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RA-20-0267 10 CFR 50.90

September 17, 2020

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U. S. Nuclear Regulatory Commission
11555 Rockville Pike
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Subject: Duke Energy Carolinas, LLC
Oconee Nuclear Station (ONS), Units 1, 2, and 3
Docket Numbers 50-269, 50-270, and 50-287
Renewed Facility Operating License Nos. DPR-38, DPR-47, and DPR-55

Proposed License Amendment Request to Revise the Oconee Nuclear Station Current Licensing Basis for High Energy Line Breaks Outside of the Containment Building - Responses to Request for Additional Information

References:

1. Letter to the U. S. Nuclear Regulatory Commission from J. Ed Burchfield, Jr., Vice President, Oconee Nuclear Station, Duke Energy Carolinas, LLC, "Proposed License Amendment Request to Revise the Oconee Nuclear Station Current Licensing Basis for High Energy Line Breaks Outside of the Containment Building," dated August 28, 2019 (ADAMS Accession No. ML19240A925).
2. Letter from the U. S. Nuclear Regulatory Commission to J. Ed Burchfield, Jr., Vice President, Oconee Nuclear Station, Duke Energy Carolinas, LLC, "Oconee Nuclear Station, Units 1, 2, and 3 – Request for Additional Information Re: Revision of Licensing Basis for High Energy Line Breaks Outside of the Containment Building," dated May 6, 2020 (ADAMS Accession No. ML20125A361).
3. Letter to the U. S. Nuclear Regulatory Commission from J. Ed Burchfield, Jr., Vice President, Oconee Nuclear Station, Duke Energy Carolinas, LLC, "Proposed License Amendment Request to Revise the Oconee Nuclear Station Current Licensing Basis for High Energy Line Breaks Outside of the Containment Building – Responses to Request for Additional Information," dated June 15, 2020 (ADAMS Accession No. ML20168A980).
4. Email from the U. S. Nuclear Regulatory Commission to Timothy D. Brown, Oconee Nuclear Station, Duke Energy Carolinas, LLC, "Request for Additional Information (14 through 16) – Oconee Nuclear Station, Units 1, 2, and 3 – HELB LAR," dated August 14, 2020 (ADAMS Accession No. ML20227A372).

Pursuant to 10 CFR 50.90, Duke Energy Carolinas, LLC (Duke Energy) submitted a License Amendment Request (LAR) which proposes to revise the ONS current licensing basis regarding the high energy line breaks (HELBs) outside of the containment building on August 28, 2019 (Reference 1).

The Nuclear Regulatory Commission (NRC) began an audit of various HELB documentation in February 2020. As a result of the audit, the NRC determined that additional information was needed to support its review of the HELB LAR (Reference 1). Draft requests for additional information (RAIs) were discussed with the NRC on May 1, 2020, to support understanding of the questions and information needed. The NRC issued the initial set of RAIs on May 6, 2020 (Reference 2) and the responses to the RAIs were submitted on June 15, 2020 (Reference 3).

A second set of draft RAIs were discussed with the NRC on August 11, 2020, to ensure mutual understanding. The NRC issued the additional RAIs on August 14, 2020 (Reference 4). Enclosure 1 provides the responses to the RAIs.

No changes to Technical Specifications are proposed. There are no additional changes to the Updated Final Safety Analysis Report. The responses to the RAIs specifically have been reviewed and determined to not affect the conclusions of the Significant Hazards Consideration provided in the LAR dated August 28, 2019 (Reference 1) or the revisions in the June 15, 2020 response to RAIs (Reference 3).

Inquiries on this proposed amendment request should be directed to Timothy D. Brown, ONS Regulatory Projects Group, at (864) 873-3952.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 17, 2020.

Sincerely,

J. Ed Burchfield, Jr.
Vice President
Oconee Nuclear Station

Enclosure 1: Responses to Requests for Additional Information cc w/enclosure and attachments:

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ENCLOSURE 1

RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION

Enclosure 1
Responses to Requests for Additional Information

Pursuant to 10 CFR 50.90, Duke Energy Carolinas, LLC (Duke Energy) submitted a License Amendment Request (LAR) which proposes to revise the Oconee Nuclear Station (ONS) current licensing basis (CLB) regarding the high energy line breaks (HELBs) outside of the containment building on August 28, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession Number (No.) ML19240A925). The LAR includes revisions to the Updated Final Safety Analyses Report (UFSAR) in support of the revised HELB licensing basis.

