## 3.3 Wind and Tornado Loadings

All seismic Category I and II structures, systems, and components (SSCs), except those not exposed to wind, are designed for wind and tornado/hurricane loadings.

### 3.3.1 Wind Loadings

The design wind loadings on the surfaces of seismic Category I and II SSCs subject to wind are determined in accordance with ASCE/SEI 7-05 (Reference 1).

Load combinations including wind loads are discussed in Section 3.8.

#### 3.3.1.1 Design Wind Velocity and Recurrence Interval

The 50-year 3-second wind gust speed of 64.8 m/s (145 mph) corresponds to the wind speed at 10 m (33 ft) above ground for exposure Category C (open terrain), as defined in Section 6.5.6.3 of ASCE/SEI 7-05 (Reference 1). A recurrence interval of the design wind speed is 50 years with a 0.02 annual probability of being exceeded.

The design wind speed specified for the APR1400 standard plant covers most of the contiguous United States based on the basic wind speed map provided in Figure 6-1 of ASCE/SEI 7-05 (Reference 1).

The COL applicant is to demonstrate that the site-specific design wind speed is bounded by the design wind speed of 64.8 m/s (145 mph) (COL 3.3(1)).

#### 3.3.1.2 Determination of Applied Forces

Wind pressure on the surfaces of the seismic Category I and II SSCs is determined in accordance with Equation (6-15) of ASCE/SEI 7-05 (Reference 1). The wind directionality factor ($K_d$), velocity pressure exposure coefficient ($K_z$), and topographic factor ($K_{zt}$) are defined in SRP 3.3.1 and comply with the provisions given in SRP 3.3.1. For seismic Category I and II SSCs, an importance factor (I) of 1.15 is used in order to be compatible with the recurrence interval of 100 years. Exposure category D is applied in determining wind loads regardless of the site location.

The wind pressures and forces on the surfaces of seismic Category I and II SSCs are determined based on one of the methods provided in ASCE/SEI 7-05.

All non-safety-related facilities subject to winds are designed using the same design wind speed and methodology applied to seismic Category I SSCs except the load combinations. A wind-loading-caused full or partial failure of seismic Category II SSCs adjacent to seismic Category I SSCs does not affect the ability of the seismic Category I SSCs to perform their intended safety functions. Otherwise, the seismic Category I SSCs are designed to maintain their integrity from the failure of seismic Category II SSCs.

The COL applicant is to demonstrate that the site-specific seismic Category II SSCs adjacent to seismic Category I SSCs are designed to meet the provisions described above (COL 3.3(2)).

### 3.3.2 Tornado Loadings

The APR1400 standard and site-specific plant is designed to protect SSCs listed in the Appendix to NRC Regulatory Guide (RG) 1.117 (Reference 2) from tornadoes and hurricanes. All seismic Category I and II SSCs subject to tornado and hurricane winds are designed to meet the acceptance criteria described in Section 3.8.

#### 3.3.2.1 Applicable Design Parameters

As provided in Table 2.0-1, the design basis tornado parameters are the same as those of Region I and categorized in NRC RG 1.76 (Reference 3). The annual probability of exceedance of the design basis tornado described above is $10^{-7}$, and the corresponding recurrence interval is approximately 10 million years.

The maximum wind speed of design basis hurricane is 116 m/s (260 mph) from the wind speed contour maps for hurricane-prone regions of the contiguous United States presented in NRC RG 1.221 (Reference 4). The annual probability of exceedance of the design basis hurricane is $10^{-7}$. The wind speed is nominal 3-second peak gust at a height of 10 m (33 ft) in flat open terrain.

The seismic Category I and II SSCs subject to extreme winds such as the design basis tornado or design basis hurricane are designed individually for the postulated extreme winds enveloping both the design basis tornado and design basis hurricane in terms of straight winds and wind-borne missiles. The pressure drop effects due only to the design basis tornado are combined with the design basis hurricane loadings, as described in Subsection 3.3.2.2.4.

