SOARCA Seismic Issue

Briefing for M. Virgilio, DEDMRT

Dec. 11, 2008

Background

- Sequences for Peach Bottom and Surry selected early 2007 – briefed ACRS July 2007
- ACRS in an October 2008 meeting identified a potential LERF seismic event for Surry from NUREG-1150
  - SBO + LOCA + direct containment failure
  - In NUREG-1150, consequence analysis for this sequence was not reported because of uncertainty with comparison to non-nuclear seismic risks. Performed as a sensitivity calculation in NUREG/CR
- Sequence originally screened out, qualitatively, by project
  - Low frequency
  - High uncertainty (both seismic input and fragility input)
- First quantitative estimate in October at roughly 5×10^{-8}, below our criterion
- Recent quantitative reassessment using updated seismic hazard curve (but old fragility estimates) suggests this sequence has a frequency of ~2×10^{-7} which meets screening criterion
- Questions remain on the state of quantification of the event
- How do we address?

Options

- Option 1 – SECY and Exec Summary exclude sequence from SOARCA analysis, acknowledge existence but defer to future resolution in separate project (when better quantification is available)
  - No delay
  - Develop a separate seismic research program to address this long-standing issue
    - Investigate the recent Japanese seismic experience at the Kashiwazaki-Kariwa nuclear power plant
    - Impact of seismic on dual units
    - Develop seismic PRA guidance
- Option 2 – SECY and full NUREG address event with expedited and limited update of fragility and seismic
  - Assessment of mitigation, accident progression and source term, and offsite consequences as necessary depending on outcome of seismic + fragility
  - Requires assessment of non-nuclear risks from seismic
  - Modest delay (~10 months)

Options (cont)

- Option 3 – SECY and full NUREG address event rigorously both seismic hazard and plant specific fragility for LOCA and containment failure
  - Assessment of mitigation, accident progression and source term and offsite consequences as necessary
  - Requires assessment of non-nuclear risks from seismic
  - Potentially lengthy delay (2 yrs?)
- Option 4 – Assume worst case and calculate the consequences for the event
  - Assessment of mitigation, accident progression and source term and offsite consequences as necessary
  - Requires assessment of non-nuclear risks from seismic
  - Delay of approximately 1 year

Option 1 – SECY w/Executive Summary

- Pros
  - No delay
  - Seismic event is highly uncertain
    - Seismic hazard curve
    - Fragility estimates
  - GI-199 ongoing
  - Near term resolution highly unlikely - much work needed (Plant specific detailed seismic modeling is ultimately required, reconciliation of Japanese seismic experience for US plants) – methods must be developed
  - Consistent with current PRA treatment (event not identified in Surry or Peach Bottom IPEEE)
    - No requirement for seismic PRA
  - Consistent with SOARCA focus on mitigation – extreme seismic event has little/no remedy
- Cons
  - Potential LERF event not analyzed
  - Potential conflict with ACRS, stakeholders

Option 1 – SECY w/Executive Summary (cont)

- Schedule
  - Provide SECY and Executive Summary to Commission in January 2009 to meet existing milestone to report results
  - Provide NUREG to Commission in April 2009
- Additional resources –
  - Address long-standing seismic issue in a separate research program
- Staff recommend this option

Option 2 – Quick Reassessment of Large Seismic Event

- Pros
  - Provides updated estimate for the frequency of this event, an updated look at seismic and fragility which is needed
  - If frequency determined to be sufficiently high, analysis of event would then provide bound on consequences
  - More complete picture of risk provided/quantified
  - Less potential for ACRS conflict

- Cons
  - Long-standing issue; quick reassessment not likely to be dispositive or demonstrably "realistic"
  - Tendency toward conservatism in "quick reassessment" when data or methods are lacking (this is a "con" which is not unique to this issue)
  - Difficulty in assessing non-nuclear seismic risk; masonry buildings
  - Several month delay in SOARCA
  - Highlight on EP without rigorous quantification (if event is ultimately screened-in)
  - Quick reassessment may be subject of strong criticism if event is ultimately screened out
  - Will need to include source term from spent fuel pool and ISFSIs failures

Option 2 – Quick Reassessment of Large Seismic Event

- Schedule
  - Provide SECY and NUREG to Commission in late 2009
- Resources
  - Updated seismic and fragility estimates – 10 staff-months
  - Integrating seismic and structural information to develop new seismic event CDFs – 5 staff-months
  - Assessment of direct offsite health consequences of earthquake (collapse of office buildings and schools) – 2 staff-months, ~$200k contractor support
  - If screened in, mitigation review, accident progression and consequence analyses, documentation – 6 staff months, ~$250k contractor support
- Communication Issues (for Options 2, 3, and 4)
  - Licensees
    - Need time to let them respond (new seismic event identified)
  - SOARCA Steering Committee, ACRS, Commission TAs

