issues were recently documented in NRC Inspection Report No. 50-269,270,287/2005-04 dated October 28, 2005:

- Green NCV 50-270/05-04-09 – Untimely Corrective Actions for Repairs to a Unit 2 East Penetration Room Floor Seal – Contrary to 10 CFR Part 50, Appendix B, Section XVI, Corrective Action (which requires that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected), the licensee failed to correct a partially extruded Unit 2 east penetration room floor seal that, if left uncorrected, could degrade to the point that safety related equipment could be affected following a HELB. Because this issue was of very low safety significance and because it has been entered into the licensee's corrective action program, this violation is being treated as an NCV, consistent with Section VI.A.1 of the NRC Enforcement Policy.
- Green NCV 50-269,270,287/05-04-05 – Failure to Implement an Inspection Program for the MS Lines – Contrary to 10 CFR Part 50, Appendix B, Criterion X, Inspection (which requires that a program for inspection of activities affecting quality shall be established and executed to verify conformance with the instructions and procedures), the licensee failed to establish and execute an inspection program for inspection of the MS lines committed to as part of their response to the 1972 AEC letter. Because the failure to perform the inspections was considered to be of very low safety significance and because it has been entered into the licensee's corrective action program, this violation is being treated as an NCV consistent with Section VI.A.1 of the NRC Enforcement Policy.
- Green NCV 05-269,270,287/05-04-04 – Failure to Develop and Implement a Cleanliness Inspection Program for the Containment Electrical Penetrations – Contrary to 10 CFR Part 50, Appendix B, Criterion X, Inspection (which requires that a program for inspection of activities affecting quality shall be established and executed to verify conformance with the instructions and procedures), the licensee failed to establish an inspection program for the containment electrical penetrations to ensure proper cleanliness of the penetrations. Because this issue was of very low safety significance and because it has been entered into the licensee's corrective action program, this violation is being treated as an NCV consistent with Section VI.A.1 of the NRC Enforcement Policy.

- URI 05-269,270,287/05-04-11, Failure to Identify Unmitigated/Unprotected Feedwater Line Terminal Ends – Contrary to 10 CFR Part 50, Appendix B, Criterion XVI, Corrective Action (which requires that measures shall be established to assure that conditions adverse to quality are promptly identified), the licensee failed to identify that unprotected feedwater line terminal ends existed that could impact the mitigation systems needed to protect the plant from a HELB. Pending the NRC’s determination of risk significance, this apparent violation has been identified as a URI.
- URI 05-269,279,287/05-04-10, – Failure to Maintain Containment Electrical Penetration Enclosures – Contrary to 10 CFR Part 50, Appendix B, Criterion XVI, Corrective Action (which requires that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected), the licensee failed to identify and correct penetration covers that had been removed or misadjusted over a number of years of maintenance activities, which created conditions adverse to quality where dust dirt, rust and spray could impact circuits needed to mitigate the consequences of a HELB and cause erratic operation of the 120 VAC and 120 VDC vital electrical systems. Pending the NRC’s determination of the risk significance, this issue has been identified as a URI.
- URI 05-269,270,287/05-04-07 – Untimely Corrective Actions in Correcting the East Penetration Room Blowout Panel Deficiency – Contrary to 10 CFR Part 50, Appendix B, Criterion XVI, Corrective Actions (which requires in part that measures be established to assure that conditions adverse to quality, such as deficiencies, deviations, and non-conformances are promptly identified and corrected), Units 1, 2, and 3 have continued to be operated outside their licensing basis for meeting HELB criteria because the east penetration room blowout panels are not assured of opening to prevent auxiliary building flooding, the panels do not meet the design criteria for blowout capacity, and corrective actions have not been taken in a timely manner to resolve the deficiency. Pending the NRC’s determination of the risk significance, this apparent violation has been identified as a URI.
- URI 05-269,270,287/05-04-08, Failure to Meet the Reportability Requirements of 10 CFR 50.73 for the East Penetration Room Blow Out Panel Deficiency – Contrary to 10 CFR 50.73(a)(2)(v) (which requires the reporting of any event or condition that could have prevented the fulfillment of the safety function of structures or systems that are needed to (A) shut down the reactor and maintain it in a safe shutdown condition (licensing basis is cold shutdown) and (D) mitigate the consequences of an accident), the licensee failed to report that improper modifications to the east penetration room blowout panels would prevent the fulfillment of the safety function of the HP injection system to mitigate the consequences of an HELB accident (i.e., to shut down the reactor and maintain it in a cold shutdown condition). Pending the NRC’s determination of the safety significance, this apparent violation has been identified as a URI.

Oconee Nuclear Station, Units 1, 2, and 3

cc:

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