### 3.3.2.2 Determination of Forces on Structures

The forces on seismic Category I and II SSCs due to the postulated extreme winds are obtained using methods outlined in Subsection 3.3.1.2. The missile barriers of the seismic Category I structures are designed based on the missiles listed in Table 3.5-2. The design method of missile barriers is presented in Subsection 3.5.3. The pressure drop effects due to the design basis tornado are determined using the guidance provided by E. Simiu et al. (Reference 5). The loading combinations associated with the postulated extreme wind loadings are described in Tables 3.8-2, 3.8-9A, and 3.8-9B.

#### 3.3.2.2.1 Hurricane Velocity Forces

Velocity forces due to the postulated extreme winds are determined using the approach described in Subsection 3.3.1.2 in conjunction with an importance factor (I) of 1.15 in accordance with SRP 3.3.2.

#### 3.3.2.2.2 Hurricane Missile Effects

The missile barriers of seismic Category I structures are designed in accordance with the missile spectrum identified in Table 3.5-2. The missile barriers are designed to prevent the penetration, perforation, and withstand scabbing effects due to the hurricane missiles, as described in Subsection 3.5.3.

#### 3.3.2.2.3 Tornado Pressure Drops

Pressure drop effects during the design-basis tornado are evaluated based on the enclosure category of seismic Category I and II SSCs, as applicable. Vented or partially enclosed

and enclosed buildings are designed to withstand the pressure drop while pressure drop effects are not considered in the interior of unvented structures.

3.3.2.2.4 Combined Extreme Wind Effects

The loading combinations of the individual extreme wind loading components are in accordance with SRP 3.3.2. The total extreme wind load $W_t$ used in the load combinations described in Section 3.8. is determined for the combined effects using the following relationships:

$$W_t = W_w$$

$$W_t = W_p$$

$$W_t = W_m$$

$$W_t = W_w + 0.5\ W_p$$

$$W_t = W_w + W_m$$

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

Where:

$W_t$ = total extreme wind load

$W_w$ = load from hurricane wind effect

$W_p$ = load from tornado atmospheric pressure change effect

$W_m$ = load from hurricane missile impact effect

Pressure drop effects due only to the design-basis tornado are combined with the design basis hurricane loadings.

3.3.2.3 Effect of Failure of Structures or Components Not Designed for Extreme Wind Loads

Failure of any SSCs not designed for postulated extreme wind loads does not affect the capability of safety-related SSCs to perform their intended safety functions.

The non-safety-related SSCs not designed for extreme wind loads are evaluated and designed using one of the following methods:

a. Designing the SSCs with seismic Category II designation and adjacent to seismic Category I SSCs to wind, and tornado/hurricane loadings

b. Investigating the effect of adjacent structural failure on seismic Category I SSCs to provide reasonable assurance that the ability of the seismic Category I SSCs to perform their intended safety functions is not impacted or affected

c. Designing and providing a structural barrier to protect seismic Category I SSCs from adjacent structural failure

The COL applicant is to provide reasonable assurance that site-specific structures and components not designed for extreme wind loads do not impact either the function or integrity of adjacent seismic Category I SSCs (COL 3.3(3)).

### 3.3.3 Combined License Information

COL 3.3(1) The COL applicant is to demonstrate that the site-specific design wind speed is bounded by the design wind speed of 64.8 m/s (145 mph).

COL 3.3(2) The COL applicant is to demonstrate that the site-specific seismic Category II structures adjacent to the seismic Category I structures are designed to meet the provisions described in Subsection 3.3.1.2.

COL 3.3(3) The COL applicant is to provide reasonable assurance that site-specific structures and components not designed for the extreme wind loads do not impact either the function or integrity of adjacent seismic Category I SSCs.

### 3.3.4 References

1. ASCE/SEI 7-05, “Minimum Design Loads for Buildings and Other Structures,” American Society of Civil Engineers/Structural Engineering Institute, 2006.

2. NRC RG 1.117, "Tornado Design Classification," Nuclear Regulatory Commission, April 1978.

3. NRC RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Rev. 1, Nuclear Regulatory Commission, March 2007.

4. NRC RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," Nuclear Regulatory Commission, October 2011.

5. E. Simiu and R.H. Scanlan, "Wind Effects on Structures: Fundamentals and Applications to Design," John Wiley & Sons, Inc., New York, 3rd Edition, 1996.