U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Containment Venting Systems for Mark I and Mark II Containments

Bill Borchardt
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

	Severe Accident Capable Vent (Option 2)		Filtered Vent (Option 3)	
Total Costs ($k)	(2,027)[1]		(16,127)	
Core Damage Frequency per year	$2x10^{-5}$	$2x10^{-4}$	$2x10^{-5}$	$2x10^{-4}$
Total Benefits($k)	938	9,380	1,648	16,480
Net Value ($k)	(1,089)	7,353	(14,479)	353
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**

Qualitative Factors

	Option 1	Option 2	Option 3	Option 4
Defense in Depth		☑	☑☑☑	☑☑
Uncertainties		☑	☑☑☑	☑☑
Severe Accident Management		☑	☑☑	☑
Hydrogen Control		☑☑	☑☑	☑
External Events		☑	☑☑	☑☑
Multi-unit Events		☑	☑☑	☑☑
Independence of Barriers		☑	☑☑☑	☑☑
Emergency Planning		☑	☑☑☑	☑☑
Consistency between Technologies	☑☑☑			☑
Severe Accident Policy	☑☑			☑
International Practices		☑	☑☑☑	☑☑

Summary of Pros and Cons

Option	Pros	Cons
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

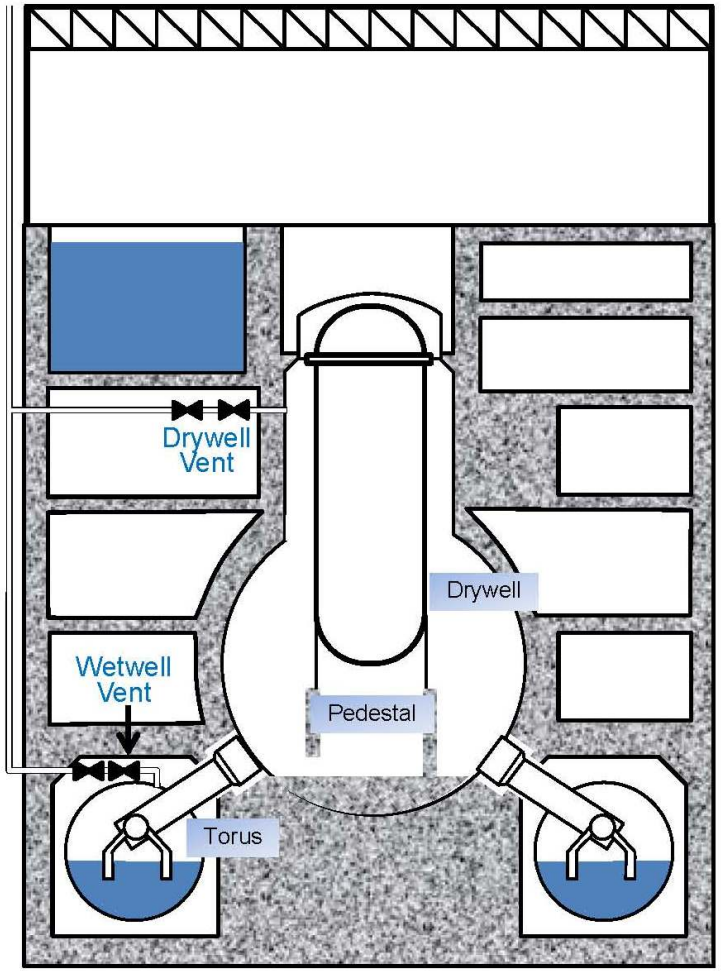

Figure 3-1
Representative Mark I containment layout

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

Mark II Containment

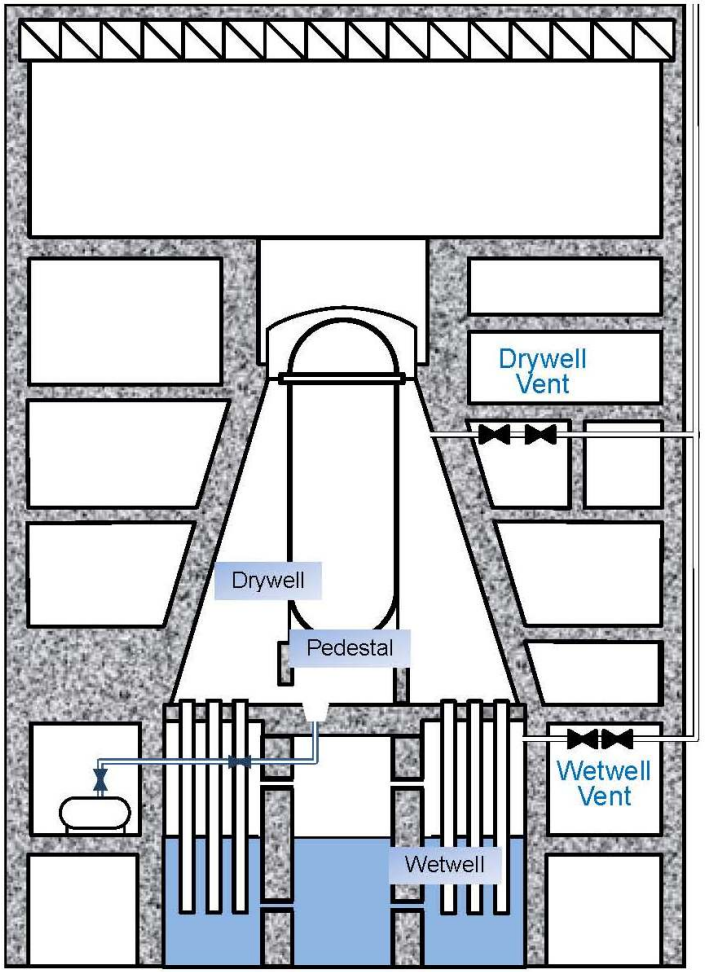

Figure 3-4
Representative Mark II containment layout

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