Best Practices in Literature Review for the 10 Year Extreme Wind Update at the DOE Pantex Site

Presented by

B&W technical services Pantex

Pro2Serve® Professional Project Services, Inc.

EKU™

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DOE Standards

- DOE O 420.1 – Basis of Requirements
- DOE 1020 – Soon to be updated
- Development of several ANS consensus codes have replaced several older DOE standards

New DOE 1020 for Wind

NPH Analysis and Design Process

- Step 1: Establish performance requirements for SSCs
- Step 2: Calculate maximum NPH demands on SSCs resulting from NPH Events
- Step 3: Design of SSCs to ensure their ability to maintain required functionality

ANSI/ANS – 2.3 - 2011

Scope

Establishes guidelines to estimate the frequency of occurrence and the magnitude of parameters associated with rare meteorological events such as tornadoes, hurricanes, and extreme straight line winds at nuclear facility sites within the continental United States

Wind Hazard Analysis

- Straight Line Winds
- Tornadic Winds
- Hurricane Winds
- Atmospheric Pressure Change
- Wind Generated Missiles

Straight Line Winds

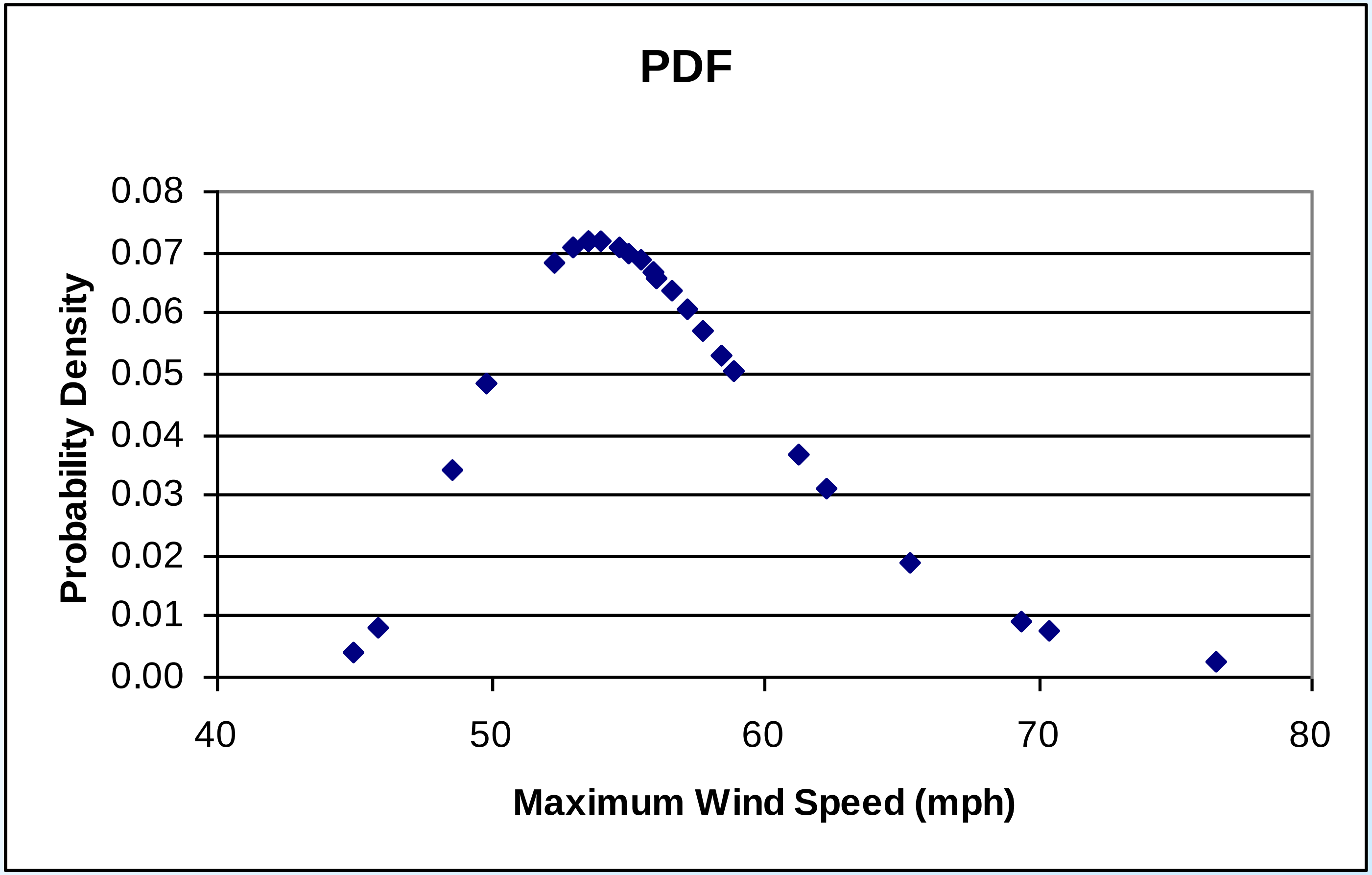
- Use of Regionalized Data
- Localized Analysis??
- Data Collection
  - 33 feet elevation
  - 3 second gust

