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RS-23-084 10 CFR 50.90
July 24, 2023

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

LaSalle County Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-11 and NPF-18
NRC Docket Nos. 50-373 and 50-374

Subject: Response to Request for Additional Information regarding the Application to Revise Design Basis to Allow Use of Plastic Section Properties in Lower Downcomer Braces Analysis

References:

1. Letter from K. Lueshen (Constellation Energy Generation, LLC) to Nuclear Regulatory Commission, "Application to Revise Design Basis to Allow Use of Plastic Section Properties in Lower Downcomer Braces," dated January 12, 2023 (ML23013A076)

2. Email from R. Kuntz (Nuclear Regulatory Commission) to J. Taken (Constellation Energy Generation, LLC), "LaSalle Downcomer analysis amendment request (EPID L-2023-LLA-0008)," dated May 25, 2023

In Reference 1, Constellation Energy Generation, LLC (CEG) requested an amendment to Renewed Facility Operating License Nos. NPF-11 and NPF-18 for LaSalle County Station (LSCS), Units 1 and 2 which proposed to revise the design basis for the lower downcomer braces.

In Reference 2, the Nuclear Regulatory Commission (NRC) requested additional information necessary to support its review of Reference 1. A clarification call was held to ensure a common understanding of the information sought.

This letter is being submitted to respond to the Reference 2.

The information contained in this does not alter the conclusion in Reference 1 regarding the no significant hazards consideration or the environmental considerations.

CEG is notifying the State of Illinois by transmitting a copy of this letter (without attachments) to the designated State Officials in accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b).

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Jason C. Taken at (630) 657-3660.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 24th day of July 2023.

Respectfully,

Lueshen, Kevin Digitally signed by Lueshen, Kevin Date: 2023.07.24 12:23:38 -05'00'

Kevin Lueshen
Sr. Manager Licensing
Constellation Energy Generation, LLC

Attachment: Response to Request for Additional Information

cc:

U.S. NRC Region III, Regional Administrator
U.S. NRC Senior Resident Inspector, LaSalle County Station
Illinois Emergency Management Agency and Office of Homeland Security

ATTACHMENT
Response to Request for Additional Information

Request for Additional Information

LaSalle County Station, Units 1 and 2

License Amendment Request:

Revise Design Basis to Allow Use of Plastic Section Properties in

Lower Downcomer Braces Analysis

RAI-1

Requirements:

- 10 CFR 50.55a, “Codes and Standards,” requires that SSCs be designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed.

- 10 CFR 50, Appendix A, General Design Criterion (GDC) 1, “Quality standards and records,” with respect to ensuring that the structures important to safety other than containment are designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the safety function to be performed.

- 10 CFR Part 50, Appendix A, GDC 2, “Design bases for protection against natural phenomena,” as it relates to the design of seismic Category I structures, systems, and components (SSCs), requires, in part, that the SSCs important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety functions.

- 10 CFR 50, Appendix A, GDC 16, "Containment Design," requires that reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

- 10 CFR 50, Appendix A, GDC 50, “Containment Design Basis," requires that the reactor containment structure, including access openings, penetrations, and the containment heat removal system shall be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident. This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, such as energy in steam generators and as required by § 50.44 energy from metal-water and other chemical reactions that may result from degradation but not total failure of emergency core cooling functioning, (2) the limited experience and experimental data available for defining accident phenomena and containment responses, and (3) the conservatism of the calculational model and input parameters.

- In Subsection, 1.2.2.4.1, "Primary Containment," of LSCS Updated Final Safety Analysis Report (UFSAR), Revision 13, the last paragraph on Page 1.2-15, states "The drywell and wetwell are separated by reinforced concrete floor which is penetrated by 98 stainless steel downcomers."

Background:

The license amendment request dated January 12, 2023, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23013A076), states:

a) In Section 2.0, "Design Input," on Page 4 of Attachment 3, "Based on discussion with Exelon on 5/18/2020, the reduction in thickness for an operating life of 40 years is to be used herein" and that red_{corr} = 1 mil/year. In Section 3.0, "Assumptions & Engineering Considerations," on Page 9 of Attachment 3, "There are no unverified assumptions used in the preparation of this analysis."

b) In Section 6.1, "Methodology," on Page 12 of Attachment 3, "The loads on the downcomer vents ... are put into the PIPSYS model to determine the moments and axial loads at a joint."

c) In Section 6.2, "Acceptance Criteria," on Page 25 of Attachment 3, "However, for the lower downcomer braces and gusset plate section, Licensing Action LI-21-0215 allows the use of plastic section properties."

