NAC INTERNATIONAL

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Discussion for Seismic Stack Up
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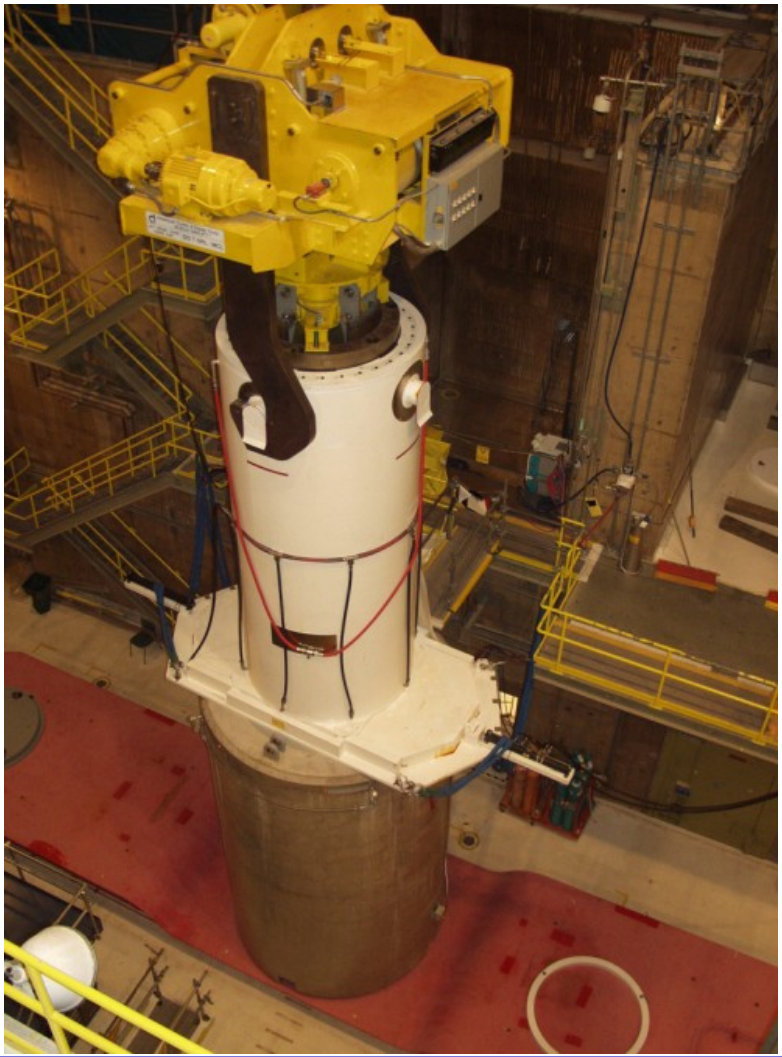
Transportable Storage Canister (TSC) Loading Operation

- Final operation of fuel loading is to insert the welded TSC from a shielded transfer cask into a vertical concrete cask.
- In a typical US plant, the TSC is transferred to the concrete cask inside a 10CFR part 50 building.

TSC Loading Operation

- A shielded transfer cask is positioned on top of concrete cask via an adaptor plate.
- TSC is lowered into the concrete cask.
- Final closure of concrete cask is performed.
- Loaded concrete is moved to the ISFSI pad.

