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Serial: BSEP 14-0076

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-71 and DPR-62
Docket Nos. 50-325 and 50-324
Response to Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805 (NRC TAC Nos. ME9623 and ME9624)

References:

1. Letter from Michael J. Annacone (Carolina Power & Light Company) to U.S. Nuclear Regulatory Commission (Serial: BSEP 12-0106), *License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)*, dated September 25, 2012, ADAMS Accession Number ML12285A428

2. Letter from Michael J. Annacone (Carolina Power & Light Company) to U.S. Nuclear Regulatory Commission (Serial: BSEP 12-0140), *Additional Information Supporting License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)*, dated December 17, 2012, ADAMS Accession Number ML12362A284

3. Letter from Farideh Saba (USNRC) to George T. Hamrick (Duke Energy Progress, Inc.), *Second Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805 (TAC Nos. ME9623 and ME9624)*, dated February 12, 2014, ADAMS Accession Number ML14028A178

4. Letter from George T. Hamrick (Duke Energy Progress, Inc.) to U.S. Nuclear Regulatory Commission (Serial: BSEP 14-0029), *Response to Additional Information Regarding Voluntary Risk Initiative National Fire protection Association Standard 805 (NRC TAC Nos. ME9623 and ME9624)*, dated March 14, 2014, ADAMS Accession Number ML14079A233

5. Letter from George T. Hamrick (Duke Energy Progress, Inc.) to U.S. Nuclear Regulatory Commission (Serial: BSEP 14-0035), *Response to Additional Information Regarding Voluntary Risk Initiative National Fire protection Association Standard 805 (NRC TAC Nos. ME9623 and ME9624)*, dated April 10, 2014, ADAMS Accession Number ML14118A105

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6. Electronic Mail from Andrew Hon (U.S. Nuclear Regulatory Commission) to William R. Murray (Duke Energy Progress, Inc.), *Brunswick Steam Electric Plant, Units 1 and 2 – Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805 (TAC Nos. ME9623 and ME9624)*, dated June4, 2014, ADAMS Accession Number ML14155A209.

Ladies and Gentlemen:

By letter dated September 25, 2012 (i.e., Reference 1), as supplemented by letter dated December 17, 2012 (i.e., Reference 2), Duke Energy Progress, Inc., submitted a license amendment request (LAR) to adopt a new, risk-informed, performance-based (RI-PB) fire protection licensing basis for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. On February 12, 2014 (i.e., Reference 3), the NRC provided a request for additional information (RAI) regarding the fire probabilistic risk assessment. By letters dated March 14, 2014 (i.e., Reference 4); and April 10, 2014 (i.e., Reference 5); Duke Energy responded to the RAI. Subsequently, on June 4, 2014 (i.e., Reference 6), the NRC provided an electronic, follow-up RAI. The response to the follow-up RAI is enclosed.

This document contains no new regulatory commitments.

Please refer any questions regarding this submittal to Mr. Lee Grzeck, Manager – Regulatory Affairs, at (910) 457-2487.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on June 26, 2014.

Sincerely,

George T. Hamrick

George T. Hamrick

Enclosure:

Response to Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805 cc (with enclosure):

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Response to Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805

By letter dated September 25, 2012, as supplemented by letter dated December 17, 2012, Duke Energy Progress, Inc., submitted a license amendment request (LAR) to adopt a new, risk-informed, performance-based (RI-PB) fire protection licensing basis for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. On February 12, 2014, the NRC provided a request for additional information (RAI) regarding the fire probabilistic risk assessment. By letters dated March 14, 2014 and April 10, 2014; Duke Energy responded to the request for additional information (RAI). Subsequently, on June 4, 2014, the NRC provided an electronic, follow-up RAI. The response to the follow-up RAI is provided below.

