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U. S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Document Control Desk

Subject: Oconee Nuclear Station
Docket Nos. 50-269, 270, and 287
High-Energy Line Break Outside Reactor Building Methodology

On June 30, 2005, representatives of Duke Energy Corporation (Duke) met with the Nuclear Regulatory Commission (NRC) to discuss the High Energy Line Break (HELB) revalidation project ongoing at Oconee Nuclear Station (ONS) and issues related to the HELB current design and licensing basis. The presentation by Duke included a discussion of the background that led to the initiation of the project, a general description of the project tasks and their status, a discussion of the current licensing basis and ONS adherence to those requirements, and a description of risk reduction modifications that would help reduce the HELB mitigation risks at ONS.

Two issues were discussed that required additional clarification as follows:

- The consideration of jet impingement associated with critical cracks in the original Oconee licensing basis (MDS report OS-73.2, "Analysis of Effects Resulting from Postulated Piping Breaks Outside Containment for Oconee Nuclear Station, Units, 1, 2, & 3").
- The definition of safe end state related to HELB mitigation as defined in the Oconee HELB licensing basis.

These issues are discussed in Attachment 1.

As communicated during the 6/30/05 meeting, a primary objective of the ongoing HELB revalidation project is to resolve the existing ambiguity resulting from a poorly documented licensing basis. License Amendment Requests will

A001

be submitted as the project progresses to include this detail in the current licensing basis, thus eliminating such ambiguities for the future.

If there are any additional questions, please contact Reene' Gambrell at (864) 885-3364.

Very Truly Yours,

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ATTACHMENT 1

Request for Additional Information

Attachment 1
Request For Additional Information

QUESTION 1:

Were the effects from jet impingement associated with critical cracks included in the original Oconee licensing basis defined in MDS report OS-73.2, "Analysis of Effects Resulting from Postulated Piping Breaks Outside Containment for Oconee Nuclear Station, Units, 1, 2, & 3."?

ANSWER:

Yes, jet impingement from critical cracks was evaluated relative to the associated environmental effects. Environmental affects from break locations that could affect the ability to achieve safe shutdown were determined to bound the conditions associated with critical cracks. In Duke's response to Question 8 (given in the June 22, 1973 supplement to the original HELB submittal OS-73.2), "Have the effects of critical cracks impingements been analyzed?", it was noted that "As described in 2.1.1 the consequences of critical cracks were analyzed and accounted for in the report." Section 2.1.1 of the HELB submittal OS-73.2 entitled "Postulated Piping Break Locations," notes in part that .."all locations of consequence were reviewed." ONS interprets these statements to mean that all break locations which have consequences that could affect the ability of the plant to be safely shutdown were reviewed and analyzed.

Further, since these breaks would result in more severe environmental conditions than created by critical cracks similarly located, due primarily to the difference in mass flow rates, then the environmental conditions associated with breaks bound those associated with critical cracks. Systems and components required to reach safe shutdown located in closed compartments such as the East Penetration Room, were environmentally qualified. Environmental qualification of electrical components was based on the applied pressure, temperature, and steam air environment (100% humidity) resulting from the break.

The physical attributes of a jet from a critical crack were not established in the original HELB licensing basis. As ONS stated during the meeting held 6/30/05, documentation supporting the original HELB submittal is incomplete and provides no additional definition for jet lengths for critical cracks. Previous licensing actions have indicated that NUREG/CR-2913, "Two-Phase Jet Loads" establishes an acceptable approach for defining the length of jets from critical cracks. Using this approach, safe shutdown equipment located in the East Penetration Room would be adequately protected from jet impingement.

To conclude, jet impingement effects from critical cracks were included in the original Oconee HELB licensing basis, given the interpretation that jet impingement results in the environmental effects of temperature, pressure, and 100% humidity. This approach appears consistent with other licensing actions regarding HELB made in the early 1970's. Furthermore, the environmental effects resulting from postulated breaks given in the original Oconee HELB licensing basis (OS-73.2) bound those of critical cracks located in the same area as the breaks. The environmental qualification of systems and components is based on the conditions created in the aftermath of those postulated breaks.

QUESTION 2:

Is the safe end state related to HELB mitigation defined as "hot shutdown" or "cold shutdown" in the Oconee HELB licensing basis?