The purpose of this enclosure is to provide responses to the Nuclear Regulatory Commission's (NRC) requests for additional information (RAIs) concerning HELBs outside of the containment building that were issued August 14, 2020 (ADAMS Accession No. ML20227A372). Prior to issuance, a clarification call with the NRC was held on August 11, 2020 to ensure understanding and the information needed. The following information are the responses to the RAIs. References cited within the responses are listed following the response to RAI 16.

RAI 14: East Penetration Room Response to HELB

Regulatory Basis:

- UFSAR, Section 3.1.40, "Criterion 40 – Missile Protection (Category A)," states:
    - Protection for engineered safety features shall be provided against dynamic effects and missiles that might result from plant equipment failures.
- Item 20 in the Giambusso Letter requested a description be provided of the assumptions, methods, and results of analyses, including steam generator blowdown, used to calculate the pressure and temperature transients in compartments, pipe tunnels, intermediate buildings, and the Turbine Building following a pipe rupture in those areas.

Discussion

The discussion in Attachment 9 to the license amendment request addressing Item 20 of the Giambusso Letter is not adequate to define the analysis of the pressure and temperature response to a postulated break in the main steam or main feedwater headers in the East Penetration Room. The staff considered the results of this evaluation particularly safety significant because the results are inputs to structural and control room integrity evaluations necessary to provide assurance that key safety functions would be accomplished following such breaks.

Request

The staff requests that the licensee provide the following information related to the East Penetration Room pressure and temperature response to postulated main steam and main feedwater HELBs:

- Please describe the assumed orientation of the HELB discharges and the basis for the assumed orientation; for circumferential terminal end breaks, explain how the pressure and temperature results would bound circumferential cracks with less favorable orientations (i.e., discharge is away from blow-out panels).
- Please describe the GOTHIC model and assumptions related to the configuration of volumes and junctions between volumes; provide the basis for loss coefficients at junctions and boundary conditions for volumes.
- Please describe how blow-out panels were modeled to reflect opening pressure and inertia of the panels.
- Please describe other assumptions and initial conditions necessary to understand the model.
- Please provide the peak pressure and temperature results.

RAI 14 Response:

- Please describe the assumed orientation of the HELB discharges and the basis for the assumed orientation; for circumferential terminal end breaks, explain how the pressure and temperature results would bound circumferential cracks with less favorable orientations (i.e., discharge is away from blow-out panels).

Walkdowns were performed for the postulated Main Steam (MS) and Main Feedwater (MFW) HELBs in the East Penetration Room (EPR), including the effects of pipe movement and jet formation. The guidance for determining the pipe movement and jet directions/lengths is given in the HELB walkdown procedure and included in calculation OSC-11769 (Reference 4). Only one MS line is located in the EPR. The MS line enters the EPR at an angle of 56^{o} relative to the North-South axis in the room. The break is postulated to occur at a 90^{o} bend in the MS line, which is a short distance from the Reactor Building (RB) wall. The break is assumed to occur at the weld just outside of containment before the first elbow, as the weld is the portion of the pipe most likely to fail. From the break, the turbine side whips with a hinge at the 2nd elbow from the break. This elbow is located 7.5 feet below the first elbow outside of containment and is spring supported. The whip ends with the turbine side of the pipe opening, pointing vertically upward. The steam generator side jet forms perpendicular to the RB wall directed away from the RB, towards an empty area of the EPR.

A secondary flow path is used to model the flow in the vertical direction from the turbine side of the break. This flow is not nearly as large in magnitude as the flow from the steam generator side. The flow from the turbine side of the break has lower steam flow and blow down from the turbine side ceases quickly.

There are no other postulated MS breaks in the EPR for the modeled MS break to bound. The MS lines are seismically analyzed, and a stress criterion was used to determine if any arbitrary circumferential breaks or cracks would be postulated per Generic Letter (GL) 87-11. The stresses in the portion of the MS line inside the EPR did not meet the criteria to postulate any additional HELBs.

