Omaha Public Power District

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

July 24, 2013
LIC-13-0104

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

References:
1. Docket No. 50-285
2. Letter from OPPD (L. P. Cortopassi) to NRC (Document Control Desk) "Exigent License Amendment Request 13-02 Revise Current Licensing Basis to Adopt a Revised Design Basis / Methodology for Addressing Design-Basis Tornado / Tornado Missile Impact," dated July 21, 2013 (ML13203A136) (LIC-13-0061)
3. Email from NRC (J. M. Sebrosky) to OPPD (B. R. Hansher), "Fort Calhoun Tornado Missile Protection Request for Additional Information (MF2469)," dated July 23, 2013 (ML13205A018) (NRC-13-0089)
4. Email from NRC (J. M. Sebrosky) to OPPD (B. R. Hansher), "Fort Calhoun Tornado Missile Protection Request for Additional Information (MF2469)," dated July 24, 2013 (ML13205A125) (NRC-13-0092)

SUBJECT: Reply to NRC Request for Additional Information (RAI) Regarding Exigent License Amendment Request 13-02 Revise Current Licensing Basis to Adopt a Revised Design Basis / Methodology for Addressing Design-Basis Tornado / Tornado Missile Impact

On July 21, 2013, pursuant to 10 CFR 50.90 and 10 CFR 50.91(a)(6), the Omaha Public Power District (OPPD) submitted an exigent license amendment request (LAR) (Reference 2) proposing to amend Fort Calhoun Station (FCS), Unit No. 1, Renewed Facility Operating License No. DPR-40 by revising the current licensing basis (CLB) pertaining to protection from tornadoes and tornado-generated missiles.

On July 22, and July 23, 2013, teleconferences between representatives of OPPD and NRC Staff were held to discuss the LAR. Following the July 23, 2013 phone call, the NRC emailed (Reference 3) the attached questions. On July 24, 2013, the NRC revised Balance of Plant Branch (SBPB)-RAI 2 (Reference 4). OPPD agreed to respond by July 24, 2013 and hereby submits answers to the NRC questions.

No commitments to the NRC are contained in this submittal.

If you have any additional questions, or require further information, please contact Mr. Bill R. Hansher at (402) 533-6834.

I declare under penalty of perjury that the foregoing is true and correct; executed on July 24, 2013

Sincerely,

Louis P. Cortopassi
Site Vice President and CNO

LPC/JAC/mle

Attachment: OPPD Response to NRC Request for Additional Information
Enclosure: Overlay of 0.5 Mile Radius

c: A. T. Howell, NRC Regional Administrator, Region IV
J. M. Sebrosky, NRC Senior Project Manager
L. E. Wilkins, NRC 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 Response to NRC Request for Additional Information

MECHANICAL AND CIVIL ENGINEERING (EMCB)-RAI-1

Regarding the modification of the current licensing basis (CLB) requirements related to the FCS design basis tornado (DBT) and tornado missiles, the Reference indicates that the guidance of Regulatory Guide (RG) 1.76, Revision 1, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," will be implemented as part of the proposed LAR. Please address the following as they relate to the use of RG 1.76, Revision 1, as part of the proposed LAR:

a. Clarify whether the appropriate DBT and DBT missile input parameters found in RG 1.76, Revision 1, will be applied only to new structures, systems, and components (SSCs) or will apply to both new and existing SSCs.

OPPD Response

The characteristics of the DBT and associated missiles found in RG 1.76, Revision 1 are used in combination with the methodology of Bechtel Topical Report BC-TOP-9A to protect new and existing SSCs. Thus, in accordance with USAR Appendix G, Criterion 2, this ensures the plant can be safely shutdown and maintained in a safe shutdown condition during a DBT.

b. If the RG 1.76, Revision 1, parameters denoted in part a. above will be utilized for existing SSCs, provide a technical justification which demonstrates that the design margins will be maintained for the existing SSCs that must withstand tornado loads (i.e., the ability of these SSCs to withstand a DBT and tornado-generated missile is not reduced as a result of this change).

OPPD Response

This discussion addresses the existing SSCs that are required to withstand tornado loads. The existing SSCs that are included are the containment building and other Class 1 structures (i.e., auxiliary building and intake structure).

Containment – Margin Discussion

The criteria for the containment building design basis are shown below. The critical characteristics that govern the design basis for the containment building are described in USAR Appendix G, Criterion 2 and are summarized as follows:

- 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.
- 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 the 100-year period of recurrence: 90 mph base wind at 30 feet above ground level.

- 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.