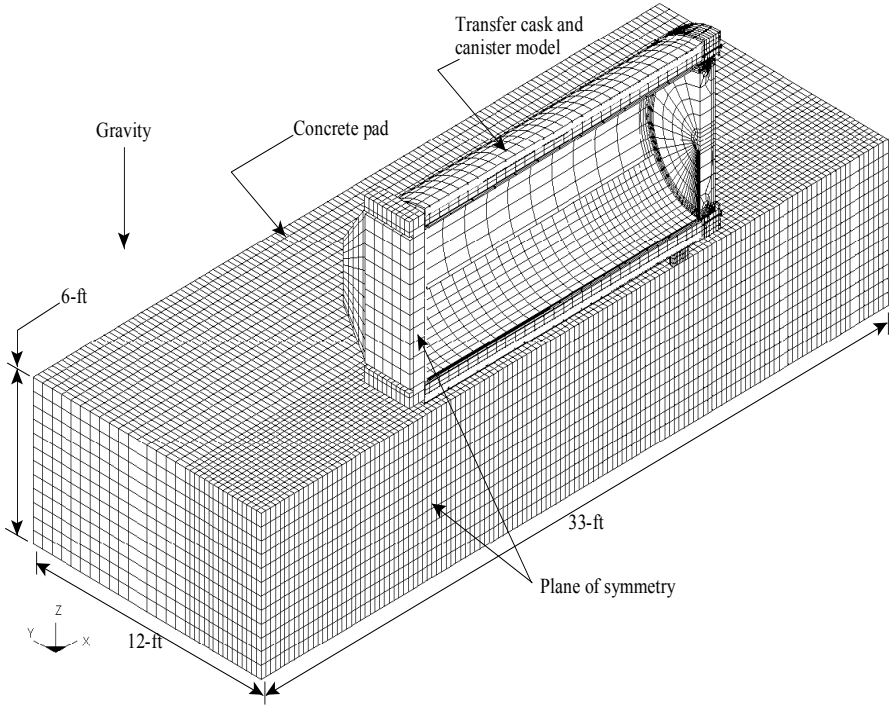


Seismic Evaluation

- Objective is to confirm stability of the system during a seismic event.
- A variety of solutions have been implemented to maintain safety.
- One solution is to use a lift system to maintain control of the cask and canister during operations.

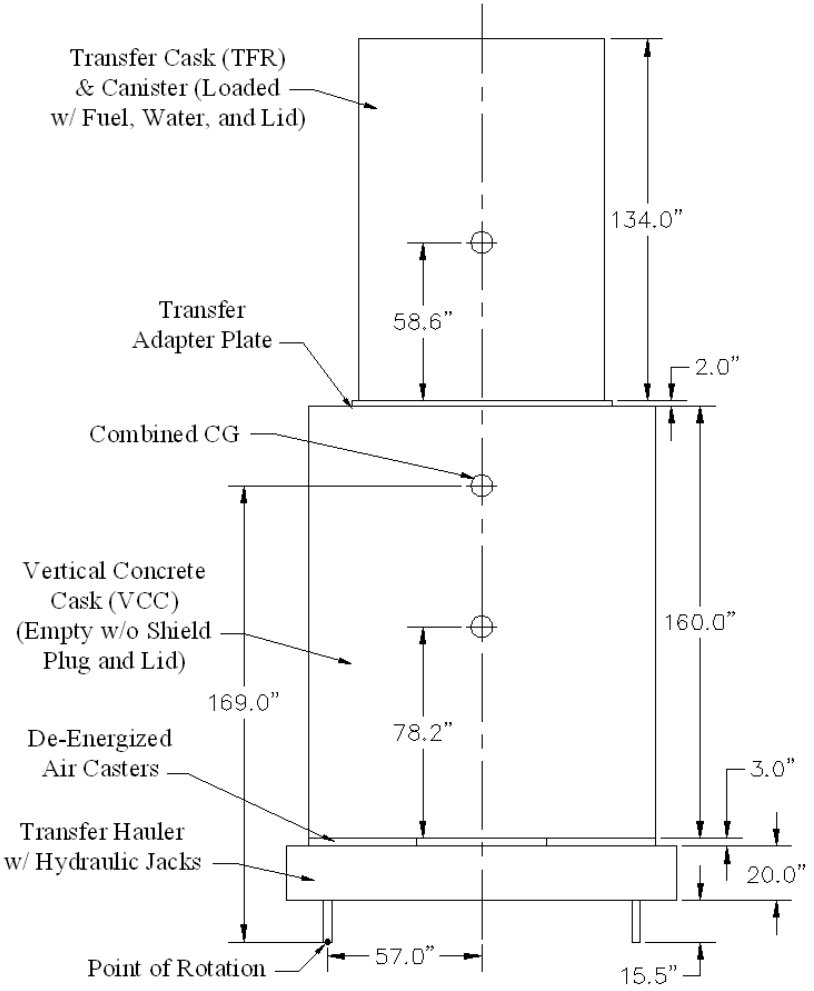
Seismic Evaluation-Consequences

- Another solution path alternative is to evaluate the transfer cask impact due to instability and to confirm confinement is maintained.
- Requires detailed examination (LS-DYNA) of the accident conditions.
- Requires detailed modeling of the inelastic behavior of the shielded cask, the canister confinement and target.
- ASME Appendix F is conservative for this energy limited event.
- Strain based criteria is applicable.
- Critical strains develop in a compressive region.



