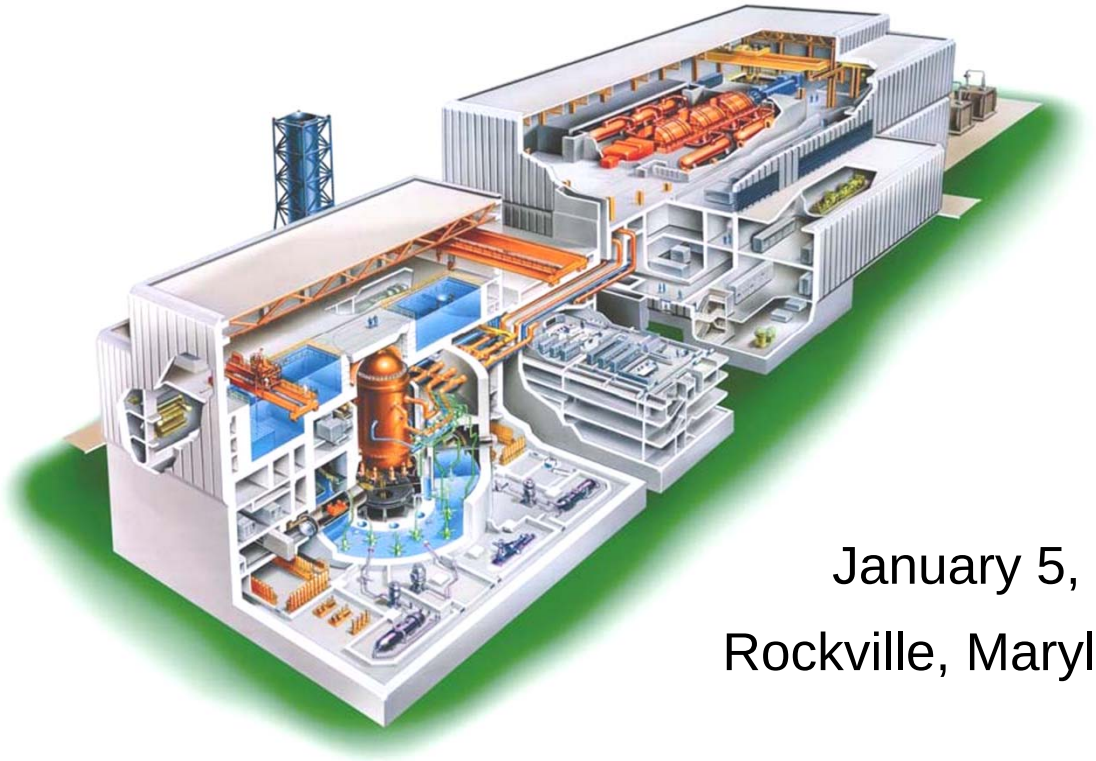
NRC Public Meeting

South Texas Project
Combined License Application
FSAR Chapters 2 and 3
Application of Regulatory Guide 1.221



January 5, 2012

Rockville, Maryland, USA

Nuclear Innovation
North America LLC

Agenda
Thursday, January 5

PURPOSE:

To discuss the scope, methodology, and schedule to address RAI 02.03.01-24 pertaining to hurricane wind and associated missiles as applied to the STP Units 3 and 4 COL application

TOPIC	LEAD
Opening Remarks	NRC/NINA
Overview of application of RG 1.221 to the STP Units 3&4 COLA	NINA
Scope and Impact on Chapter 2	NINA
Scope and Impact on Chapter 3	NINA
Review Action Items	ALL

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Applicant's Opening Remarks

Scott Head

Manager, Regulatory Affairs

NINA

Applicant's Attendees

Dick Bense	NINA Licensing Engineer
Scott Head	NINA Manager, Regulatory Affairs
Steve Thomas	NINA Manager, Engineering
Al Gutterman	Morgan, Lewis & Bockius LLP
P. K. Agrawal	Sargent & Lundy License & Structural Design Manager
Bob Hooks	Sargent & Lundy Structural Design Director

Opening Remarks – Applicant's Desired Outcomes

1. **Develop a consensus that the proposed RAI response meets NRC expectations.**
2. **Understand the impact and strategy of implementing RG 1.221 for STP 3&4**

Introduction

- **STP 3&4 is willing to commit to RG 1.221 to address COL Item 3.5.4.2**
- **Hurricane Wind (210 mph)**
- **Hurricane missiles**
- **Design of structures is not significantly impacted by RG 1.221**
- **Design parameters are incorporated in Chapter 2**
- **Analytical methodology in Chapter 3 is unchanged – pointers to hurricane criteria**
- **All as-built structures require re-evaluation to validate the final design – ITAACs**

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Overview of Applicability of RG 1.221 to the STP Units 3&4 COL Application