By adopting RG 1.76, Revision 1 input missile characteristics combined with the Bechtel Topical Report BC-TOP-9A methodology, the containment design basis does not change. The tornado missile design is not a critical design characteristic for the containment building. The adoption of RG 1.76 does not change any input parameters on the critical design basis characteristics associated with the containment building.

Class I Structures (auxiliary building and intake structure) – Margin Discussion:

OPPD is requesting to adopt RG 1.76, Revision 1 combined with the Bechtel Topical Report BC-TOP-9A methodology as a combined entity and evaluated as a combined entity. These documents are approved by the NRC as an appropriate method for evaluating tornado missiles with a defined margin acceptable to the NRC for safe shut down of nuclear reactors.

Excerpt from NAV DOCKS P-51:

The two methods of analysis given in the paper--one for impact penetration and the other for blast resistance--are adaptable for practical use. No claim is advanced regarding the exactness of either method. However, owing to the many indeterminate factors affecting the conditions of loading and assumptions of behavior, such exactness is neither deemed feasible of attainment nor essential for a practical or adequate solution of the problem.

For the needed brevity, the scope of the paper is limited primarily to design problems of surface structures built of reinforced concrete.

The tornado missile characteristics combined with the methodology (NAV DOCKS P-51) is limited to concrete structures and the margin of the missile characterization (inputs) combined with the methodology (P-51) is not exact. NAV DOCKS P-51 contains assumptions where characteristics are neglected without determining if is conservative to do so; therefore, the design margin established by this methodology is undefined. It is more reasonable to adopt RG 1.76, Revision 1 combined with the Bechtel Topical Report BC-

TOP-9A as the new CLB to establish an updated basis that has been previously accepted by the NRC with a known margin.

c. Confirm that the design margins for the FCS containment structure will be maintained following implementation of the revised tornado loading parameters, including those for tornado-generated missiles.

OPPD Response

As stated in the response to question b, the design margins for the FCS containment structure will be maintained and will not change following the implementation of the revised tornado parameters.

EMCB-RAI-2

The CLB methodology used for evaluating the impacts of tornado missiles at the FCS is documented in NAV DOCKS P-51, August 1950, "Design of Protective Structures (A New Concept of Structural Behavior)." The Reference indicates that the proposed method for determining the impact of tornado missiles on SSCs will be based on Bechtel Power Corporation's Topical Report BC-TOP-9A, Revision 2, September 1974, "Design of Structures for Missile Impact," which was reviewed and approved by the Atomic Energy Commission ((AEC), the predecessor of the NRC). Please address the following as they relate to the use of BC-TOP-9A:

a. Tables 1 and 2 of the Reference provide a comparison between the CLB and RG 1.76, Revision 1, criteria for DBT missiles. Please provide a similar comparison of the key portions of the methodologies used for evaluating missile impacts in both NAV DOCKS P-51 and BC-TOP-9A.

OPPD Response

OPPD is requesting that RG 1.76, Revision 1 and Bechtel Topical Report BC-TOP-9A be evaluated as an entity as they will be adopted into the current licensing basis as a combined entity. Combined together, these documents provide an appropriate methodology for evaluating tornado missiles with a defined margin to assure safe shut down of Fort Calhoun Station during a DBT. NAV DOCKS P-51 contains assumptions where certain characteristics are neglected without determining if it is conservative to do so. As a result, it is difficult to provide a detailed comparison with the Bechtel methodology.

A comparison analysis (OPPD FC07012) looked at several methods and demonstrates that at velocities 200 feet per second (fps) and below, the National Defense Research Council (NDRC) formula proposed in "A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects," by R.P. Kennedy, Nuclear Engineering and Design 1976 provides more conservative results in comparison to NAV DOCKS P-51.

As an example, the following tables compare concrete perforation (Table 1) and scabbing threshold thickness (Table 2) for the CLB 3" pipe missile derived from P-51 methodology versus that derived with the NDRC formula:

Table 1 – Perforation Thickness

Velocity (fps)	P-51 (ft)	NDRC (ft)
50	0.03	0.24
100	0.10	0.42
200	0.39	0.70
300	0.79	0.89
400	1.26	1.03
500	1.75	1.18
600	2.23	1.35
640	2.42	1.42

Table 2 – Scabbing Thickness

Velocity (fps)	P-51 (ft)	NDRC (ft)
50	0.04	0.52
100	0.15	0.80
200	0.58	1.00
300	1.19	1.17
400	1.89	1.33
500	2.62	1.49
600	3.34	1.67
640	3.63	1.76

