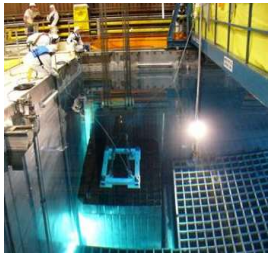
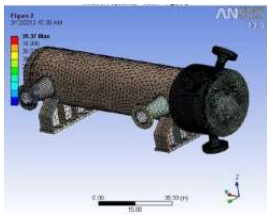
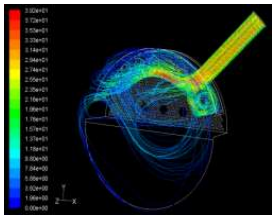
Consideration of Extreme Environmental Phenomena During Short Term Operations and Transient Loading Events










Overview

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- Background Information
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- Summary Conclusions
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Meeting Objective

- To brief the NRC staff on Holtec's position regarding the treatment of an Extreme Environmental Phenomena (EEP) during transient or transitional evolutions that occur in the course of Short-Term Operations (STO) in a cask loading campaign
- Follow up to Holtec letter to NRC dated May 12, 2021 (Document ID 5018082)

Issue Identification

- HI-STORM FSAR (100 and FW) does address the occurrence of an Extreme Environmental Phenomena such as a tornado missile impact or a design basis earthquake during Short Term Operations. It does not consider transient loading/unloading operations that are necessary to carry out a dry storage loading campaign at a nuclear plant
- This raises the following question (as an example):
  - Is it necessary to perform a deterministic analysis of a tornado generated large missile strike on a HI-TRAC while it is being upended on transporter?
- Traditionally tornado missile impacts have been addressed by administrative controls

Background Information

- **Extreme Environmental Phenomena (EEP)** are episodic loads characterized by very short duration and severe dynamic conditions, which fall into two categories:
  - Impactive loadings typified by tornado-borne missiles
  - Inertial loadings typified by high winds, tsunamis, floods or earthquakes
- **Short-Term Operation (STO)** refers to the series of operational steps that occur during the implementation of pool-to-pad evolutions in a dry storage campaign; transient evolutions are a subset of STO of very short duration
- HI-STORM FSARs do not consider EEP loads on the system during transient conditions that invariably occur during every STO

Background Information (cont.)

- NUREG-1536 and NUREG-2215 state:
  - "… an earthquake or tornado may occur at any time and in combination with any "normal" condition."
  - "The NRC staff considers that tornado and tornado missiles may occur without warning."
- Meanwhile, HI-STORM 100 FSAR/COC state:
  - "…tornado wind and tornado-generated missile data applicable to the HI-STORM 100 System (Tables 2.2.4 and Table 2.2.5) will be used in the design of the CTF unless existing site data or a probabilistic risk assessment (PRA) for the CTF site with due consideration of short operation durations indicates that a less severe tornado missile impact or wind loading on the CTF can be postulated." [FSAR]
  - Tornado missile load "may be reduced or eliminated based on a PRA for the CTF" [COC]

Background Information (cont.)

- Above excerpts indicate that while the impact of a tornado missile on the cask during an STO requires consideration in a generic sense, the impact of a tornado missile on an ancillary such as the CTF is subject to a PRA to determine the intensity or probability of the loading event
- Holtec typically does not use the PRA approach to reduce the intensity of an EEP loading applied to a site during an STO
- However, transient evolutions of a very short duration, such as installation of lift jacks, slings, top lid bolts, etc., do not merit an explicit deterministic analysis because they are transitional operations of such short duration that a probability analysis will readily filter them out as non-credible loading scenarios
- Furthermore, there are too many physical states that occur during the transitional evolution to lend to deterministic analyses

Background Information (cont.)

- The definition of environmental phenomena is grounded on the notion of probability
- For Part 72 facilities, Commission Order CLI-01-22 affirms that:
  - "A facility need not be designed to withstand every conceivable accident, but only those found to be "credible""
  - Both the Commission and the ASLB agreed that "one in a million is the appropriate "threshold probability," beneath which a posited accident can be ignored in the facility's design"
- Therefore, the simultaneous occurrence of a transient evolution and an EEP does not need to be analyzed if probability is below 1E-06

Background Information (cont.)

- EXAMPLE: Consider the case of a Design Basis Earthquake (BDE) with a 10,000 year return period
  - Earthquake probability equals 1E-04 per year
  - Simultaneous occurrence of a DBE and a transient STO is non-credible if the cumulative time duration of transient configuration in a year does not exceed:

    T = (1E-06) (24 hours/day) (365 days/year) / (1E-04) = 87.6 hours

Background Information (cont.)

- NUREG/CR-4461 provides extensive information on the probabilities of tornado wind speeds and tornado impacts throughout the U.S.

Probability Per Year	Maximum Tornado Wind Speed (mph)
1E-5	168
1E-6	202
1E-7	230

- RG 1.76 Rev. 1 specifies a maximum tornado wind speed of 230 mph for the U.S.
  - Indicates that the threshold for considering tornado impacts should be of the order of 1E-7 per year

Background Information (cont.)

- For any safety- relevant cask configuration that is present all year long (e.g., HI-STORM overpacks at the ISFSI), tornado impacts are evaluated at the maximum speed
  - HI-STORM FSARs consider bounding tornado wind speed of 360 mph
- For transient evolutions that only last for days or hours per cask, the probability of a high velocity tornado missile impact would be on the order of 1E-9 or less
- Administrative controls to monitor local weather conditions/forecast can reduce event probability even further

Summary Conclusions

- Freestanding HI-STORM overpacks on the ISFSI are qualified for tornado missile impacts in the FSAR as they are present outside of the Part 50 structures for the entire year
- Freestanding HI-TRACs outside of the Part 50 structure are also explicitly qualified for conditions where they are in full contact with ground or supported in a stable configuration even though such conditions would only exist for a small fraction of a year
- Other STOs may occur where the HI-STORM or HI-TRAC are not fully supported from underneath, such as periods of lifting. For those transient operations that occur multiple times during cask loading at a site, the cumulative duration of such loadings should be used to determine whether they merit exclusion from a deterministic analysis
- A deterministic analysis may be performed to ensure that the fuel will not be damaged or the MPC will not be breached if the probability of an episodic load is above the credible level

Final Resolution

- Revise text in Chapter 12 of the HI-STORM FW FSAR via the ECO/72.48 process to incorporate the following changes:
  - Add specific discussion regarding the possibility of a tornado missile strike on the cask or its handling equipment (while actively being raised or lowered) which although extremely unlikely could hypothetically lead to an uncontrolled cask drop;
  - Include results for a generic cask drop evaluation from a maximum height of 90 inches above the target surface (ISFSI pad) to demonstrate no fuel rod rupture and loss of confinement
    - Cask is assumed to drop in the vertical orientation which is the most vulnerable impact direction for the stored fuel assemblies per NUREG-1864, as well as the MPC enclosure vessel

Thank You

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