Dick Bense

Licensing Engineer

NINA

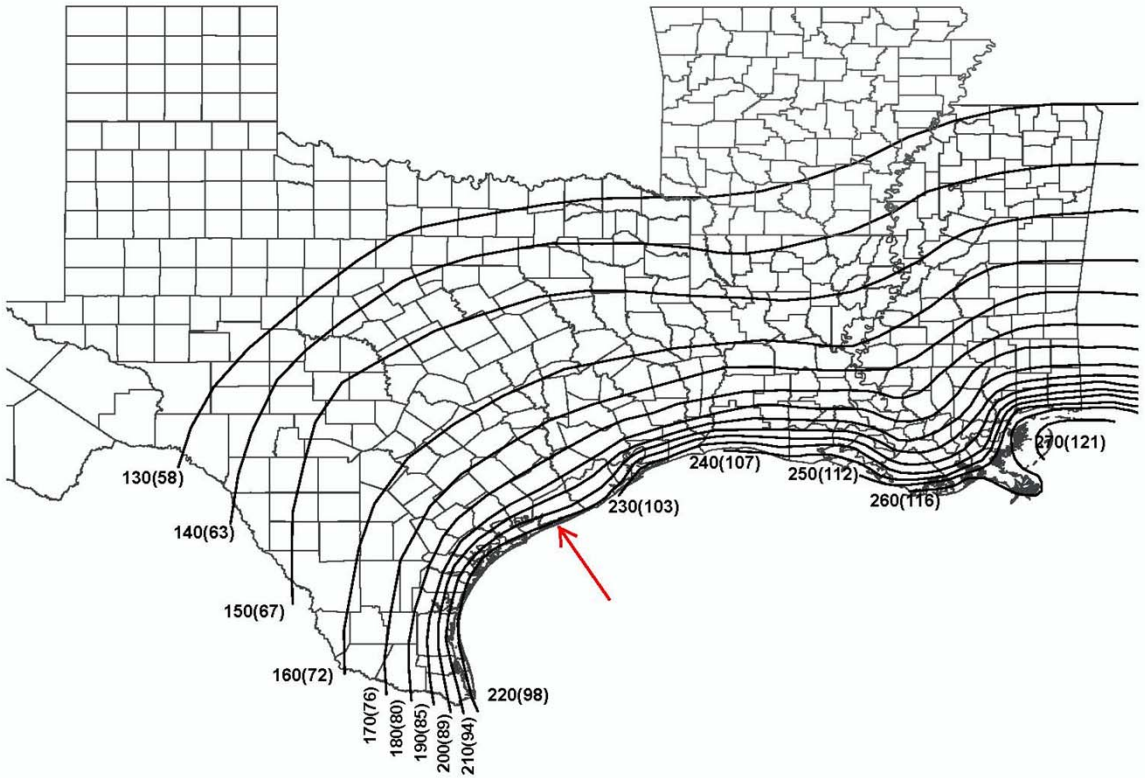
Overview of Application of RG 1.221 to the STP Units 3&4

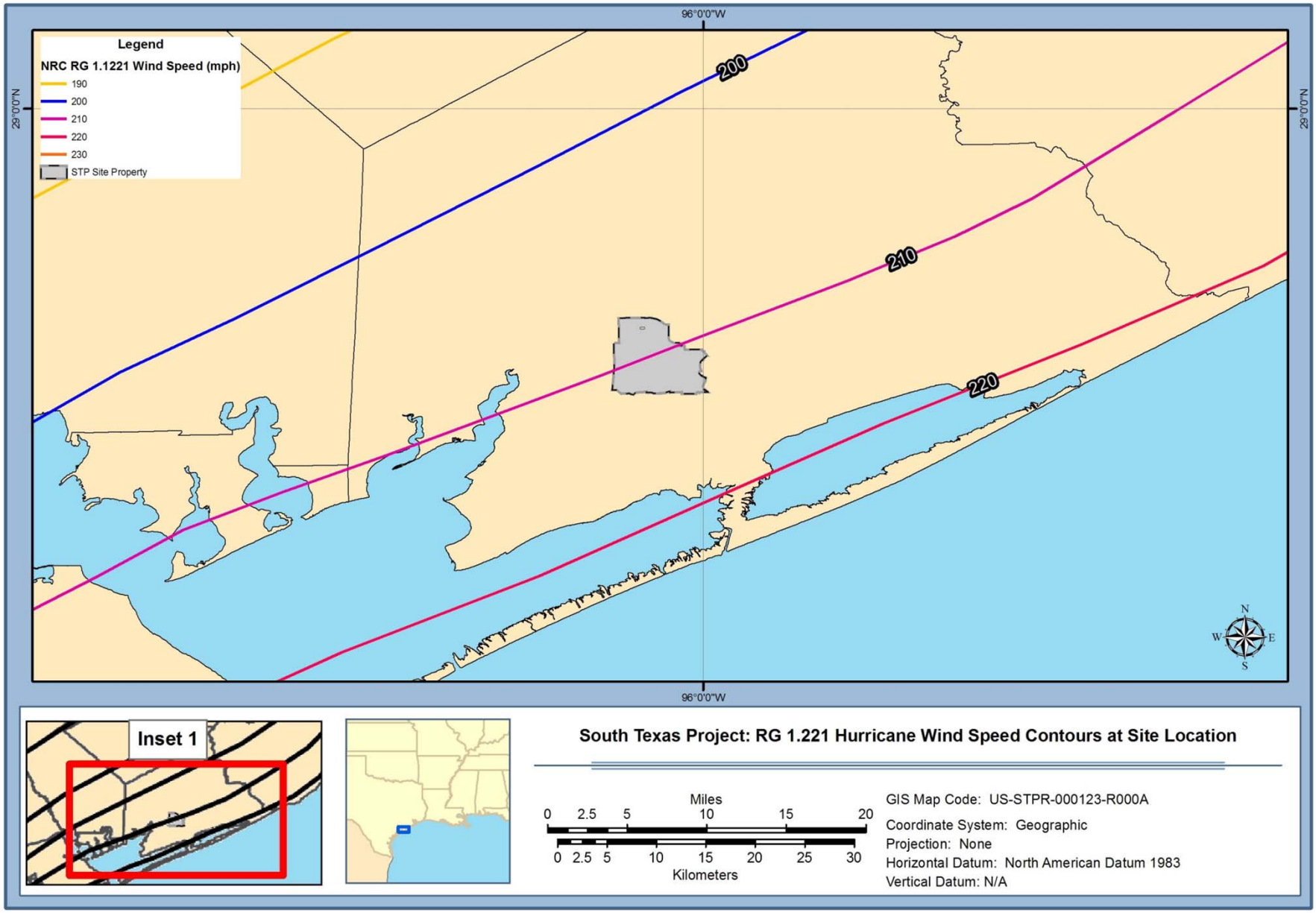
- **NINA will revise the STP 3&4 COLA to incorporate the guidance provided in RG 1.221 Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants, Rev 0, Issued October 2011**