Analysis of Wind Data

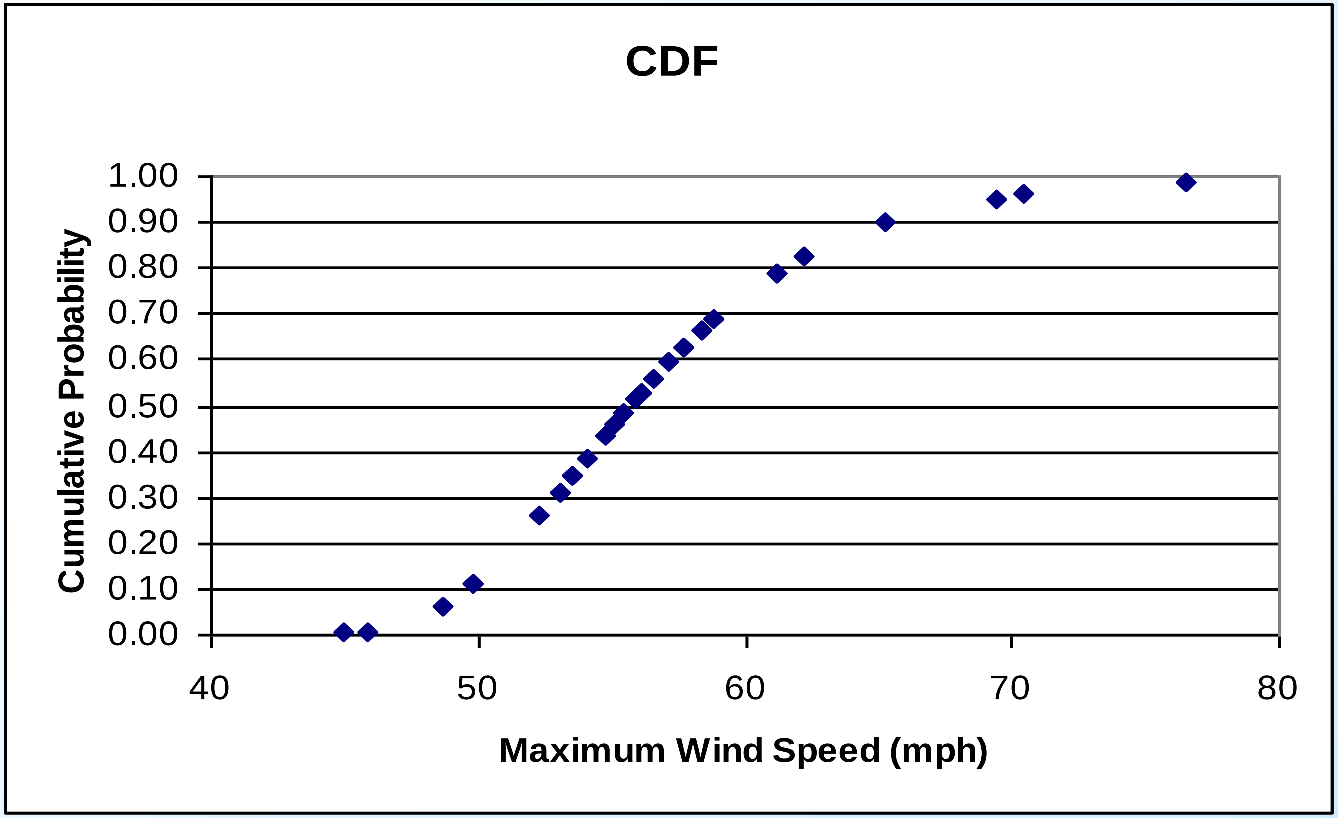
Fisher-Tippett Type I (Gumbel) distribution shall be used