Option 3 – Detailed Reassessment of Large Seismic Event

- Pros
  - Provides modern/updated assessment of seismic risk
  - More comparable in analytical quality to assessment of internal events
  - Would provide basis for updating EE PRA methods /standards
  - Technical basis for new regulatory requirements
- Cons
  - Longstanding issue; significant uncertainties in event frequency and fragility will remain
  - Extent of uncertainty will depend on analyses/expert elicitation
  - Difficulty in assessing non-nuclear seismic risk
  - Problems similar to option 2 – if screened out or screened in
  - If screened out – skepticism (though less than option 2)
  - If screened in - emphasis on EP, Commission policy (greater than option 2)
  - Focus of SOARCA activities and report will be radically altered, focus will be shifted to low frequency/ end-of-spectrum seismic event with limited prospect of mitigation, still well below safety goal
  - Emphasis by stakeholders will be on sequence which looks like 1982 study - SST1?
  - Significant delay and cost
  - Will need to include source term from spent fuel pool and ISFSIs failures

Option 3 – Detailed Reassessment of Large Seismic Event

- Schedule
  - Provide NUREG to Commission TBD (2010?)
- Resources
  - Updated seismic and fragility estimates – 2 staff-years
  - Integrating seismic and structural information to develop new seismic event CDFs – 2 staff-years, $2 million for a seismic PRA
  - Assessment of direct offsite health consequences of earthquake (collapse of office buildings and parking garages) – 2 staff-months, $200k contractor support
  - Assessment of mitigation measures, accident progression, and source term, and offsite radiological consequences – 8 staff-months and $350k contract dollars
- Communication Issues (for Options 2, 3, and 4)
  - Licensees
    - Need time to let them respond (new seismic event identified)
  - SOARCA Steering Committee, ACRS, Commission TAs

Option 4 – Assume Worst Case: Calculate Consequences

- Pros
  - No perception of screening out a sequence that could be above the 1E-7 threshold
  - Highlights that seismic initiators are the dominant events
    - Focus PRA efforts on external events
    -
- Cons
  - Counter to the SOARCA philosophy to use realistic estimates
  - Legitimizes a sequence that still has much uncertainty since last addressed in NUREG-1150 ~ 20 years ago
    - Old fragility estimates
  - The sequence becomes the focus of SOARCA results

Option 4 – Assume Worst Case: Calculate Consequences (cont)

- Schedule
  - Provide NUREG to Commission TBD (Early 2010)
- Resources
  - Assessment of direct offsite health consequences of earthquake (collapse of office buildings and parking garages) – 2 staff-months, $200k contractor support
  - Assessment of mitigation measures, accident progression, and source term, and offsite radiological consequences – 8 staff-months and $350k contract dollars
- Communication Issues (for Options 2, 3, and 4)
  - Licensees
    - Need time to let them respond (new seismic event identified)
  - SOARCA Steering Committee, ACRS, Commission TAs

SOARCA Seismic Issue

Briefing for the Commissioners' Technical Assistants

Dec. 17, 2008

Background

- Sequences for Peach Bottom and Surry selected early 2007 – briefed ACRS July 2007
- ACRS in an October 2, 2008 public meeting identified a potential LERF seismic event for Surry from NUREG-1150
  - SBO + LOCA + direct containment failure
  - In NUREG-1150, consequence analysis for this sequence was not reported because of a lack of quantification of non-nuclear seismic risks necessary for comparison. Performed as a sensitivity calculation in NUREG/CR
- Sequence originally screened out, qualitatively, by project
  - Low frequency
  - Lack of current plant specific quantification for fragility
  - Lack of licensee analysis for identification / quantification
- First quantitative estimate in October at roughly 5×10^{-8}, below our criterion
- Recent quantitative reassessment using updated seismic hazard curve (but old fragility estimates) suggests this sequence has a frequency of ~2×10^{-7} which meets screening criterion
- Questions remain on the state of quantification of the event
- How do we address?

Path Forward

- Approach – exclude sequence from SOARCA analyses, acknowledge existence but defer to future resolution in separate project (development of better quantification is needed)
  - No delay in analyses
  - Develop a separate seismic research program to address this long-standing issue
    - Investigate the recent Japanese seismic experience at the Kashiwazaki-Kariwa nuclear power plant
    - Develop seismic PRA guidance

Path Forward (cont)

- Advantages
  - No delay
  - Seismic event is poorly quantified
    - Seismic hazard curve
    - Fragility estimates
  - Individual ACRS members consented
  - GI-199 ongoing
  - Near term resolution highly unlikely - much work needed (Plant specific detailed seismic modeling is ultimately required, reconciliation of Japanese seismic experience for US plants) – methods must be developed
  - Consistent with current PRA treatment (event not identified in Surry or Peach Bottom IPEEE)
    - No requirement for seismic PRA
  - Consistent with SOARCA focus on mitigation – extreme seismic event has little/no remedy
- Disadvantages
  - Potential LERF event not analyzed
  - Potential conflict with some stakeholders

Other approaches considered

- Address event with expedited and limited update of fragility and seismic
- Address event rigorously both seismic hazard and plant specific fragility for LOCA and containment failure
- Assume worst case and calculate the consequences for the event

Summary

- Identification of potential large seismic event does not diminish the overall SOARCA messages
  - Sequences in the 10^{-5} to 10^{-7}/reactor-year range can be mitigated by SAMGs, post-9/11 measures
  - Releases from sequences, assuming no mitigation, are small and delayed
    - Phenomena that resulted in large early release shown to be extremely unlikely or unfeasible
      - alpha-mode failure
      - direct containment heating
  - Releases from thermally induced steam generator tube rupture are small, due to subsequent hot leg and lower head failure