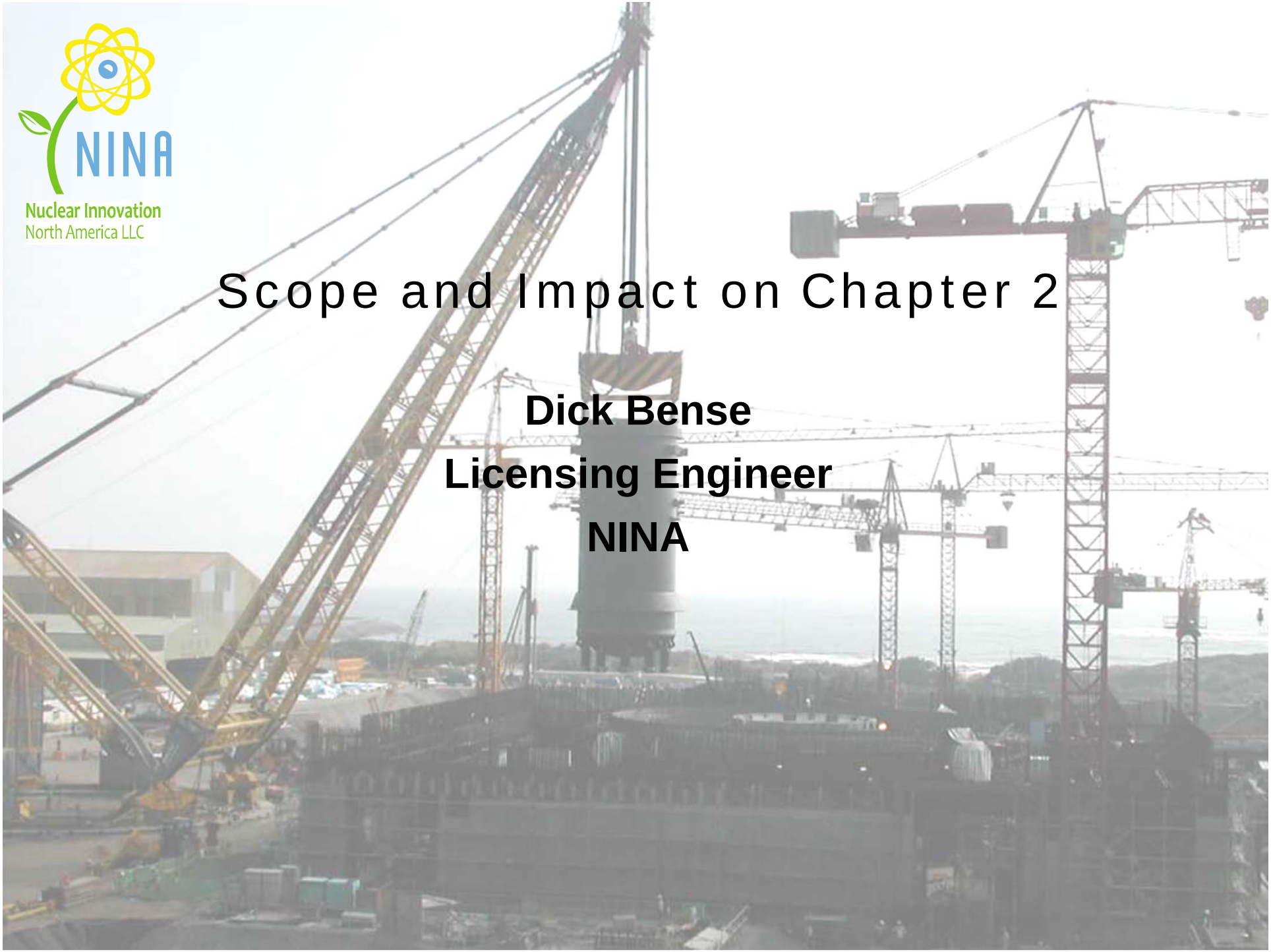
- **STP site specific design-basis hurricane windspeed:**
  - **338 kilometers per hour (km/h) (210 miles per hour (mph)) for a 3-second wind gust**

Hurricane Wind Speed Selection

Figure 1 **Design-Basis Hurricane Windspeeds for the Western Gulf of Mexico U.S. Coastline Representing Exceedance Probabilities of 10^{-7} per Year. Values are nominal 3-second gust windspeeds in miles per hour (meters per second) at 33 ft (10 m) above ground over open terrain (reproduced from NUREG/CR-7005).**




96°0'0"W
29°0'0"N
Legend
NRC RG 1.1221 Wind Speed (mph)
190
200
210
220
230
STP Site Property
200
210
220
N
W
E
S
Inset 1
South Texas Project: RG 1.221 Hurricane Wind Speed Contours at Site Location
Miles
0 2.5 5 10 15 20
0 2.5 5 10 15 20 25 30
Kilometers
GIS Map Code: US-STPR-000123-R000A
Coordinate System: Geographic
Projection: None
Horizontal Datum: North American Datum 1983
Vertical Datum: N/A



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Scope and Impact on Chapter 2