Probabilistic Risk Assessment (PRA) Request for Additional Information (RAI) 1.d.02

In a letter dated March 14, 2014, ADAMS Accession No. ML14079A233, the licensee responded to PRA RAI 1.d.01. The response to this RAI explains that, in addition to an in-depth review of a sampling of plant records for performance of the "Transient Fire Load Evaluation" procedure, the licensee assessed the last three years of transient combustible violations provided in the Fire Protection Program System Health Reports. A number of violations appear to be dismissed based on the following rationale: "Based on their fire procedure, this would likely not be a violation because Attachment 3 exempts this type of material from transient combustible controls for both 'No Storage' locations and 'Non-Intervening Combustible Zones'." These violations appear to represent circumstances in which quantities of combustible sources existed in the plant that could have contributed to a fire.

a. Explain and justify how these violations were considered in the determination of reduced Heat Release Rates (HRRs) for transient fires. Include in this discussion explanation of whether these violations could have resulted in a transient fire exceeding the reduced HRR rates credited in the Fire PRA.

Response

In evaluating the relevance of historical violations of the superseded administrative control program, 0FPP-013, *Transient Fire Load Evaluation*, with respect to the Fire PRA, the previous response discussed the hypothetical treatment under the current administrative control program, FIR-NGGC-0009, *NFPA 805 Transient Combustibles and Ignition Source Controls Program*. This was done to illustrate the difference between the reactive approach of the superseded procedure and the pro-active approach in the current procedure. Because FIR-NGGC-0009 includes both provisions for supporting the reduced HRRs credited in the Fire PRA and a list of specific combustible materials that have been pre-evaluated to be acceptable within those constraints, none of the violations so identified could have resulted in a transient fire exceeding the reduced HRRs credited in the Fire PRA.

PRA RAI 01.f.ii.02

In the same letter, the licensee responded to PRA RAI 1.f.ii.01. The response to this RAI explains that main control room (MCR) abandonment is only credited for loss of habitability (i.e., not loss of control/function), and that MCR fire scenarios were separately evaluated for loss of control/function that leads to core damage without crediting alternate shutdown. This approach is asserted to be conservative. Given that MCR abandonment appears to be evaluated as a single scenario using a single conditional core damage probability/conditional large early release probability (CCDP/CLERP) (though an event tree was used to calculate the single CCDP/CLERP values), it is still not clear how the abandonment scenario addresses the possibility of different fire induced impacts like spurious failures that can accompany a fire that leads to abandonment.

a. Explain how the single abandonment scenario addresses the various possible fire-induced failures. Specifically include discussion of how the following scenarios are addressed:

    i. Scenarios where fire fails only a few functions aside from forcing MCR abandonment and successful alternate shutdown is straightforward.
    ii. Scenarios where fire could cause some recoverable functional failures or spurious operations that complicate the shutdown but successful alternate shutdown is likely.
    iii. Scenarios where the fire-induced failures cause great difficulty for shutdown by failing multiple functions and/or complex spurious operations that make successful shutdown unlikely.

b. If fire-induced failures of MCR functions are not considered in abandonment scenarios, provide justification for their exclusion.

    i. Describe whether credited abandonment actions from the abandonment procedure is correct for loss of function or spurious actions that may occur as a result of a fire leading to abandonment.
    ii. If abandonment actions do not account for these effects then describe how fire-induced failures are considered in modeling of abandonment scenarios and include those failures as part of the integrated analysis performed in response to PRA RAI 23.

Response

For main control room fires, the Fire PRA broadly characterized the contributions to risk as attributable to either a loss of control or a loss of habitability. A loss of control leads directly to core damage which is quantified by the Fire PRA. Core damage is assumed for a loss of habitability with some probability for operator recovery through the successful implementation of the alternate safe shutdown (ASSD) procedures. Although the contributions to risk were separately characterized, the fire events postulated to cause those contributions were not, in that there was no assignment of a split fraction for the ignition frequency. To assess the risk due to a loss of control, the applicable bin-specific ignition frequency was apportioned to each ignition source in the main control room. Likewise, to assess the risk due to a loss of habitability, the applicable bin-specific ignition frequency was again apportioned to each ignition source in the main control room. These risk contributions are then summed to obtain the total risk. This "double-counting" of the ignition frequency simplifies the analysis and yields conservative results overall.

