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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

Duke Energy Generation Services (Duke) is submitting Oconee Nuclear Station's (ONS) methodology for "Analysis of Effects Resulting From Postulated Piping Breaks Outside Containment For Oconee Nuclear Station, Units 1, 2 & 3" for NRC review.

Criteria for postulating rupture locations and providing protection methods for piping inside containment are not within the scope of this submittal. The original High Energy Line Break (HELB) criteria outside containment for ONS are documented in MDS Report No. OS-73.2 dated 4/25/73 and Supplement 1 to MDS Report No. OS-73.2 dated 6/22/73. Design methodologies and protection requirements were based on standard practice and approved criteria at that time (1973). The rules and guidelines to address the HELB issue provided in Appendix A to 10CFR50, General Design Criteria (GDC) 4, "Environmental and Missile Design Bases" were in the developmental stage during that time frame and were, therefore, not included in the initial ONS HELB licensing position. However, Duke responded positively and adequately to the analysis requested in the Atomic Energy Commission (AEC) letter authored by A. Giambusso dated 12/15/72. This is documented in the ONS Unit 2 and 3 Safety Evaluation Report received from the AEC dated 7/6/73.

Significant technical and regulatory advances in pipe rupture postulation and protection requirements have taken place since ONS was designed and built in the early 1970's. Duke has chosen to update the existing pipe rupture criteria for ONS to include the advances that have been made.

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Attachment 1 identifies and documents Duke's updated position on various requirements pertaining to pipe ruptures outside containment. The position has been established considering the technical and regulatory requirements at the time of plant design and construction, current NRC Standard Review Plan (SRP) guidance, and Generic Letter 87-11, modified as justified, to be compatible with existing design bases methods for ONS. The purpose of the updated criteria is to provide acceptable pipe rupture postulation and protection methods for the plant that meet the intent of current NRC requirements.

ONS HELB Methodology was discussed in a conference call with the Nuclear Regulatory Commission (NRC) Staff on 10/11/01. Duke requests a meeting at some later date to discuss this methodology and answer any questions the Staff may have regarding Duke's approach.

Duke's proposed methodology is very similar to Florida Power Corporation's methodology and submittal for Crystal River 3 dated 12/18/89. The submittal was approved by the NRC on 04/11/90.

Duke has a significant, self-initiated project underway to re-constitute HELB design and licensing basis. The purpose of this letter is to obtain NRC concurrence with the planned project approach. Based on Duke's HELB project schedule, staff concurrence on the proposed methodology is requested by 12/31/01. Duke will submit a revision to the licensing basis upon completion of the HELB project to reflect a new HELB licensing basis for the facility.

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

Very Truly Yours,

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Attachments

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ATTACHMENT 1

High Energy Line Break Methodology

Attachment 1
High Energy Line Break Methodology

Duke Energy Generation Services (Duke) performed an assessment in 1998 that identified issues with the original High Energy Line Break (HELB) analysis. As a result of this assessment, Duke initiated a project to update the original HELB work. This initiative was communicated to Region II management during a January 26, 1999, management meeting. The primary objective of this project is to revalidate and update the Oconee Nuclear Station (ONS) HELB study originally completed in 1973 for the present day plant configuration. In the initial phase of the project, Duke created the methodology to be used to identify the postulated break locations and then generated a list of break locations with their associated interactions. In the next phase, the interactions developed in the initial phase will be evaluated from a plant shutdown perspective. Before beginning the next phase, Duke seeks concurrence from the NRC regarding the methodology used to determine break locations in the initial phase.

Criteria for postulating rupture locations and providing protection methods for piping inside containment are not within the scope of this submittal. The original HELB criteria outside containment for ONS are documented in MDS Report No. OS-73.2 dated 4/25/73 and Supplement 1 to MDS Report No. OS-73.2 dated 6/22/73. Design methodologies and protection requirements were based on standard practice and approved criteria at that time (1973). The rules and guidelines to address the HELB issue provided in Appendix A to 10CFR50, General Design Criteria (GDC) 4, "Environmental and Missile Design Bases" were in the developmental stage during that time frame and were therefore not included in the initial ONS HELB licensing position. However, Duke responded positively and adequately to the analysis requested in the Atomic Energy Commission (AEC) letter authored by A. Giambusso dated 12/15/72. This is documented in the ONS Unit 2 and 3 Safety Evaluation Report received from the AEC dated 7/6/73.

