UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
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March 12, 2002

EA-02-034

Duke Energy Corporation
ATTN: Mr. W. R. McCollum
Vice President
Oconee Nuclear Station
7800 Rochester Highway
Seneca, SC 29672

SUBJECT: OCONEE NUCLEAR STATION - NRC INSPECTION REPORT 50-269/00-08, 50-270/00-08, AND 50-287/00-08; PRELIMINARY WHITE FINDING

Dear Mr. McCollum:

On March 31, 2001, the NRC completed a quarterly inspection at your Oconee Nuclear Station. The inspection findings were documented in the subject report, which was issued on April 30, 2001.

Section 1R06.1 of the subject report discusses the vulnerability to flooding in the auxiliary building from a rupture of the high pressure service water (HPSW) piping. Redundant trains of emergency core cooling systems (ECCS) and other safety-related systems could be disabled if sufficient quantities of flood water accumulated in the lower levels of the auxiliary building. Using the significance determination process (SDP), this issue was preliminarily determined to be White (i.e., an issue with some increased importance to safety, which may require additional NRC inspection) for Unit 1 only. As indicated in the enclosed SDP Phase III Summary, the issue appears to have a low to moderate safety significance because of the potential that both seal injection and component cooling functions related to cooling the reactor coolant pump (RCP) seals could be disabled. This would result in an increased likelihood of a loss of coolant accident caused by an RCP seal failure. While the flooding vulnerability also exists for Units 2 and 3, the risk significance for these units was determined to be of very low safety significance, Green. The reason for the difference in risk between the units is that Unit 1 was evaluated for a one-year period when the older style (temperature sensitive) RCP seals were in place and Units 2 and 3 had high temperature RCP seals for the period being assessed.

Two apparent violations related to the potential for auxiliary building flooding from a rupture of HPSW piping were identified. They involved: (1) the failure to comply with License Condition 3.E of the Oconee facility operating license for not implementing and maintaining in effect all provisions of the NRC-approved fire protection program, in that you did not assure that a rupture of the fire suppression system in the auxiliary building would not significantly impair safety-related equipment; and (2) the failure to promptly correct this condition adverse to quality as required by 10 CFR 50, Appendix B, Criterion XVI, Corrective Action. Specifically, in February 1996 and June 1998, Problem Identification Process reports (PIPs) were written concerning the HPSW piping in the auxiliary building being filled and pressurized versus a dry system. However, despite your discovery of this condition, prompt corrective actions to resolve

this issue were not taken (e.g., it was not until August 2001 that an Abnormal Operating procedure was developed to provide operator guidance for response to an auxiliary building flood, etc.). These two apparent violations are being considered for escalated enforcement action in accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions - May 1, 2000" (Enforcement Policy), NUREG-1600.

Before the NRC makes a final decision in this matter, we are providing you an opportunity to request a Regulatory Conference where you would be able to provide your perspectives on the significance of the issue, the bases for your position, and whether you agree with the apparent violations. If you choose to request a Regulatory Conference, we encourage you to submit your evaluation and any differences with the NRC evaluation at least one week prior to the conference in an effort to make the conference more efficient and effective. If a conference is held, it will be open for public observation. The NRC will also issue a press release to announce the conference.

Please contact Mr. Robert Haag at (404) 562-4550 within 7 days of the date of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision and you will be advised by separate correspondence of the results of our deliberations on this matter.

Since the NRC has not made a final determination in this matter, a Notice of Violation is not being issued at this time. In addition, please be advised that the number and characterization of the apparent violations may change as a result of further NRC review.

