UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 17, 2017

Ms. Mary J. Fisher
Senior Director for Fort Calhoun
Station Decommissioning
Omaha Public Power District
Fort Calhoun Station
9610 Power Lane, Mail Stop FC-2-4
Blair, NE 68008

SUBJECT: FORT CALHOUN STATION, UNIT 1 - ISSUANCE OF AMENDMENT RE: REVISE CURRENT LICENSING BASIS TO USE AMERICAN CONCRETE INSTITUTE ULTIMATE STRENGTH REQUIREMENTS (CAC NO. MF8525; EPID L-2016-LLA-0013)

Dear Ms. Fisher:

The U.S. Nuclear Regulatory Commission has issued the enclosed Amendment No. 293 to Renewed Facility Operating License No. DPR-40 for the Fort Calhoun Station, Unit 1 (FCS), in response to your application dated October 25, 2016, as supplemented by letter dated September 25, 2017.

The amendment revises the FCS Updated Safety Analysis Report to change the structural design methodology for the Auxiliary Building at FCS. Specifically, the amendment makes the following changes: (1) use of the ultimate strength design method from the industry standard American Concrete Institute (ACI) 318-63, "Publication SP-10, Commentary on Building Code Requirements for Reinforced Concrete," for normal operating/service conditions for future designs and evaluations; (2) use higher concrete compressive strength values for Class B concrete, based on original strength test data; (3) use higher reinforcing steel yield strength values, based on original strength test data; and (4) make minor clarifications, including adding a definition of control fluids to the dead load section of the Updated Safety Analysis Report.

A copy of the related Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's next biweekly *Federal Register* notice.

Sincerely,

James Kim

James Kim, Project Manager
Special Projects and Process Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-285

Enclosures:
1. Amendment No. 293 to DPR-40
2. Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OMAHA PUBLIC POWER DISTRICT

DOCKET NO. 50-285

FORT CALHOUN STATION, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 293
Renewed License No. DPR-40

1. The Nuclear Regulatory Commission (NRC, the Commission) has found that:

   A. The application for amendment by the Omaha Public Power District (the licensee), dated October 25, 2016, as supplemented by letter dated September 25, 2017, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this license amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No. 293, Renewed Facility Operating License No. DPR-40 is hereby amended to authorize the revision to the Fort Calhoun Station, Unit 1, Updated Safety Analysis Report as set forth in the Omaha Public Power District's application dated October 25, 2016, as supplemented by letter dated September 25, 2017, and as evaluated in the NRC staff's Safety Evaluation issued with this amendment.

3. The license amendment is effective as of its date of issuance and shall be implemented within 90 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Douglas A. Broaddus, Chief
Special Projects and Process Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Date of Issuance: November 17, 2017

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 293 TO RENEWED FACILITY

OPERATING LICENSE NO. DPR-40

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION, UNIT 1

DOCKET NO. 50-285

1.0 INTRODUCTION

By letter dated October 25, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16299A275), as supplemented by letter dated September 25, 2017 (ADAMS Accession No. ML17268A221), Omaha Public Power District (OPPD, the licensee) submitted a license amendment request (LAR) to revise Section 5.11, "Structures Other Than Containment," of the Fort Calhoun Station, Unit 1 (FCS) Updated Safety Analysis Report (USAR) to allow the following for future design and evaluation of Auxiliary Building reinforced concrete structural elements:

1. For normal operating/service conditions, replace the working stress design (WSD) method with the ultimate strength design (USD) method from the American Concrete Institute (ACI) 318-63 Code. The USD method will be applied only to the Auxiliary Building at FCS for normal operating/service conditions. All other structures and foundations, including the Auxiliary Building foundation mat and spent fuel pool (SFP), will continue to utilize the most conservative requirements of the current license basis (CLB).
2. Use higher concrete compressive strength based on original 28-day test data. This proposed change is not applicable to the Auxiliary Building foundation mat, the SFP, or the Auxiliary Building exterior walls below the 1007-foot elevation.
3. Use higher reinforcing steel yield strength values based on original strength test data. This proposed change is not applicable to the Auxiliary Building foundation mat or SFP.
4. Adding a definition of control fluids to the dead load section.

