Omaha Public Power District
444 South 16th Street Mall
Omaha, NE 68102-2247

April 25, 2014
LIC-14-0036

10 CFR 50.90

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

Fort Calhoun Station, Unit No. 1
Renewed Facility Operating License No. DPR-40
NRC Docket No. 50-285

Subject: License Amendment Request (LAR) 14-05; Design and Evaluation of Seismic Class I Structures Using ASCM Developed Floor Response Spectra

Reference: 1. Letter from NRC (S. Bloom) to OPPD (T. L. Patterson), *Safety Evaluation of Alternate Seismic Criteria and Methodologies – Fort Calhoun Station (TAC No. M71408),* dated April 16, 1993 (NRC-93-0150)

Pursuant to 10 CFR 50.90, the Omaha Public Power District (OPPD) hereby requests an amendment to Renewed Facility Operating License No. DPR 40 to permit the use of seismic floor response spectra in the design and evaluation of seismic Class I structures and structural elements attached to structures. In Reference 1, the NRC approved these spectra for use in piping, and heating, ventilation, and air conditioning (HVAC) design at Fort Calhoun Station.

OPPD had originally intended that the new floor response spectra could be used universally for all applications as an alternative means of determining the seismic input for evaluations and design. However, Reference 1 does not clearly state that the alternate seismic criteria and methodologies (ASCM) floor response spectra can be universally applied. Hence, this license amendment request (LAR) seeks to clarify the issue and amend the USAR accordingly.

OPPD requests approval of the proposed amendment by April 15, 2015 and will implement the amendment within 30 days of NRC approval. The amendment will facilitate restoration of the design criteria for containment internal structures during the 2015 refueling outage, scheduled to begin April 13, 2015.

This LAR has been evaluated in accordance with 10 CFR 50.91(a)(1) using criteria in 10 CFR 50.92(c). OPPD has determined that this LAR involves no significant hazards consideration. The basis for this determination is included in the Enclosure.

In accordance with 10 CFR 50.91, a copy of this application, with attachments, is being provided to the designated State of Nebraska official.

No commitments to the NRC are contained in this submittal.

A001
NRR

If you have any additional questions, or require further information, please contact Mr. Bill R. Hansher at (402) 533-6894.

I declare under penalty of perjury that the foregoing is true and correct; executed on April 25, 2014.

Sincerely,

Michael J. Prospero
Plant Manager

MJP/JAC/mle

Enclosure: OPPD's Evaluation of the Proposed Change(s)

c: M. L. Dapas, NRC Regional Administrator, Region IV
J. M. Sebrosky, NRC Senior Project Manager
J. C. Kirkland, NRC Senior Resident Inspector
Director of Consumer Health Services, Department of Regulation and Licensure, Nebraska Health and Human Services, State of Nebraska

OPPD's Evaluation of the Proposed Change

License Amendment Request 14-05; Design and Evaluation of Seismic Class I Structures Using ASCM Developed Floor Response Spectra

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ATTACHMENTS:

1. USAR Pages – Page Markups
2. USAR Pages – Clean Pages

1.0 SUMMARY DESCRIPTION

This license amendment request (LAR) proposes to amend Section 5.11 and Appendix F of the Fort Calhoun Station (FCS), Unit No. 1, Updated Safety Analysis Report (USAR). The changes clarify the licensing and design basis to permit the use of new seismic floor response spectra (FRS) for use in structural analysis and design. The new floor response spectra are known as Alternate Seismic Criteria and Methodologies (ASCM).

2.0 DETAILED DESCRIPTION

In Reference 6.1, the Omaha Public Power District's (OPPD) submitted for NRC review and approval, an alternative to existing FCS USAR criteria and methodologies for determining the seismic loading applicable to all types of applications. OPPD's submittal was also intended to provide for alternate methodologies for seismic analysis of piping (large and small bore), structures, heating, ventilation, and air conditioning (HVAC) (i.e., ductwork, supports and hardware), pipe supports, electrical raceways, instrument tubing and anchor bolts used for piping, raceway and HVAC systems. After subsequent discussions and NRC's RAIs, the scope of the original submittal was reduced so that only the following were included: the new seismic floor response spectra, the analytical methodologies for piping, and the criteria and methodologies for HVAC. In Reference 6.2, the NRC approved the ASCM floor response spectra concluding that the seismic analysis methods for piping and HVAC were acceptable. The SER also stated that the remaining open items related to the structural and geosciences areas of ASCM were closed.