The tables clearly show that at velocities 200 fps and below, the NDRC formula yields more conservative results than the P-51 methodology. (Note: Table 2 of RG 1.76, Revision 1 states the maximum velocity of the RG 1.76, Revision 1, schedule 40 pipe missile in Region I of the United States where FCS is located is 135 ft/s.) Thus, at lower missile velocities (i.e., those described in RG 1.76, Revision 1), the NDRC formula provides more conservative results than NAV DOCKS P-51. Although not evaluated, the NDRC formula applied to the schedule 40 pipe missile with a greater mass than the CLB missile would also be expected to have more conservative results than NAV DOCKS P-51.

b. Section 4.1.3 of the Reference denotes Section 3.5.3 of the Standard Review Plan ((SRP) or NUREG-0800) as an approved methodology for the design of structures, shields, and barriers for use in nuclear power plants. Discuss the relationship between the criteria and methods found in SRP Section 3.5.3, Revision 3, and the criteria and methods found in BC-TOP-9A.

OPPD Response

Section 4.1.3 references NRC approved methodologies pertaining to tornadoes and tornado missiles for the convenience of NRC reviewers. A comparison of NUREG 0800 (SRP) Section 3.5.3 to Bechtel Topical Report BC-TOP-9A is as follows:

SRP Acceptance Criteria

1. *For Local Damage Prediction*

A. *Concrete*

Sufficient thickness of concrete should be provided to prevent perforation, spalling, or scabbing of the barriers in the event of missile impact.

OPPD is using the criteria that the missiles shall not penetrate concrete structures. Secondary missiles from scabbing are evaluated and meet the requirements of the SRP.

For local behavior of concrete design, Section 3.5.3 of the SRP states that a paper by Kennedy should be utilized for estimating penetration of a missile into concrete. Section 2.2.1 of the Kennedy paper discusses the modified Petry formula as one common approach; this is the approach adopted by BC-TOP 9A.

"A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects", R.P. Kennidy, 1976 is a paper that discusses the difference between the NDRC (1946) and what is considered the Modified NDRC (1976) method. The main difference is a combination of equations in the NDRC that allows extrapolateion of the slab thickness to the projectile diameter ratios less than three without leading to unreasonable results. BC-TOP-9A is not subject to this condition for slab evaluations.

B. *Steel*

The results of tests conducted by the Stanford Research Institute (SRI) on the penetration of missiles into steel plates are summarized in "U.S. Reactor Containment Technology" (ORNL/NSIC-5, Vol.1, Chapter 6, Oak Ridge National Laboratory, 1965) by W.B. Cottrell and A.W. Savolainen. The equations presented in aforementioned document are acceptable. Other equations such as the Ballistic Research Laboratory formula described in, "Reactor Safeguards," by C. R. Russell, published by MacMillan, New York, 1962, may be used, provided the results are either comparable to those obtained by using the aforementioned "U.S. Reactor Containment Technology" method or are validated by penetration tests.

OPPD uses the steel design from the Bechtel Topical Report BC-TOP-9A for steel barriers and uses steel allowable ductilities from AISC N690 (1994).

C. Composite Sections

For composite or multi-element barriers, procedures for prediction of local damage are acceptable if the residual velocity of the missile perforating the first element is considered as the striking velocity for the next element.

OPPD uses a multi barrier approach for items such as metal on a concrete floor with a 2 inch topping to eliminate scabbing.

2. For Overall Damage Prediction

To prepare an evaluation in compliance with BC-TOP-9A, the analysis looks at the specific penetration requirements and a second residual affect on the overall concrete structure element.

Balance of Plant Branch (SBPB)-RAI 1

Regulatory Guide (RG) 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants", states that "the automobile missile is considered to impact at all altitudes less than 30 feet (9.14 meters) above all grade levels within 0.5 miles (0.8 kilometers) of the plant structures." As stated in the license amendment request (LAR), the grade levels within 0.5 miles of the plant structures are as high as 1,070 feet mean sea level (MSL). Per the direction of RG 1.76, an automobile missile from this elevation must be postulated to impact the auxiliary building roof at elevation 1,044 MSL. The licensee has proposed to eliminate this impact by implementing procedural controls that will prevent automobiles from being staged at or crossing through elevations high enough to require postulating an impact with the auxiliary building roof during severe thunderstorm warnings and tornado watches/warnings. In order to determine the acceptability of this departure from RG 1.76, the staff requires the following information:

a. Is the impact of an automobile missile with the auxiliary building roof the only interaction that is being eliminated by procedural controls?