The supplemental letter dated September 25, 2017, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the NRC staff's proposed no significant hazards consideration determination as published in the *Federal Register* (FR) on January 17, 2017 (82 FR 4930).

2.0 REGULATORY EVALUATION

Section 1.1, "Definition of Classes," of Appendix F, "Classification of Structures and Equipment and Seismic Criteria," of the FCS USAR, describes Class I structures and components as vital to safe shutdown and isolation of the reactor and those whose failure might cause or increase the severity of an accident which could result in an uncontrolled release of radioactivity. Section 1.2, "Classification of Buildings and Structures," of Appendix F of the FCS USAR lists the Auxiliary Building (including the control room, spent fuel storage pool, safety injection and refueling water storage tank and emergency diesel-generator rooms) as Class I structures.

As stated in Appendix G, "Responses to 70 Criteria," of the FCS USAR, FCS was licensed in accordance with the 70 draft General Design Criteria published for comment in the *Federal Register* (32 FR 10213) on July 11, 1967. Appendix G of the FCS USAR describes Criterion 2, "Performance Standards," in part, as follows:

> 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.

The FCS addressed this performance standard by designing Class 1 concrete structures in accordance with an NRC-approved design code; ACI 318-63, which is FCS's current code of record.

3.0 TECHNICAL EVALUATION

In Section 2, "Detailed Description," of the LAR, the licensee stated, in part, that

> The need to reevaluate portions of the Auxiliary Building was identified as part of an extent of condition review for design issues associated with the Containment Internal Structure (CIS). In 2012, two latent engineering errors were discovered during preparations for a planned extended power uprate of FCS. A detailed review concluded that several concrete beams in the CIS do not meet the current design basis. An operability determination was completed demonstrating that the CIS is operable. A preliminary assessment of the Auxiliary Building was also performed for the extent of condition evaluation which concluded the Auxiliary Building has similar design discrepancies. An operability determination was completed demonstrating that the Auxiliary Building is also operable.

As described in Section 2 of the LAR and Section 5.11.2, "Design of Structures – Class I," of the FCS USAR, the Auxiliary Building is a multi-floored, reinforced concrete, Class I structure located adjacent to the containment structure. The foundation mat for the Auxiliary Building and the containment structure is an integral unit supported on piles driven to bedrock. The Auxiliary Building is a box-type structure with internal bracing provided by vertical concrete walls and

horizontal floor slabs. The SFP is contained within the Auxiliary Building and consists of a stainless steel lined concrete structure. The Control Room is also contained in the Auxiliary Building. The changes proposed in the LAR would apply only to the Auxiliary Building, excluding the SFP and the foundation mat.

The technical evaluation of this safety evaluation is organized in four subsections (3.1, 3.2, 3.3, and 3.4) outlining the four requested items in the LAR.

3.1 Use USD from the ACI 318-63 Code for Normal Operating/Service Conditions

3.1.1 Licensee Technical Evaluation

Section 2.2, "Use USD for Normal Operating/Service Conditions," of the LAR states that USD is used for "no loss of function" loading conditions and the LAR proposes to expand the use of USD for use in normal operating/service loading conditions. The strength reduction factors would remain the same as those already in use for the no loss-of-function conditions. This change will only apply to new designs or to re-evaluations of concrete structures in the Auxiliary Building, not including the SFP or Auxiliary Building foundation mat.

Section 2.2, Table 5, "Load Combinations," of the LAR explains that the USD load factors and load conditions were developed by reviewing the existing USD USAR combinations for extreme conditions, as well as guidance on load factors in ACI 318-71 and ACI 349-97. Table 5 includes four USD load combinations, which have been updated from the existing three WSD equations in the existing USAR. Combinations one and four update the existing WSD equations with USD load factors similar to factors in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), while combinations two and three modify existing USD USAR equations which are currently used for extreme conditions.