d) In Section 2.0, "Design Input," on Page 8, in Item 3, "Lower Downcomer Brace Plate," of Attachment 3, "Elastic section modulus of effective gusset section (S_{gp})," and "Plastic section modulus of effective gusset section" were calculated to be 184 in^3 and 29.54 in^3, respectively.

e) Based on the review of the calculations in Attachment 3, the staff did not find any calculations qualifying the welds at the connection of lower downcomer bracing members.

f) In Section 6.2 "Acceptance Criteria," on Page 25 of Attachment 3,

> As previously discussed, LC #7 controls for the bracing members based on the existing analyses and is considered in this evaluation. The allowable stresses for

this LC (abnormal extreme environmental) are defined per Table 4.3-2 of the LaSalle DAR (Ref. 1c) and are provided below:

S_7 = 1.6*AISC allowable not to exceed 0.95Fy

Consistent with the existing evaluations, the maximum allowable stress of $0.95F_y$ is applicable to axial tension and bending, as well as axial compression. Section 1.7 of Calc. 187 (Ref. 3a) states that an allowable stress of $0.95F_y$ is acceptable for axial compression loads since the loads are dynamic in nature and last only a short time.

g) In Section 6.2 "Acceptance Criteria," on Page 25 of Attachment 3, "Additionally, per SRP Section 3.6.2 (Ref. 8b), Subsection III.2.a, a 10% increase of the minimum specified design yield strength may be used in the analysis to account for strain rate effects under dynamic loading. This increase is considered for the axial and bending allowables only."

<u>Issues</u>:

a) It is not clear why the corrosion reduction in thicknesses of the structural members were limited to 40 years, and how the annual corrosion reduction is assured to be to be a linear value of 1 mil/year for the duration of the operations where the lower downcomer bracing members are in stagnant and unrefreshed water environment.

b) It is not clear whether the steel gusset plates, as plate-elements, can be modeled as integral parts of downcomer piping using the PIPSYS program. Is there a three-dimensional element in PIPSYS program that can characterize the gusset-plates in mathematical models?

c) It is not clear how the American Institute of Steel Construction (AISC) code can be implemented to determine plastic section property(ies) to qualify the structural integrity of seismic Category I SSCs.

d) The values of elastic and plastic section modulus of effective gusset plate section are calculated in one of the orthogonal directions only. However, based on the configuration in Figure 2.1-2, "Lower Downcomer Gusset Plate Dimensions," the section properties of gusset plate configuration are different and shall be calculated in both orthogonal directions.

e) It is not clear whether the stresses of welds at the connections of lower downcomer bracing members are within the weld acceptance criteria since no weld calculations are provided in the application.

f) It is not clear why the calculated shear stresses were not compared against the acceptance criterion for shear stresses (0.95 x F_y / $(3)^{1/2}$ = 0.548 x F_y) as it was provided in Table 3.8-9 in Revision 13 of the LSCS UFSAR.

g) Standard Review Plan (SRP) Section 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," (ADAMS Accession No. ML16088A041) specifically provides information concerning break and crack location criteria and methods of analysis for evaluating the dynamic effects associated with postulated breaks and cracks in high-and moderate-energy fluid system piping, including "field run" piping inside and outside of containment. Then a 10 percent increase of minimum specified design yield strength (S_y) to account for strain rate effects may not be applicable for the structural members of the supports. Therefore, it is not clear whether any other industrial and/or regulatory requirement(s) allows the use of a 10 percent increase of minimum specified design yield strength (S_y) in the analyses to account for strain rate effects for the structural members of seismic Category I supports.

<u>Requests</u>:

a) Justify why the corrosion reduction in thicknesses of the structural members were limited to 40 years, and how the annual corrosion reduction is assured to be to be a linear value of 1 mil/year for the duration of the operations.

<u>CEG RESPONSE:</u>

The corrosion reduction in thicknesses is based on the original license period of the plant (40 years). The downcomers and bracing are included in the LSCS ASME Section XI, Subsection IWE Aging Management Program (AMP) to support License Renewal. The AMP will cover the Period of Extended Operation. The corrosion rate of 1 mil/year is a conservative value, as documented corrosion rates of weathering steels with similar chemical properties to that of ASME A618 Type II are noted between 0 to 1 mil/year per existing industry references. (U.S. Steel, "Steels for Nuclear Applications" Volume 5, "Corrosion in Nuclear Reactors" and the Metals Handbook 9th Edition Volume 13, "Corrosion"). The linearity of the corrosion rate is in line with the standard industry guidance for weathering steels. Once the oxide layer forms, over the period of plant operations the corrosion rate can be considered linear due to the corrosion resistance properties of the material.

b) Confirm whether the steel gusset plates, as plate-elements, can be modeled as an integral part of downcomer piping using the PIPSYS program. Is there a three-dimensional element in the PIPSYS program that can characterize the gusset-plates in a mathematical model? If not, justify whether the closed pipe element behavior is representative of open-sections, like gusset-plates, in analytical mathematical models under external loading conditions.

