Containment Venting Systems for Mark I and Mark II Containments

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Executive Director for Operations

January 9, 2013
Agenda

• Status of Lessons Learned
  – Michael Johnson, Deputy Executive Director for Reactor and Preparedness Programs

• Technical and Regulatory Analysis for Venting Systems
  – John Monninger, Deputy Director, Division of Operating Reactors Licensing
Status of Lessons Learned

• Mitigation Strategies
• Reliable Hardened Vents
• Spent Fuel Pool Instrumentation
• Requests for Information
• Rulemakings
• Tier 2/3 Activities
Near Term Activities

• Periodic Update Paper Feb
• Recommendation 1 Paper Feb
• SBO Proposed Rule Paper April
SECY-12-0157, Venting Systems for Mark I and II Containments

• Overall Approach
  – Identification of Options
  – Technical and Regulatory Analysis
    • Accident Modeling
    • Quantitative Costs and Benefits
    • Qualitative Factors
  – Stakeholder engagement
  – Recommendation
Background

• Mark I and Mark II Containments
  – Small volume
  – High conditional failure probability
  – Venting considerations

• Fukushima Dai-ichi Accident
  – Loss of electrical power and heat sink
  – Containment performance
Reliable Hardened Vent Order

- Order EA-12-050 – Focused on accident prevention
  - Reliable and dependable containment vent operation
  - Greater mitigation capability consistent with NRC’s defense-in-depth philosophy
  - Issued for adequate protection
Commission Taskings

• SRM on SECY-11-0137
  – Quickly shift and merge the issue of filtration of containment vents with the Tier 1 hardened vent issue

• SRM from August 7, 2012 Briefing
  – Discuss accident sequences where the filters are and are not beneficial
Identification of Options

1) Reliable hardened vents only
2) Severe accident capable vents
3) Filtered vents
4) Severe accident confinement strategy
Evaluation of Options

• Assessed using quantitative and qualitative factors
• Analyzed plant response, radiological releases, and risk implications
• Focused on Options 2 and 3
• Range of alternatives for Option 4 complicates staff assessments
## Quantitative Analysis

<table>
<thead>
<tr>
<th></th>
<th>Severe Accident Capable Vent (Option 2)</th>
<th>Filtered Vent (Option 3)</th>
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</thead>
<tbody>
<tr>
<td><strong>Total Costs ($k)</strong></td>
<td>(2,027)$^{1}$</td>
<td>(16,127)</td>
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<tr>
<td><strong>Core Damage Frequency per year</strong></td>
<td>2x10^{-5}</td>
<td>2x10^{-4}</td>
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<tr>
<td><strong>Total Benefits($k)</strong></td>
<td>938</td>
<td>9,380</td>
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<tr>
<td><strong>Net Value ($k)</strong></td>
<td>(1,089)</td>
<td>7,353</td>
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</table>

**Note 1** – Cost higher for Mark II Containments
Qualitative Analysis

• Identified 11 factors
• Primary consideration – Enhance defense in depth
  – Address high containment failure probability of Mark I and II designs
  – Significantly reduce releases
  – Provide mitigation independent of plant response
<table>
<thead>
<tr>
<th>Qualitative Factors</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
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<tr>
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<tr>
<td>Uncertainties</td>
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<tr>
<td>Hydrogen Control</td>
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<td>Consistency between Technologies</td>
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<td>Severe Accident Policy</td>
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<td>International Practices</td>
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# Summary of Pros and Cons

<table>
<thead>
<tr>
<th>Option</th>
<th>Pros</th>
<th>Cons</th>
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</thead>
</table>
| 1      | • Severe Accident Policy  
  • Resource savings                                                      | • Containment failure probability  
  • Severe accident design                                                |
| 2      | • Hydrogen control  
  • Severe accident management                                          | • Cost/benefit assessment  
  • Uncertainty in offsite releases                                      |
| 3      | • Enhances defense-in-depth  
  • Severe accident management  
  • Hydrogen control  
  • Lowest offsite releases  
  • Independent of plant response  
  • Minimizes operator actions  
  • Existing technology                                                    | • Cost/benefit assessment  
  • Large footprint for filter tank                                         |
| 4      | • Potentially more performance based  
  • Severe accident management  
  • Smaller footprint on site than Option 3                                 | • Timeliness of resolution due to unproven strategies  
  • Addresses fewer accident scenarios than Option 3  
  • Dependent on plant response  
  • Demands on operators                                                     |
Conclusion

• The combination of quantitative and qualitative factors supports the installation of currently available filtered venting systems at BWRs with Mark I and II containments (Option 3)
List of Acronyms

• BWR – Boiling water reactor
• NRC – Nuclear Regulatory Commission
• SBO – Station blackout
• SRM – Staff requirements memorandum
Backup Slides
Qualitative Factors

- Consideration of qualitative factors
- Federal Government, Commission, and Staff guidance
- Limitations
- Role and weighting of factors part of decision-making
Mark I Containment

Reproduced from EPRI Technical Report 1026539
“Investigation of Strategies For Mitigating Radiological Releases in Severe Accidents; BWR Mark I and Mark II Studies”
Final Report, September 2012

Figure 3-1
Representative Mark I containment layout
Mark II Containment

Figure 3-4
Representative Mark II containment layout

Reproduced from EPRI Technical Report 1026539
“Investigation of Strategies For Mitigating Radiological Releases in Severe Accidents; BWR Mark I and Mark II Studies” Final Report, September 2012