This request is focused solely on the application of the new ASCM floor response spectra to structures and structural elements attached to structures. Since the NRC's approval of the new spectra, OPPD has utilized them successfully in the design of both piping and structural applications. However, an NRC inspector has asked whether the ASCM floor response spectra are approved for structural applications as well as for piping. This issue is documented in Fort Calhoun Station's Corrective Action Program. Section 2.2.3 of USAR Appendix F (Reference 6.3), states: "A review of these analyses and criteria was performed by the NRC, and Reference 5 [i.e., the Reference 6.2 NRC Safety Evaluation Report] documents NRC acceptance of them as the basis for an alternate (i.e. in lieu of the original design basis) seismic criteria and methodology for analyses of equipment and structures at Ft. Calhoun."

However, the Reference 6.2 SER is unclear regarding the use of ASCM floor response spectra in structural applications. Therefore, this LAR proposes to revise USAR, Section 5.11.3, "Design Criteria – Class I Structures" (Reference 6.4). The proposed change identified by double underline clarifies that the seismic "g" loading factors utilized for determining seismic loadings on structures may be determined from either one of two sources; the original plant design criteria utilizing the response curves in Figures F-1 and F-2, or alternatively the ASCM floor response spectra.

The LAR also proposes to add a paragraph to USAR, Appendix F, Section 2.1.4. The new paragraph also identified by double underline states that the ASCM curves from

Reference 3.6 can be used for determining the "g" value for determining seismic loading on structures and structural elements attached to structures (e.g., pipe supports) as an alternative to the original (and still existing) seismic criteria. Reference 3.6 as identified in USAR, Appendix F is engineering analysis EA-FC-94-003, "Alternate Seismic Criteria and Methodologies," Revision 0, which has since been updated and is now Revision 1.

3.0 TECHNICAL DESCRIPTION

The original submittal of the ASCM floor response spectra was presented in three parts:

1. the methodology to generate seismic ground motion spectra,
2. the methodology to apply the spectra developed in Part 1 to plant structures in order to arrive at structural floor response spectra, and
3. the seismic qualification of piping systems, pipe supports, mechanical and electrical components, raceways, conduits and other equipment.

This LAR is solely to permit application of the seismic floor response criteria developed in Part 2 to structures and structural elements attached to structures (e.g., pipe supports).

The ASCM curves are based on the Housner ground response spectrum anchored to 0.17 g as defined in the USAR applied at the foundation elevation in the free field. The actual time histories used in the analysis were the identical time histories used in the original design of the plant structures. The curves are in actually refined versions of the plant's existing (original) design basis.

Over the course of their review of Reference 6.1, the NRC, assisted by Brookhaven National Laboratory (BNL) generated several questions and comments. These issues were addressed and closed out either by OPPD providing new information, OPPD commitments for the development of the new curves, or by OPPD's withdrawal of portions of the original submittal. The NRC's final Safety Evaluation Report (SER) enclosed with Reference 6.2 addressed and closed the final technical issues associated with the new curves. The technical issues included the following:

- The use of the Housner ground response spectrum anchored at 0.17g and applied at the foundation elevation as input to the soil structure interaction analysis.
- The lack of documentation on the pile system design to account for overturning and sliding forces acting on the intake structure. OPPD satisfactorily addressed this by reviewing the original design basis documentation, which was found to include calculations of seismic vertical and shear forces and overturning moments of Class I structures. The NRC concluded that the original design had adequately accounted for the seismic overturning and shear loads on the piles.
- In response to the NRC's request for additional information regarding accidental torsion and the method of generating spectra for the ASCM, OPPD stated that the three dimensional dynamic model used in ASCM considers the as-built eccentricities and properties of the plant. The model includes offsets between the mass and stiffness centers for each major elevation of the plant structures. The responses to the structures are calculated for the simultaneous seismic excitation in three

directions, and that torsional degrees of freedom are included in those responses. The ASCM floor response spectra were derived as an envelope of the responses obtained at the extreme corners of each floor elevation at the center of mass. The staff agreed that enveloping of the maxima from all FRS curves for each floor elevation introduces sufficient margin of conservatism to consider the possible effects due to accidental torsion.