ANSWER:

The safe end state for HELB's at Oconee is scenario specific. In December 1972, the Atomic Energy Commission requested that the effects of high energy line breaks outside containment be adequately analyzed and documented by licensees and applicants such that the effects could be evaluated by the AEC. The intent of the letter was for licensees and applicants to demonstrate that the nuclear plant was designed such that the reactor could be shutdown and maintained in a safe shutdown condition in the event of a HELB outside containment, including the double ended rupture in the largest pipe in the main steam and main feedwater systems. It was also intended that plant structures, systems, and components important to safety were designed and located in the facility to accommodate the effects of the HELB to the extent necessary to assure the safe shutdown of the reactor and the ability to maintain it in a safe shutdown condition.

To assist licensees and applicants in providing the necessary information for review, the AEC provided a list of general information required by the staff for consideration.

Included in the general information required by the AEC were:

1. Verify any structural failures caused by the HELB do not prevent:
   a. Mitigation of the consequences of the accident
   b. Capability to bring the unit(s) to a cold shutdown condition
2. Verify HELBs do not directly or indirectly result in a loss of redundancy in any portion of the protection systems, Class 1E electrical system, engineering safeguards equipment, cable penetrations, or interconnecting cables that are required to mitigate the consequences of the HELB and place the reactor in a cold shutdown condition.
3. A loss of redundancy is permitted for HELBs that disable protection functions provided that the break does not require protective action and there is no loss of function.
4. Assurances should be provided that the control room would remain habitable and its equipment functional after a steam line or feedwater line break, or the capability exists for shutdown and plant cooldown in another habitable area.
5. A summary of emergency procedures that would be followed after a pipe break accident, including the automatic and manual operations required to place the unit(s) in a cold shutdown condition.

The information requested by the AEC was submitted by Duke Power Company in a report identified as MDS Report No. OS-73.2. Breaks were postulated in accordance with the AEC guidelines. 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. Operators may elect however to shut down the unit for repairs. Therefore, cold shutdown would not be considered to be safe shutdown for those postulated breaks.

The report identified a number of high energy systems with their associated postulated breaks that may adversely affect the operation of the reactor coolant system. Discussion was provided to describe how the consequences were mitigated followed by a plant cooldown to a cold shutdown condition. These systems included:

1. Main Feedwater System (inside the turbine building)
2. Auxiliary Steam System
3. High Pressure Injection - Normal makeup line

The report stated that main and emergency feedwater may be lost as well as the 4160V switchgears following pipe ruptures in the feedwater lines and auxiliary steam lines in the vicinity of the 4160V switchgears. The report also states that the loss of 4160V switchgears would result in the loss of both high pressure and low pressure injection systems. Based on the severity of the consequences, Duke committed to installing new redundant emergency feedwater lines away from these postulated break areas with cross connects to the other units' emergency feedwater systems. The AEC requested that Duke describe how the plant would mitigate the consequences of these main feedwater line breaks after the design changes were completed. Duke responded to this question in Supplement 1 to the report. In Supplement 1, Duke described that following design changes, emergency feedwater could be restored via the new emergency feedwater lines to mitigate the loss of main and emergency feedwater. Power would then need to be manually restored to a high pressure injection pump from the 4160V switchgear not affected by the accident to enable a plant cooldown. The 4160V switchgear not affected by the break was identified in the report as the auxiliary service water switchgear. Supplement 1 concluded that an orderly cooldown to a cold shutdown condition could be accomplished by the installation of the redundant emergency feedwater supply lines.

It should be noted that neither the report nor the supplement ever addressed restoring low pressure injection for decay heat removal. Therefore, one may conclude that restoration of emergency feedwater via the new emergency feedwater lines and restoration of a single high pressure injection pump was sufficient to bring the unit to a cold shutdown condition. However, the steam generators are designed to cool the unit down to approximately 250°F. Thus, it is not possible to bring the station to cold shutdown utilizing just the steam generators for decay heat removal. The low pressure injection system would be utilized to cool the unit from approximately 250°F to below 200°F. Restoration of a low pressure injection pump would be required to achieve cold shutdown.