Dick Bense

Licensing Engineer

NINA

Scope and Impact on Chapter 2

- **Table 2.0-2, Comparison of ABWR Standard Plant Site Design Parameters and STP 3 & 4 Site Characteristics**
  - **STP Site Hurricane Wind Speed and Missiles**
  - **Design requirements and exceptions applicable to tornado wind speeds and tornado-generated missiles noted in various sections of COLA are also applicable to hurricane wind speed and associated hurricane-generated missile spectrum (Refer to STP DEP 3.5-2).**

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Scope and Impact on Chapter 3

Bob Hooks

Building Design Director

Sargent & Lundy

Scope and Impact on Chapter 3

- A detailed discussion of structural parameters for hurricane analysis and design is being described in Appendix 3H, Section 3H.11, Design for Site-Specific Hurricane Winds and Missiles
- Other portions of Chapter 3 (Sections 3.4, 3.5. and 3.6) and Appendix 3H (Sections 3H.1, 3H.2, 3H.3, 3H.6, and 3H.7) are being modified to identify hurricane design and analysis requirements and, in most cases, refer to Section 3H.11 for details

Scope and Impact on Chapter 3

- The STP 3&4 Seismic Category I structures are rugged and robust. They are designed for a variety of Severe Environmental and Extreme Environmental events.
- The loads are (as applicable) those associated with:
  - Natural phenomena—wind, floods, tornados (including tornado missiles), earthquakes, rain and snow.
  - Internal events—floods, pipe breaks and missiles
  - Normal plant operation—live loads, dead loads, temperature effects
- Hurricane loading, as defined in Regulatory Guide 1.221, is one more consideration

Scope and Impact on Chapter 3

- Before RG 1.221, the DCD had no specific hurricane requirements
- Hurricane loads, following regulatory guidance, were addressed under Extreme Wind Loading
- After RG 1.221, additional analysis for hurricane wind pressure and hurricane missiles will be added to other Chapter 3 evaluations for STP 3&4 structures, as shown on the following slides

Hurricane Loading

The following hurricane load effects are considered in the design:

Wind pressure ..... (W_h)

Missile impact..... (W_{mh})

Total hurricane load, including missile effects……..…. (W_{th})

Where, $W_{th} = W_h + W_{mh}$

Wind Pressure

Hurricane Wind Pressure (W_h)

Unlike tornado wind pressures, there is no reduction in hurricane wind pressures due to size of the structure. In addition, hurricane wind pressures vary along the height of the structure, whereas, tornado wind pressures are considered uniform along the height of the structure. Hurricane wind pressures are computed using the procedure described in Chapter 6 of ASCE 7-05, in conjunction with the maximum wind speed defined above and the following parameters:

Exposure Category C

Importance factor 1.15

Velocity pressure exposure coefficient as per ASCE 7-05 Table 6-3, but ≥ 0.85

Topographic factor 1.0

Wind directionality factor 1.0

Missile Parameters

Types	Dimensions	Mass
Automobile	16.4 ft x 6.6 ft x 4.3 ft (5 m x 2m x 1.3m)	4,000 lb (1,810 kg)
Schedule 40 Pipe RG 1.221 & RG 1.76 R1	6.625 in. dia. x 15 ft long (0.168 m dia. x 4.58 m long)	287 lb (130 kg)
Armor Piercing Shell 8.0 in. dia. DCD Tornado	276 lb (0.2 m dia.)	 (125 kg)
Solid Steel Sphere	1 in. diameter (25.4 mm diameter)	0.147 lb (0.0669 kg)

Load Combinations

Notations

S = Normal allowable stress for allowable stress design method

U = Required strength for strength design method

D = Dead load

F = Load due to weight and pressure of fluid with well-defined density and controllable maximum height

H = Lateral soil pressure and groundwater effects under normal operating conditions

L = Live load

R_o = Piping and equipment reaction under normal operating condition (excluding dead load, thermal expansion and seismic)

T_o = Normal operating thermal expansion loads from piping and equipment

W_{th} = Total hurricane load, including missile effects

Load Combinations

Structural Steel:

$1.6S = D + L + F + H + R_o + T_o + W_{th}$

Reinforced Concrete:

$U = D + L + F + H + R_o + T_o + W_{th}$

Evaluations

Global evaluations consist of the following:

- The structure, in its entirety, is evaluated for the total hurricane load (W_{th}) in conjunction with all other applicable loads
- The sliding and overturning stability of the structure is evaluated considering the total hurricane load (W_{th}) in conjunction with all other applicable loads. The load combination and the required safety factor for stability evaluations:
  - Stability load combination: D + H + W_{th}
  - Minimum Required Safety Factor for sliding and overturning = 1.1

Local evaluations consist of the following:

- Local damage evaluation in terms of penetration, perforation, and spalling
- Flexural and shear capacity evaluation of the panel impacted by the hurricane missile considering the total hurricane load (Wth) in conjunction with all other applicable loads