- OPPD performed a parametric study as required by the NRC to demonstrate that the effects of soil property variation could be included within the ± 15% spectra peak broadening methods used to develop the design FRS. OPPD performed the analysis and used 1.3 times the "best estimate" (BE) of soil properties as the upper bound and 0.7 time the BE for the lower bound. This was based on the fact of extensive remedial treatment at the time of construction. OPPD performed a statistical analysis of 696 standard penetration tests after the site was densified and found that the relative density for the entire area was not less than 85% at an overall confidence level of 96.5%. The staff agreed with the use of 1.3 times the BE value for the upper bound value.
- The NRC questioned how radiation damping was considered in the soil structure interaction (SSI). OPPD reported that it performed a free vibration analysis of the SSI model and calculated a logarithmic decay of the basemat response. This analysis indicated a total damping of 13% from which the soil material damping of 6.3% was subtracted to obtain the estimate of radiation damping of 6.7%. The staff considered the issue closed because the estimate was considered conservative.
- The NRC requested additional information on soil compaction and liquefaction, and on the results of any surveillance program to check elevation levels for settlement. OPPD reported that it had first installed foundation piles, and then compacted the soils around them using the Vibroflotation system to achieve the desired average relative density of 85% to prevent liquefaction during a design basis earthquake. OPPD also reported that there is no surveillance program for settlement measurement but that there has been no observable settlement in the soils beneath seismic Class I and non-seismic structures. OPPD also reported that there has been no growth in the minor cracks in the tendon tensioning gallery that where noted during construction. The staff considered the issue closed.

In the Reference 6.2 SER's introduction, it states, "The staff considers the amended version of the ASCM as documented by the July 31, 1992 submittal [Reference 6.5] acceptable, with the exception of damping values for non-rectangular cold-formed duct structures, which would need further staff review." There were no remaining technical issues with respect to the FRS.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

The following documents were found to provide regulatory guidance with respect to seismic floor response spectra for nuclear power plants and were utilized during the NRC's review of References 6.1 and 6.5 (note, this list is not all inclusive):

- Standard Review Plan 3.7.1, *Seismic Design Parameters*
- U.S. NRC Regulatory Guide 1.60, *Design Response Spectra for Seismic Design of Nuclear Power Plants*
- U.S. NRC Regulatory Guide 1.122, *Development of Floor Response Spectra for Seismic Design of Floor-Supported Equipment or Components*

General Design Criteria:

Fort Calhoun Station was licensed for construction prior to May 21, 1971, and at that time committed to the draft General Design Criteria (GDC). The draft GDC are contained in Appendix G (Reference 6.6) of the FCS USAR and are similar to 10 CFR 50, Appendix A, *General Design Criteria for Nuclear Power Plants.* The draft GDC that are most applicable to this issue are USAR Appendix G, Criterion 2, *Performance Standards* and Criterion 9, *Reactor Coolant Pressure Boundary.*

CRITERION 2 - PERFORMANCE STANDARDS [Pertinent text shown below]

Those systems and components of reactor facilities which are essential to the prevention of accidents which could affect public health and safety or to mitigation of their consequences shall be designed, fabricated, and erected to performance standards that will enable the facility to withstand, without loss of the capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, flooding conditions, winds, ice and other local site effects. The design bases so established shall reflect: (a) Appropriate consideration for the most severe of these natural phenomena that have been recorded for the site and the surrounding area and (b) an appropriate margin for withstanding forces greater than those recorded to reflect uncertainties about the historical data and their suitability as a basis for design.

This criterion is met. The systems and components of the Fort Calhoun Station, Unit No. 1 reactor facility that are essential to the prevention or mitigation of accidents that could affect public health and safety are designed, fabricated, and erected to withstand without loss of capability to protect the public, the additional forces that might be imposed by natural phenomena such as earthquakes, tornadoes, floods, winds, ice and other local site effects.

The containment will be designed for simultaneous stresses produced by the dead load, by 60 psig internal pressure at the associated design temperature, and by the application of forces resulting from an earthquake whose ground motion is 0.08g horizontally and 0.053g vertically. Further, the containment structure will be designed to withstand a sustained wind velocity of 90 mph in combination with the dead load and design internal pressure and temperature conditions. The wind load is based on the highest velocity wind at the site location for 100-year period of recurrence: 90 mph base wind at 30 feet above ground level. Other Class I structures will be designed similarly except that no internal pressure loading is applicable. Class I systems will be designed for their normal operating loads acting concurrently with the earthquake described above.