Significant technical and regulatory advances in pipe rupture postulation and protection requirements have taken place since ONS was designed and built in the early 1970's. Duke has chosen to update the existing pipe rupture criteria for ONS to include the advances that have been made.

This attachment identifies and documents Duke's updated position on the various issues pertaining to pipe rupture requirements outside containment. The position has been established considering the technical and regulatory requirements at the time of plant design and construction, current NRC Standard Review Plan (SRP) guidance, and Generic Letter 87-11, modified as justified, to be compatible with existing design bases methods for ONS. The purpose of the updated criteria is to provide acceptable pipe rupture postulation and protection methods for the plant that meet the intent of current NRC requirements.

This response documents any deviations or changes from the original MDS Reports dated 4/25/73 and 6/22/73, respectively. It also establishes the assumptions made for the new analysis.

Duke's proposed methodology is very similar to Florida Power Corporation's methodology and submittal for Crystal River 3 dated 12/18/89. The submittal was approved by the NRC on 04/11/90.

DEVIATIONS:

Deviation 1: Criteria established in the AEC letter dated 12/15/72 stated that Systems (or portions of system) be identified for which protection against pipe whip is required. ONS has deviated from this requirement in that certain systems are excluded based on operating time.

No HELB protection requirements are needed if total system operation time is less than 1% total plant operating time or time as High Energy Line (HEL) is less than 2% system operating time. Piping which operates at pressures and temperatures meeting high energy requirements is not considered high energy if the total time spent in operation at high energy conditions is less than either of the following: a)1% of the normal operating life of the plant or, b)2% of the time required to accomplish its system design function. For these systems, no breaks are postulated. This is

justified based on the very low probability of a HELB occurring during the limited operability time for these systems.

Deviation 2: The AEC letter dated 12/15/72, as supplemented on 1/17/93, stated that criteria used to determine the pipe break locations in the piping systems should be equivalent to the following: "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 ½ the pipe diameter in length and ½ the wall thickness in width."

Duke submits a partial deviation from the postulation of critical cracks:

A. For piping that is rigorously analyzed (i.e. stress analysis information is available), critical cracks shall be postulated in Class 2 or 3 piping at axial locations where the calculated stress for the applicable load cases exceeds .4(S_A + S_h). For Class 2 or 3 piping, applicable load cases include internal pressure, dead weight (gravity), thermal, and seismic (defined as operational basis earthquake, OBE).

B. For non-safety class piping that is rigorously analyzed (i.e. stress analysis information is available),

critical cracks shall be postulated at axial locations where the calculated stress for the applicable load cases exceed .33(S_A + S_h). Applicable load cases include all those given for Class 2 or 3 piping, with the exception of seismic. The lower threshold for non-safety piping is a new threshold not specifically addressed in the AEC letter dated 12/15/72. This new threshold reflects the recognition that non-seismically designed piping should have a margin of safety against seismically induced cracks. Lowering the multiplier from .4 to .33 provides a suitable margin against seismically induced cracks in otherwise non-seismically designed piping. The reduction in the multiplier is based on the low seismic spectra to which ONS is designed and the recognition of the inherent ruggedness of power plant piping demonstrated by experience data.

Rules for postulation of cracks in Class I piping are not defined, since there is no Class I piping located outside of containment at ONS.

Actual stresses used for comparison to the threshold shall be calculated in accordance with the ONS Power Pipe Code of Record, USAS B31.1.0, 1967 Edition, "Code For Pressure Piping." Allowable stress values S_h and S_A shall be taken from the applicable appendices of USAS B31.1.0, or USAS B31.7, February 1968 Edition including Errata of June 1968, as appropriate.

C. For Piping that is not rigorously analyzed (i.e. stress analysis information is not available),

critical cracks shall be postulated at axial locations based on targets, or that produce the most severe environmental effects.

These proposed deviations follow the requirements, in part, given in Branch Technical Position MEB 3-1, Sections B.1.e (1) through (3).