DCD Structures

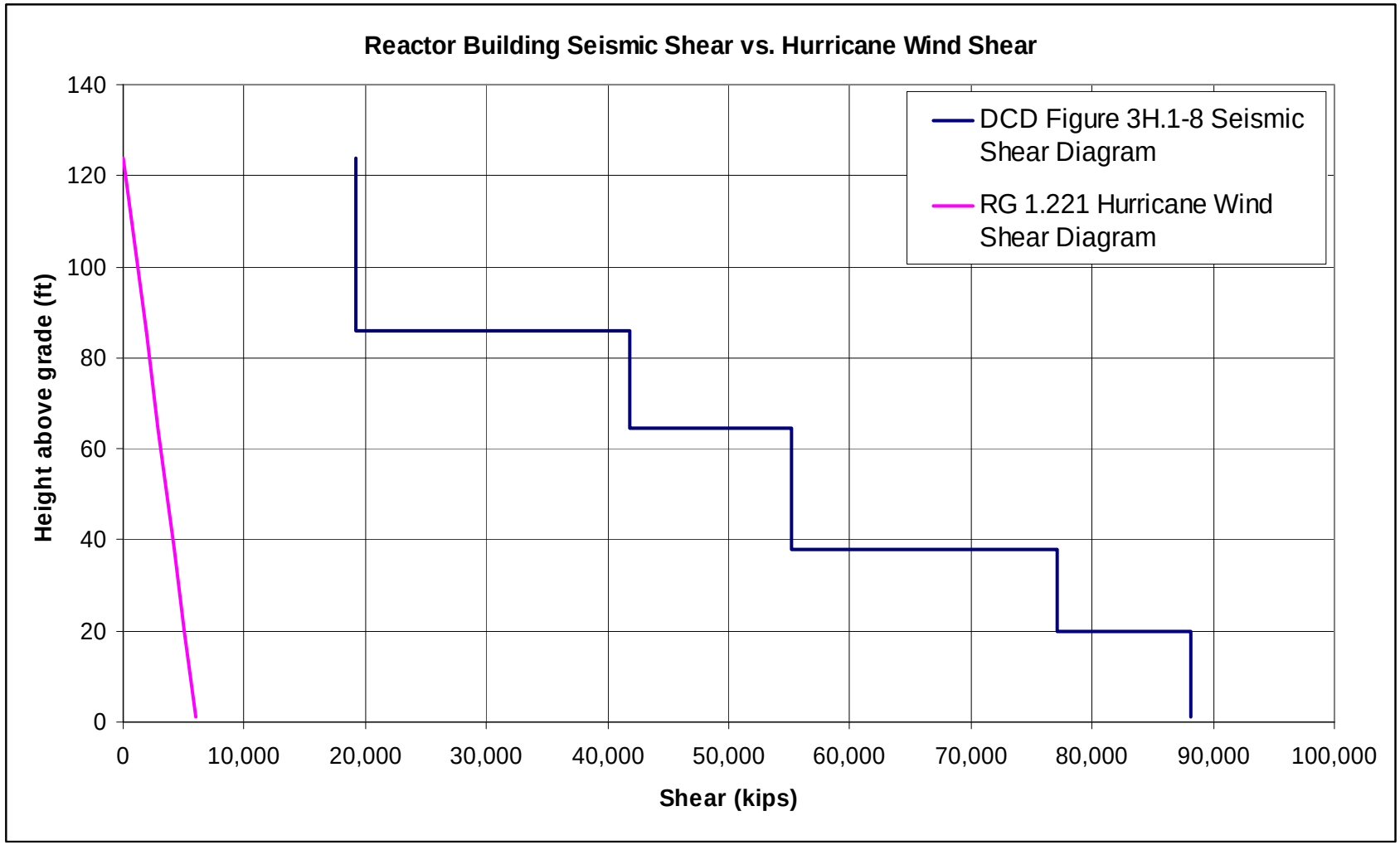
Comparision of RG 1.221 and Tornado Requirements for DCD Structures

Wind type	Reg Guide	Wind speed (mph)	Horizontal Missile Velocity (m/s)			Vertical Missile Velocity (m/s)		
			Auto	Pipe	Sphere	Auto	Pipe	Sphere
Hurricane	1.221	210	59.6	46.6	40.9	26	26	26
Tornado	DCD	300	47	47	47	32.9	32.9	47

- **Seismic Category I DCD structures:**
  - **Reactor Building (RB)**
  - **Control Building (CB)**
  - **Diesel Generator Fuel Oil Tunnels (DGFOT)**

DCD Structures

Preliminary Results



DCD Structures

- **Global evaluations**
  - **Preliminary evaluations* show that the overall design is not controlled by hurricane loading**
  - **Preliminary evaluations* show that the stability is not controlled by hurricane loading**
- **Local evaluations**
  - **Preliminary evaluations* show that the wall and slab designs are adequate to resist local damage (penetration, perforation, and spalling)**
  - **Flexural and shear capacity will be confirmed** for wall and roof panels impacted by hurricane missiles considering the total hurricane load (W_{th}) in conjunction with all other applicable loads**

