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Licensing Approach for DSRS 3.7-3.8 Topics

March 25, 2014

(Redacted Version)

This material is based upon work supported by the Department of Energy under Award Number DE-NE0000583.

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Agenda

- Objectives
- Seismic Site Interface Requirements
  - Farhang Ostadan
- Key Locations for Seismic Response
  - Michael McHood
- Dynamic Soil Pressure
  - Jack Demitz
- Conclusions

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Objectives

- Discuss specific guideline topics in DSRS for seismic area
- Share proposed plans to address NRC guidance
- Solicit feedback

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Seismic Site Interface Requirements

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Objective

- Review the following two items related to Draft DSRS 3.7.1 and 3.7.2

1. Confirm seismic site interface requirements for applicability of the Certified Design to a candidate site

2. Discuss and agree on site-specific SSI analysis requirements

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Applicability of the Certified Design

- Seismic applicability of the certified design to specific site condition follows DC/COL-ISG-017

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Applicability of the Certified Design

- **DC/COL-ISG-017**

  - 5.1 Position on Comparison of CSDRS with the Site-Specific Seismic Demand

    - 5.1.3 Embedded Structures Analyzed as Embedded Structures in the Certified Design

    "The procedure described in Section 3.1.3 of the NEI white paper (Ref. 3) is acceptable with the following considerations. The procedure in Section 3.1.3 of Ref. 3 states that the envelope of the CSDRS-based FIRS for all the generic soil properties is obtained and used for the comparison. This is acceptable if the design loads and the in-structure response spectra were based on the envelope of all the generic soil profiles in the DCD."

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Applicability of the Certified Design

- NEI white paper (Ref. 3)
  - 3.1.3 Embedded Structures Analyzed as Embedded Structures in the Certified Design

    "If, in the certified design, CSDRS is used as outcrop motion in the free field at the foundation level of the structure, the CSDRS-based foundation motion is the same as the CSDRS. For this evaluation, CSDRS can be compared with the FIRS computed as outcrop (SCOR) motion for design applicability evaluation."

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Applicability of the Certified Design

SUMMARY

- Draft DSRS 3.7.1 and 3.7.2 did not change the basis for seismic evaluation of the applicability of the certified design to a candidate site

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- mPower will follow DC/COL-ISG-017 to assess applicability of the mPower design to a candidate site

[Proprietary per Affidavit 5(a)-(f)]

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Site Specific SSI Analysis

- **DC/COL-ISG-017**
  - 5.2 Position on Site-Consistent Seismic Input and Soil Profiles Properties for the SSI

    "When a site-specific SSI analysis is conducted, two approaches are acceptable to obtain the site-consistent seismic input for the SSI analysis. Either one of the two approaches can be used for this purpose. However, before conducting a detailed SSI analysis, it is essential to demonstrate that the PBSRS are enveloped by the FIRS convolved up to the surface using the three soil properties for the SSI model – upper bound, best estimate, and lower bound. The basic steps of these two options are described below. Whichever option is chosen, the detailed steps in the selected approach must be followed, as described in the NEI white paper (Ref. 3) for the first approach and the BNL report (Ref. 4) for the second."

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Site Specific SSI Analysis

- NEI white paper describes the process for computing FIRS and PBSRS. The FIRS can be used as SSI input motion for site specific SSI analysis as long as the envelope of the amplified surface motion using FIRS as input in the deterministic soil column analysis (typically 3 columns) exceeds probabilistically derived site specific PBSRS at the surface for both horizontal and vertical motions.
- If the check can not be made, the SSI input motion needs to be modified (or additional soil columns considered) so the surface motion exceeds PBSRS

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Site Specific SSI Analysis

Draft DSRS 3.7.1 (I.1.A):

- Requires generation of PBSRS for H and V motions at the surface
- Requires generation of PBRS for H and V motions at various elevations
- Requires deterministic SSI analysis to be based on the free-field motion that envelops PBSRS and PBRS at multiple elevations
- For sites with uniform velocity, PBSRS and one PBRS at central depth are considered adequate
- For sites with unusual velocity characteristics one or more additional depths are selected to generate PBRS

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Site Specific SSI Analysis

DISCUSSION

- For COL applicant, it is not clear how many PBRS are needed and the requirement for selection of the additional elevations are not described
- It is to be noted that both deterministic and probabilistic site response analysis capture the site profile stratigraphy and soil property variation in the response even for non-uniform soil sites

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[Proprietary per Affidavit 5(a)-(f)]

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Site Specific SSI Analysis

SUMMARY

- It is proposed that the two site-specific motions, PBSRS at the surface, [ ] be considered for checking the adequacy and/or modification of the FIRS for site specific SSI analysis
- No additional PBRS are deemed necessary for site specific analysis

[Proprietary per Affidavit 5(a)-(f)]

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Discussion/Questions?