Deviation 3: Criteria established in the AEC letter dated 12/15/72 state that ASME Section III Code Class 2 and 3 piping breaks should be postulated to occur at the following locations in each piping run or branch run:

Any intermediate locations between terminal ends where either the circumferential or longitudinal stresses derived on an elastically calculated basis under the loadings associated with seismic events and operational plant conditions exceed 0.8 (S_h + S_A) or the expansion stresses exceed 0.8 S_A.

Duke seeks deviation from this criterion in that breaks are not being postulated based on stresses exceeding .8 S_A. Thermal stresses are secondary in nature, and taken in absence of other stresses, do not cause rupture in pipes. This complies with MEB 3-1 requirements for postulating intermediate breaks, based on stress, for Class II piping systems.

Deviation 4: Criteria established in the AEC letter dated 12/15/72 state that ASME Section III Code Class 2 and 3 piping breaks should be postulated to occur at the following locations in each piping run or branch run:

Intermediate locations in addition to those determined by Deviation 3, selected on reasonable basis as necessary to provide protection. As a minimum, there should be two intermediate locations for each piping run or branch run.

Consistent with GL 87-11, Duke plans to deviate from the postulation of Arbitrary Intermediate Breaks provided in the AEC's 12/15/72 letter:

A. For piping that is rigorously analyzed (i.e. stress analysis information is available), intermediate breaks shall be postulated in Class 2, 3 piping at axial locations where the calculated stress for the applicable load cases exceed $.8(S_A + S_h)$. Applicable load cases include internal pressure, dead weight (gravity), thermal, and seismic (defined as operational basis earthquake, OBE).

B. For piping that is rigorously analyzed (i.e. stress analysis information is available), intermediate breaks shall be postulated in non-safety class piping at axial locations where the calculated stress for the applicable load cases exceed $.66\ (S_A + S_h)$. Applicable load cases include all those given in A above, with the exception of seismic. The lower threshold for non-safety piping is a new threshold not specifically addressed in the AEC letter dated 12/15/72. This new threshold reflects the recognition that non-seismically designed piping should have a margin of safety against seismically induced ruptures. Lowering the multiplier from .8 to .66 provides a suitable margin against seismically induced ruptures in otherwise non-seismically designed piping. The reduction in the multiplier is based on the low seismic spectra to which ONS is designed and the recognition of the inherent ruggedness of power plant piping demonstrated by experience data.

C. For piping that is not rigorously analyzed (i.e. stress analysis information is not available),

intermediate breaks shall be postulated at axial locations based on targets, or that produce the most severe environmental effects.

Rules for postulation of breaks in Class I piping are not relevant in this submittal, since there is no Class I piping located outside of containment at ONS.

Actual stresses used for comparison to the threshold shall be calculated in accordance with the ONS Power Pipe Code of Record, USAS B31.1.0, 1967 Edition, "Code For Pressure Piping." Allowable stress values S_h and S_A shall be taken from the applicable appendices of USAS B31.1.0, or USAS B31.7, February 1968 Edition including Errata of June 1968, as appropriate.

Structural HELB Terminal Ends

Terminal Ends are vessel/pump nozzles, penetrations, in-line anchors and branch-to-run connections that act as essentially rigid constraints to piping thermal expansion. A branch connection appropriately modeled with the run (flexibility and movements) where the branch connection stress is accurately known uses the stress criteria for postulating breaks. For unanalyzed branch connections or connections where the stress is not accurately known, local targets will determine break locations.

Deviation 5: The AEC letter dated 12/15/72 provides criteria to determine pipe break orientation at break locations and specifies that longitudinal breaks in piping runs and branch runs be postulated for 4 inches nominal pipe size and larger.

Circumferential breaks are postulated at all terminal ends. Longitudinal breaks are not postulated at terminal ends, unless the

piping at the terminal end is of a seamed design. This is consistent with specifications in B.3.b.(2) of MEB 3-1.

ASSUMPTIONS FOR METHODOLOGY:

The following are key assumptions applied in the ONS Methodology:

1. The ONS Plant initial state is considered to be 100% power operation.

2. The Jet Impingement Cone Geometry and Jet Impingement Effective Length are postulated in accordance with NUREG/CR-2913, "Two Phase Jet Loads".