In addition to the apparent violations discussed above, a related violation was identified for the failure to update the Final Safety Analysis Report (FSAR), as required by 10 CFR 50.71(e), to correctly reflect the latest information developed regarding portions of the HPSW piping in the auxiliary building being filled and pressurized. Section (e)(4) of 10 CFR 50.71 requires that revisions to the FSAR shall be filed annually or 6 months after each refueling outage provided the interval does not exceed 24 months. Violations involving the failure to update the FSAR could impact the NRC's ability for oversight of licensed activities. Therefore, the significance of not updating the FSAR within the time period specified by 10 CFR 50.71 (e), to reflect the latest auxiliary building flood design basis, was not evaluated through the SDP; but rather, was evaluated in accordance with the guidance in Section IV.A.3 of the NRC Enforcement Policy. As such, the NRC has concluded that this violation should be characterized at Severity Level IV due to its low safety significance and because the particular regulatory process was not significantly impeded. Additionally, it has been determined that this violation should be non-cited in accordance with Section VI.A.1 of the NRC's Enforcement Policy. For the administrative purpose of identifying this non-cited violation with a unique inspection report related number, this non-cited violation will be identified accordingly in a future NRC Integrated Inspection Report.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system

(ADAMS). ADAMS is accessible from the NRC Web site at
http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Victor M. McCree, Deputy Director
Division of Reactor Projects

Docket Nos.: 50-269, 50-270, 50-287
License Nos.: DPR-38, DPR-47, DPR-55

Enclosure: SDP Phase III Summary

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SDP Phase III Summary

Plants: Oconee 1, 2 &3

I. Background

At Oconee Nuclear Station, the high pressure service water (HPSW) system serves as the fixed fire protection system. There is approximately 173 feet of the 16-inch diameter HPSW piping in the auxiliary building with other smaller diameter pipes attached to the header. If a rupture of the non-seismically qualified HPSW piping occurs, the auxiliary building would be flooded with the HPSW inventory from the pipe break. Based on licensee calculations, less than 100,000 gallons would be necessary to flood the High Pressure Injection (HPI) and Low Pressure Injection/Reactor Building Spray (LPI/RBS) rooms. This would result in disabling all Unit 1 & 2 Emergency Core Cooling System (ECCS) pumps. Less than 50,000 gallons would be necessary to flood the HPI and LPI/RBS rooms for Unit 3 and disable all of Unit 3 ECCS pumps.

Flooding of all HPI pumps could result in a reactor trip due to loss of reactor coolant system (RCS) makeup capability. In addition to disabling the HPI and LPI/RBS pumps, a large flood could also disable the Component Cooling Water (CCW) system for all three Units. The power supply breakers for all CCW pumps (Units 1, 2, 3) are located in motor control centers (MCCs) on the first floor of the auxiliary building. Furthermore, the breakers are on the bottom row of the MCCs, and are more vulnerable to the effects of room flooding. Approximately 500,000 gallons of fluid would be necessary to disable the HPI and CCW systems. When the HPI and CCW systems become disabled, normal RCP seal cooling is unavailable. Under this condition, the Standby Shutdown Facility (SSF) Reactor Coolant Makeup pump provides the capability for RCP seal cooling.

Units 2 & 3 contain Bingham RCPs and seals. Up until November 2000, Unit 1 had Westinghouse RCPs with the old style seals installed.

Performance Deficiency - Oconee was not designed to prevent a rupture of the HPSW piping in the auxiliary building from significantly impairing SSCs important to safety. Mitigation capabilities had not been established to prevent flooding that results from a rupture of HPSW piping from disabling ECCS functions. Corrective actions to resolve this condition, which was initially recognized in 1996 and1998, have not been prompt. This condition has existed since initial plant operation.

Exposure Time -This condition has existed since the Oconee units were originally licensed for operation.

Date of Occurrence - 1970s

II. Safety Impact:

WHITE for Unit 1 prior to installation of new RCP seals & GREEN for Units 2 & 3.

III. Risk Analysis/Considerations

1. Assumptions

(a) Seismic Event - A seismic event could result in a HPSW piping rupture and cause flooding in the auxiliary building, which disables the HPI and CCW pumps.