The operator recovery of implementing the ASSD procedures as applied to the loss of habitability scenario is premised on two requirements. The first requirement concerns the operator's ability to recognize when habitability makes it necessary to abandon the main control room. The second requirement is that the equipment needed to implement the ASSD capability is independent of and separated from that in the main control room. Consequently, fire-induced failures in the main control room do not affect the equipment needed to implement the ASSD procedures.

a. The operator recovery of implementing the ASSD procedures is only applied to the loss of habitability scenario. It does not address fire-induced failures because the equipment required for implementation of the ASSD strategy is not affected by fires in the main control room. For those scenarios where fire-induced failures result in a loss of control leading to core damage, the analysis does not mitigate the associated risk by crediting main control room abandonment to implement the ASSD procedures. Effectively, the assumption is that the main control room abandonment strategy always fails for loss of control scenarios regardless of whether the fire fails only a few functions, or multiple functions, or some recoverable functions, or causes spurious operations.

b. The operator recovery of implementing the ASSD procedures is only applied to the loss of habitability scenario. Fire-induced failures of main control room functions are not considered in the abandonment scenario because the equipment required for implementation of the ASSD strategy is not affected by fire-induced equipment failures in the main control room. The credited abandonment actions include the transfer of control for the required equipment to a location outside the main control room, and the equipment controlled from there is sufficient to achieve and maintain safe and stable conditions. The abandonment risk includes random failures and unavailability of the required equipment and related human errors including the failure to transfer control to a location outside the main control room.

PRA RAI 01.f.iii.02

In the same letter, the licensee responded to PRA RAI 1.f.iii.01. The disposition to this RAI states that the large early release frequency (LERF) contribution from MCR abandonment due to habitability was estimated to be 10% of the core damage frequency (CDF) for MCR abandonment, based on the Internal Events PRA where LERF is 8% of CDF. Containment bypass scenarios, such as interfacing system loss-of-coolant-accident (ISLOCAs), are often major contributors to LERF.

a. Justify that the relative likelihood/frequency of containment bypass scenarios for the Fire PRA, as compared to that for core damage scenarios, is not higher than for the Internal Events PRA.

Response

The relative likelihood/frequency of containment bypass scenarios, as compared to that for core damage scenarios, is justified as not being higher than that for the Internal Events PRA because the estimation of the LERF contribution as 10% of CDF is limited to main control room abandonment due to loss of habitability.

For main control room fires, the Fire PRA broadly characterized the contributions to risk as attributable to either a loss of control or a loss of habitability, with a loss of control leading to core damage and a loss of habitability providing some probability for operator recovery through the implementation of the alternate safe shutdown procedures. Although the contributions to risk were separately characterized, the fire events postulated to cause those contributions were not, in that there was no assignment of a split fraction for the ignition frequency. To assess the risk due to a loss of control, the applicable bin-specific ignition frequency was apportioned to each ignition source in the main control room. Likewise, to assess the risk due to a loss of habitability, the applicable bin-specific ignition frequency was again apportioned to each ignition source in the main control room. These risk contributions are then summed to obtain the total risk. This "double-counting" of the ignition frequency simplifies the analysis and yields conservative results overall. Effectively, there is no risk mitigation credit for abandoning the main control room to implement the alternate safe shutdown procedures; there is only the additional risk of not implementing the procedures successfully.

The LERF contribution for containment bypass scenarios, such as Interfacing System Loss of Coolant Accidents (ISLOCAs), would be attributed to fire-induced equipment failures resulting in a loss of control leading to core damage. As such, that contribution to LERF is quantified separate from and in addition to the estimate of LERF for failing to implement the alternate safe shutdown procedures successfully following main control room abandonment due to habitability. When necessary, the credited abandonment actions transfer control of the required equipment to a location outside the main control room, and the equipment controlled from there is sufficient to achieve and maintain safe and stable conditions. The quantification of the risk of abandonment includes random failures and unavailability of the required equipment and related human errors including the failure to transfer control to a location outside the main control room and the failure to close the main steam isolation valves (MSIVs) and remove power from the Reactor Protection System panels. These later two steps assure Group 1 containment isolation occurs and prevent/mitigate spurious opening due to fire damage. The failure to perform these two actions is conservatively counted toward CDF, and therefore LERF, without regard to whether the fire damage set requires the actions.

Since containment bypass scenarios are part of the Internal Events PRA but not part of the main control room abandonment, the 10% estimation of the LERF contribution from main control room abandonment compared to the 8% for the Internal Events PRA is a very conservative treatment.

