3.3 WIND AND TORNADO LOADINGS

3.3.1 WIND LOADINGS

All exposed structures are designed for wind loading.

3.3.1.1 Design Wind Velocity

The design wind velocity for all structures is 80 mph at 30 ft above ground for a 100-year recurrence interval. The design wind velocity is based on Figure 5 of Reference 3.3-1. (References are listed in Subsection 3.3.3.)

The vertical velocity distribution is based on Table 1(a) of Reference 3.3-2. The velocity distribution is tabulated in Table 3.3-1.

A gust factor of 1.1, as given in Reference 3.3-2, is used.

3.3.1.2 Determination of Applied Forces

The procedure used to transform the wind velocity into an effective pressure applied to exposed surfaces of structures is as described in Reference 3.3-2 and is summarized as follows:

The dynamic pressure is given by:

$q = 0.002558\ V^2$ where,

q = Dynamic pressure in psf

V = Wind velocity in mph (design wind velocity x gust factor).

The local pressure at any point on the surface of a building is equal to:

$$q \times Cp$$

Where

Cp = Pressure coefficient.

The total pressure on a building is equal to:

$$q \times C_D$$

Where,

C_D = Shape coefficient.

The Susquehanna SES structures have sloping roofs with a pitch less than 20 degrees. The following are values for Cp and C_D. (See Reference 3.3-2, p. 1151 and Figure 7.)

Cp for windward wall = 0.8 (pressure)

Cp for leeward wall = -0.5 (suction)

Cp for windward slope = 0

Cp for leeward slope = -0.6 (suction)

C_D = 1.3 (pressure).

Wind loads on structures are tabulated in Table 3.3-1.

Exposed tanks are designed to resist a minimum wind load of 30 psf on the vertical projection, based on Reference 3.3-3. For cylindrical tanks, wind is considered acting on six-tenths of the vertical projection. No increases in allowable working stresses are permitted for these structures for loading conditions involving wind.

3.3.2 TORNADO LOADINGS

Table 3.3-2 lists the systems that are protected against tornadoes and the enclosures which provide this protection. This table is based on NRC Regulatory Guide 1.117 (Reference 3.3-4).

3.3.2.1 Applicable Design Parameters

The following design parameters are used for the design of tornado-resistant structures and are based on Reference 3.3-5:

a) Dynamic Wind Loading

Tangential speed: 300 mph
Translational speed: 60 mph

These speeds apply to all tornado-resistant structures except the Diesel Generator 'E' Building where a tangential speed of 290 mph and a translational speed of 70 mph are used.

b) Pressure Differential Between the Inside and Outside of a Building

A pressure drop of 3 psi is applied. A rate of 1 psi per second is used for all tornado-resistant structures except the Diesel Generator 'E' building where a rate of 2 psi per second is used.

c) Tornado-Generated Missiles

These are discussed in Subsection 3.5.1.4.

3.3.2.2 Determination of Forces on Structures

The following procedures are used to transform the tornado loadings into effective loads on structures:

a) Dynamic Wind Loading

A procedure the same as the one utilized to transform the wind velocity into an effective pressure, as described in Subsection 3.3.1.2, is used with the following exceptions:

1) Velocity and velocity pressure are assumed not to vary with height.
2) The gust factor is taken as unity.

As shown in Figure 5 of Reference 3.3-5, and as explained therein, the equivalent uniform tornado wind velocity on the building due to a tangential component of 300 mph and a translational component of 60 mph is 220 mph. The pressure loads are calculated on the basis of a uniform 300 mph wind velocity for all tornado-resistant structures except the Diesel Generator 'E' Building where they are calculated using a 360 mph wind velocity. The pressure loads are as follows:

	For All Tornado-Resistant Structures Except the Diesel Generator 'E' Bldg.	For the Diesel Generator 'E' Bldg.
Windward pressure on walls:	185 psf	266 psf
Leeward suction on walls:	115 psf	166 psf
Total design pressure:	300 psf	432 psf
Suction (uplift) on roof:	140 psf	199 psf

"The turbine building is designed to resist the tornado loading assuming 2/3 of the metal siding and the roof deck being blown away. However, all the frames are designed for the full tornado loading. The metal siding and the roof deck of all structures are not designed to resist full tornado loading."

b) Differential Pressure Loading

Differential pressure loading is calculated using the following pressure-time function:

The differential pressure is assumed to vary from zero to 3 psi, remain at 3 psi for 2 seconds and then return to zero. A rate of 1 psi per second is used for all tornado-resistant structures except the Diesel Generator 'E' building where a rate of 2 psi per second is used.

