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HI-STORM 100U
LAR 1014-6
RAI #2 Acceptance Review

Holtec International

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Agenda / Purpose of Meeting

- Ensure current LAR advances to rulemaking without further delay
- Discuss technical issues to ensure follow-up LAR is managed effectively
- Discuss Administrative Recommendations

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Current LAR Resolution

- Differential Settlement
  - Option 1: Support Foundation directly on bedrock
  - Option 2: Support Foundation on substrate with shear wave velocity ≥ 3500 fps
  - Possible Option 3: Support Foundation on concrete pillars that go down to bedrock (Hope Creek), no more than 30 ft (used in the seismic analysis)
  - FSAR Changes: None
  - CoC Changes: Appendix B Section 3.4; items 6.c through 13

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Proposed CoC Appendix B Section 3.4

- Item 6.c. For underground casks (VVMs), the shear wave velocity of the substrate on which the SUPPORT FOUNDATION rests shall be greater than or equal to 3500 ft/s or the SUPPORT FOUNDATION shall rest directly on bedrock. (option for construction with pilings)
- Delete Items 7, 11 and 12
- Item 8. For HI-STORM 100U ISFSI only: The Support Foundation Pad (mat) for a VVM array established in a construction shall be of monolithic construction to maximize the physical stability of the underground installation.
- Item 9. For HI-STORM 100U ISFSI only: Radiation Protection Space (RPS) as defined in Subsection 5.7.9 of Appendix A, is intended to ensure that the substrate material (such as natural subgrade, and engineered fill) remains essentially intact under all service conditions including during an excavation activity adjacent to the RPS.
- Table 3-3 Value for Shear Wave Velocity below Foundation Pad ≥3500 fps
- Item 13. For HI-STORM 100U ISFSI only: Excavation can only occur at a distance from the RPS greater than 10 times the depth of the planned excavation.

Current LAR Resolution (cont.)

- Analysis of Top Surface Pad (TSP)
  - Loads: Live, Dead, Seismic, NO settlement, Response to 1st round RAI question 2-1 (LAR 1014-6) explains how the TSP is decoupled from the System.
  - Separate Presentation (Alan Soler)
  - FSAR changes: short description
  - CoC changes: none

Current LAR Resolution (cont.)

- Excavation outside Radiation Protection Space (RPS)
  - Distance to RPS 10 times the excavation depth
  - Temporary solution
  - FSAR: unchanged
  - CoC: keep RPS, add restriction
- RPS / retaining wall
  - FSAR change: will be removed
  - CoC change: will be removed

Next LAR

- ITS Categories
- Differential Settlement
- Radiation Protection Space

Next LAR – ITS Categories

- Top Surface Pad, Support Foundation, VVM Interface Pad and lateral subgrade were changed to ITS-C in the last round of RAIs on LAR 1014-6 per NRC request – question 3-8

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Next LAR – ITS Categories (cont.)

- Top Surface Pad (TSP)
  - Purpose has been set down in FSAR Section 2.I.
  - Only function is to provide a transporter path.
  - Serves no shielding function and is isolated from the VIP and the CEC.
  - Exceeding stress limits on the TSP has no impact on public health and safety.
  - Should be changed back to NITS.

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Next LAR – ITS Categories (cont.)

- Support Foundation
  - Potential inconsistency between aboveground and belowground system
  - 2nd round RAI question 3-9 – "The Staff agrees that the design of ISFSI pads for stand alone storage casks, such as the HI-STORM 100, is not part of the FSAR."
  - NUREG 1536– "Reinforced concrete pads that support confinement casks in storage do not constitute "pavements." As such, they should be designed and constructed as foundations under an applicable code, such as ACI 318, ACI 349 or UBC. Such pads typically are not classified as important to safety; however, in some cases they may be."
  - NUREG/CR-6407 Section 6.2.3 names the concrete support pad for a concrete shielded type storage system as ITS-C.
  - What are the criteria?

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Next LAR – Differential Settlement

- 2nd Round RAI LAR 1014-6
  - Question 3-9 "Provide the minimum steel reinforcement requirements for the Support Foundation based on the seismic analyses that have been performed and the structural criteria to minimize long-term settlement."
    "…a reinforced concrete pad or foundation slab constitutes a design when the thickness, concrete strength and reinforcements have been specified.""
  - Question 3-6 "…the use of individual VVM "padlets" may lead to unacceptable differential settlement between adjacent VVMs. Such differential settlement can be completely avoided by using a continuous reinforced concrete Support Foundation."

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Next LAR – Differential Settlement (cont.)

- Guidance in regulations
  - Section 2.I provides design requirements and design codes for the 100U. ACI-318 (05) is the concrete code and sets limits on allowable bending moments and shear forces. The load combinations in that code do not include settlement. There is, however, a statement saying "Estimates of differential settlement…….should be based on a realistic assessment…."
  - NUREG 1536 says "If strength may be reduced during the design life by differential settlement, …, those effects shall be incorporated in the dead load, D" and "Loads resulting from differential settlement, …, if they produce the most adverse loading conditions, are included in dead load."
  - NUREGs for Power Reactors (1.138, 1.198) - settlement should be considered but do not provide guidance.

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Next LAR – Differential Settlement (cont.)

- What are the acceptance criteria? What are we supposed to do?
- Proposed Analysis
  - Use accepted soil mechanics formulations to determine long term settlement under an isolated loaded VVM and under an isolated empty VVM for specified soil compression index and void ratio.
  - Use this information to determine effective elastic foundation modulus under loaded and unloaded regions of Support Foundation.
  - Solve structural problem as a dead load case of partially loaded support foundation. Consider a 4 x 4 array with 1 loaded VVM in the corner. Add this as an additional dead load case that must be considered along with others in ACI Code load combinations.
- FSAR content: updated accordingly
- CoC changes: Add appropriate limits on soil characteristics to insure meeting normal ACI Code limits.