(b) Piping Structural Condition - The HPSW piping is built to ANSI B31.1 standard, is butt welded, and is erected and supported in accordance with standard Duke Power installation specifications for non-seismic qualified piping. The portion of the HPSW piping in the auxiliary building is a carbon steel (A106, Grade B) 16-inch outer diameter pipe with nominal wall thickness of 0.375 inch and design pressure of 150 psig at 100^0F. Based on the licensee's recent Non-Destructive Examination (NDE) ultrasonic test results for selected portions of the HPSW piping and calculated stresses in the piping versus actual allowable pipe stress, the licensee's conclusion of adequate HPSW pipe structural integrity was viewed as acceptable.

Beyond a seismic event, HPSW pipe rupture could ocurr due to a corrosion attack or a design & construction defect.

(c) Fragility of HPSW Piping - The HPSW is built and installed to the same Code requirements as the Balance-of-Plant (BOP) piping. Since seismically-induced failure of piping supports is the failure mode for BOP piping (Oconee IPE report, page 3.2-4), it is reasonable to assume that the fragility of HPSW piping can be modeled with the fragility parameters for the BOP piping supports. The fragility values (as shown on Table 3-1, Oconee IPEEE report) are 1.77g for the median ground acceleration capacity, 0.46 for the inherent randomness about the median, and 0.43 for the uncertainty about the median value.

The median ground acceleration capacity of 1.77g for the Oconee piping supports was calculated using the seismic fragility data for pipe supports at the McGuire plant (built and installed according to Duke Power specifications). For the McGuire pipe supports, the median ground acceleration capacity was calculated to be 2.66g based on the Safe Shutdown Earthquake (SSE) of 0.15g peak acceleration for the McGuire station (see Table 5-8 on page 5-79, Seismic Fragilities of Structures and Components at the McGuire Nuclear Station, September, 1983). Based on the Maximum Hypothetical Earthquake (MHE) of 0.1g peak ground acceleration for the Oconee site, the seismic capacity for the Oconee piping supports was determined to be: [2.66g x (0.1/0.15)] = 1.77g median ground acceleration capacity. In reviewing the calculations for the seismic capacity of the McGuire pipe supports, it was noted that a strength factor of 3.5 was used in the derivation of the median ground acceleration capacity. This appears to be consistent with the pipe stress margin of (15000 psi/3878 psi) = 3.87 for the HPSW piping.

Based on the median ground acceleration capacity of 1.77g, the value of 0.46 for randomness about the median, and the value of 0.43 for uncertainty, the ground

acceleration for HPSW piping failure is (1.77g)(0.46)(0.43) = 0.35g. Using the licensee-provided fragility curves (mean value, 5 percent, 50 percent, and 95 percent confidence levels) for HPSW piping supports, it was conservatively determined that the probability of HPSW piping support failure, given a ground acceleration of 0.35g, is 0.1.

(d) Conditional Core Damage Probability - The conditional core damage probability (CCDP) of a RCP seal LOCA event for Oconee Unit 1 (wherein RCPs were equipped with old style Westinghouse o-ring seals prior to Fall of 2000) was approximately 3E-1. This is also the failure probability of the Safe Shutdown Facility. When the SSF fails upon demand, a RCP seal LOCA would occur. In the case of Oconee Units 2 & 3, the RCPs are Bingham-Willamette pumps and the CCDPs were estimated to be 6.6E-2 based on 0.22 (probability of seal LOCA) x 0.3 (probability of SSF failure to provide RCP seal cooling within 10 minutes). In this risk analysis, it is conservatively assumed that the CCDP of a RCP seal LOCA event at the Oconee plants is 0.3.

(e) Piping Rupture Consequences - Small diameter piping will be excluded from consideration. Due to the significantly lower flow rates translating into far greater operator response times, these initiators are qualitatively not significant. Therefore, the large diameter 16" pipe is primarily the piping of concern.

(f) Portion of HPSW Piping in Auxiliary Building - Based on the licensee's review of piping lengths of all HPSW piping with outer diameter of 4 inch or greater, it was determined that about 20 percent of HPSW piping is located in the Auxiliary Building. If HPSW piping breaks in another location (e.g., turbine building, buried in ground, etc.), loss of HPI/CCW due to flooding will not occur. Therefore, a partitioning factor of 0.2 is applied in the risk analysis for the seismic portion of the risk analysis. For convience in deriving an initiating event frequency, 4" diameter piping or greater will be used in the seismic portion of the evaluation. For pipe ruptures via other mechanisms, the lenght of 16" diameter piping in the auxiliary building was estimated at 173 feet with 50 welds.