*** Calculations will be complete prior to the final audit of Section 3.8 in February 2012**

**** Confirmatory structural analysis will be completed during final as-built reconciliation (ITAAC)**

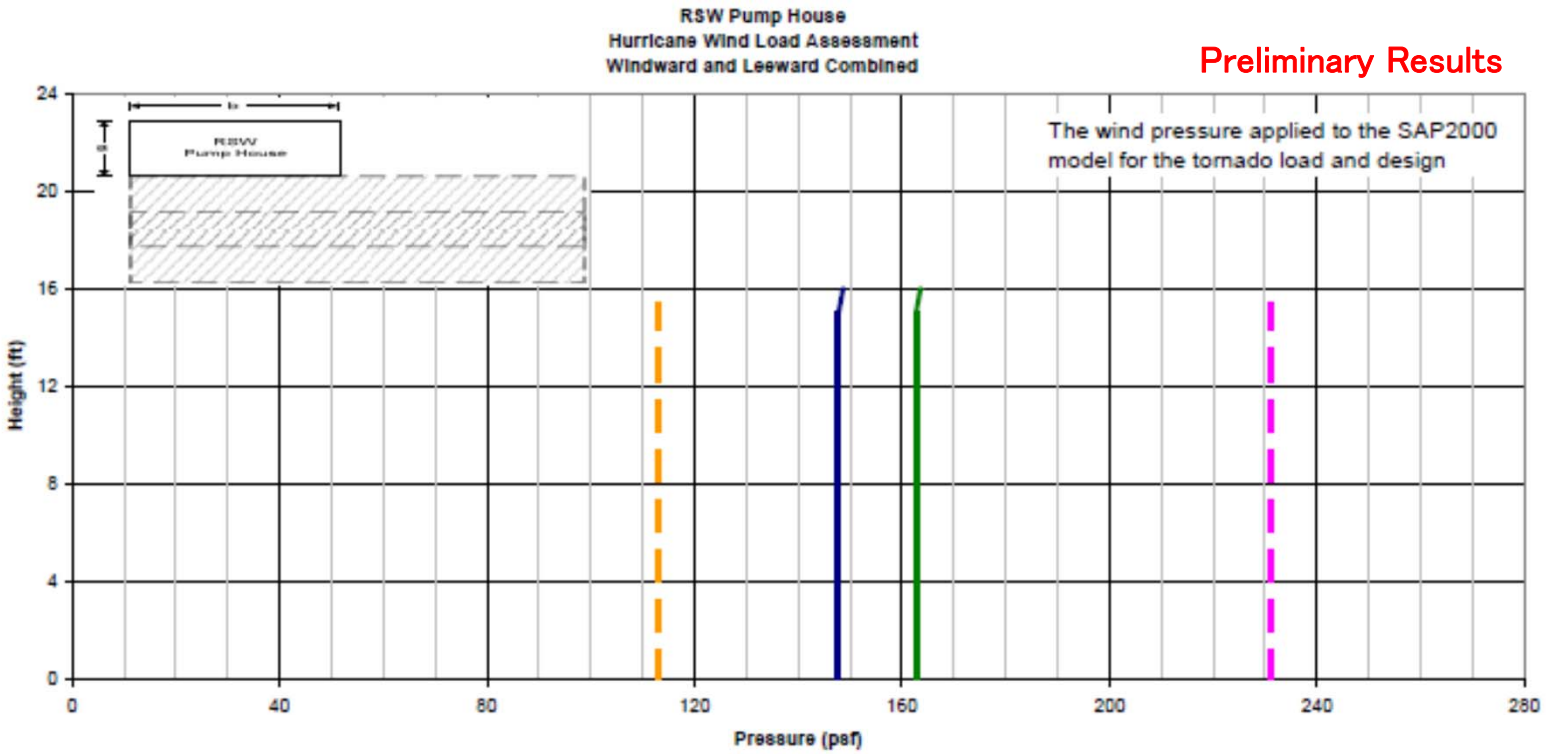
Site-Specific Structures

Comparision of RG 1.221 and RG 1.76 for Site-Specific Structures

Wind type	Reg Guide	Wind speed (mph)	Horizontal Missile Velocity (m/s)			Vertical Missile Velocity (m/s)		
			Auto	Pipe	Sphere	Auto	Pipe	Sphere
Hurricane	1.221	210	59.6	46.6	40.9	26	26	26
Tornado	1.76 (2007)	200	34	34	7	22.8	22.8	4.7

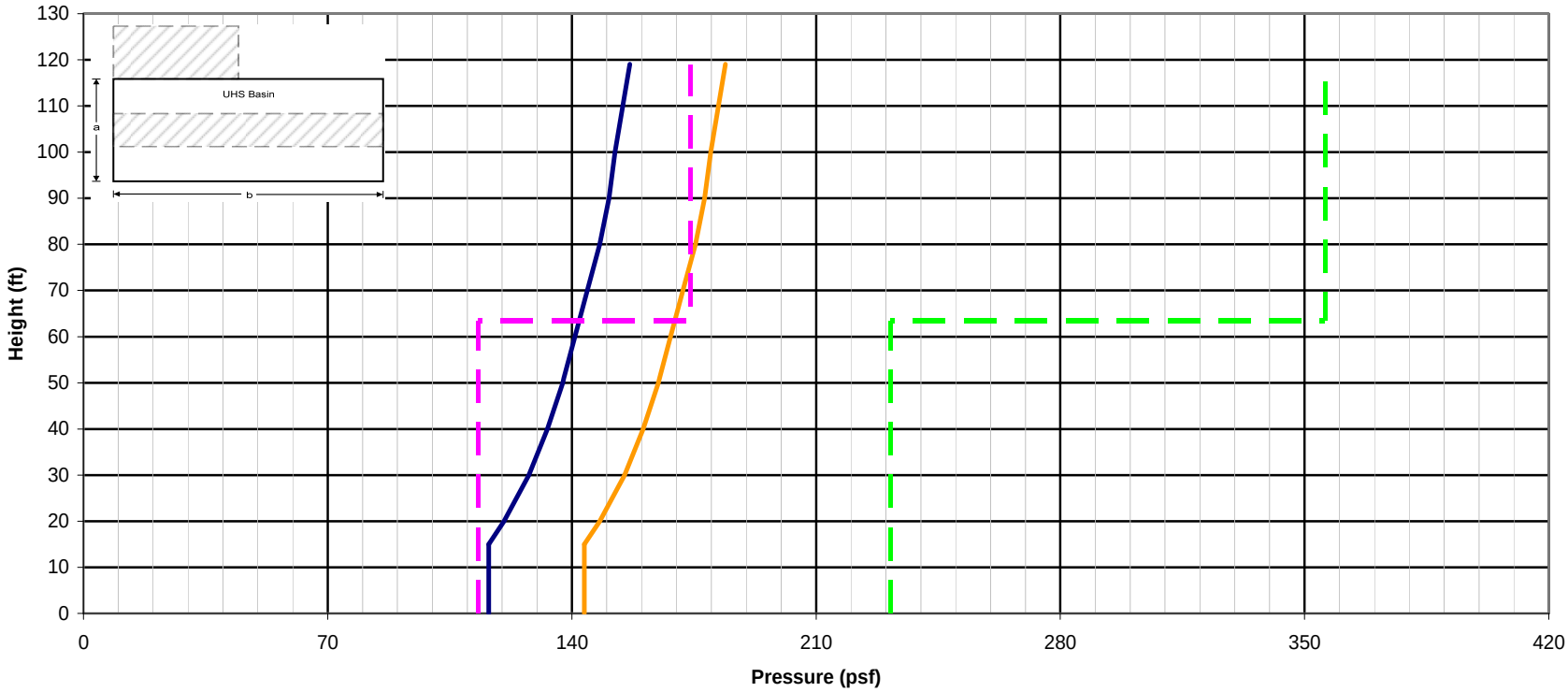
- **Site-Specific Seismic Category I structures:**
  - **Reactor Service Water (RSW) Piping Tunnels**
  - **Ultimate Heat Sink (UHS)/Reactor Service Water (RSW) Pump House**
  - **Diesel Generator Fuel Oil Storage Vaults (DGFOSV)**