There are two MFW lines in the EPR, with breaks postulated at the penetrations and critical cracks at various locations along the MFW lines in the EPR. A rupture restraint and guard pipe are provided for both MFW penetrations. The guard pipe limits jet impingement resulting from the postulated terminal end break. The guard pipe also directs flow of the leakage away from vulnerable mechanical and electrical equipment and the penetrations located in the EPR. The jets for the MFW line terminal end breaks are also directed away from the blowout panels. The whip restraints and guard pipes are described in the LAR. Cracks produce shorter jets that are postulated in all radial directions. Pressurization and temperature rise are modeled for MFW cracks and the blowout panel function in the model is to prevent over pressurization of the EPR.

- Please describe the GOTHIC model and assumptions related to the configuration of volumes and junctions between volumes; provide the basis for loss coefficients at junctions and boundary conditions for volumes.

In the development of the GOTHIC models used to simulate the response in the Oconee EPR, the guidelines issued by Zachry Nuclear Engineering (the GOTHIC code vendor) have been adhered to regarding the use of lumped parameter versus subdivided volumes, junction orientations, adequate numbers of flow paths to model recirculation patterns, etc. These guidelines are included with the GOTHIC Version 8.2 documentation.

There are four volumes used in the GOTHIC simulations, with three of these volumes used to model the EPR. The column designations described below are taken from the Unit 3 EPR, which is representative of all three ONS Units.

Volume 1 represents a narrow section between columns 90-91/P-T which borders the West Penetration Room (WPR). The volume is modeled as a lumped parameter volume, as the distance between this area and the MS HELB piping within the EPR is substantial. Volume 1 is connected to Volume 2 with Junctions 3 and 4.

Volume 2 represents the main section of the EPR, bounded by columns 91 and 97 in the North-South direction and by columns P-Ra in the East-West direction.

In the most recently developed GOTHIC model, Volume 2 is subdivided into a fine calculational mesh to provide greater detail. This allows for more accurate modeling of the flow patterns in the room and the orientation of the pipe break, which provides greater detail of the temperature results for evaluation of the containment penetrations along the boundary of the RB. Because the MS and MFW lines are within Volume 2 for the entirety of their runs within the EPR, all postulated MS and MFW HELBs are within Volume 2. Although recirculation patterns are evident, the predominant flow pattern following the postulated break is out the break into Volume 2 and then through the blowout panels into the atmosphere.

Volume 3 represents a small section of the EPR between columns 96-97/N-P. It is connected to the remainder of the EPR with a set of junctions. This volume is not subdivided and is modeled with a lumped parameter volume. The pressurization of Volume 3 following the postulated MS HELB led to the opening of the blowout panels between Volume 3 and the atmosphere. Therefore, there is also flow leaving the EPR through the Volume 3 blowout panels.

Volume 4 represents the atmosphere, with a large free volume of 1e+10 ft^3. All junctions representing the blowout panels are connected to this volume.

Since the boundaries between Volumes 1, 2, and 3 are largely defined by column lines in open space rather than physical flow paths (i.e. ducts or pipes), the losses for the junctions between these volumes are not large. Nominal loss coefficients of 0.01 are used for junctions connecting Volumes 1 and 2 (conservatively increased from 0.0), and 0.028 for junctions connecting Volumes 2 and 3. These loss coefficients are calculated using Reference 9 formulas for sudden contractions and enlargements. The more refined GOTHIC models use conservatively higher loss coefficients for these junctions.

Junctions 3 and 4, which connect Volumes 1 and 2, are connected to the lowest and highest levels within Volume 2 to allow for recirculation between these volumes. Due to the distance between these connections and the MS HELB location, this modeling of the flow paths is not expected to have a large impact on the analysis results.

The connections between Volumes 2 and 3 require more than 2 junctions to adequately model the flow behaviors following the postulated MS HELB. The flow from the affected steam generator is partially oriented in the direction of these flow paths, and there are multiple blowout panels connecting Volume 3 with the atmosphere. Therefore, more than 2 flow paths are required to simulate the circulation patterns in this region of the EPR. The connections between Volumes 2 and 3 represent open space between the 822' and 837' elevations of the EPR (since the floor of Volume 3 is higher than the rest of the room).

Since there are a number of nodes along Column P at the southernmost end of the EPR at which this connection would be present (depending on the nodalization scheme), there are a corresponding number of junctions used to connect these volumes. Half of these connections are from the "middle" vertical node along the five southernmost columns into Volume 3, with the other half from the "upper" vertical node into Volume 3. The total flow area of (16.5' x 16'), or 264 ft^2, is divided equally between these ten flow paths.