PRA RAI 06.02

The disposition to PRA RAI 06.01 presents results of a sensitivity in which Main Control Board (MCB) scenarios are multiplied by the whole MCB ignition frequency rather than a fraction of the frequency. Given that this sensitivity study appears to only impact sequence frequencies, it is not clear why there is asymmetry between CDF and LERF sensitivity results. Similarly, the results of the integrated analysis provided in response to PRA 23 shows that, whereas change in (Δ) CDF, Δ LERF, and CDF increased as a result of the integrated analysis, the LERF decreased in a number of cases. It is not clear why LERF would trend in an opposite direction from CDF.

a. Please explain and justify these seeming anomalies.

Response

The baseline method for calculation of risk associated with the Main Control Board used a fire modeling approach and credited in-cabinet incipient detection. The sensitivity analysis used the statistical modeling approach in Appendix L of NUREG/CR-6850 and did not credit the incipient detection. The "seeming anomaly" is that the calculated CDF for the sensitivity is higher than the baseline CDF while the calculated LERF is lower. The reason is the two methodologies quantify fires which have different target sets. The baseline methodology credited incipient detection for early suppression but postulated scenarios where suppression and detection failed, permitting the fire to grow large enough to damage not only the entire panel but also external cables in trays/conduits above the panel. In these cases, the target sets sometimes contained sufficient components to cause both core damage and a large early release such that the calculated LERF value equaled or nearly equaled the calculated CDF value. In contrast, the Appendix L methodology typically quantified target sets for smaller fires which were contained within a panel, or multiple panels where propagation was appropriate, but with no damage to cables outside of the Main Control Board. The calculated LERF value for these fires was usually less than and often significantly less than the calculated CDF value. So while the Appendix L methodology had a higher CDF value, the postulated scenarios were less likely to cause a large early release and hence a lower LERF value.

A similar "seeming anomaly" exists in response to PRA RAI 23 where the calculated change in Unit 1 LERF for the control power transformer (CPT) and state of knowledge correlations (SOKC) sensitivity was negative while the change in Unit 1 CDF was positive. In this case, the values represent small changes, less than 1% from the baseline, and the small negative value resulted from the UNCERT's use of Monte Carlo simulation combined with removal of the CPT credit having created no change in Unit 1 LERF. The change was close enough to zero that a Monte Carlo simulation caused a slight negative value.

PRA RAI 22.c.01

In the same letter dated March 14, 2014, the licensee responded to PRA RAI 22.c. Regarding the final five bullets of part (c) of this RAI, on improvements made to facilitate fire modeling, two of the explanations are not clear.

a. Explain more fully what the constant of 6 minutes was used for and the modeling with which it was replaced.

b. Also, describe more fully how the hot gas layer (HGL) modeling basis changed, including how the "total energy released" is modeled in the updated HGL analysis.

Response

a. The constant of 6 minutes was included in the calculation of the time-to-damage for the closest external target in the zone of influence (ZOI) fire scenario. Although the technical basis was poorly documented, the effect of including the 6 minutes in the time-to-damage calculation was to decrease the probability of non-suppression for the scenario.

   As a replacement for the constant 6 minutes, each ZOI scenario was split into two time-dependent scenarios.

   - The first scenario included targets that would be damaged within 5 minutes of the time-to-damage of the closest target. Those targets were modeled as failed with the closest external target at the time-to-damage of the closest target.
   - The second scenario included the remainder of the targets in the ZOI. Those targets were modeled as failed 5 minutes after the time-to-damage of the closest target.

A probability of non-suppression was then calculated for each scenario based on the applicable time of failure.

b. The basis used to determine whether an HGL develops for a particular scenario was changed because the comparison between the conditions required for an HGL in a particular room and the conditions produced by a particular fire scenario in that room was using dissimilar parameters. In particular, the conditions required for an HGL in a particular room were expressed as an average heat release rate over a 30 minute time period, while the conditions produced by a particular fire scenario in that room were expressed as an instantaneous heat release rate. This comparison of dissimilar parameters was performed at 1 minute time intervals over a 60 minute time period and, consequently, sometimes produced non-conservative results. To more reliably determine whether a particular scenario resulted in the formation of an HGL, both parameters were changed to be expressed as the total energy released. Currently, the total energy released by a scenario is accumulated at 1 minute time intervals and compared over a 60 minute time period to the total energy required to be released into the room to form an HGL.