Wind Pressure



UHS Hurricane Wind Load Assessment
Windward and Leeward Combined (Full Basin)

Preliminary Results



- Hurricane Wind Load - Based on wind approaching the short side, a, of the UHS (Calculated in accordance with ASCE 7-05 using wind speed of 210 mph per RG 1.221)
- Hurricane Wind Load - Based on wind approaching the long side, b, of the UHS (Calculated in accordance with ASCE 7-05 using wind speed of 210 mph per RG 1.221)
- Tornado Wind Load (Loading from calculation U7-UHS-S-CALC-DESN-6002 Rev. E - considers wind speed of 200 mph)
- Design Hurricane Wind Load (Loading from calculation U7-UHS-S-CALC-DESN-6002 Rev. E - considers wind speed of 186 mph with 1.7 load factor)

Site-Specific Structures

- **Global evaluations**
  - **Preliminary evaluations* show that the overall design is not controlled by hurricane loading**
  - **Preliminary evaluations* show that the stability is not controlled by hurricane loading**
- **Local evaluations**
  - **Preliminary evaluations* show that the wall and slab designs are adequate to resist local damage (penetration, perforation, and spalling)**
  - **Flexural and shear capacity will be confirmed** for wall and roof panels impacted by hurricane missiles considering the total hurricane load (W_{th}) in conjunction with all other applicable loads**

*** Calculations will be complete prior to the final audit of Section 3.8 in February 2012**

**** Confirmatory structural analysis will be completed during final as-built reconciliation (ITAAC)**

II/I Structures

- **Global evaluations**
  - **Preliminary evaluations* show that the overall design is not controlled by hurricane loading**
  - **Preliminary evaluations* show that the stability is not controlled by hurricane loading**

*** Confirmatory structural analysis will be completed during final as-built reconciliation (Revise II/I ITAAC)**

II/I Structures

Comparision of RG 1.221 and tornado requirements DCD structures

Wind type	Reg Guide	Wind speed (mph)
Hurricane	1.221	210
Tornado	DCD	300

- Non-Seismic Category I structures with potential interaction with Seismic Category I structures
  - Turbine Building (TB)
  - Service Building (SB)
  - Radwaste Building (RWB)
  - Control Building Annex (CBA)
  - Stack on the Reactor Building roof

Structural ITAACs

- **The existing ITAAC, Table 2.15.10 Reactor Building, Item 10. "A structural analysis will be performed which reconciles the as-built data with structural design basis as defined in Section 2.15.10"**
- **RG 1.221 changes the structural design basis to include hurricane wind and hurricane wind generated missiles**
- **Existing design is sufficiently robust to accommodate these effects**
- **To provide positive assurance that hurricane effects are reconciled at the same level as other events, a new site-specific ITAAC, Table 3.0-25, Reactor Building – Design for Hurricane, has been added**

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Applicant Closing Comments / Action Items

Scott Head

Manager, Regulatory Affairs

NINA

Summary

- **STP 3&4 is willing to commit to RG 1.221 to address COL Item 3.5.4.2**
- **Hurricane Wind (210 mph)**
- **Hurricane missiles**
- **Design of structures is not significantly impacted by RG 1.221**
- **Design parameters are incorporated in Chapter 2**
- **Analytical methodology in Chapter 3 is unchanged – pointers to hurricane criteria**
- **All as-built structures require re-evaluation to validate the final design – ITAACs**