The containment structure is predicted to withstand without loss of function the simultaneous stresses produced by the dead load, by 75 psig internal pressure and temperature associated with this pressure and by an earthquake whose ground motion is 0.10g horizontally and 0.07g vertically.

The containment structure is predicted to withstand without loss of function 125% of the force corresponding to a 90 mph wind impinging on the building concurrently with the stresses associated with the dead load and 75 psig internal pressure.

With no earthquake or wind acting, the structure is predicted to withstand 90 psig internal pressure without loss of function.

Under each of these conditions, stresses in the structural members will not exceed 0.95 yield.

CRITERION 9 - REACTOR COOLANT PRESSURE BOUNDARY

The reactor coolant pressure boundary shall be designed and constructed so as to have an exceedingly low probability of gross rupture or significant leakage throughout its design lifetime.

This criterion is met. Reactor coolant system components are designed for a pressure of 2500 psia and a temperature of 650°F. The nominal operating conditions of 2100 psia and an average reactor coolant system temperature of 572.5°F permit an adequate margin for normal load changes and operating transients. The components are designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code, Section III. Codes and standards for components of the engineered safeguards systems are delineated in Criterion 1. Reactor coolant loop piping is designed in accordance with ANSI B 31.1 plus nuclear code cases. Other reactor coolant boundary piping is in accordance with the intent of ANSI Draft Code for Nuclear Piping B31.7 of February 1968. Quality Control, inspection, and testing as required by these standards ensure the integrity of the reactor coolant system and are described in Appendix A and Section 4.5 of the USAR.

In addition to the code requirements listed, the reactor coolant loop piping is designed to meet the cyclic loading requirements and transient conditions stated for the reactor pressure vessel in Section 4.2.2 of the USAR. This piping is designed to withstand the dynamic seismic loadings for Class I structures under the rules listed in Section 2.0, Appendix F, of the USAR.

The ASCM floor response spectra (FRS) represent a refined version of the plant's original design basis. As such, the design margins for applications utilizing the FRS will be maintained with respect to the design basis earthquake. Therefore, the proposed changes ensure that the plant will continue to comply with USAR, Appendix G, Criterion 2, and Criterion 9.

4.2 Significant Hazards Consideration

The Omaha Public Power District (OPPD) has evaluated whether or not a significant hazards consideration is involved with proposed amendment(s) by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. **Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?**

   No, this change to the Updated Safety Analysis Report (USAR) has no effect on the consequences of any accident, as it makes no physical changes to the plant. Since the Alternate Seismic Criteria and Methodologies (ASCM) floor response spectra (FRS) represent a refined version of the plant's original design basis, the design margins for any application utilizing the FRS will be maintained with respect to the design basis earthquake. Thus, the proposed amendment does not result in a significant increase in the probability or consequences of an accident previously evaluated.

2. **Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?**

   No, the change to the USAR does not change any accident analyses, does not make any physical changes to the plant, and does not change the way the plant is operated. The only change is to permit the utilization of the ASCM curves in the design and evaluation of structural applications. The curves themselves are based on the same earthquake as the plant's original design. Thus, the proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. **Does the proposed amendment involve a significant reduction in a margin of safety?**

   No, the ASCM FRS is based on the same earthquake as the plant's original design basis. The ASCM FRS are refined curves of the same design basis and thus, the design margins of any application or evaluation utilizing the ASCM FRS will be maintained with respect to the design basis earthquake. Thus, the proposed amendment does not involve a significant reduction in a margin of safety.

4.3 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure.

Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22 (c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 REFERENCES

6.1 Letter from OPPD (K. J. Morris) to NRC (Document Control Desk), *Request for Review of Alternate Seismic Criteria*, dated December 2, 1988 (LIC-88-0506)

6.2 Letter from NRC (S. Bloom) to OPPD (T. L. Patterson), *Safety Evaluation of Alternate Seismic Criteria and Methodologies – Fort Calhoun Station (TAC No. M71408)*, dated April 16, 1993 (NRC-93-0150)

6.3 Fort Calhoun Station USAR, Appendix F, *Classification of Structures and Equipment and Seismic Criteria*

6.4 USAR, Section 5.11, *Structures – Structures Other than Containment*

6.5 Letter from OPPD (W. G. Gates) to NRC (Document Control Desk), *Resolution of Remaining NRC Open Items on Alternate Seismic Criteria and Methodologies (ASCM)*, dated July 31, 1992 (LIC-92-0016R)

6.6 USAR, Appendix G, *Responses to 70 Criteria*

USAR Page Markups

5.11 Structures Other Than Containment

5.11.1 Classification of Structures

Structures are classified into two categories. Class I and Class II. As described in Appendix F, Class I structures include containment (including all penetrations and air locks, the concrete shield, the liner and the interior structures), the auxiliary building (including the control room, spent fuel pool, safety injection and refueling water storage tank and emergency diesel-generator rooms), and the intake structure.

USAR Section 5.11 describes the auxiliary building, intake structure, and the interior structures of containment. The containment building (walls, roof, flat base) is described in Section 5.5.

5.11.2 Design of Structures – Class I

Class I structures were designed to ensure that their functional integrity under the most extreme environmental loadings, such as tornado or maximum hypothetical earthquake, will not be impaired and thereby, prevent a safe shutdown of the plant.

The seismic input for the internal structure of the reactor vessel, was obtained by "normalizing" the response spectra, Figure F-1 and F-2 (Appendix F) to a ground acceleration equal to the maximum acceleration of the reactor vessel flange.

5.11.3 Design Criteria – Class I Structures

a. Loadings

Class I structures were designed for seismic loads as discussed in Appendix F. The seismic "g" loading factors utilized for determining seismic loads may be determined using either one of two means available. The first means is to determine the "g" factor using the response curves shown in Figures F-1 and F-2 as described in Section 2.1.4 of Appendix F. The second alternative is to determine the "g" factor using the ASCM generated floor response spectra also described in Section 2.1.4 of Appendix F. This applies to structures and structural elements attached to structures (e.g., pipe supports).

Potential seismic loadings were specified as static mechanical loads for the design of the reactor coolant pumps and their drives. These loadings include inertia loadings at the center of gravity of the pump-drive assemblies, nozzle loads at the pump suction and discharge and support (hanger) reactions at the pump support lugs. In design calculations for the pump casings, potential seismic loads, in combination with other

2.1.4 Response Curves

Response curves are shown in Figures F-1 and F-2 for the design and maximum hypothetical earthquakes respectively and were used for the design of Class I components and structures.

The response spectrum concept provides a conservative approach which has been found generally to be satisfactory for other sites with similar sub-surface conditions. The spectra conform to the average spectra developed by Housner (and presented in Reference 1) for frequencies higher than about 0.33 cycles per second. The spectra for frequencies lower than about 0.33 cycles per second were prepared utilizing data presented by Newmark (Reference 2).

The spectra have been 'normalized' to a horizontal ground acceleration of eight percent of gravity for the design earthquake and seventeen percent of gravity for the maximum hypothetical earthquake.

An alternative method of determining the seismic loads for a Class 1 structure and structural elements attached to structures is available using the ASCM floor response spectra provided in Reference 3.6. The maximum "g" value from the curve for the building floor at which the structure is anchored is to be used.

2.1.5 Refueling Equipment

All refueling equipment (including refueling pool crane) is designed for a seismic loading of .09g vertical and .19g horizontal applied simultaneously. The stress under the combined deadweight live and seismic loads will not exceed the allowable stress of the material. Furthermore, the equipment will withstand a simultaneous vertical acceleration of .13g and a horizontal acceleration of .27g in conjunction with normal loads without exceeding material minimum yield stresses. Guide rollers restrict lateral movement of the refueling machine and the spent fuel handling machine on their rails and have been designed for seismic loads in excess of the above values. In addition, because of its high center of gravity, the spent fuel handling machine is provided with keepers to prevent overturning under seismic shock conditions.

2.2 Methods of Analysis for Class I Structures and Components

2.2.1 General

The following methods of analysis were applied to Class I structures, systems and equipment:

a. The natural frequency of vibration of the structure or component was determined.

USAR Clean Pages

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