PRA RAI 23.01

With respect to the response to RAI 01.d.02, if the transient combustible violations cited cannot be explained or justified to support use of reduced transient heat release rates (HRRs), then use another value for the HRR to

a. Justify its use and incorporate that value in the integrated analysis provided in response to PRA RAI 23. In addition, based on the response to RAI 24.01 below, revise all estimates of the risk and delta-risk metrics to exclude the credit for the "panel methods" approach.

Response

No modification of the response to PRA RAI 23 was proposed because the response to RAI 01.d.02 explained that the transient combustible violations have no impact on the reduced transient heat release rates.

In addition, the estimates of the risk and delta-risk metrics were not revised because the response to RAI 24.01 clarified that the frequency multiplier used for closed 480V motor control centers (MCCs) was not a "panel methods" approach.

PRA RAI 24.01

In the same letter dated March 14, 2014, the licensee responded to PRA RAI 24. The disposition to this RAI presents a new implementation item (i.e., #13) that commits to replacing unacceptable methods with acceptable methods prior to self-approval in cases where impact was shown to be minimal in the current submittal, with one exception. That exception is stated to be replacing the "panel methods" approach (assumption that 10% of the electrical panels meet the definition of an open panel).

a. Either provide justification for this, including a phenomenological basis beyond the historical fire events database, or

b. Confirm how you will modify the new implementation item #13 to include removal of credit for use of the "panel factors" method.

Response

The 10% multiplier is neither a "panel methods" approach nor a "panel factors" method. Brunswick MCCs were evaluated as either a vented ignition source or an un-vented ignition source (i.e., closed) depending upon the individual MCC construction. About 2/3 of the 480V and 250VDC MCCs were determined to be vented ignition sources. The remaining 1/3 of the MCCs were determined to be unvented ignition sources and consistent with the written guidance in NUREG/CR-6850 section 11.5.1.7.3. The 10% multiplier is not a "panel factors" method, which was described in the NRC's June 21, 2012, (i.e., "Giitter") letter (i.e., ADAMS Accession Number ML12171A583), as:

> ...using a single "factor," blends together all the case-specific phenomena that contribute to growth of a fire within an electrical cabinet and then assigns an "average" or “aggregate” propagation probability on a generic basis for igniting the first cable tray.

In marked contrast, unvented MCC scenarios postulated with the 10% multiplier were assessed on a case-by-case basis, using accepted fire modeling tools and practices, as applicable. Ignition sources were characterized using a two-point HRR model, and target sets were defined by the spatial relationships to the ignition source of interest. Fire growth and decay were modeled for individual ignition sources in terms of fire intensity and duration. Target damage was based on the exposure environment exceeding the applicable damage threshold with the non-suppression probability based, in part, on the time to reach the damage threshold. Propagation to secondary combustibles reflected the spatial relationships to the ignition source with consideration for the possible presence of credited barriers.

As used in the BSEP Fire PRA, the 10% multiplier for otherwise non-propagating ignition sources constitutes a reasonably realistic yet conservative treatment of modeling uncertainties, including arcing faults in 480V MCCs for which no specific guidance is provided in NUREG/CR-6850. The use of this 10% multiplier results in a risk increase relative to what is required by the guidance in NUREG/CR-6850.

This 10% multiplier has been reviewed with the NRC on multiple occasions and does not represent a method that has been deemed unacceptable to the NRC. This approach was presented on slide 17 (i.e., ADAMS Accession Number ML12152A145) at the May 31, 2012, BSEP Pre-LAR Application Meeting with the NRC. Section 3.4.7 of the Safety Evaluation accompanying the June 28, 2010, NFPA 805 License Amendment for the Harris Plant (i.e., ADAMS Accession Number ML101750602) described this as a reasonable basis for considering the Harris Plant MCCs as closed cabinets and concluded that the risk evaluations were reasonable and conservative.

Duke Energy is an active participant in industry efforts to improve Fire PRA methods and is aware of both a short-term and a long-term approach currently being developed for this issue. The short-term approach is expected to be bounded by the conservative risk assessment described in the response to this RAI. The long-term approach is expected to be more realistic and would be addressed through the normal PRA maintenance process.

Based on the above discussion, no modification of implementation item #13 was proposed.