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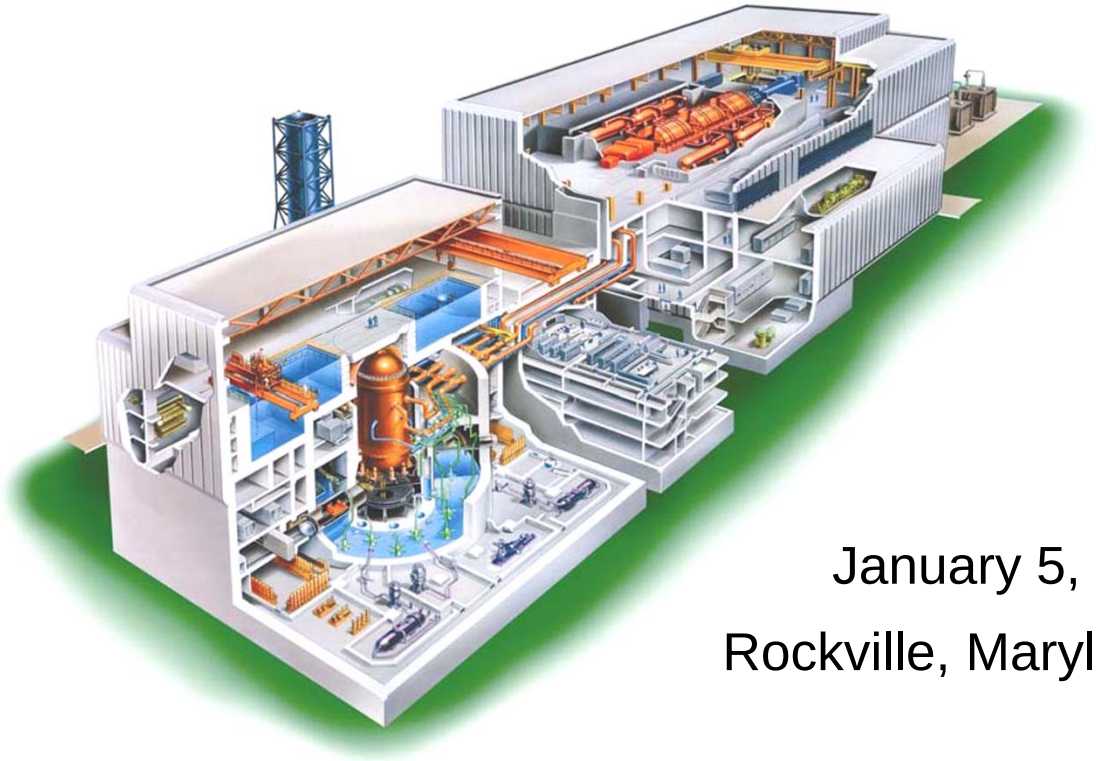

January 5, 2012

Rockville, Maryland, USA

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Table 2.0-2 Comparison of ABWR Standard Plant Site Design Parameters and STP 3 & 4 Site Characteristics (Continued)

Subject	ABWR Standard Plant Site Design Parameters	STP 3 & 4 Site Characteristics	Bounded (Yes/No)	Discussion
Tornado	Maximum Tornado Wind Speed: 483 km/h (300 mph)	322 km/h (200 mph)	Yes	Further information on tornado parameters is provided in Subsection 2.3S.1.
	Maximum Rotational Speed: 386 km/h (240 mph)	257 km/h (160 mph)	Yes	
	Translational Velocity: 97 km/h (60 mph)	64 km/h (40 mph)	Yes	
	Radius: 45.7 m (150 ft)	45.7m (150 ft)	Yes	
	Maximum Pressure Drop: 13.827 kPaD (2.0 psi)	6.2 kPaD (0.9 psi)	Yes	
	Rate of Pressure Drop: 8.277 kPa/s (1.2 psi/sec)	2.8 kPa/sec (0.4 psi/sec)	Yes	
	Missile Spectra: Spectrum I [4]	STP site is enveloped by the maximum tornado wind speed corresponding to a probability of 1×10^{-7} per year 483 km/h (300 mph)	Yes	Further information on missile spectra is provided in Subsections 3.5.1.4.

Three-second gust wind speed is always greater than the fastest mile wind speed. In the reference ABWR DCD, the listed extreme of 122 mph is the fastest mile wind speed. This corresponds to a 139 mph 3-second gust; therefore, the calculated 100-year fastest mile 3-second gust related to the reference ABWR DCD is not exceeded.

The reference ABWR DCD Tier 1, Table 5.0 and reference ABWR DCD Tier 2, Table 2.0-1 include the following site parameter values for Extreme Wind, for which the ABWR plant is designed:

- 177 km/h (110 mph) equivalent to 126 mph (3-second gust) - Basic Wind Speed, 50-year recurrence interval (for design of nonsafety-related structures only)
- 197 km/h (122 mph) equivalent to 139 mph (3-second gust) - 100-year recurrence interval (for design of safety-related structures only)

Using the data and the methodology recommended in Reference 2.3S-10, both the site-specific 50-year fastest mile basic wind speed and 100-year recurrence interval fastest mile wind for the STP 3 & 4 site are less than or equal to those specified in the reference ABWR.

The NOAA Coastal Services Center (CSC) Hurricane Track Query was also used to review the historical record of tropical cyclone tracks and intensities near the STP 3 & 4 site for the period from 1851 to the present. This review identified eleven tropical cyclones with wind speeds that exceed a design basis wind loading for the STP 3 & 4 site calculated in accordance with Reference 2.3S-10. The top five storms include: Not named 1886 (155 mph sustained wind speed); Not named 1900 (144 mph sustained wind speed); Not named 1932 (144 mph sustained wind speed); Not named 1945 (138 mph sustained wind speed); and Hurricane Carla 1961 (144 mph sustained wind speed). The maximum wind speeds are not measured by anemometers for these eleven storms and estimates are from other data. Additionally, CSC Hurricane Track Query is typically not used for the determination of design wind loading for buildings. However, wind speeds identified during this review fall within the envelope for wind speeds addressed in Sections 2.3S.1.3.2, "Tornadoes," and do not represent a threat to the integrity of any STP 3 & 4 SSC.

Using the data and the methodology recommended in Reference 2.3S-10 to verify design basis wind loadings are less than or equal to those specified in the reference ABWR without specific consideration of the CSC Hurricane Track Query data, satisfy the requirements of ASCE/SEI-7-02 (Reference 2.3S-10) and NUREG-0800 (Reference 2.3S-6). The ASCE/SEI-7-2002 design standard wind speed map considered wind speeds of historically reported hurricanes and is updated periodically. Therefore, appropriate consideration has been given to the most severe tropical cyclones historically reported and the consequences of these storms are bounded by other phenomena considered in the design basis.

2.3S.1.3.1.2 STP