- Generalized Extreme Value Distribution
  - NIST Statistical Engineering Division
  - NIST e-Handbook of Statistics
  - Coats and Murray (A little dated…)

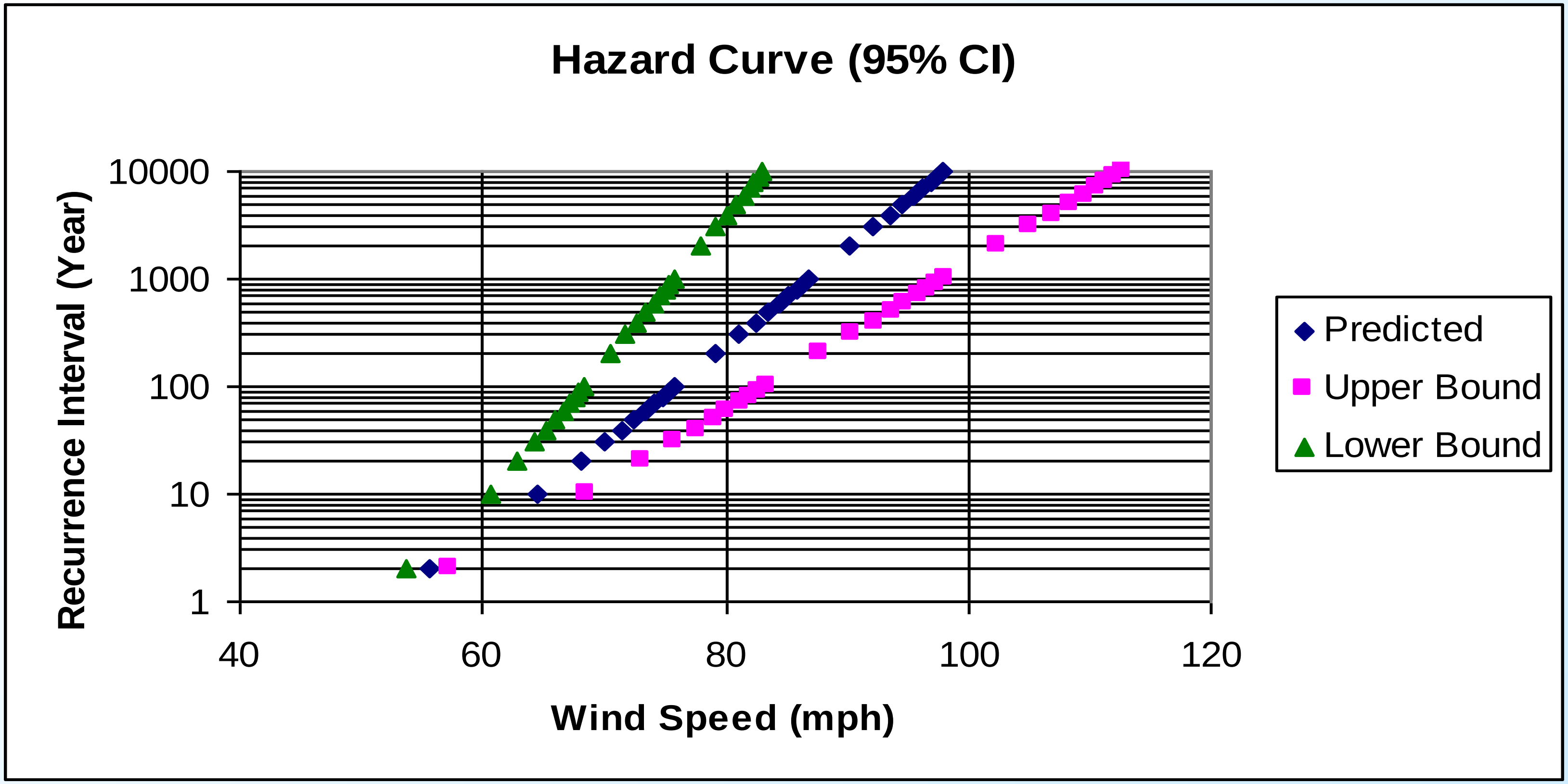
Probability Distribution



Cumulative Distribution



Hazard Curve



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Tornadic Winds

TORNADO model from LLNL recommended for estimation of expected wind speeds

- May require conversion to EF Scale and 3-second gust wind speeds to be compatible