(g) Recovery by Isolating Pipe Rupture - For this analysis it is assumed that operators can not isolate the pipe rupture, following a siesmic event. Recovery by isolating the pipe rupture is credible following the other pipe rupture mechaisms. The NRC's ASP methodolgy was used to develop the HEPs.

2. Model Used - Hand calculation with basic event information from the licensee's full scope model, ASP for HEPs and the Rhodes model for RCP seal LOCA probabilities.

3. Significant Influence Factors - the RCP seal/o-ring configuration.

IV. Calculations

1. Unit 1 - The seismic-induced core damage frequency (CDF) and the internal flooding-induced CDF will be considered additive.

NON-CONFORMING CASE Unit 1

A. Seismic CDF -The seismic-induced core damage frequency (CDF) equation for the flood scenario can be defined as follows:

$F_{CDF} = E_i * P_r * P_f * P1$

where E_i = Frequency of earthquake at a given ground peak acceleration

P_r = Recovery failure by not isolating piping rupture

P_f = Pipe rupture probability at a given peak ground acceleration earthquake

P1 = Conditional core damage probability due to SSF failure not providing RCP seal cooling

Seismic Event Frequency -Based on review of the Oconee seismic hazard curves for peak ground acceleration (Figure 3-1 on page 3-68, Oconee IPEEE study), the mean annual exceedance probability of a seismic event with a peak ground acceleration of 0.35g is about 3E-5.

The seismic-induced CDF estimate for HPSW pipe rupture leading to flooding in the auxiliary building is calculated as shown below:

F_{CDF} = (3E-5) Earthquake Initiating Frequency x (0.1) Probability of HPSW Piping Failure x (0.3) CCDP x (0.2) % of HPSW Piping in Aux Bldg x (1) P_r = 1.8E-7/yr

Licensee calculations using the SEISM (Seismic Event Impact Sequence Model) computer code showed that the seismic-induced CDF was estimated to be 4.2E-7/yr based on combining the earthquake frequency curve with the fragility curve for the HPSW piping supports. Also, in this case, no credit for isolating the rupture is considered.

Given that the non-conforming CDF is so low, the delta CDF would be even lower. Therefore, the lack of seismic qualification of the HPSW piping is of very low risk significance. The seismic contribution can be excluded from further consideration.

B. Non-conforming Flooding-induced CDF

The core damage frequency (CDF) equation for the internal flood scenario can be defined as follows:

$F_{CDF} = E_i \; P_r * P1$

where E_i = Frequency of piping rupture

P_r = Recovery failure by not isolating piping rupture

P1 = Conditional core damage probability due to SSF failure to provide RCP seal cooling capability

HPSW pipe rupture due to service experience is calculated by considering the pipe rupture frequencies for failure mechanisms such as corrosion attack and design/construction defects. Although thermal fatigue is another failure mechanism that occurs in the heat affected zone near a weld, this failure mechanism was not considered in this risk analysis because the HPSW piping in the auxiliary building does not experience extreme changes in temperature. Assuming that the rupture is a leak with a flow rate greater than 50 gpm, the mean pipe rupture frequencies for corrosion attack and design defect respectively, are assumed to be 1.33E-7/pipe foot year and 3.47E-7/weld year, based on the reported pipe failure rates for Babcock and Wilcox Service Water Systems (see Table A-40, Piping System Failure Rates and Rupture Frequencies for Use in Risk-Informed Inservice Inspection Applications, EPRI TR-11180, September, 1999).