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Key Locations for Seismic Response

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Key Locations for Seismic Response

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- After a seismic event, recorded responses at selected key locations can be used for post event evaluation

[Proprietary per Affidavit 5(a)-(f)]

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Key Locations for Seismic Response

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Key Locations for Seismic Response

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[Proprietary per Affidavit 5(a)-(f)]

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Key Locations for Seismic Response

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[Proprietary per Affidavit 5(a)-(f)]

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Key Locations for Seismic Response

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[Proprietary per Affidavit 5(a)-(f)]

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Key Locations for Seismic Response

[Proprietary per Affidavit 5(a)-(f)]

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Key Locations for Seismic Response

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Locations for Seismic Instrumentation

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- Some of the proposed key locations may not be appropriate for instrumentation due to heat or radiation concerns and/or accessibility for maintenance (e.g. Reactor Vessel Upper Support).
- Will Regulatory Guide 1.12 be revised in the near future?

[Proprietary per Affidavit 5(a)-(f)]

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Discussion/Questions?

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Dynamic Soil Pressure

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Dynamic Soil Pressure

- Draft DSRS Section 3.8.4 provides guidance consistent with SRP 3.8.4 Rev. 4 for the calculation of dynamic soil pressure
- Consideration of dynamic lateral soil pressures on embedded walls is acceptable if the lateral pressure loads are evaluated for the governing of the following three cases:
  1. Sum of the static earth pressure plus dynamic earth pressure calculated in accordance with ASCE 4-98 Section 3.5.3.2(2) { Wood Method }
  2. Sum of the static earth pressure plus dynamic earth pressure calculated using an embedded SSI/Finite Element Model
  3. Fraction of passive pressure that is effectively mobilized. Should include fraction of passive earth pressure assumed in stability calculations performed in accordance with SRP 3.8.5

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Dynamic Soil Pressure

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Dynamic Soil Pressure

- The basis for Wood solution is not directly applicable to the mPower design:

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[Proprietary per Affidavit 5(a)-(f)]

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Discussion/Questions?

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Plant Heat Sinks

March 25, 2014

(Redacted Version)

This material is based upon work supported by the Department of Energy under Award Number DE-NE0000583.

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Agenda

- Objectives
- Reactor Systems Overview
- Heat Sink Overview
  - System & Applicable DCD Sections
  - Heat Sink Process Flows
  - Physical Orientation of Heat Sinks
- Heat Sink Modes of Operation
  - Normal Operation & Shutdown
  - Loss of Feedwater
  - Loss of Off-Site Power & Station Blackout
  - Design Basis Accident
- Summary and Review

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Objectives

- Provide an overview of plant heat sinks with identification of reactor systems they support
- Identify where each system will be addressed in the DCA (DSRS references)

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mPower Systems & DCD Sections

- Reactor Cooling System (RCS) – 5.4
- Auxiliary Condenser (CNX) – 5.4.14
- CNT Passive Containment Cooling Tank (PCCT) – 6.2.2
- Emergency Core Cooling (ECC) – 6.3
- Component Cooling Water (CCW) – 9.2.2
- CIR Air Cooled Heat Exchanger (ACHE) – 9.2.5
- Chilled Water (CHW) – 9.2.7
- Reactor Coolant Inventory (RCI) – 9.3.6
- Heating Ventilation & Cooling (HVAC) – 9.4
- Steam (STM) – 10.3
- Main Condenser (CND) – 10.4.1
- Circulating Water (CIR) Cooling Tower – 10.4.5
- Feedwater (FW) – 10.4.7

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Reactor Systems Overview

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RCI System Configuration

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RCI Purification Function

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RCI RHR Function

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RCI High Pressure Decay Heat Removal

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CNX In Operation

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Containment Heat Removal

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Heat Sink Overview

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Heat Sink Process Flows

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[Proprietary per Affidavit 5(a)-(f)]

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Heat Sink Locations – Site Plot Plan

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[Proprietary per Affidavit 5(a)-(f)]

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Heat Sink Locations – RSB Roof Plan

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[Proprietary per Affidavit 5(a)-(f)]

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Plant Heat Sinks

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Connection

= Piped

= Other

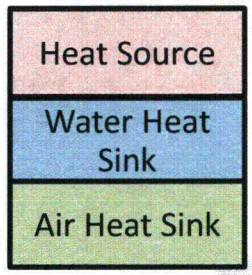
Power Supply

O = Offsite/Aux

D = Diesel

B = Battery

N = None



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Heat Sink Modes of Operation