3. Standard Review Plan section 3.6.1 requires a postulated break at all valves forming the separation between High Energy and Moderate Energy piping. If the piping is analyzed such that the computed stresses are reasonably known, then a break is postulated based on the stress value and compared to the Oconee pipe break stress threshold value given. For non-analyzed pipe, a break is postulated based on local targets.

4. A Loss of Offsite Power (LOOP) is not assumed to occur coincident with the HELB. However, the large steam line break accident described in Chapter 15 of the UFSAR requires the postulation of a LOOP.

   The original HELB report did not postulate a LOOP for any of the HELB's. However, the Main Steam Line Break (MSLB) accident described in the UFSAR Section 15.13 does consider a LOOP. This accident requires the postulation of a LOOP in addition to a non-LOOP. The small steam line break is described in the UFSAR Section 15.17. This accident does not require postulation of a LOOP.

5. Safe shutdown for ONS is defined as Mode 3 with an average reactor coolant temperature $\geq$ 525°F. Overcooling events can lead to reactor coolant temperatures < 525°F. Safe shutdown for these events includes reestablishing and maintaining shutdown margin > 1%Δk/k with RCS temperatures and pressures

being controlled in accordance with plant emergency procedures.

The original HELB did not specify safe shutdown conditions.

6. The assumed safe end-state is safe shutdown for each HELB. Safe shutdown is defined in assumption 5. The ability to achieve long term decay heat removal will be verified. Long term decay heat removal is considered to be normal decay heat removal via the Low Pressure Injection (LPI) system or secondary side cooling via the steam generator(s) until the LPI system can be placed into service.

   The original HELB Report described plant cooldown to cold shutdown conditions. However, it was recognized that certain events could lead to the loss of normal decay heat removal via the LPI system. These events relied upon Station ASW for long term decay heat removal. It should be recognized that decay heat removal via the steam generators is acceptable as a long term decay heat removal method, but the reactor coolant system cannot be cooled to < 200°F (cold shutdown condition).

7. A seismic event is not postulated to occur coincident with a pipe break. Therefore, non-seismic equipment may be credited for HELB mitigation.

   The NRC addressed information that Duke had submitted concerning seismic events. The correspondence explains that although seismic loads are used as design criteria for systems, structures, and components that mitigate and prevent large break loss of coolant accidents with a LOOP, a seismic event or an independent pipe break is not postulated to occur coincident with a LOCA. In addition, the correspondence also states that pipe failures during seismic events are not postulated.

8. Single active failures are postulated for accident mitigation, as well as the achieving and maintaining safe shutdown. However, single active failures are not postulated for plant cooldown. Single failures are not postulated for establishing long-term decay heat removal.

9. The Standby Shutdown Facility (SSF) is assumed to be available as a means of safe shutdown following events that lead to a loss of normal plant systems.

The Standby Shutdown Facility provides capability to shut down the nuclear reactors from outside the control room in the event of a fire, flood, or sabotage-related emergency. The SSF is also credited as the alternate AC (AAC) power source and the source of decay heat removal required to demonstrate safe shutdown during the required station blackout coping duration. It provides additional "defense-in-depth" by serving as a backup to safety-related systems. The SSF has the capability of maintaining Mode 3 (with Tave $\geq$ 250°F) in all three units for approximately three days following a loss of normal AC power. It is designed to maintain reactor coolant system (RCS) inventory, maintain RCS pressure, remove decay heat, and maintain shutdown margin.

10. Unaffected units' EFW systems are assumed to be available to mitigate a loss of EFW pumps/inventory on the affected unit.

The original HELB report identified numerous secondary piping breaks which led to a loss of both main and emergency feedwater systems on a given unit. At the time of the report, the Station Auxiliary Service Water (ASW) pump was the only means of delivering water to the steam generators following the identified line breaks. A commitment was made to install new EFW piping with cross-connects between all three units to eliminate the single failure vulnerability of the Station ASW pump. This cross-connect capability exists today, but requires local manual operation to cross-connect the units. This will continue to be credited for events where personnel access to the areas can be demonstrated.