E_i = Frequency of piping rupture = {1.33E-7/pipe ft * 173 ft of 16" HPSW pipe in aux bldg} + {3.47E-7/welds * 50 welds on 16" HPSW aux bldg pipe} = 2.3E-5 + 1.74E-5 = 4E-5

P_r = Failure to isolate piping rupture before HPI & CC is lost to RCPs. The dominate failure probability is assumed to be from the operator action portion as opposed to equipment failure. The Human Error Probability (HEP) is derived using the Accident Sequence Precursor HEP sheet. Since there is an inadequate procedure, substantial diagnostic activities would be needed to determine the appropriate response. Specifically:

Diagnostic Failure Probability = 1E-2 * Peformance Shaping Factors (PSFs)

PSFs to be considered beyond nominal value of 1:

<u>Complex, stress & workload</u> - this would be high threat & stress with expansive time - 2. Given a rupture of the 16" piping, the two HPSW pumps would go to runout of approximately 19,000 gpm total. 498,000 gallons are necessary to cause loss of HPI & CC or, 26 minutes would be available if the pumps continually ran at runout and operators failed to secure the pumps. If operators secured the pumps, an estimated 5,000 gpm would gravity feed into the auxiliary building without isolation. Assuming that operators secure the HPSW pumps fairly early in the event or the pumps catastrophically fail (for example, after 5 minutes), the time for operators to isolate the rupture would be:

19,000 gpm x 5 minutes = 95,000 gallons

498,000 - 95,000 = 403,000 gallons

403,000 gallons / 5000 gpm = 81 minutes

Based on the assumption that the HPSW pumps would be secured early in the event, it is reasonable to assign an expansive period of time (86 minutes) rather than an adequate period of time (26 minutes) to perform the isolation.

Procedures - there would be drawings available to determine where to isolate the leak and there would be indications that the leak was from HPSW - poor procedure present - 5.

Solving: HEP = 1E-2 * 2 * 5 = 1E-1

F_{CDF} = (4E-5) x (1E-1) x (0.3) = 1.2E-6/yr for Unit 1 (prior to RCP upgrade)

BASE CASE

A. Seismic Portion - As previously stated, the base case CDF would be even lower than the non-conforming condition. Therefore, the lack of seismic qualification of the HPSW piping is of very low risk significance. The seismic contribution can be excluded from further consideration.

B. In the basline CDF, operators would have the proper procedural direction to isolate the rupture; therefore, the only modification from the non-conforming CDF would be the HEP of isolating the rupture. This new base case HEP would be a Response Task instead of a Diagnostic Task. The specific HEP derivation would be:

Response Failure Probability = 1E-3 * Peformance Shaping Factors (PSFs)

The PSFs considered beyond a nominal value of 1 or different from the non-conforming case are:

Complex, stress & workload - this would be high threat & stress with expansive time - 2.

Procedures - there would be an adequate procedure directing the valve to be closed that would isolate the rupture - 1

Solving: HEP = 1E-3 * 2 = 2E-3

Substituting: BASE F_{CDF} = (4E-5) x (2E-3) x (.3) = 2.4E-8/yr

DELTA CDF - CDF_{DELTA} = F_{CDF} - BASE F_{CDF} = 1.2E-6/yr - 2.4E-8/yr = 1.18E-6/yr [the seismic portion of the delta CDF has been excluded due to its small contribution]

2. Units 2 & 3

The only difference between the CDFs, base case and non-conforming, is the inclusion of a 0.22 failure probability of RCP seal LOCA vs. a failure probability of 1. Therefore:

F_{CDF} = (4E-5) x (1E-1) x (0.3) x (.22) = 2.64E-7/yr for Unit 2 or 3

BASE F_{CDF} = (4E-5) x (2E-3) x (.3) x (.22) = 5.3E-9/yr for Unit 2 or 3

CDF_{DELTA} = F_{CDF} - BASE F_{CDF} = 2.64E-7 - 5.3E-9 = 2.59E-7/yr for Unit 2 or 3

V. Conclusions

Risk increase over the base case was > 1E-6 for Unit 1 only. Therefore, the issue is White for Unit 1. As for Units 2 & 3, the issue is Green. The ample (expansive) time designation to isolate the leak appears more appropriate than the adequate time designation. Whether the high temperature RCP seals are installed on the units is the most significant influence factor on the color.