Discussion for break mitigation followed by plant cooldown was provided for other breaks where only long term decay heat removal via the low pressure injection system was defined as the end state. The systems included:

1. Main Steam System
2. Main Feedwater System (inside the penetration room)
3. Condensate System
4. Feedwater Heater Drains and Vents

The report does not specifically define cold shutdown as the end state. However, as previously mentioned, the UFSAR states that the low pressure injection system is designed to cool the unit down from approximately 250°F to cold shutdown conditions. Therefore, it is reasonable to conclude that cold shutdown was considered to be the end state for these breaks.

Discussion for break mitigation followed by a plant cooldown was provided for some breaks where no long term decay heat removal source was given. The systems included:

1. Turbine Extraction System
2. High Pressure Injection - Seal Supply line
3. High Pressure Injection - Letdown line

The report did not specifically state what system was used for long term decay heat removal. In addition, the report did not specifically describe the end state for these breaks. However, the consequences of these breaks did not identify any adverse consequences to the low pressure injection system or the electrical distribution system supporting its operation. Therefore, it is reasonable to conclude that cold shutdown was considered to be the end state for these breaks.

Finally, other breaks were discussed that placed no requirement on reactor shutdown or plant cooldown. These systems included:

1. Emergency Feedwater System

Since the consequences of the breaks did not have any effect on other plant systems, it is reasonable to conclude that power operation was considered to be the end state for these breaks.

At Oconee, event mitigation is divided into two parts. The first part is accident mitigation to bring the unit to a stable safe shutdown condition. The second part is to cooldown the plant to a safe end state as defined by the ONS licensing basis for that accident.

Oconee considers the attributes of a safe shutdown condition to be:

- Bring the reactor to a sub-critical condition and maintain adequate shutdown margin.
- Maintain reactor coolant inventory at a sufficient level to protect the core

- Control reactor coolant pressure within acceptable limits
- Control reactor coolant temperature within acceptable limits by removing core decay heat

Oconee considers the safe end state to be a condition where the plant could be maintained in a long term condition. The safe end state conditions can vary from cold shutdown to Mode 3 with Reactor Coolant Temperature ≥ 525°F, depending on the event. The safe end state is dictated by ONS Licensing correspondence for events on a case-by-case basis. If no safe end state has been defined, then ONS typically applies Mode 3 with RCS average temperature at or greater than 525°F.

The differentiation between safe shutdown and safe end state has been made to reflect the different requirements for systems, structures, and components. Equipment required to mitigate the consequences of the accident and bring the unit to a stable safe shutdown condition conform to QA-1 and single failure standards. Plant cooldown is not considered to be part of accident mitigation. Some equipment, credited for plant cooldown and the establishment of a cold shutdown condition, do not conform to the single failure and QA-1 standards.

Equipment classified as QA Condition 1 is listed in section 3.1.1 of the UFSAR. The reactor coolant pump motors and their associated power source are not classified as QA-1. These pumps are required to perform a normal plant cooldown. If the reactor coolant pumps are lost, then the plant would be maintained in Mode 3 with reactor coolant temperature at or greater than 525°F. Natural circulation provides an acceptable means of decay heat removal from the core. Natural circulation cooldown is not expected to be undertaken except for small break loss of coolant accidents. If the reactor coolant pumps could not be restored, and a natural circulation cooldown must be initiated, then the operators would be directed to open the reactor vessel head vents to continuously vent the head to prevent void formation during cooldown. Although the reactor vessel head vents are classified as QA Condition 1, the vent pathway is not designed to meet the single failure criterion. This has been previously reviewed and approved by the NRC in response to Generic Letter 81-21.

To conclude, HELB outside containment mitigation is divided into two parts. The first part is accident mitigation to bring the unit to a stable safe shutdown condition. Equipment used in this phase of event mitigation is limited to that equipment meeting QA Condition 1 standards. The second part is to cooldown the plant to a safe end state. Oconee"s licensing basis credits equipment that is not QA Condition 1 nor designed to meet single failure criterion. The Giambusso letter requested that the capability to achieve cold shutdown be addressed. Oconee considers this to be the generic safe end state for HELB outside containment. However, the safe end state for each break is defined as that which was described in the MDS Report. In some cases, cold shutdown was listed as the end state. However, not all breaks define cold shutdown as the safe end state. For those breaks where no end state is defined, Mode 3 with RCS temperature at or above 525°F will be assumed.