3.3 Wind and Tornado Loadings

Seismic Category I structures are designed to withstand the effects of wind and tornado loadings. A combined license (COL) applicant that references the U.S. EPR design certification will determine site-specific wind and tornado characteristics and compare these to the standard plant criteria. If the site-specific wind and tornado characteristics are not bounded by the site parameters, postulated for the certified design, then the COL applicant will evaluate the design for site-specific wind and tornado events and demonstrate that these loadings will not adversely affect the ability of safety-related structures to perform their safety functions during or after such events.

3.3.1 Wind Loadings

The U.S. EPR wind pressure loads are determined in conformance with ASCE/SEI Standard 7-05, "Minimum Design Loads for Buildings and Other Structures" (Reference 1). A COL applicant that references the U.S. EPR design certification will demonstrate that failure of site-specific structures or components not included in the U.S. EPR standard plant design, and not designed for wind loads, will not affect the ability of other structures to perform their intended safety functions.

3.3.1.1 Design Wind Velocity

The design basic wind speed is a 3-second gust speed at 33 feet above ground. The basic wind speed (V) is 145 mph in open terrain, exposure category C associated with a 50-year mean recurrence interval. The basic wind speed is increased by an importance factor of 1.15 to obtain a 100-year mean recurrence interval for the design of safety-related and quality-related structures.

3.3.1.2 Determination of Applied Wind Forces

Wind velocity is converted into an effective pressure to be applied to surfaces of structures in conformance with Reference 1.

Effective wind design velocity pressure (q_z) on structural elements is calculated in conformance with Reference 1, Equation 6-15, as follows:

$$q_z = 0.00256\, K_z\, K_{zt}\, K_d\, V^2\, I \text{ (lb/ft}^2\text{)},$$

Where:

q_z = velocity pressure in pounds per square foot at height "z".

K_z = velocity pressure exposure coefficient at height "z" for Exposure Category C, which is determined in conformance with Reference 1,Table 6-3, but not less than 0.87.

K_{zt} = topographic factor = 1.0 for U.S. EPR standard plant design.

K_d = wind directionality factor = 1.0 for U.S. EPR standard plant design.

V = basic wind speed in miles per hour = 145 mph.

I = importance factor = 1.15 for safety-related and quality-related structures, systems and components (SSC). The importance factor is used to adjust the velocity pressure, q_z, to the appropriate 100-year mean recurrence interval for design of safety-related and quality-related SSC.

Effective pressure loads on structural elements and members are determined in conformance with the applicable requirements of Reference 1, Sections 6.5.12 through 6.5.15. Gust factors are applied in accordance with requirements of this standard.

ASCE paper No. 3269, "Wind Forces on Structures" (Reference 2) is used to determine the external pressure coefficients for distribution of wind pressures around the circumferences of the Reactor Shield Building and the vent stack.

3.3.2 Tornado Loadings

Seismic Category I structures are designed to resist tornado loadings and remain functional during and following a tornado event. In addition, Non-Seismic Category I structures, that have the potential to interact with Seismic Category I structures are evaluated to demonstrate they do not affect Seismic Category I structures under tornado load conditions. Tornado loads are applied to the roofs and exterior walls of such structures. For Radwaste Seismic Structures, classified as RW-IIa per RG 1.143, additional tornado loadings also apply, as specified in RG 1.143.

A COL applicant that references the U.S. EPR design certification will demonstrate that failure of site-specific structures or components not included in the U.S. EPR standard plant design, and not designed for tornado loads, will not affect the ability of other structures to perform their intended safety functions.

Tornado loads include loads caused by the tornado wind pressure (W_w), tornado atmospheric pressure change effect (W_p), and tornado-generated missile impact (W_m). One hundred percent of the design live load is considered with tornado load combinations. Refer to Section 3.8 for loading combinations and acceptance criteria for tornado loads considered in combination with other loads. Refer to Section 3.5 for a description of tornado wind-generated missile loads and design criteria.

Local damage, such as cracking and spalling of concrete and permanent deformation of structural members and elements, is permissible when structures are designed for tornado missile impact loads, provided that Seismic Category I structures remain functional during and subsequent to the missile strike. Structural integrity is demonstrated for all Seismic Category I structures as a result of a tornado wind-

generated missile impact analysis, see Section 3.5.1.4. No adverse effects, such as concrete spalling and cracking, occur as a result of secondary missiles.

3.3.2.1 Applicable Tornado Design Parameters

The following parameters, determined in conformance with RG 1.76, are used for the design basis tornado:

- Radius of maximum rotational speed = 150 ft.
- Maximum wind speed = 230 mph.
- Maximum rotational speed = 184 mph.
- Maximum translational speed = 46 mph.
- Maximum pressure drop = 1.2 psi.
- Rate of pressure drop = 0.5 psi/s.