Section 4.2, "Precedent," of the LAR notes that several operating nuclear power plants constructed in the same era as FCS were licensed to use ACI 318-63 USD for normal operating/service loads and that some plants have used more recent code editions for modification and evaluation of structures moving forward. The LAR notes that the USD method is an accepted industry standard used for the design and analysis of reinforced concrete structures.

3.1.2 NRC Staff Evaluation

The NRC staff reviewed the information in the LAR and notes that the USD method is already used in the licensee's design basis for no loss-of-function conditions. The staff also notes that the USD method is the main design method in ACI 349-97 and is approved for use by the NRC in Regulatory Guide (RG) 1.142, Revision 2, "Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)," November 2001 (ADAMS Accession No. ML013100274). The staff reviewed the proposed USD load factors and load combinations and notes that the proposed equations account for all of the loads in the existing CLB equations and apply appropriate load factors based on guidance in ACI 318-71 and/or ACI 349-97. Combinations one and four use load factors for the design loads in the combination consistent with those in Section 9.2.1 of ACI 349-97, which is in accordance with Section 3.A of SRP Chapter 3.8.4, "Other Seismic Category I Structures," Revision 4.

However, the second and third load combinations (associated with footnote (2) in LAR Table 5) use the existing USAR USD equations for the no loss-of-function condition (extreme condition)

and modify the equation by replacing the differential pressure component with the live load, and the differential temperature component with the soil load. The LAR notes that the resulting equation is "similar" to ACI 318-71 equation 9-2 (the load factors are not the same as equation 9-2). It was unclear to the NRC staff why it is appropriate to modify in this fashion the loads in existing USD equations for extreme load conditions to develop load factors for USD service load combinations; and selectively choosing numerically inconsistent load factor values from later editions of ACI 318 without reconciling with other related code provisions, and/or existing NRC staff positions in the SRP and RG 1.142.

To address this, the NRC staff issued a request for additional information (RAI) dated July 13, 2017 (ADAMS Accession No. ML17194A973), requesting the licensee to justify the proposed load factors associated with USD service load combinations in the second and third equations (associated with footnote (2)) in LAR Table 5. In its RAI response dated September 25, 2017, the licensee stated that the USD methods of ACI 318-63 will be used in combination with the factored load combinations as defined in ACI 318-71. The RAI response updated LAR Table 5 to incorporate the load factors from ACI 318-71 and updated the corresponding footnotes. The response also included an updated USAR markup for USAR Section 5.11.3.4.

The NRC staff reviewed the licensee's response and notes that all of the updated load factors are taken from ACI 318-71. For consistency, the licensee removed the discussion of ACI 349-97 and the SRP from the footnotes associated with load combinations one and four; however, the factors remained the same and align with the factors in ACI 318-71. The staff also notes that the updated load factors, along with the footnotes in LAR Table 5 and in USAR Section 5.11.3.4, account for the design provisions in Section 9.3 of ACI 318-71. The staff finds the licensee's response acceptable because it aligns the USD load equations with the equations in ACI 318-71, which is an acceptable design code, and the response addresses the associated design provisions in Section 9.3 of ACI 318-71.

Based on its review, the NRC staff finds it acceptable for the licensee to use the USD method because the licensee is proposing to use an accepted design method with reasonable load factors and is accounting for all the loading conditions present in the CLB. As noted in Section 5.11.3.4 of the USAR markup, this change only applies to the Auxiliary Building, excluding the foundation mat and the SFP.

3.2 Use Higher Concrete Compressive Strength Based on Original Test Data

3.2.1 Licensee Technical Evaluation

Section 2.3, "Determination of Increased Concrete Compressive Strength Based on Original Test Data," of the LAR states that the Auxiliary Building was originally designed using 4000 pounds per square inch (psi) concrete. The LAR proposes to evaluate the Auxiliary Building using concrete compressive strength of 4500 psi based on actual 28-day test data while meeting the strength testing requirements of the FCS licensing basis concrete building code ACI 318-63, Section 504. This change will only apply to the Auxiliary Building and will not include the SFP, Auxiliary Building exterior walls below 1007 feet elevation or the foundation mat. The process for determining the compressive strength will follow the procedure outlined in ACI 318-63 and will be limited to no greater than the 95 percent confidence level of all test data analyzed. This statistical analysis will be documented in a FCS design basis calculation.

