REVISIONS TO SEISMIC ANALYSIS OF HI-STORM 100U

ALAN I. SOLER
HOLTEC INTERNATONAL

AGENDA

- HISTORY
- REVIEW OF MAJOR CONCERNS
- MOVING FORWARD
- CLOSURE

HISTORY –(CONT'.)

- HOLTEC RESPONSE TO RAI#2 SET:
  - IMPROVED FEA MODEL WITH DETAILED MPC AND CONTENTS TO ADDRESS INFLUENCE OF CONTENTS AND LOAD PATH QUESTION.
  - A REQUIRED SAFETY FACTOR OF 2 WAS SET TO REASONABLY COVER ALL THE POSSIBLE SITE CONFIGURATIONS SINCE IT IS NOT POSSIBLE TO DEFINE A UNIQUE CONFIGURATIONS THAT COULD BE DEFINED AS "BOUNDING".
  - FSAR REWRITTEN TO REQUIRE EACH SITE TO PERFORM SITE-SPECIFIC ANALYSIS (INCLUDING PAD AND SUBGRADE UNDER PAD DETAILS) USING THE METHODOLOGY AND SINGLE CAVITY MODEL IN THE FSAR. FSAR SIMULATION SET THE METHODOLOGY

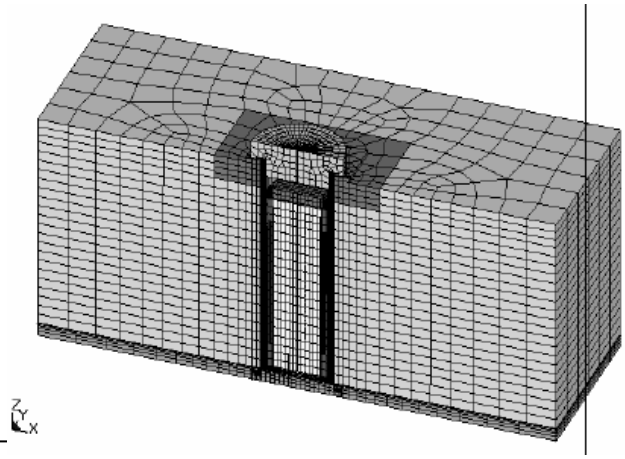
HISTORY (CONT'.)

- STAFF CONCLUDED HOLTEC RESPONSE INADEQUATE TO MAKE A FINAL DETERMINATION OF STRUCTURAL ACCEPTABILITY….HERE WE ARE!
- IN ORDER TO MOVE FORWARD, FIRST REVISIT THE STRUCTURAL SUBMITTAL IN RESPONSE TO 2ND SET OF RAI'S. FEA MODEL IN HOLTEC RESPONSE TO RAI #2 SET SHOWN IN NEXT SLIDE.

ORIGINAL SUBMITTAL

- NO UNIQUE CONFIGURATION THAT CAN BE SHOWN TO BOUND ALL SITES.
- THEREFORE, BOUNDING ANALYSES CANNOT BE ESTABLISHED.
- THEREFORE, ORIGINAL SUBMITTAL FOCUSED ON SINGLE UNDERGROUND CAVITY AND PROVIDED A METHODOLOGY IN LIEU OF BOUNDING SOLUTION(S).

SINGLE VVM WITH SURROUNDING SUBGRADE – CONTROL MOTION INPUT AT BASE OF PAD, SO NO PAD FLEXIBILITY OR SUBGRADE BELOW PAD. HOMOGENEOUS SOFT SOIL SURROUNDING VVM.



EXCERPTS FROM SUPPLEMENT 3.I

3.I.4.7.1 *Seismic Methodology*

> ***NOTE***
> *Section 3.I.4.7.1, in its entirety, is incorporated into the HI-STORM 100 CoC by reference (CoC Appendix B, Section 3.4) and may not be deleted or altered in any way without prior NRC approval via CoC amendment. The text of this section is, therefore, shown in bold type to distinguish it from other text.*

iii. Prepare a single VVM model with foundation pad modeled and undergirding substrate modeled down to bedrock. Boundary conditions at the defined lateral boundary of the modeled substrate should minimize or eliminate reflection of waves.

vii. All safety factors associated with the CEC must be greater than or equal to 2.0 to justify the use of a single VVM model for an ISFSI that will house multiple VVMs. Reinforce the VVM, as required, and rerun the problem until all factors of safety in the CEC are greater than or equal to 2.0. All safety factors associated with the CEC contents must meet the limits summarized in Subsection 2.I (Table 2.I.6).

MAJOR CONCERNS OF STAFF

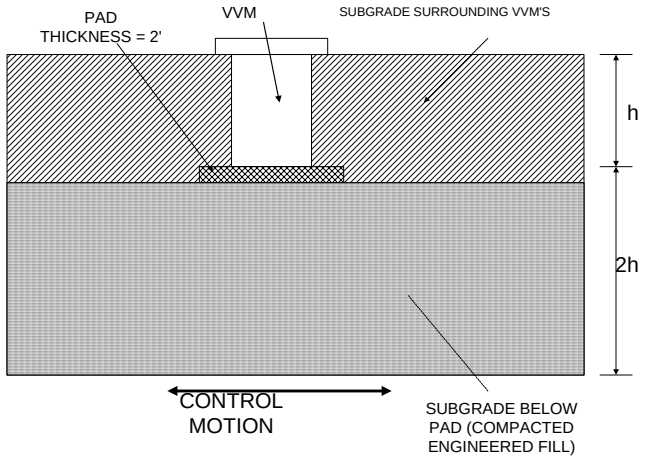
- CONCERN THAT FSAR SAMPLE SIMULATION ESTABLISHING PROPOSED METHODOLOGY DID NOT INCLUDE EFFECT OF CONCRETE PAD FLEXIBILITY.
- CONCERN THAT SAMPLE SIMULATION ESTABLISHING PROPOSED METHODOLOGY DID NOT INCLUDE EFFECT OF SUBGRADE UNDER PAD.
- CONCERN THAT MANDATED INCREASED SAFETY FACTOR MAY NOT BE ENOUGH TO ACCOUNT FOR EFFECT OF MULTIPLE CAVITIES.
- BOTTOM LINE…CONCERN THAT TOO MUCH LEFT TO DISCRETION OF SITE WITH NO SIMPLE WAY TO ENSURE REGULATORY OVERSIGHT.