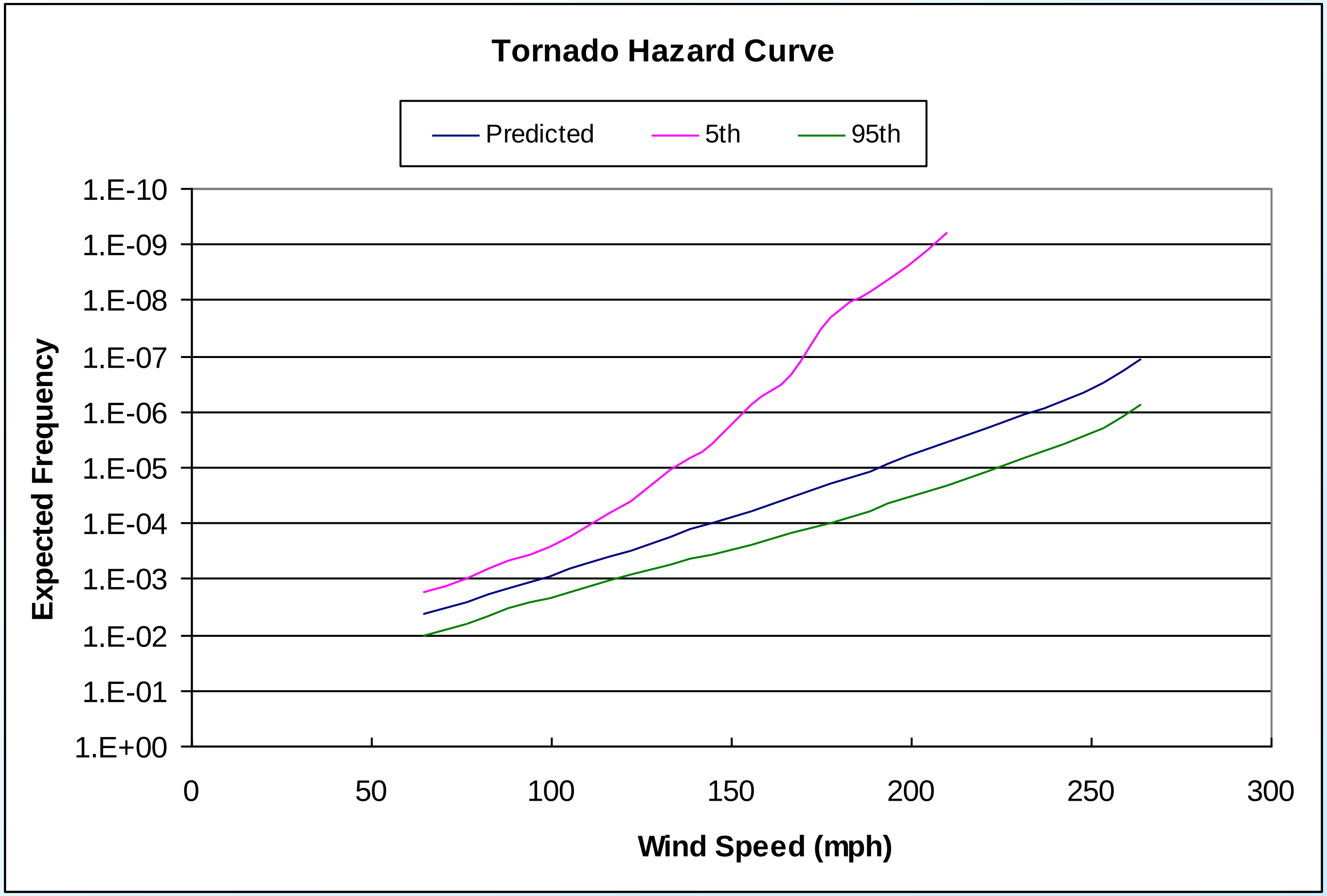
Values from TORNADO Model may be utilized without modification* unless:

- High frequencies of F-4 or F-5 tornadoes are reported

Tornado Ranking Scales

Fujita Scale			EF Scale	
F Number	Fastest ¼ mile (mph)	3 Second Gust (mph)	EF Number	3 second Gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

Tornado Hazard Curve

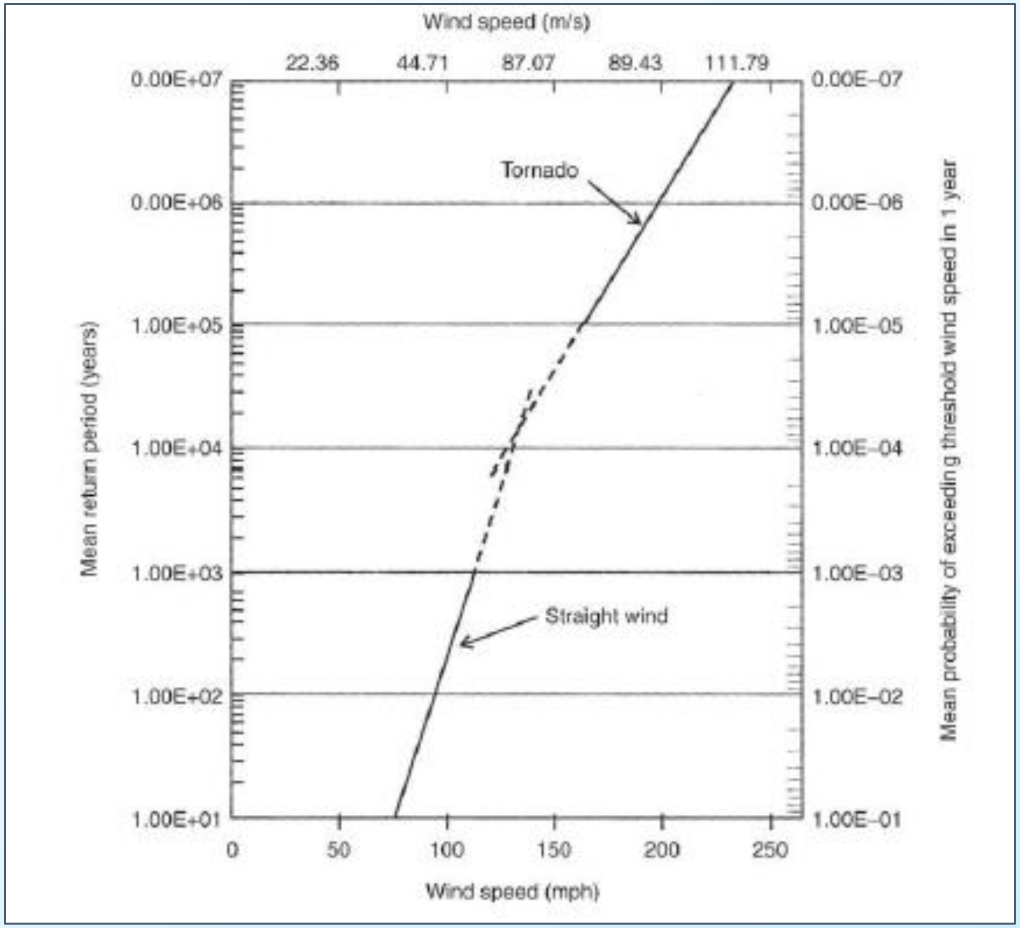


Hurricane Winds

- Similar to straight winds in nature
- In general, will utilize the design curves provided in ANS 2.3-2011

Regionalization of Wind Speeds

Composite Wind Curves



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Composite Wind Curves (cont.)