Blowout panels are used as necessary on safety-related structures to minimize differential pressure.

c) Tornado-Generated Missiles

Tornado-generated missiles used in the design of the tornado-resistant structures are given in Table 3.5-4 except those missiles used in the design of the Diesel Generator 'E' Building which are given in Table 3.5-4a. The barrier design procedures are described in Subsection 3.5.3.

Loadings a), b), and c) are combined in the following manner to obtain the total tornado loading:

(i) W' = Ww
(ii) W' = Wp
(iii) W' = Wm
(iv) W' = Ww+0.5Wp
(v) W' = Ww+Wm
(vi) W' = Ww+0.5Wp+Wm

Where,

W' = Total tornado load
Ww = Tornado wind load
Wp = Tornado differential pressure load, and
Wm = Tornado missile load

3.3.2.3 Effect of Failure of Structures or Components Not Designed for Tornado Loads

Structures not designed for tornado loads are checked to ensure that during a tornado they will not generate missiles that have more severe effects than those listed in Table 3.5-4. The modes of failure of these structures are analyzed to verify that they will not collapse on safety related structures.

3.3.2.4 Safety-Related Equipment Not Protected By Reinforced Concrete

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

SECURITY-RELATED INFORMATION. TEXT WITHHELD UNDER 10 CFR 2.390

3.3.3 REFERENCES

3.3-1. H. C. S. Thom, "New Distributions of Extreme Winds in the United States," Journal of the Structural Division, ASCE (July 1968), p. 1787.

3.3-2. "Wind Forces on Structures", ASCE Paper No. 3269, Transactions, Volume 126, Part II (1961), p. 1124.

3.3-3. "Steel Tanks, Standpipes, Reservoir, and Elevated Tanks for Water Storage," AWWA Standard, D100-73.

3.3-4. "Tornado Design Classification," US NRC Regulatory Guide 1.117, (June 1976).

3.3-5. J. A. Dunlap and Karl Wiedner, "Nuclear Power Plant Tornado Design Considerations," Journal of the Power Division, ASCE, (March 1971).

3.3-6 "Design Basis Tornado For Nuclear Power Plants," US NRC Regulatory Guide 1.76, (April 1974).

TABLE 3.3-1

WIND LOADS ON STRUCTURES

Height Zone	Basic Wind Velocity	Dynamic Pressure	Wall Load		Total Design	Roof Load
			Windward Pressure	Leeward Suction	Pressure	Suction
(ft)	(mph)	q(psf)	0.8q	0.5q	1.3q	.6q
0-50	80	20	16	10	26	12
50-150	95	30	24	15	39	18
150-400	110	40	32	20	52	24
400-700	120	45	36	23	59	27

TABLE 3.3-2

TORNADO WIND PROTECTED SYSTEMS AND TORNADO RESISTANT ENCLOSURES

	Protected System	Tornado Resistant Enclosure
1.	Reactor coolant pressure boundary	Reactor Building
2.	Reactor core and reactor vessel internals	Reactor Building
3.	Systems or portions of systems required for	
	a) Reactor shutdown	Reactor Building
	b) Residual Heat Removal	Reactor Building
	c) Cooling the spent fuel storage pool	Reactor Building
	d) Makeup water for primary system	Reactor Building
	e) Systems necessary to support service water, cooling water source, and component cooling	ESSW Pumphouse and Reactor Building
4.	Reactivity control systems	Reactor Building and Control Building
5.	Control room	Control Building
6.	Monitoring, actuating, and operating systems important to safety	Reactor Building and Control Building
7.	Electric and mechanical devices and circuitry between the process sensors and the input terminals of the actuator systems involved in generating signals that initiate protective action	Reactor Building, Diesel Generator Buildings, and ESSW Pumphouse

TABLE 3.3-2 (Continued)

	Protected System	Tornado Resistant Enclosure
8.	Long-term emergency core cooling system	Reactor Building, Diesel Generator Buildings, and ESSW Pumphouse
9.	Class 1E electric systems	All Seismic Category I structures