PUBLIC MEETING WITH THE NUCLEAR ENERGY INSTITUTE (NEI) AND THE BWR OWNERS' GROUP (BWROG)

VENTING FOR MARK I AND MARK II CONTAINMENTS

FEBRUARY 4 AND 5, 2013

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Purpose

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- Improve understanding of the work done and reasoning behind (1) the NRC staff's assessment and recommendation on Mark I and II containment venting, and (2) the industry's assessments and preferred approach for minimizing radiological releases and reducing land contamination

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Overview and Discussion on Options and Recommendation in SECY-12-0157

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Division of Operating Reactor Licensing

Agenda – February 4, 2013

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1:00 – 1:10 p.m. Welcome/Introductions/Logistics
1:10 – 3:50 p.m. Overview and discussion on containment venting systems including filtering strategies for use at BWR Mark I and II plants
NRC (60 minutes)
NEI (30 minutes)
Break (10 minutes)
NEI (60 minutes)
3.50 – 4:50 p.m. Public questions and comments
4:50 – 5.00 p.m. Closure

Agenda – February 5, 2013

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- **9:00 – 9:10 a.m**. Welcome/Introductions/Logistics
- **9:10 – 11:30 a.m**. Plant tabletop evaluation of potential strategies to mitigate severe accidents resulting from Fukushima-type events
- **11:30 – 12:00 p.m**. Public questions and comments
- **12:00 – 1:00 p.m**. Lunch break
- **1:00 – 3:00 p.m**. Follow-up steps after Commission decision on SECY-12–0157 including functional requirements for severe accident capable and/or filtered containment vent systems
- **3:00 – 3:15 p.m**. Break
- **3:15 – 3:50 p.m**. Public questions and comments
- **3:50 – 4:00 p.m**. Closure

Background - NRC

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- NTTF Report - Safety through defense-in-depth
  - Prevention, mitigation, and emergency preparedness
- Recommendation 5.1 - Reliable hardened vents
- SECY-11-0137 - Filtration of containment vents identified as an additional recommendation warranting further consideration and potential prioritization
- SRM - Quickly shift and merge the issue of filtration of containment vents with the Tier 1 hardened vent issue

Background - Industry

- NEI - Containment filtration strategies for mitigating radiological releases to reduce the risk of land contamination
- EPRI - The end product of this technical report is a set of strategies and functions that can be used individually or collectively to reduce radiological releases and limit land contamination

Background - Industry

- BWROG Plant Evaluation of Severe Accident Mitigation Strategies
  - Evaluate the implementability at a specific plant of strategies (outlined in EPRI 2012 Technical Report 1026539) for mitigating severe accident scenarios initiated by a long-term loss of electric power

Mark I/II Containment Integrity Issues

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Mechanism	Consideration	
Containment bypass	Low frequency	
Liner melt through	Drywell flooding	
Overtemperature	Venting, sprays	
Overpressure	Venting	*SECY focus*

EPRI - BWROG focus

Drywell Flooding

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- Generic Considerations and Assessments
  - Containment Performance Improvement Program
  - NUREG/CR-5423, “The Probability of Liner Failure in a Mark-I Containment
  - NUREG/CR-6025, “The Probability of Mark-I Containment Failure by Melt-Attack of the Liner”
  - IPE/IPEEE Program
  - Emergency Operating Procedures
  - Severe Accident Management Guidelines
  - Reactor Oversight Process Significance Determination Process (IMC 0609)

Drywell Flooding

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- Plant Specific Assessments - “Create a reactor cavity flooding system”
  - Peach Bottom (p. E.G-47)
    - Already installed
    - Flooding of the PBAPS containment is proceduralized in the EOPS. In addition to the normal injection sources, HPSW, Condensate Transfer, Refueling Water Transfer, Fire and SBLC can be used

Drywell Flooding

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- Plant Specific Assessment - “Create a reactor cavity flooding system”
  - Columbia Generating Station (p. E-173)
    - Already implemented at CGS
    - CGS has the capability to flood the RPB and primary containment. Therefore, the intent of the SAMA has already been implemented at CGS.

Drywell Flooding

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- 50.54(hh)
  - NEI 06-12"B.5.b Phase 2 & 3 Submittal Guideline"
    - Section 3.4.9 Inject Water into the Drywell
      - Provide cooling of the core debris and scrubbing of fission products, in the event core damage and vessel failure can not be prevented
      - Provide an AC-power-independent means to inject at least 300 gpm of water to the drywell for a period of 12 hours. The water injection can be directly to the drywell, or through lines connected to the RPV. This could utilize the Phase 2 portable pump or other existing sources.

Drywell Flooding

- Mark II Suppression Pool Bypass
  - Section 4.1 of Draft Proposed Order for Option 2 or 4
    - Licensees shall make necessary modifications to address the potential for suppression pool bypass due to molten core debris melting through susceptible drain lines and downcomers. Acceptable approaches could include providing protection for the susceptible drain lines and downcomers, or installation of an engineered filtered containment venting system.