MOVING FORWARD-CONCERNS #1 AND #2

SINGLE VVM SIMULATION OF METHODOLOGY (ONE VVM WITH NONLINEAR CONTACT WITH SUBGRADE AND MPC WITH RATTLING FUEL) IS EXTENDED:

1. AN ELASTIC CONCRETE PAD UNDER THE VVM IS INCLUDED. PAD SIDE LENGTH IS 2 x DIAMETER OF VVM. PAD THICKNESS IS 2'.
2. A HOMOGENEOUS ELASTIC SUBGRADE UNDER THE PAD IS INCLUDED. DEPTH TO LEVEL WHERE CONTROL MOTION IS APPLIED = 2 x VVM CAVITY LENGTH BELOW BASE OF VVM (for sample problem in FSAR)
3. CONTROL MOTION MOVED TO BASE OF SUBGRADE.
4. "MINOR CONCERNS" RAISED BY STAFF ADDRESSED.

CONFIGURATION FOR FSAR EXAMPLE OF METHODOLOGY



PAD PROPERTIES

Pad concrete compressive strength
= 4 ksi

Single layer substrate under pad - wave speed = 1200 ft/sec.

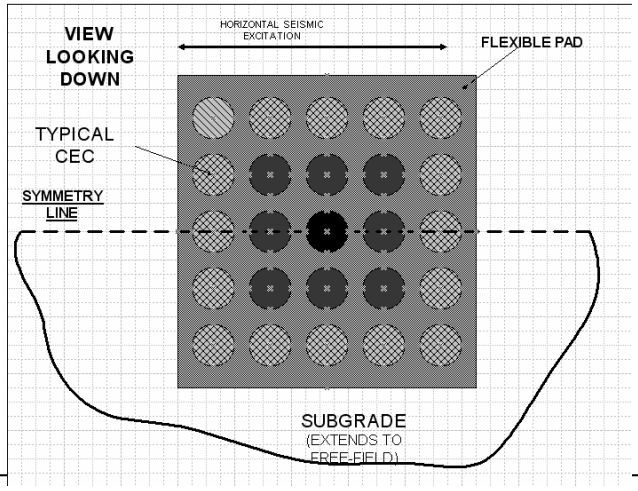
Single layer substrate surrounding VVM - wave speed = 800 ft./sec.

Pad extent beyond single cavity is ½ of minimum spacing between VVMs per FSAR.

MOVING FORWARD - STAFF CONCERN #3

- PARAMETER STUDY AS STATED IN FOLLOWING SLIDES TO ADDRESS MULTIPLE CAVITY SENSITIVITY.
- PARAMETER STUDY RESULTS REPORTED IN CALCULATION PACKAGE
- FOCUS ON MAXIMUM VVM EXCURSIONS VS. VVM ARRAY SIZE – USE “SASSI” TO MINIMIZE TIME IMPACT.
- 1 VVM; 3 X 3 VVM ARRAY; 5 X 5 VVM ARRAY – (make use of symmetry in model)

SASSI ARRAYS (VIEWED FROM ABOVE)



DETAILS OF LINEAR MODEL FOR PARAMETER STUDY

- SUBGRADE UNDER PAD AND SUBGRADE SURROUNDING VVMs HAVE SAME MODULUS AS FSAR SINGLE VVM SOLUTION.
- NO NON-LINEAR EFFECTS (NO CONTACTS, NO RATTLING)
- PAD THICKNESS, DEPTHS OF SUBGRADE, VVMs SAME AS FSAR.
- MASS OF VVM CONTENTS LUMPED WITH CEC SHELL
- USE SAME CONTROL MOTION AS FSAR AT SAME DEPTH.
- COMPARE MAX. HORIZONTAL DISPLACEMENTS FOR 1, 3X3, 5X5 -> DEMONSTRATE THAT INCREASING SAFETY FACTOR ON SINGLE VVM SOLUTION ACCOUNTS FOR MULTIPLE VVMs

PROPOSED TEXT REVISION IN 3.I.7.1 AND IN COC

ENHANCE FSAR TEXT TO ENSURE THAT IT CLEARLY EXPOUNDS WHAT SHOULD BE INCLUDED IN SINGLE VVM SIMULATION METHODOLOGY.

SINCE MPC QUALIFIED TO 45 G'S, AND SINCE SYSTEM QUALIFIED FOR BURIAL UNDER DEBRIS, COC WILL SUGGEST THAT GOOD SITING AND CONSTRUCTION PRACTICE OBVIATES NEED FOR SITE-SPECIFIC SIMULATION IF SEISMIC INPUT G-LEVEL BELOW A PRESCRIBED VALUE.

BOTTOM LINE…..

Recognizing the difficulty of achieving a "bounding solution" and the fact that no parameter study can provide a bounding solution, does the proposed path to a re-submittal provide sufficient information to the Staff to reach a definitive conclusion when Holtec resubmits?

That is, in the interest of minimizing the Staff's time and effort, Holtec would like to nail everything down (as much as legally possible) on philosophy and specific inputs prior to re-submittal so as to eliminate an RAI.