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Next LAR – RPS

- Retaining Wall
  - X feet from existing ISFSI
  - Not connected to ISFSI
  - Temporary or permanent
  - Maybe constructed with the initial ISFSI
- Analyses
  - Seismic, accidents
- FSAR changes: description, analyses
- CoC changes: requirements

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Administrative Recommendations

- " … CoC 1014 Amendment 7 will be modified to make it applicable to only the HI-STORM 100U System"
- The 100U is not "unique", it shares the HI-TRAC and the MPCs with the aboveground systems.
- All FSAR information pertinent to 100U is contained in supplements labeled "I".
- Proposed CoC and TS already written with differentiations for above and underground systems, no further changes necessary.
- 72.48s and all future amendments will require maintenance of two FSARs and Certificates under one Docket.
- A "split" will create unnecessary additional work for the certificate holder and licensee.
- What is the safety significance of the proposed action?

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PRESENTATION TO NRC 3-30-09

Structural Analysis of HI-STORM 100U Top Surface Pad

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CONFIGURATION

- Top surface pad (TSP) is structurally isolated from the VVM interface pad (VIP) by expansion joints.
- TSP simulated as concrete beam grid surrounding the array of VVMs and resting on substrate surrounding VVMs. This substrate is founded on the support foundation.
- Configuration of TSP:
  - 24" thick; compressive strength=4000 psi
  - reinforcement - #10@9" each face
  - 2" cover air side; 3" cover substrate side
  - minimum pitch specified in licensing drawing
  - 3 x 3 array modeled in ANSYS Workbench

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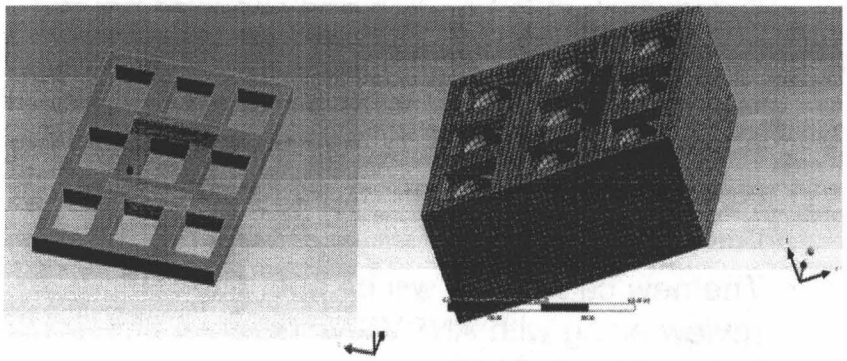
TOP SURFACE PAD



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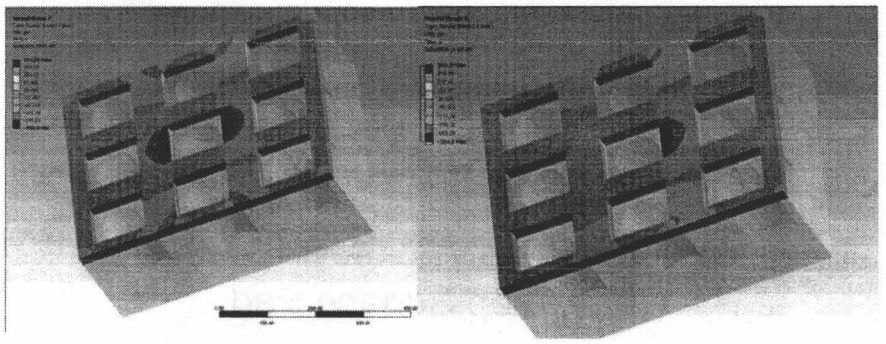
COMMENTS

- Transporter contact patch is 198" x 24" per track. This underestimates area and overestimates applied pressure to concrete. Using "future" transporters, there could be a 15-30% increase in footprint area.
- Total transporter weight is 450,000 lb. This overestimates current designs by 50,000 lb.

ASSUMPTIONS

- TSP underlying substrate has shear wave velocity = 800 f/s (per CoC, Appendix B.)
- Load combinations per ACI 318-05; loaded transporter and TSP weight considered as live load for simplicity.
- Two load combinations considered:
  - 1.6L
  - L+E; E=design basis seismic load
- No long term differential settlement - TSP sees only immediate loading from traversing transporter

STRESS DISTRIBUTION IN DIRECTION OF TRANSPORTER PATH-LOAD COMBINATIONS 1 AND 2



ACI CODE SAFETY FACTORS

- Preliminary - (undergoing technical review and concurrence)

ITEM	SF(BENDING)*	SF(SHEAR)	MAX. LOCAL DISPLACEMENT (INCH)
TRANSPORTER PATH - LOAD COMB. 1	8.32	17.547	0.062
CROSS-BEAM - LOAD COMB. 1	5.68	3.145	0.055
TRANSPORTER PATH - LOAD COMB. 2	7.963	7.295	0.077
CROSS-BEAM - LOAD COMB. 2	4.951	1.07	0.068

* SF = SAFETY FACTOR

CALCULATION PACKAGE

- Safety factors in bending and shear computed using average surface stresses across beam width to compute moments and shear forces that are compared with ACI Code allowable values.
- New calculation will be added to existing calculation package.
- The new calculation will be submitted for staff review along with ANSYS workbench files on or before April 6, 2009.