

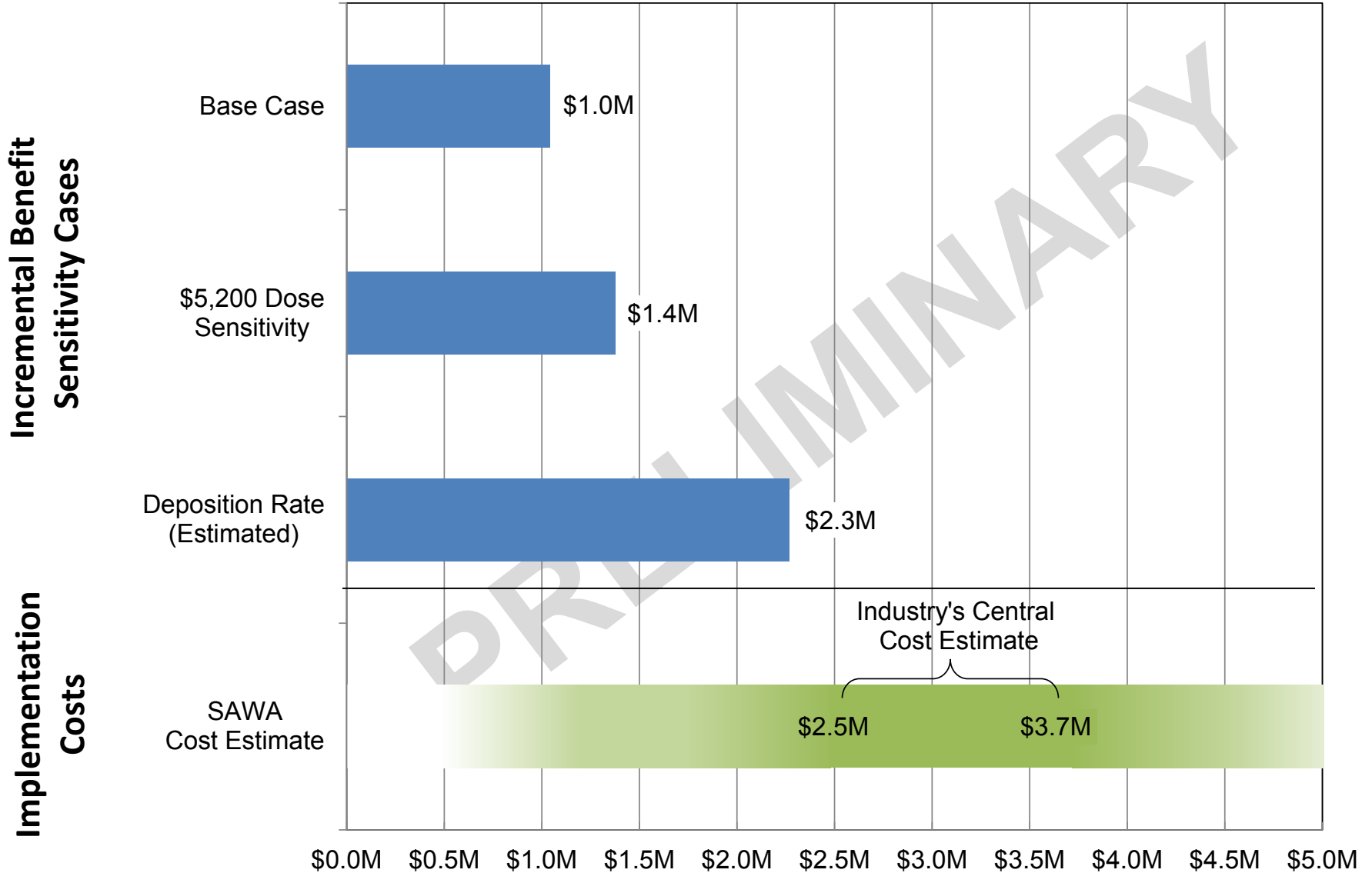
# Containment Protection and Release Reduction of Boiling Water Reactors with Mark I and Mark II Containments Rulemaking