Section 3.2, "Determination of Increased Concrete Compressive Strength Based on Original Test Data," of the LAR states that the quality records from original concrete test data from

construction supports a higher compressive strength. This is based on having 342 sample tests that are applicable to the Auxiliary Building, along with the statistical analysis that was conducted in accordance with ACI 318-63 and summarized in LAR Reference 6.21, "Fort Calhoun Station Calculation FC08499, Evaluation of FCS Concrete Compressive Strength Data" (ADAMS Accession No. ML16165A029).

3.2.2 NRC Staff Evaluation

The NRC staff reviewed the licensee's proposal and notes that the proposed concrete compressive strength will be determined in accordance with a statistical analysis as outlined in the FCS existing design code of record (ACI 318-63). The analysis will be based on 342 sample tests from the Auxiliary Building, which provide a good representation of the concrete used in construction of the Auxiliary Building. Additionally, the new strength value will not be applied to concrete in exterior walls below the 1007-foot elevation or the foundation mat because these areas have been exposed to groundwater, which may have limited the strength gain in these areas.

The statistical analysis has been completed (LAR Reference 6.21, ADAMS Accession No. ML16165A029) and was submitted in response to a request for additional information on a previous FCS LAR which was withdrawn. The NRC staff reviewed the analysis and notes that it was completed on the appropriate concrete test samples that are relevant to the Auxiliary Building and completed in accordance with ACI 318-63. The proposed value of 4500 psi is below the calculated ACI 318-63 limits, as well as the additional licensee imposed conservative limit of the 95 percent confidence level.

Based on the licensee's statistical evaluation of the 342 concrete compressive strength tests associated with the Auxiliary Building, the staff finds it acceptable to increase the concrete compressive strength to 4500 psi. The proposed value of 4500 psi is below the ACI 318-63 limits and the licensee identified limit of the 95 percent confidence level; therefore, there is high confidence that the 4500 psi strength will be met by the concrete in the structure. As noted in Section 5.11.3.8 of the USAR markup, this change only applies to the Auxiliary Building, excluding the foundation mat, exterior walls below the 1007-foot elevation and the SFP.

3.3 Use Higher Reinforcing Steel Yield Strength Values Based on Original Strength Test Data

3.3.1 Licensee Technical Evaluation

Section 3.3, "Determination of Increased Reinforcing Steel Yield Strength Based on Original Test Data," of the LAR states that FCS quality records show that there were 202 heat code samples used in the construction of the Auxiliary Building. Some of the heat code yield stress values could not be identified and 184 of the 202 samples are known. Based on 184 samples specifically used for the Auxiliary Building construction, the 95 percent confidence level is equal to 43.82 ksi for the entire data set. The minimum 95 percent confidence level for each of the individual bar size data sets is equal to 42.02 ksi for #3 bars. As a result, the current design steel yield strength (i.e., 40 ksi) is increased to 42 ksi with high confidence for the Auxiliary Building. Section 2.1.3, "Use of Increased Reinforcing Steel Yield Strength (Use original test data for design basis) – See Section 2.4 for Additional information," of the LAR notes that this proposed change only applies to the Auxiliary Building, excluding the foundation mat and the SFP.

3.3.2 NRC Staff Evaluation

The NRC staff reviewed the licensee's proposed change and notes that the lower limit yield strength for 95 percent of the total population, with 95 percent confidence, is 43.82 ksi. The minimum 95 percent confidence level for each individual bar size is 42.02 ksi for #3 bars. The staff notes that the licensee conservatively used 42 ksi as the value for all rebar in the Auxiliary Building. Based on the licensee's statistical evaluation of the 184 rebar samples associated with the Auxiliary Building, the staff finds it acceptable to increase the rebar steel yield strength to 42 ksi. There is high confidence that the 42 ksi strength will be met by the rebar in the structure. As noted in Section 5.11.3.9 of the USAR markup, this change only applies to the Auxiliary Building, excluding the foundation mat and the SFP.