- Please describe how blow-out panels were modeled to reflect opening pressure and inertia of the panels.

From calculation, OSC-8104 (Reference 5), the blowout panels are modeled as "quick open" valves. These valves are placed on individual junctions to represent the blowout panels. The opening pressure of the blowout panels was determined via structural failure analysis calculation, OSC-2034 (Reference 6). Each panel has a distinct opening pressure. When the determined differential pressure is reached for a panel, the entire panel is taken as opened.

There are numerous blowout panels on each unit. They are all simulated as "quick open" valves, with the actuating signal being the differential pressure between the junction end in the penetration room and the atmosphere. These differential pressure setpoints vary from 0.4 to 6.8 psid.

Due to the subdivisions with Volume 2, some of the panels are re-distributed (split among different flow paths) among appropriate sub-volumes of the EPR. The impact of the redistribution is negligible on the analysis results.

The majority of the blowout panels are between the South and West walls of Volume 2 and the atmosphere. The lone blowout panel along the South wall of Volume 3 is also re-distributed to allow for the possibility of recirculation of flow between Volume 3 and the atmosphere. This use of dual flow paths aligns with GOTHIC modeling recommendations between lumped parameter volumes.

Following the MS HELB, there was no recirculation between Volume 3 and the atmosphere due to the ongoing flow of steam into Volume 3 from the break. The pressurization of Volume 3 following the MS HELB led to the immediate opening of the blowout panels between Volume 3 and the atmosphere, with significant margin. Therefore, the lumped parameter modeling for Volume 3 had no impact on the behavior of the blowout panels in this area.

- Please describe other assumptions and initial conditions necessary to understand the model.

With the exception of a slightly higher assumption for the atmosphere temperature (105°F) in the Appendix C model, there are no differences in initial conditions between the analyses conducted with either model. These initial conditions are given below:

EPR:
Initial temperature = 120°F
Initial pressure = 14.7 psia
Initial humidity = 10%

Atmosphere:
Initial temperature = 90°F / 105°F
Initial pressure = 14.7 psia
Initial humidity = 10%

The more detailed GOTHIC model allowed for a more exact representation of the break orientation, so this assumption is different than those made in the original analysis regarding the break. This more detailed model also required slightly different modeling of the blowout panels (greater redistribution of large panels across smaller sub-volumes within the EPR model), but as discussed above these differences would have no substantial impact on the analysis results.

Since the more detailed model allowed for more accurate modeling of jetting around and behind the postulated MS HELB, flow would be entering the EPR in the region behind the break (West side of blowout panels). Therefore, the more conservative assumption for the atmosphere temperature was implemented for GOTHIC analyses using the more detailed model (105°F versus 90°F).

Initial MS HELB and MFW HELB pressures and enthalpies are given below:

Steam line pressure: 944.1 psia
Steam line enthalpy: 1261.5 BTU/lbm

Feedwater line pressure: 941.87 psia
Feedwater line enthalpy: 433.89 BTU/lbm

- Please provide the peak pressure and temperature results.

The following peak pressures and temperatures were calculated for the EPR:

Case #	Break Description	Unit	Peak Press (psig)	Peak Temp (°F)
1	Feedwater Line Crack	1	0.60	213.2
2	Feedwater Line Crack	2	0.46	212.2
3	Feedwater Line Crack	3	0.68	212.3
4	Feedwater Terminal Break	1	2.01	216.2
5	Feedwater Terminal Break	2	2.03	216.2
6	Feedwater Terminal Break	3	2.14	215.2
7	Steam Line Terminal Break	1	4.12	482.0*
8	Steam Line Terminal Break	2	3.61	482.0*
9	Steam Line Terminal Break	3	3.70	482.0*

*Peak Temperatures for MS line breaks were taken from the detailed GOTHIC model.

The peak pressures and temperatures following the MS HELB using the more detailed GOTHIC model are different. The focus of the analyses conducted with the more detailed GOTHIC model was on temperatures in the vicinity of the containment penetration assemblies, rather than on larger regions of the room. Peak pressures for larger regions of the room were not presented for direct comparison with the results from the original model.