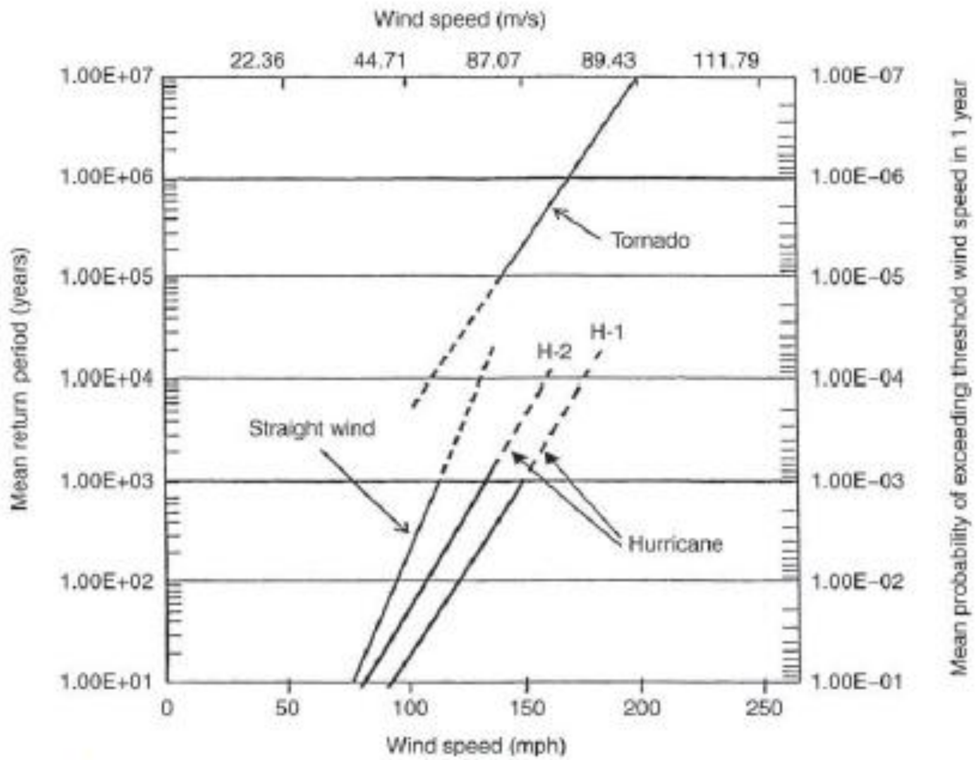
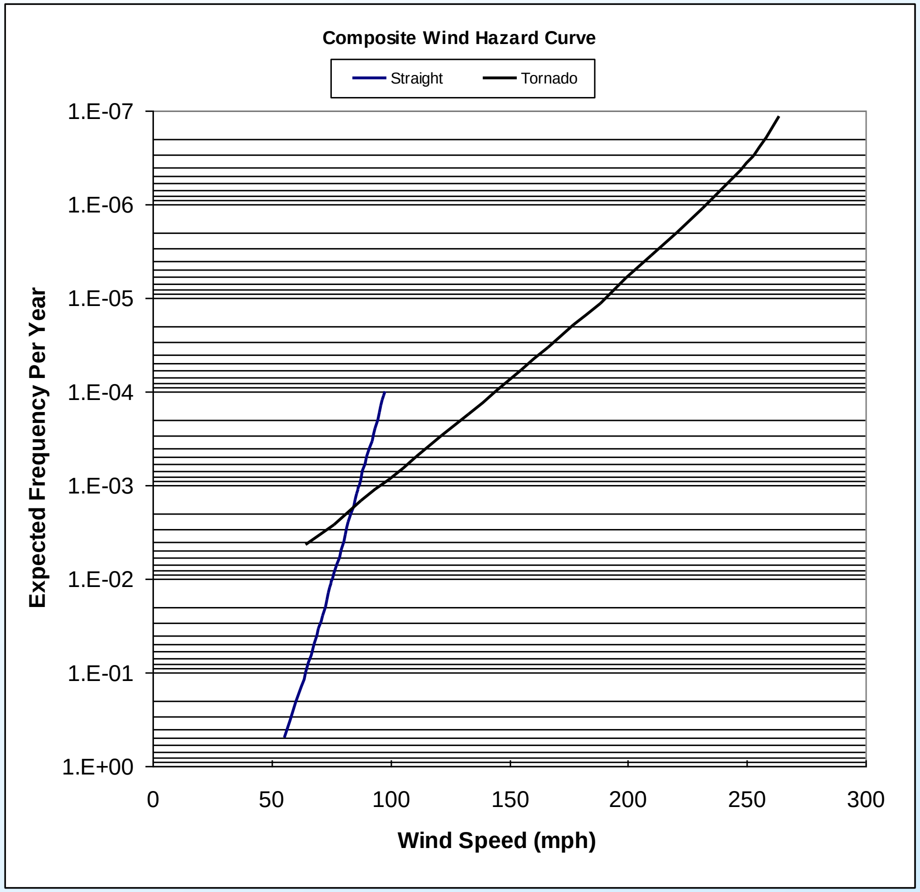