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Normal Operation

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Connection

= Piped

= Other

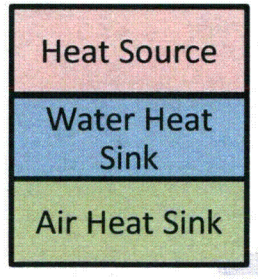
Power Supply

O = Offsite/Aux

D = Diesel

B = Battery

N = None



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Normal Shutdown – Short Term

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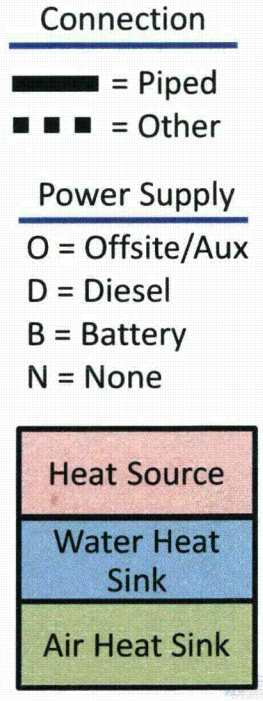

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Normal Shutdown – Long Term

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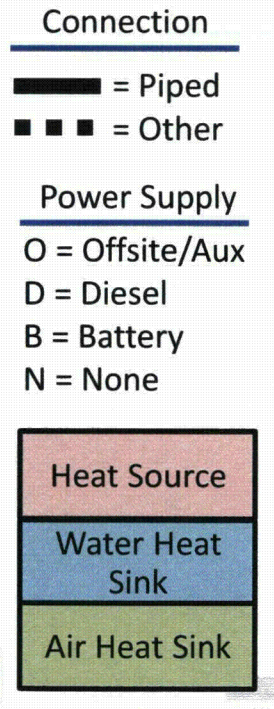

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Loss of Feedwater*

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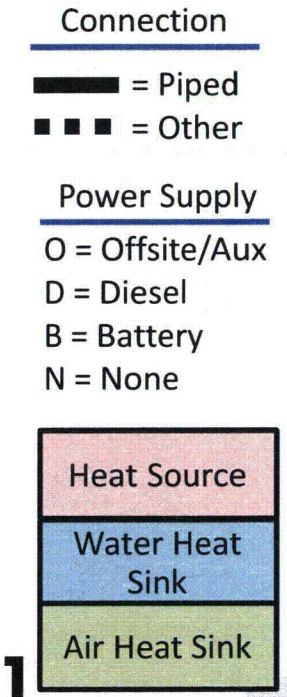

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Loss of Offsite Power

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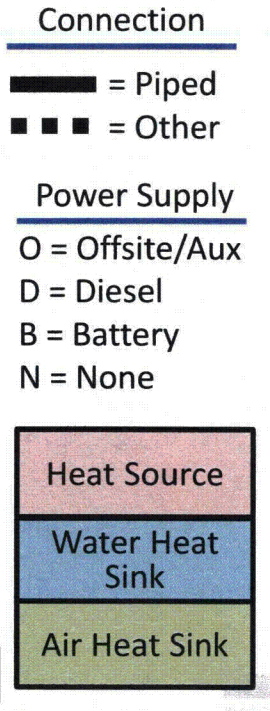

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Station Blackout (SBO)

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Connection

= Piped

= Other

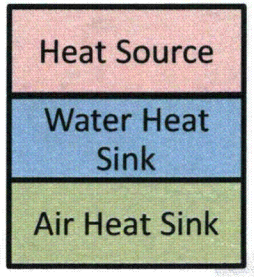
Power Supply

O = Offsite/Aux

D = Diesel

B = Battery

N = None



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Decay Heat Removal Following a DBA

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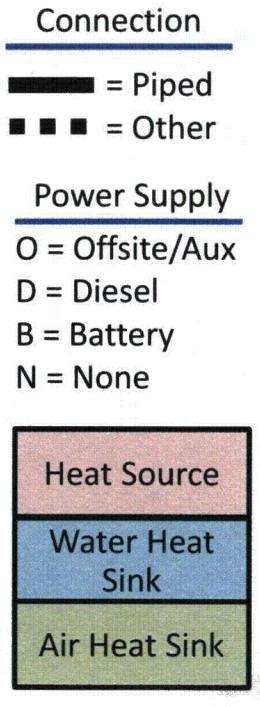

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[Proprietary per Affidavit 5(a)-(f)]

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Summary

- Water Heat Sinks
  - [

    ]
- Air Heat Sinks
  - [

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[Proprietary per Affidavit 5(a)-(f)]

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Questions

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Licensing Approach for Turbine Missile Considerations

March 25, 2014

(Redacted Version)

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Purpose/Objective

To demonstrate that the effects of turbine missiles on essential SSCs is inconsequential to the mPower design

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Physical Separation of TB-RSB