The peak pressures reached in the EPR following the double-ended MS HELB for the small sub-volumes immediately downstream of the break location were about 10 psig within the first 0.1 seconds. These pressures subside rapidly, with negative pressures induced due to the jetting effect around the break location for some of these regions. These pressures were for small regions within the EPR and would not be representative of the pressure response in the EPR as a whole. The pressure responses given in the table above from the original GOTHIC model are more representative of the peak pressures reached within the majority of the EPR.

The more detailed model also resulted in a more accurate simulation of the flow patterns in the room, with cooler air from the atmosphere coming into the EPR in some places due to the jetting effect induced by the break. This results in cooler temperatures within the room, with reduced superheat leading to lower peak temperatures. Temperatures calculated in other regions of the room (including the regions around the containment penetration locations) reach lower maximum values. The temperature response in the containment penetration locations reaches a peak value of 425°F.

An analysis of the EPR structure was performed with pressure responses that bound those developed for the MS HELB pressures listed above. This analysis is contained in calculation OSC-8602 (Reference 7). All analyzed reinforced concrete and steel structural components for each of the penetration rooms met either the elastic or plastic acceptance criteria. In all cases, the ceiling structure meets either elastic or plastic criteria and demonstrates that gross failure of the ceiling structure will not occur following the postulated MS HELB.

RAI 15: Turbine Building Main Steam HELB Effects

Regulatory Basis:

- Item 12 in the Giambusso Letter requested 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.
- Item 18 in the Giambusso Letter requested a summary be provided of the emergency procedures that would be followed after a pipe break accident, including the automatic and manual operations required to place the reactor unit(s) in a Cold Shutdown Condition. The estimated time following the accident for all equipment and personnel operational actions should be included in the procedure summary.

Discussion

The discussion in Attachment 9 to the license amendment request addressing Items 12 and 18 of the Giambusso Letter is not adequate to define the impact of a postulated break in the main steam headers in the Turbine Building on actions to achieve cold shutdown. As described in Section 3.6.1 and 3.6.2 of the Enclosure to the license amendment request, the measures to achieve cold shutdown include manual actions in the turbine building during Operational Mode 4 (RCS temperature <250°F). Low pressure steam may still be issuing from the postulated break because the main steam lines lack isolation valves.

Request

The staff requests that the licensee please address the effect of continued steam release on habitability related to operator actions necessary to place the plant in cold shutdown and the basis for the determination.

RAI 15 Response:

Following a MS HELB in the Turbine Building (TB), recovery actions may eventually be required within the TB to place the plant in cold shutdown. The habitability and capability to perform these actions is acceptable based on the following:

- the long-term nature of the required actions;
- the significant reduction in steam flow over time following the HELB;
- the physical size of the TB structure; and

- the options, if necessary, to perform isolation of the break, install barriers, redirect steam release points, or provide ventilation to improve TB access.

MS HELBs resulting in the loss of plant systems inside the TB are mitigated by the Protected Service Water (PSW) system. Should the PSW system experience a single failure, the Standby Shutdown Facility (SSF) is credited as an alternate means of achieving and maintaining Safe Shutdown (SSD). Both the PSW and SSF systems are located outside of the TB and SSD would not be impacted by a steam release within the TB. Habitability for operation of the PSW system from the Main Control Room and the SSF system from the SSF Control Room is maintained as required to support their SSD capability. Following stabilization, if the unit is being maintained from the SSF, recovery and transfer to the PSW system for extended SSD would be performed. Actions necessary to recover the PSW system are performed outside of the TB.

The PSW pump initially draws water from the Unit 2 condenser circulating water (CCW) embedded piping which is unaffected by a MS HELB within the TB. As described in the PSW safety evaluation (Reference 2), for a loss of ultimate heat sink, the PSW system has been designed to provide secondary side decay heat removal for a period of at least 30 days by cross connecting all three units CCW supply inventory. During a MS HELB, the CCW supply inventory from all three units would not be cross connected but rather the submersible pump would be installed to replenish the water inventory in the Unit 2 CCW embedded piping. The submersible pump is installed in the intake canal following a MS HELB and discharges into the Unit 2 CCW piping for extended PSW operation. The actions associated with installation of the submersible pump are performed outside of the TB. Operation for a significant time frame, similar to that evaluated for a loss of ultimate heat sink (i.e. 30 days), would be available for the PSW system by deployment of the submersible pump. Therefore, an extended time period would be available for damage assessment and recovery of the components necessary to achieve cold shutdown (<200^{o}F).