The design basis tornado for the U.S. EPR standard plant design is selected for a worst-case site in the contiguous United States, and represents a probability of exceedance of 1×10^{-7} per year.

3.3.2.2 Determination of Tornado Forces on Structures

Tornado wind velocity is converted into effective pressure loads in accordance with Reference 1 and with guidance provided in NUREG 0800, SRP Section 3.3.2.

Effective tornado wind velocity pressure, q_z, is calculated as follows:

$$q_z = 0.00256\ K_z\ K_{zt}\ K_d\ V^2\ I\ (\text{lb/ft}^2),$$

Where:

q_z = velocity pressure in pounds per square foot at height "z."

K_z = 0.87, tornado wind velocity pressure is considered constant with height.

K_{zt} = 1.0, a topographic factor of unity is used because tornado maximum wind speed is not determined based on site topography.

K_d = 1.0, a wind directionality factor of unity is used.

V = 230 mph, tornado maximum wind speed in miles per hour.

I = 1.15, importance factor.

Effective tornado wind pressure loads (W_w) on exterior surfaces of structural elements and members are determined in conformance with the applicable requirements of Reference 1, Sections 6.5.12 and 6.5.13. Gust factors are taken as unity for tornado wind.

Tornado atmospheric pressure change effect parameters (W_p) and tornado-generated missile impact parameters (W_m) are in conformance with RG 1.76.

The following combinations of the parameters of the total tornado load (W_t) are evaluated in the design of Seismic Category I structures and Seismic Category II structures, where W_w is the load from tornado wind effect, W_p is the load from tornado atmospheric pressure change effect, and W_m is the load from tornado missile impact effect:

$$W_t = W_p$$

$$W_t = W_w + 0.5W_p + W_m$$

Exterior walls and roofs of Seismic Category I structures are designed for the maximum differential pressure of 1.2 psi. When the tornado pressure boundary is not established by exterior walls or roofs, the differential pressure is taken as zero.

3.3.2.3 Interaction of Non-Seismic Category I Structures with Seismic Category I Structures

The non-Seismic Category I structures that are adjacent to the Seismic Category I Nuclear Island Common Basemat Structure, Emergency Power Generation Buildings (EPGB), and Essential Service Water Buildings (ESWB) include the Nuclear Auxiliary Building (NAB), Radioactive Waste Building (RWB), Access Building (ACB), and Turbine Building (TB). Figure 3B-1 provides a site plan of the U.S. EPR standard plant showing the plant layout.

The NAB is a non-Seismic Category I structure. However, due to the proximity of this structure to Seismic Category I structures, there is potential for tornado wind load induced interaction. Therefore, this structure is analyzed using RG 1.76 tornado wind characteristics and designed to the codes and standards associated with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure with the exception of sliding and overturning criteria. Because the NAB does not have a safety function, the NAB may slide or uplift provided that the gap between the NAB and any Category I structure is adequate to prevent interaction.

The ACB, and TB are non-Seismic Category 1 structures. However, due to proximity of these structures to Seismic Category 1 structures there is a potential for tornado wind load induced interaction. [[Therefore, these structures are analyzed using RG 1.76 tornado wind characteristics and designed to the codes and standards associated

with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure with the exception of sliding and overturning criteria. Because the ACB, and TB do not have a safety function, they may slide or uplift provided that the gap between them and any Category I structure is adequate to prevent interaction.]]

The RWPB is a reinforced concrete shear wall structure designed for tornado loading per RG 1.143 due to its classification as a RW-IIa structure. The NAB is a reinforced concrete structure located between the RWPB and the NI. Both the RWPB and the NAB are designed using the codes associated with Category I structures, resulting in inherently robust designs. Therefore, there is no potential for indirect interaction between the RWPB and the NI structures. Potential interaction between the RWB and the EPGB is precluded by separation and design. The RWB is embedded over 31.5 ft below grade and has a clear height above grade of 52.5 ft; whereas, the clearance between the two structures is 52.06 ft.

3.3.3 References

1. ASCE/SEI Standard 7-05, "Minimum Design Loads for Buildings and Other Structures," American Society of Civil Engineers/Structural Engineering Institute, 2005.

2. ASCE paper No. 3269, "Wind Forces on Structures," Transactions of the American Society of Civil Engineers, Vol. 126, Part II, 1961.

3. Deleted.

4. Deleted.

5. Deleted.

[redacted]