CEG RESPONSE:

The PIPSYS models used as input for this calculation were created during original plant design and were not updated as a result of this work. The downcomer system was modeled using beam elements that connect at nodes, as is typical practice. This is also how buildings are modeled in current engineering practice, where connecting elements (gusset plates, clip angles, etc.) are not part of the Finite Element Analysis model. As such, the gusset plates were not explicitly modeled.

Given the relatively short length of the gusset plates in relation to the overall length of the downcomer braces, using the brace section properties to model the gusset plates will have negligible impact on model stiffness. Therefore, this simplification, which is typical of engineering practice in the commercial and nuclear industries, is considered an acceptable approach.

c) Justify the use of plastic section properties under the AISC code to qualify the structural integrity of seismic Category I components.

CEG RESPONSE:

AISC does not restrict the use of plastic design, and the more recent AISC codes (including the AISC N690 nuclear code) use plastic section properties for flexural capacity of beams as a default ($M_n = F_y Z$). The 7th Edition AISC Manual includes a plastic design selection table for shapes used as beams or columns in Part 2 of the Manual.

The overarching criterion for Category I design is that the structure will allow for safe shutdown of the plant. Use of plastic section properties does not invalidate this consideration. For example, Table 3.8-11 of Dresden's UFSAR states that "…some of the materials may exceed the yield point" during the SSE. Additionally, the SSE criterion in Table 3.8-11 of the Quad Cities UFSAR is that "safe shutdown of the plant can be achieved."

d) Does the calculations of the elastic and plastic section properties of gusset plate provided in support of the amendment request consider forces in each orthogonal direction including combination of forces? If the provided analysis does not consider forces in each orthogonal direction justify the analysis or provide revised analyses as needed to support the amendment request.

CEG RESPONSE:

Section properties about each primary axis of the gusset plate are considered in Calculation L-002547 R0A (Section 2.0, Design Input #3). For a cruciform section, bending about one of the primary axes results in essentially zero stress in the section of the cross on the axis of flexure since it is at the neutral axis. Calculation L-002547 R0A considers the bounding moments about each axis, but because of the cruciform configuration, the stresses are not additive. See Section 7.4 of the calculation.

e) Provide assurance that the as-built weld joint configuration at the connections of critical locations of the lower downcomer bracing members meets the acceptance criteria.

CEG RESPONSE:

Per the design drawings, the downcomer brace gusset plate welds are either Complete Joint Penetration (CJP) welds or through-thickness Partial Joint Penetration (PJP) welds with a reinforcing fillet weld, which provide a weld strength equal to or greater than the base metal.

f) Justify why the calculated shear stresses, in the steel gusset plates, were not compared against the shear acceptance criterion as provided in Table 3.8-9 in Revision 13 of the LSCS UFSAR.

CEG RESPONSE:

Shear was determined to be noncritical in the design basis evaluations (Calculations 187, 187B, and 187K). Analysis L-002547 Rev. 0A is consistent with this approach.

Moreover, given the relatively large span-to-depth ratios of the brace members and the fact that the ends of the braces are moment connected, shear is not a controlling limit state by inspection, since the axial load and moments and the ends of the braces are very large.

For comparison, the web of the cruciform section that comprises the brace gusset plate has a shear capacity of approximately 0.55 x (50 ksi) x (10.92in) x (0.92in) = 276 kips, significantly higher than any of the member shear results tabulated in the design basis calculations.

g) Indicate the engineering requirement, industry standard, or code provision that allows the use of a 10 percent increase of minimum specified design yield strength (S_y) in the analyses to account for strain rate effects for the structural members of seismic Category I supports.

CEG RESPONSE:

Section 6.2 of the L-002547 R0A analysis discusses that this 10% increase is acceptable per Standard Review Plan (SRP) Section 3.6.2 “Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping,”, Subsection III.2.a “Dynamic Analysis Criteria,” to account for strain rate effects under dynamic loading. SRP Section 3.6.2 is specific to dynamic effects associated with pipe rupture and pipe whip restraints. While downcomer venting and seismic loading is not precisely pipe rupture, it is still a high-energy, dynamic phenomenon, and as such the use of a 10% increase to account for strain rate effects is consistent with the above-described accepted industry practice.

Additionally, AISC N690-18, Table A-N9.1.1 and Table 5.4 of ASCE’s “Report of the ASCE

Committee on Impactive and Impulsive Loads" allow a minimum dynamic increase factor of 1.1 for 50-ksi steel.