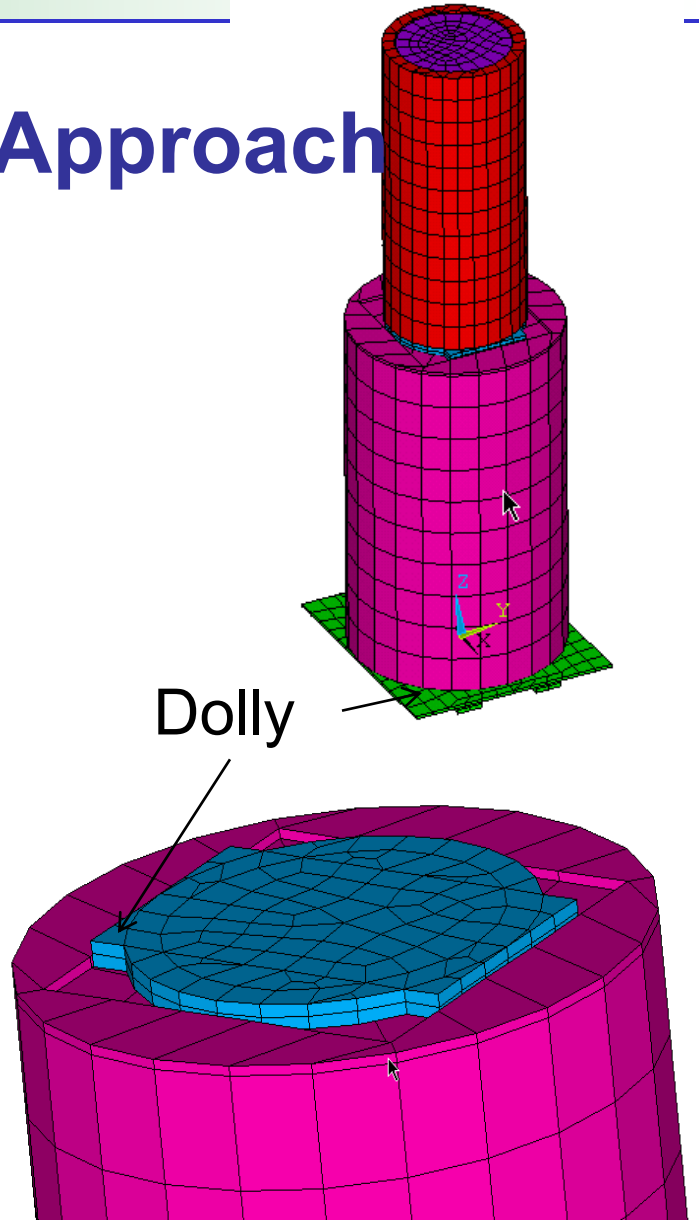
Seismic Stability-Historical Approach

- Loading evaluations have continually changed over the past two decades.
- Earlier sites used simple static evaluations for site with low seismicity.
- Minimal friction values (Mark's) confirmed that the cask would remain on the conveyance deck.
- The recent ASCE 43-05 offers an alternative to the more demanding transient evaluations