Drywell Flooding

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- Staff Assessment in SECY-12-0157
  - "This capability [drywell flooding] is important to the success of Options 2, 3, or 4 …"
  - "Another severe accident management strategy included in EOPs, SAMGs and EDMGs is containment (drywell) flooding"
  - "For the purpose of this assessment, the staff has incorporated this capability [drywell flooding] into its characterization of the status quo …"
  - "The importance of this capability to any severe accident venting requirements may warrant a more specific requirement than is currently in place under 10 CFR 50.54(hh) and the related guidance documents."

SECY-12-0157 Options

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1. No changes to address severe accident conditions (EA-12-050)
2. Severe accident capable vent
3. Engineered filter
4. Severe accident confinement strategy

SECY-12-0157 Options

- Recent discussions focus on relative merits of Option 3 vs. Option 4
  - General consensus that status quo (EA-12-050) should be enhanced to better address severe accidents
  - Option 2, “Severe accident capable vents,” is common to options being considered

Assessment of Options

- Followed established NRC process

1) NRC staff basis for additional requirements not based on adequate protection provisions of regulations
2) Determination of substantial safety improvement by NRC senior management
    - Consensus view that additional requirements warranted

Cost/Benefit Assessment

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- Cost-justified substantial safety enhancement
  - Quantitative analysis
  - Qualitative analysis
    - Enhances defense-in-depth (containment vulnerabilities and severe accident uncertainties)
    - Filter provides a fission product retention capability independent of plant accident response

Stakeholder Interactions

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- Numerous public meetings
- Stakeholder input and presentations
  - Filter vendors
  - Public interest groups
  - Regulated industry
- Advisory Committee on Reactor Safeguards

Technical Analysis

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- Various computer simulations to estimate potential benefits of severe accident capable and filtered venting systems
- Many simulations to address sensitivities
- Risk assessment to improve estimates (e.g., assumptions on reliability of drywell flooding and containment vent valves)
- Affirms importance of drywell flooding

Cost-Benefit Analysis

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Quantitative Cost/Benefit Analysis Per Plant				
	Severe Accident Capable		Filtered	
Total Costs ($k)	(2,027)[1]		(16,127)	
Core Damage Frequency	$2x10^{-5}$yr	$2x10^{-4}$/yr	$2x10^{-5}$/yr	$2x10^{-4}$/yr
Total Benefits ($k)	938	9,380	1,648	16,480
Net Value (Benefits – Costs)	(1,089)	+7,353	(14,479)	+353

(1) As discussed in Enclosures 1 and 4, the costs for severe accident capable vents for Mark II containment designs will likely be higher. The higher cost reflects the likely need to modify the containments to prevent molten core debris in the lower drywell sump drain lines from causing a bypass of the suppression pool. Avoidance of wetwell bypass is needed to make the severe accident capable vents a viable option for the Mark II containment design.