Figure 3 – Wind speeds at a Region II wind hazard site

Composite Hazard Curve



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Atmospheric Pressure Change

- Function of maximum tangential wind speed
- Pressure drop derived from ANS 2.3-2011
  - If local data exists, it should be utilized
- APC Values should be calculated by methods outlined in ANS 2.3-2011

Wind Driven Missiles

- Winds greater than 75 mph
- Winds greater than 110 mph
- Two Approaches:
  - A standard spectrum of missiles
    - ANS 2.3-2011 does provide a design spectrum of missiles
    - DOE Guidance does not include this once DOE-1020-2011 is approved
  - A probabilistic assessment of the hazard
- The use of both approaches is necessary for the appropriate analysis of a site

Design Spectrum

- Credible “Universal” scenarios
  - A larger, crushable-type missile such as an automobile
  - A hard penetrating-type missile such as a schedule 40, 6.0” diameter pipe
  - A small missile that would affect openings such as a solid steel sphere with a diameter of 1.0”

ANS Missile Spectrum

Table 4 – Standard design missile spectrum for tornado- and hurricane-type winds*

		Missile Horizontal Velocity Coefficient[1), 2)]	
Missile[3)]	Horizontal wind velocity range greater than V or V_h	Tornado (V) coefficient, k_1	Hurricane (V_h) coefficient, k_1
	Weight 4000 lb (1810 kg)[2)]		
Impact type: automobile, 20.0-ft^2 (2.0-mi^2) contact area	250 mph (400 kmph)	0.4	0.7
	200 mph (325 kmph)	0.4	0.6
	150 mph (245 kmph)	0.3	0.6
	100 mph (160 kmph)	0.3	0.5
	Weight 287 lb (130 kg)[1)]		
Penetrating-type, Schedule 40 pipe, 6.0-in. (150-mm) diameter, 15-ft (4.58-m) length	250 mph (400 kmph)	0.4	0.5
	200 mph (325 kmph)	0.4	0.5
	150 mph (245 kmph)	0.4	0.5
	100 mph (160 kmph)	0.4	0.5
	Weight 0.147 lb (0.0669 kg)[1)]		
Solid steel sphere, structural opening 1.0-in. (25-mm)-diameter	250 mph (400 kmph)	0.1	0.5
	200 mph (325 kmph)	0.1	0.4
	150 mph (245 kmph)	0.1	0.4
	100 mph (160 kmph)	0.0	0.3

* ft^2 = square feet; mi^2 = square miles; mph = miles per hour; kmph = kilometers per hour; k_1 = missile velocity coefficient as shown in note 2).

1) Vertical velocity taken as 0.67 of horizontal velocity.

2) Missile velocity = $k_1(V \text{ or } V_h)$.

3) Automobile missile impact limited to elevation ≤30 ft (9.14 m) above plant grade.

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Site Dependent Missiles

- Sites MUST be analyzed from a probabilistic standpoint with regards to sight dependent missiles…
- This analysis is based on the following:
  - Wind based occurrence in the plant vicinity in excess of 110 mph
  - Existence and availability of missiles in the area
  - Injection of missiles into the wind fields
  - Suspension and flight of these missiles associated with missile drag and lift
  - Missile orientation upon impact with the structure
  - Resulting damage to important safety equipment
- Example…

Results

- Consensus codes controlled the design of PC-0, PC-1, and PC-2 SSCs
- Overall decrease in wind speeds for PC-3 and PC-4 SSCs due to switch to EF Scale
- Validation of current missiles
  - Site specific analysis
  - Use PC-4 missiles for PC-3 design

Summary

- Much simpler process with implementation of new codes and standards
- Remains a very important aspect of safe facility design

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