Following a MS HELB in the TB, an initial blow down of the steam generators and secondary piping inventory will occur. This initial blow down is expected to provide the greatest mass and energy release rate within the TB structure and occurs over the first several hours following the MS HELB. This initial release would dissipate as the steaming rate greatly reduces to an equilibrium associated with core decay heat. As described in calculation OSC-7818 (Reference 8), decay heat for an end of cycle core after 15 minutes following reactor trip begins at approximately 2% Core Thermal Power (CTP) and quickly diminishes over time. Decay heat is approximately 0.4% CTP at 3 days and is continuing to decrease. As decay heat decreases, the steam release to the TB would likewise decrease.

The TB is an open, vented structure whose footprint is approximately 200 ft wide by 800 feet long. The TB rises from a basement elevation of 775 feet to a roof that varies in elevation from approximately 840 feet to 879 feet. The TB structure has a volume of over 10 million cubic feet. Furthermore, above grade, the TB consists of structural steel with metal siding which would readily allow for heat transfer to the outside environment. With the reduction in steam release over time, the TB environment becomes manageable as elevated temperatures and steaming becomes localized.

Typically, only one MS line is affected by a single postulated break in the MS System. Once the reactor and main turbine are tripped, the MS lines are separated by the main turbine stop valves. There are a few locations across all three units in which a single postulated break in the MS system affects both MS headers even with the closure of the main turbine stop valves. Normally, both the A and B MS lines are cross connected through the steam supply to each unit's Turbine Driven Emergency Feedwater (TDEFW) pump. Breaks in the TDEFW pump supply lines or postulated breaks that affect the supply lines can result in a blowdown of both MS lines. However, branch line isolation valves are provided on the MS supply lines to the TDEFW pump to optionally isolate ruptures in this piping once steam releases become localized and access becomes available.

A small number of HELBs may lead to secondary collateral damage that could result in failure of both MS headers. Although steam flow would initially result through both headers, long term actions could be performed following plant cooldown and stabilization to feed only a single steam generator. Feeding of a single steam generator may be preferable in providing access for recovery actions in the TB.

The MS piping inside the TB consists of both safety related and non-safety related piping. Isolation valves exist between the safety and non-safety related piping and may be used as an option to stop steam flow through breaks in the non-safety related piping once steam releases become localized and access becomes available.

For break locations that do not have isolation capabilities, other recovery actions may be utilized to control or manage localized steam releases. Such activities may include placement of temporary barriers, installation of portable fans, removal of TB siding, restoration of TB ventilation fans, and/or manually opening the atmospheric dump valves or other system vent valves to redirect steam flow.

Therefore, the long-term capability of PSW is more than adequate to provide ample time for dissipation of the initial steam release as well as time for decay heat to decrease such that any continued steam release in the large open TB structure is localized. These local steam releases may be managed using any of the previously described methods to improve TB access. Therefore, habitability conditions due to steam releases will not prevent access to the TB to recover systems needed to achieve cold shutdown.

RAI 16: Turbine Building Main Feedwater HELB Effects

Regulatory Basis:

- Item 15 in the Giambusso Letter requested a discussion be provided 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.

Discussion

The discussion in Attachment 9 to the license amendment request addressing Item 15 of the Giambusso Letter is not adequate to define the potential for flooding of the turbine and auxiliary buildings as a result of a Main Feedwater (MFDW) HELB. The discussion describes that some main feedwater HELBs could cause rupture of the condenser circulating water (CCW) piping. The rupture of the CCW piping would require implementation of an existing time critical operator action to trip the circulating water pumps to ensure the flood waters would not over-top the 20-foot-high flood protection barrier between the turbine and auxiliary buildings. Flooding of the turbine building basement would flood the low pressure service water (LPSW) pumps and the emergency feedwater pumps.

Request

The staff requests that the licensee more fully address the potential for flooding of the turbine building and the auxiliary building as a result of a HELB.

- Please address the potential for CCW piping damage from a MFDW HELB in a qualitative sense based on the number of locations where interaction could occur, the postulated break type, the potential type(s) of interaction (e.g., jet impingement or pipe whip), and the separation distance.
- Considering the damage potential, please provide justification for the reliance on repair of the LPSW pumps and associated electrical distribution to achieve cold shutdown on a risk informed basis.