OPPD Response

Yes, the impact of an automobile missile on the auxiliary building roof is the only interaction that is being eliminated by removing the potential for automobiles to be on the entrance road during a severe thunderstorm warning, tornado watch, or tornado warning. As an additional precaution, Abnormal Operating Procedure (AOP)-01, *Acts of Nature* also requires fuel movement to be suspended during these same conditions.

b. Identify any structures, parking areas, storage locations, staged equipment, or access roads located with a grade elevation sufficient to require the postulation of an automobile impact with the auxiliary building roof. How will these areas be controlled such that no automobile or equipment of similar mass and dimensions will be located within these areas?

OPPD Response

In addition to the main access road to the plant, there is a gravel road leading from the switchyard to the old steam generator storage building and up the hill to gravel parking lots located near Highway 75. These lots were created to provide parking in response to the 2011 flood. Currently, the parking lots are not used. In order to prevent unauthorized automobile access to the parking lots, chains or barriers will be placed at the entrance to the south lot (the only entrance to the north lot) and on the gravel road leading to the gravel parking lots from the switchyard. No other areas onsite pose a risk to the auxiliary building roof.

c. The LAR states the entrance road runs from Highway 75 to the protected area. Does Highway 75 pass through the 0.5 mile radius of the plant structures?

OPPD Response

No. As shown on the enclosed figure, Highway 75 is not within the 0.5 mile radius. The 0.5 mile radius is from the corner of the auxiliary building closest to Highway 75. The area between the 0.5 mile radius and the green line is the potential threat to the roof above the spent fuel pool at 1,083' MSL. The area between the 0.5 mile radius to the orange line is the potential threat to the non-radiologically controlled area of the auxiliary building roof above Room 81 at 1,057' MSL. The area between the 0.5 mile radius to the pink line is the potential threat to the auxiliary building roof above Room 69 at 1,044' MSL.

d. The site entrance road must be closed in the event of a severe thunderstorm warning or tornado watch/warning. Are personnel regularly stationed at the access control point such that the site entrance road can be closed promptly upon receipt of a weather notification?

OPPD Response

Yes. The access control point is currently staffed at all hours. AOP-01 is entered and security procedures are implemented to complete the necessary tasks, including opening the alternate access route.

e. Are the procedural controls intended to be permanent to the facility? The LAR indicates that the analysis of the impact of an automobile missile with the auxiliary building roof is ongoing. Will the auxiliary building roof be reinforced if the analysis determines that the structure is not sufficient to withstand this impact?

OPPD Response

The intention is to keep the procedural controls in place until they are no longer necessary. For example, if the access road south of the plant at a much lower elevation than the current road was made the permanent access road, the auxiliary building roof would not be a target for automobiles traversing it and procedural controls would be unnecessary. The impact of the automobile will be assessed but it is not the intention to provide additional reinforcement of the auxiliary building roof for a potential automobile missile.

f. Are there any components important to safety located on the auxiliary building roof (exposed)? If so, are these components protected against the pipe and steel sphere missiles identified in RG 1.76?

OPPD Response

There are a few components important to safety on the roof that would be susceptible to tornado missiles (specifically the control room air condensing units and the auxiliary feedwater pump FW-10 and diesel generator exhaust stacks). There are also several roof penetrations that allow a missile to bypass the roof structure where the missile could impact safe shutdown equipment. Those components important to safety on and below the auxiliary building roof, and which are vulnerable to vertical missiles are being protected against the RG 1.76, Revision 1, pipe missile and the 1" sphere.

Balance of Plant Branch (SBPB)-RAI 2

The proposed addition of Section 2.5.2.8, "Tornadoes", to the Fort Calhoun Station, Unit 1, USAR states, "At Fort Calhoun Station, designated SSCs [systems structures and components] are designed or protected to withstand the effects of the RG 1.76, Revision 1 DBT [design basis tornado] without losing the capability to perform their safety function. This ensures that the plant can be safely shutdown and maintained in a safe shutdown condition during a tornado." It is not clear what is meant by the term "designated equipment". In the July 21, 2013, license amendment request is OPPD proposing a change to its current licensing basis regarding the SSCs that are protected against DBT and DBT generated missiles?

OPPD Response

OPPD is proposing to update the methodology for evaluating tornadoes and tornado missiles to use more current NRC guidance (i.e., RG 1.76, Revision 1) regarding the characteristics of the DBT and its associated missiles and apply that guidance to analyze and where necessary, design and install protective barriers using NRC-approved methodology (i.e., Bechtel Topical Report BC-TOP-9A). OPPD is not proposing a change to the current licensing basis regarding equipment required to be protected during a tornado. In accordance with USAR Appendix G, Criterion 2, OPPD will continue to protect equipment that is required to ensure that the facility can be safely shutdown and maintained in a safe shutdown condition during a tornado. The equipment necessary to achieve and maintain safe shutdown is what is meant by the term "designated equipment" or "designated SSCs."