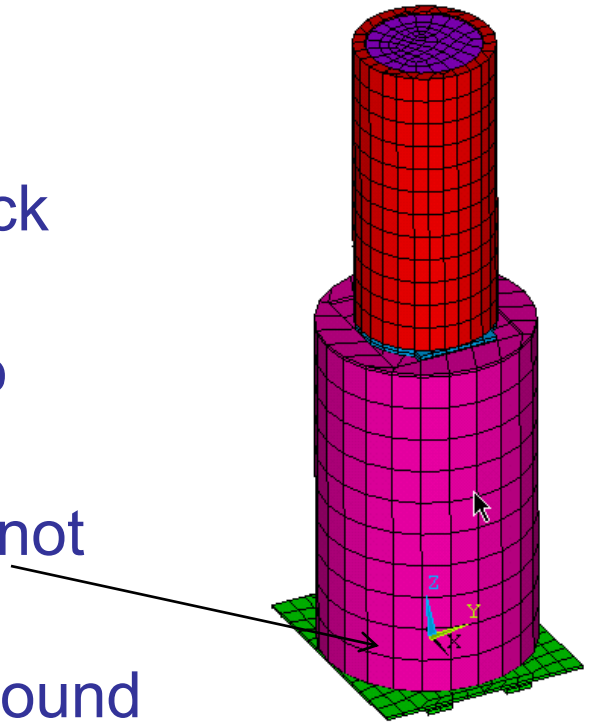
Seismic Stability-Historical Approach

- A dynamic analysis was used when the static evaluation was too conservative.
- A qualified single time history was used.
- Detailed model was used for canister, casks and interfaces
- Gaps were modeled.
  - Canister-transfer cask
  - At the interfaces
- Dolly compliance was modeled.



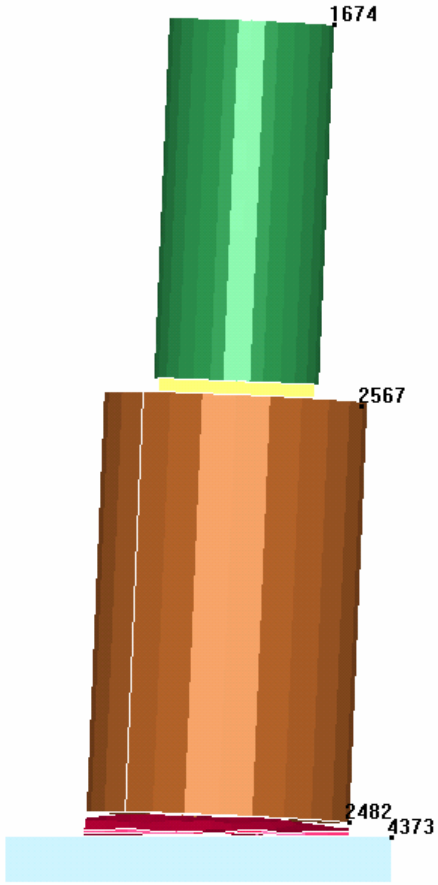
Seismic Stability-Historical Approach

- Canister and cask are allowed to rock independently
- Multiple solutions were generated to assess friction
- At locations where the interface did not prohibit unrestricted motion
- Used a lower bound and an upper bound value to assess motion
- Dolly was allowed to rock
- For some cases defense in depth considered the dolly to fail and cause further system rocking.



Seismic Stability-Historical Approach

- Uncertainties are minimized in this approach due to detailed modeling of the combined system
- Friction effects can be minimized due to the use of stops to limit motion
- For low PGA's, response is limited
- For 0.31 PGA, the tip angle was 3
- Instability angle α(ASCE 43-05)=26
- Results showed large Factors of Safety
- Methodology does not meet ASCE 43-05 criteria due to use of single earthquake time history.



Alternate Approach to Stability Assurance

- Design and fabrication of a seismic restraint can provide an alternative to avoid delays and to avoid uncertainties.
- Computational efforts are reduced to static analyses or at most, response spectrum analyses using building spectra.
- For some specific decommissioning sites, the loading occurs outside the building. A separate structure is required.
- Design and fabrication efforts are significant
- For loading operations inside the building, design, fabrication and building modifications are required.
- Operational times due to attachment/detachment of the restraint are increased, contrary to ALARA

Suggested methodology

- Operating configurations currently in place and operating under Part 50 are considered to be acceptable
- For systems with low seismicity, ASCE 43-05 offers a static approach, but a large FS of 2 needs further justification
- For systems with large FS against rocking, permit the use of a single qualified time history.