RAI 16 Response:

There are no flooding concerns due to HELB impacts to CCW piping located in the Auxiliary Building (AB). As described within Attachment 9 of the LAR (Reference 1), certain postulated HELBs may lead to failures of service water piping which could result in flooding of the TB. Specific to MFDW HELB interactions with CCW piping, certain postulated HELBs may lead to pressure boundary breaches of the system piping through either direct impact from pipe whip or indirect impact from localized structural damage in the turbine building. No generic separation distance was assumed relative to identifying impacted service water piping. Rather, each specific postulated HELB was evaluated relative to its potential interaction with surrounding components.

Direct HELB interactions from pipe whip considered both circumferential and longitudinal breaks. With respect to direct MFDW HELB impacts with service water piping, there were only three significant high energy break locations on Unit 1, one on Unit 2, and three on Unit 3. The largest equivalent service water break area identified from direct MFDW HELB impacts was 6.39 ft^2. It is noted that this equivalent break size is based on an assumed simultaneous failure of four LPSW lines (24”, 18”, 16” and 10” pipe failures combined) that were in the zone of impact from the postulated MFDW pipe break location. The TB flood scenario from UFSAR Section 3.4 is an assumed failure of a CCW expansion joint which is unrelated to a HELB scenario. The equivalent break size of 6.39 ft^2 is less than the assumed design basis TB flood break size from UFSAR

Section 3.4 which is approximately 7.23 ft^2. It is noted that the largest individual service water pipe affected from direct MFDW HELB impacts is a 24-inch pipe. This is discussed in calculation OSC-9204 (Reference 3).

MFDW HELB interactions with service water piping due to secondary effects from localized TB structural damage were also considered. With respect to secondary MFDW HELB impacts with service water piping, there were only two high energy break locations on Unit 1, three on Unit 2, and one on Unit 3. The indirect effects from potential collateral interaction with localized TB structure failures included impacts to CCW piping up to 78 inches nominal diameter (77.25 inch inside diameter). The localized TB structural damage was postulated to potentially impale or crush portions of the service water piping resulting in TB flooding. The breach in the service water piping was conservatively assumed similar to a postulated longitudinal HELB. Thus, the breach in the 78-inch nominal diameter pipe impacted by secondary effects was assumed to have a flow area of approximately 32.6 ft^2. The service water breaks associated with the indirect MFDW HELBs are discussed in calculation OSC-9204 (Reference 3). While this break size is larger than the one assumed for the UFSAR Section 3.4 TB flood, there is more time available for operator actions associated with stopping the CCW pumps. As described within Attachment 12 of the LAR (Reference 1), there is an existing time critical action (TCA) to control a design basis TB flood within 20 minutes by tripping the CCW pumps. For the HELB TB flood, the TCA for tripping the CCW pumps is 45 minutes. Although the break size is larger for the HELB TB flood, the original UFSAR Section 3.4 TB flood TCAs were established prior to plant modifications to install the six-foot turbine building drain and to provide flood protection along the TB to AB wall.

Beyond tripping the CCW pumps, stopping the flood source into the TB could require activities to lower the Keowee lake level to assess, repair, and/or isolate the damaged service water piping depending on the extent of flooding. With the flood source isolated, the TB flooding would recede through the TB drain to the Keowee tailrace. TB access would be recovered from flooding effects over the first several days following the HELB.

As described within Response to RAI 15, the long-term capability of the PSW system which is located outside of the TB would provide an extended time period for damage assessment and recovery of the components necessary to achieve cold shutdown (<200°F). Damage to the service water piping in the TB would not affect the long-term capability of the PSW pump which takes suction from the Unit 2 embedded CCW piping. Furthermore, the submersible pump is installed in the intake canal and discharges into the Unit 2 CCW piping outside of the TB.

Therefore, the long-term capability of PSW provides ample time to stop any potential flooding and to drain any resultant flooding in the TB in order to allow for recovery of systems needed to achieve cold shutdown. Based on this acceptability, modifications to protect the described service water piping failures are not required.

References:

1. Letter to the U. S. Nuclear Regulatory Commission from J. Ed Burchfield, Jr., Vice President, Oconee Nuclear Station, Duke Energy Carolinas, LLC, "Proposed License Amendment Request to Revise the Oconee Nuclear Station Current Licensing Basis for High Energy Line Breaks Outside of the Containment Building," dated August 28, 2019 (ADAMS Accession No. ML19240A925).

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