Cost/Benefit Sensitivity Studies

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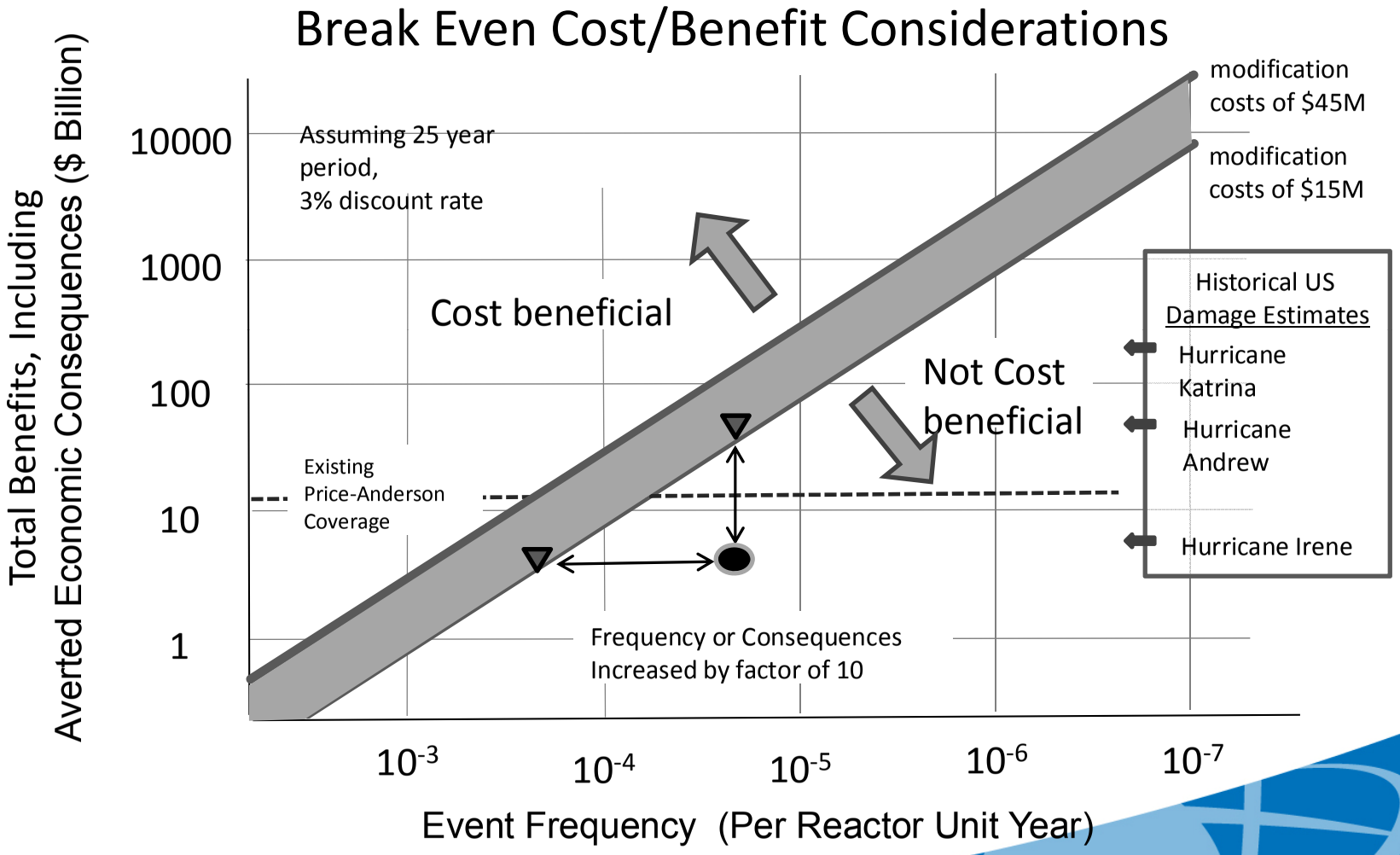

Cost/Benefit Assessment Qualitative Factors

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- Providing defense in depth
- Addressing significant uncertainties
- Supporting severe accident management and response
- Improving hydrogen control
- Addressing external events
- Addressing multi-unit events
- Considering independence of barriers
- Improving emergency planning
- Considering consistency between reactor technologies
- Considering Severe Accident Policy Statement
- Addressing international experience and practices

Defense-in-Depth

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- Containment is an essential element of defense-in-depth
- Address high conditional containment failure probability from overpressure conditions
- Filtering compensates for the loss of the containment barrier due to venting
- Filtering addresses sensitivity to plant conditions and related uncertainties

Uncertainties

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- Uncertainties in prevention and mitigation of severe accidents
  - Event frequency
  - Severe accident progression
  - Radiological consequences
  - Economic consequences

Foreign Experience

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FCVS Status at Non-U.S. BWR Facilities

FCVS Status	GE Mark I	GE Mark II	ABB Mark II	GE Mark III	Other	ABWR	Totals	
FCVS Operational	1	0	6	1	5	0	**13**	30%
Committed	6	7	0	5	4	3	**25**	57%
Considering	1	0	0	1	0	0	**2**	5%
No FCVS	2	2	0	0	0	0	**4**	9%
Non-U.S. Totals	**10**	**9**	**6**	**7**	**9**	**3**	**44**	

Japan Lessons Learned Steering Committee

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- Weighed various factors
  - Including technical arguments and likely paths to resolution (including timelines)
- Decided upon recommendation for Option 3 (engineered filtering system)

ACRS Letter

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1. Strategies that can keep the loads on the containment well below design levels most of the time.
2. Strategies that rely primarily on passive components and reduce the need for manual actions or transportation of heavy pieces of equipment
3. Strategies that are compatible with actions to flood the drywell and mitigate the potential for overfilling the wetwell.
4. Strategies that rely on scrubbing by the suppression pool, which seek to keep the pool temperature well below the saturation temperature.
5. Strategies that preserve the integrity of the drywell head seal.
6. Strategies that address hydrogen control as well as radioactive releases.

Path Forward

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- Awaiting Commission Decision
- Revisions to EA-12-050 deemed likely to require severe accident capable vents
- Deliberations on options and regulatory approaches
- Initiating interactions to develop requirements and implementation guidance

Possible Timeline for Options 2, 3 or 4

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- Commission issues SRM
  - NRC staff to hold meetings & refine orders
- SRM + 60 days: NRC issues orders
  - NRC staff to hold meetings & develop guidance
- SRM + 4 months: Issue interim staff guidance (ISG)
- SRM + 10 months: Licensees submit integrated plans
  - Every six months thereafter: Licensees to submit status report
- SRM + X years: Complete implementation by deadline defined in Order
- SRM + Y years (if applicable): Complete implementation of remaining aspects of Option 3 or 4

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Discussion