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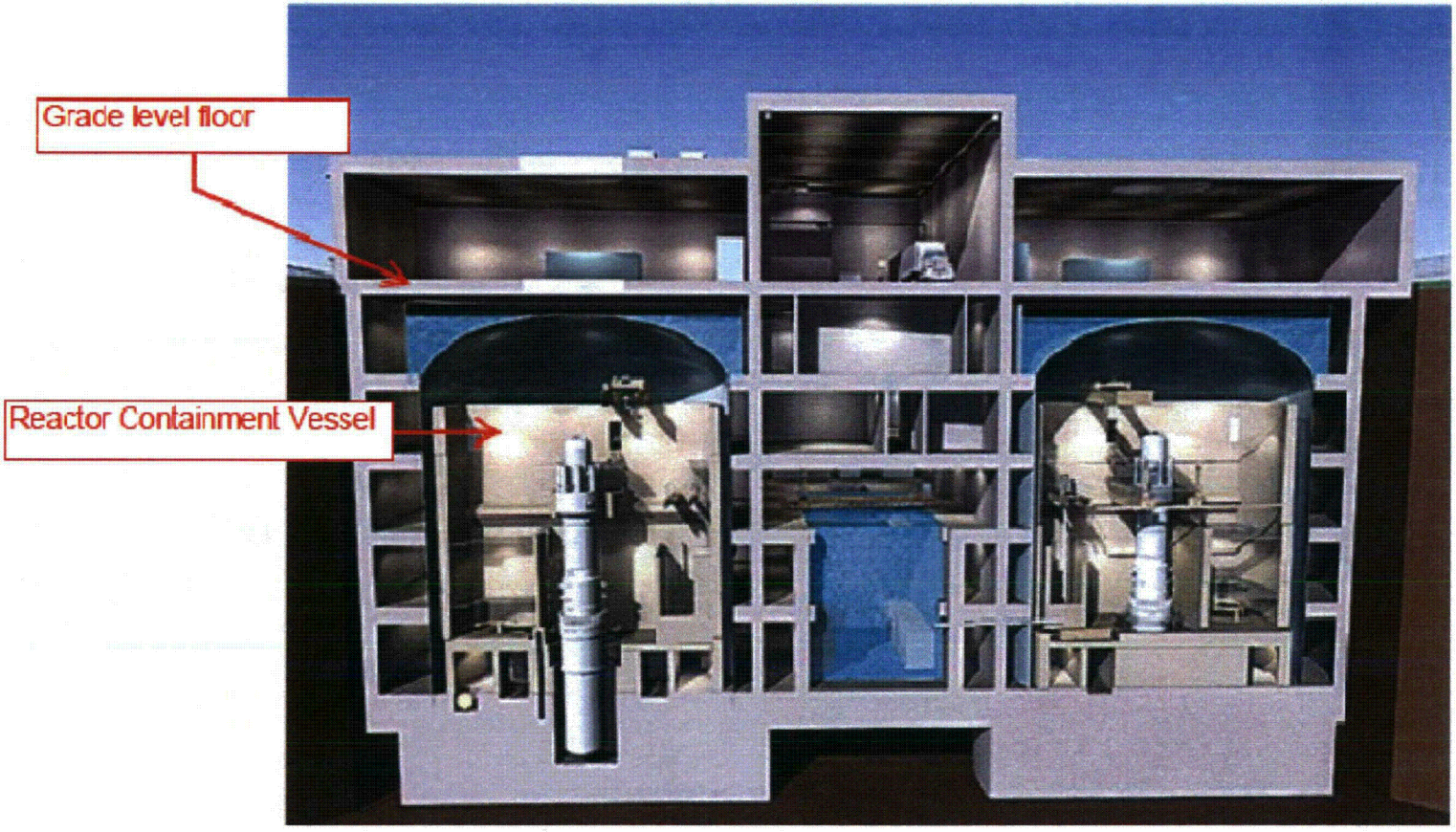
Section View of RSB



Reactor Service Building Cross-Section

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mPower Turbine Considerations

- Loss of turbine rotor integrity has [

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  - In the event of a turbine missile strike, essential SSCs required for safe shutdown are located [

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[Proprietary per Affidavit 5(a)-(f)]

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mPower Turbine Considerations

Conformance to Regulatory Guide 1.115 "Protection Against Turbine Missiles"	
Position	**Conformance**
1	**Conform** – Plant layout for essential SSCs
2	**Conform** (Position 2.d) – The mPower standard plant design provides engineered barriers to protect essential SSCs
3	**Conform** – Barrier layout/design
4	**Not Applicable** – Engineered barriers are used, thus missile probability calculations are not required to demonstrate conformance to GDC 4
5	**Not Applicable** – A determination of the applicability of RG 1.115 strike zones is not required to demonstrate GDC 4 compliance, as missile barriers are used to protect essential SSCs

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Conclusion/Questions?