3.4 Clarification of Hydrostatic Load in the USAR

3.4.1 Licensee Technical Evaluation

In Section 3.4, "Clarification of Hydrostatic Load in the USAR Section 5.11," of the LAR, the licensee stated that, consistent with ACI 349-97, the definition of the controlled hydrostatic load is changed from live load to dead load for ultimate strength design. The definition for dead load was improved by clarifying that controllable fluids are considered dead load instead of a live load. Section 2.1.4, "Clarification of Hydrostatic Load in the USAR – Sect. 2.5 for Additional Information," of the LAR notes the CLB has no discussion of hydrostatic load from controlled fluids (i.e., fluid in tanks) and that this change is considered a clarification that was identified in the LAR only because it is incorporated as part of the other proposed USAR changes.

3.4.2 NRC Staff Evaluation

The NRC staff reviewed the licensee's proposed change and finds it acceptable because it clarifies the existing CLB definition of dead load. The CLB does not currently discuss loads from controlled fluids and this change would make it clear that these loads are treated as dead loads. This aligns with current industry practice and guidance in ACI 349.

3.5 Summary

Based on the technical evaluation outlined above, the NRC staff concludes the following regarding the four requested items in the LAR:

3.5.1 It is acceptable to use the USD method for normal/operating conditions for reanalysis and future changes to the Auxiliary Building as described in Section 5.11.3.4 of the USAR markup. This change is only applicable to the Auxiliary Building and does not include the Auxiliary Building foundation mat or the SFP.

3.5.2 It is acceptable to increase the Auxiliary Building concrete compressive strength from the original design value of 4000 psi to 4500 psi as described in Section 5.11.3.8 of the USAR markup. This change is only applicable to the Auxiliary Building and does not include the Auxiliary Building foundation mat, the SFP, or the Auxiliary Building exterior walls below the 1007-foot elevation.

3.5.3 It is acceptable to increase the value of the reinforcing steel yield strength in the Auxiliary Building from the original design value of 40 ksi to 42 ksi, as described

in Section 5.11.3.9 of the USAR markup. This change is only applicable to the Auxiliary Building and does not include the Auxiliary Building foundation mat or the SFP.

3.5.4 It is acceptable to revise the CLB definition of dead load to include controlled, interior, fluid loads as described in Section 5.11.3.1(a) of the USAR markup.

Therefore, the proposed changes to the CLB as described in the FCS USAR are acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Nebraska State official was notified of the proposed issuance of the amendment on October 4, 2017. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration and there has been no public comment on such finding published in the *Federal Register* on January 17, 2017 (82 FR 4930). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that 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.

Principal Contributor: Bryce Lehman, NRR

Date: November 17, 2017

SUBJECT: FORT CALHOUN STATION, UNIT 1 - ISSUANCE OF AMENDMENT RE: REVISE CURRENT LICENSING BASIS TO USE AMERICAN CONCRETE INSTITUTE ULTIMATE STRENGTH REQUIREMENTS (CAC NO. MF8525; EPID L-2016-LLA-0013) DATED NOVEMBER 17, 2017

DISTRIBUTION:
PUBLIC
PM File Copy
RidsACRS_MailCTR Resource
RidsNrrDeEseb Resource
RidsNrrDorlLspb Resource
RidsNrrLAIBetts Resource
RidsNrrLAJBurkhardt Resource
RidsNrrPMFortCalhoun Resource
RidsRgn4MailCenter Resource
BLehman, NRR

ADAMS Accession No. ML17278A607 *memo dated

OFFICE	NRR/DORL/LSPB/PM	NRR/DORL/LSPB/LAiT	NRR/DORL/LSPB/LA	NRR/DE/ESEB/BC*
NAME	JKim	IBetts	JBurkhardt	BWittick
DATE	10/18/17	10/18/17	10/18/17	10/05/17
OFFICE	OGC - NLO	NRR/DORL/LSPB/BC	NRR/DORL/LSPB/PM	
NAME	JGillespie	DBroaddus	JKim	
DATE	10/31/17	11/16/17	11/17/17	

OFFICIAL RECORD COPY