NRC Public Meeting  
December 11, 2014

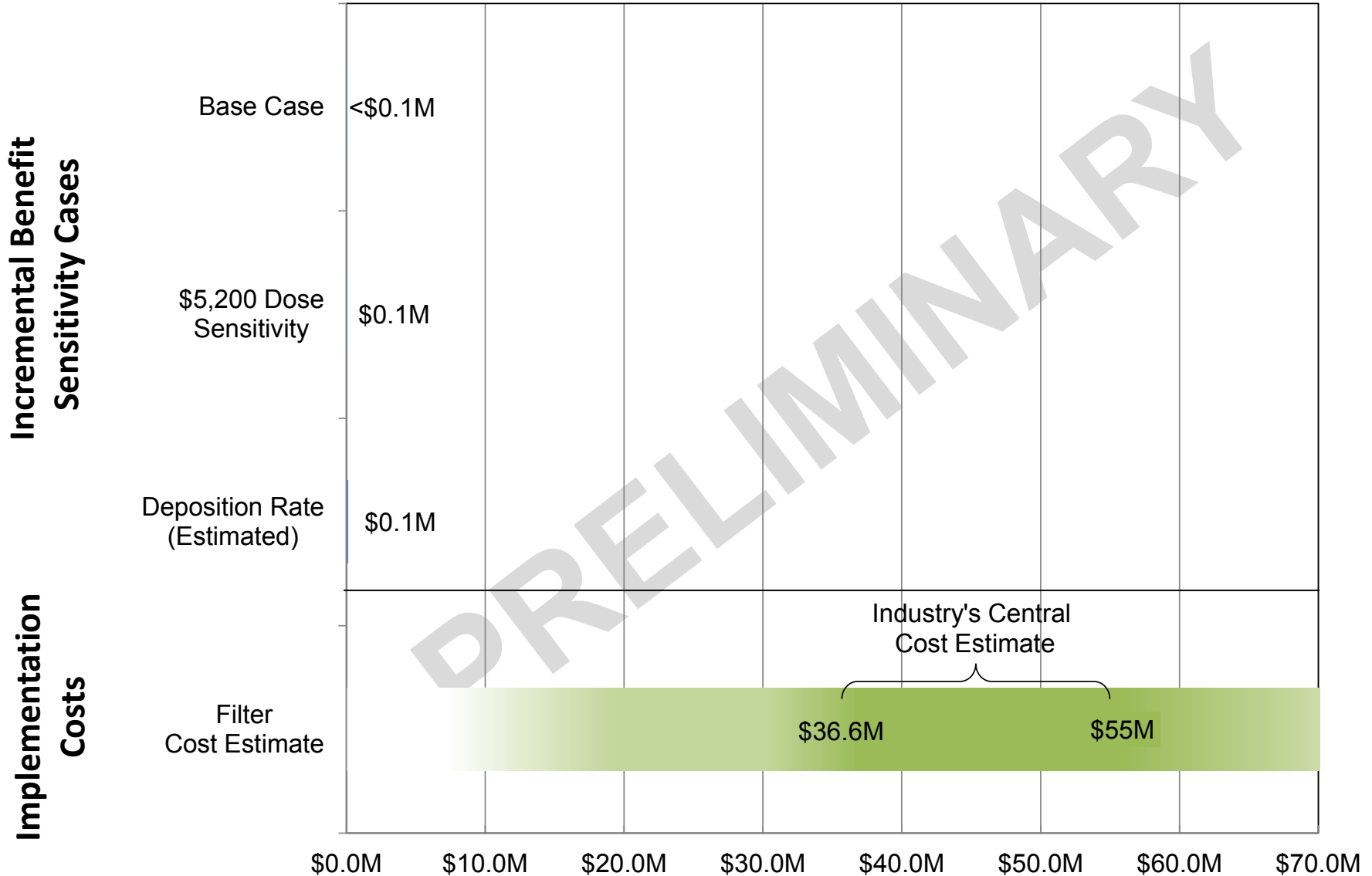


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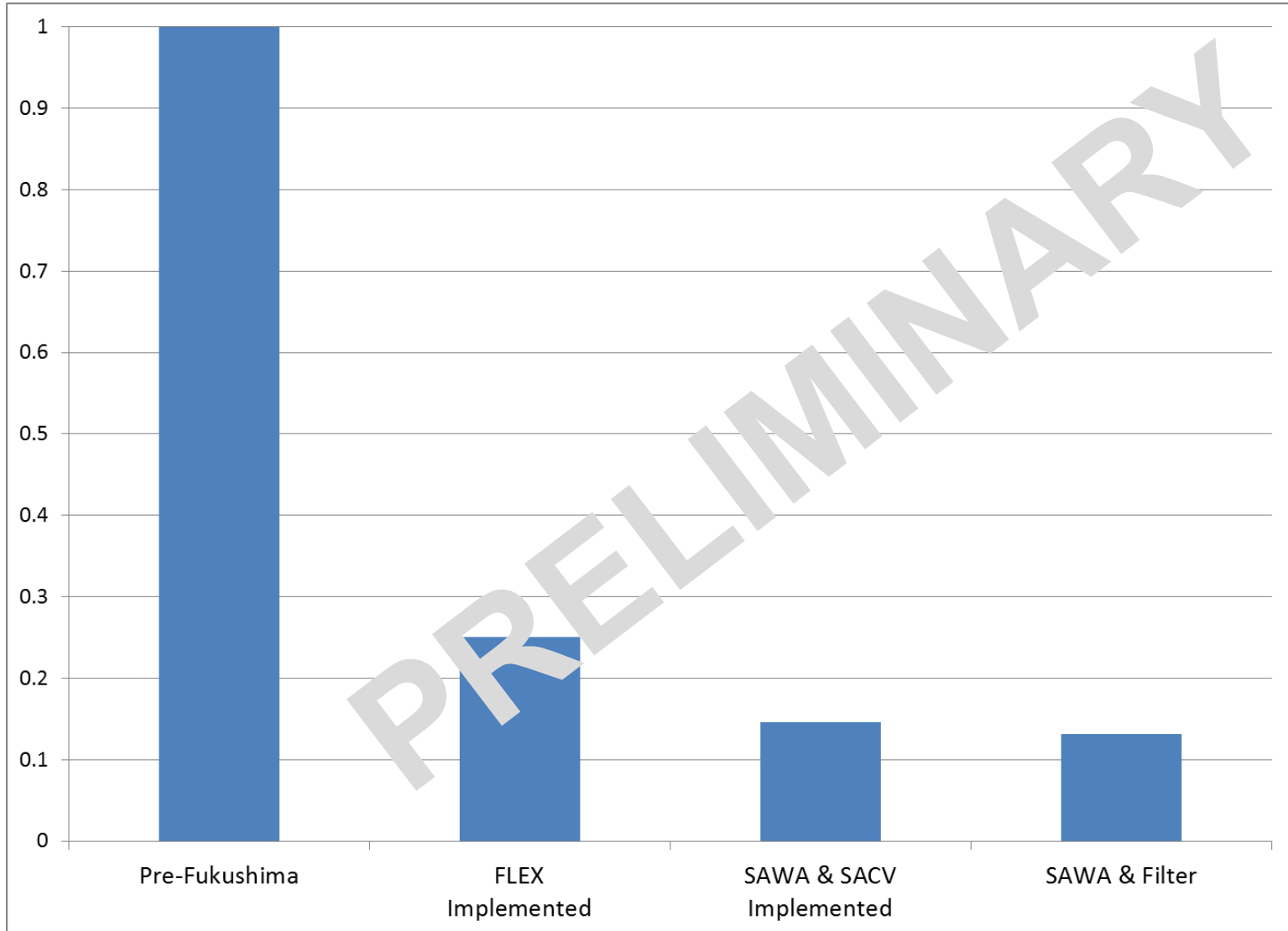
# Incremental Cost & Benefit of Severe Accident Water Addition (SAWA)



# Incremental Cost & Benefit of Large Engineered Filters



# Relative Risk Reduction



# **INSIGHTS AND CONCLUSIONS**

# General Insights

- Manual actions are needed to manage severe accidents
- Proposed guidance in NEI 13-02 for implementing Order EA 13-109 contains the essential hardware capabilities and controls for effective accident management
- BWROG SAMGs are the appropriate vehicle for directing the deployment and use of these hardware capabilities

# General Insights (Cont.)

- Effective actions can strongly influence the course of an accident, the ultimate damage state of the plant, and the resulting source terms
  - Without intervention, containment failure, hydrogen explosions in reactor buildings, and substantial radiological releases can occur
  - Specific actions can preserve the integrity of fission product boundaries and greatly reduce the magnitude of radiological releases
- Actions to vent containment via the wetwell airspace and add water to provide cooling of core debris are effective in reducing releases
- Additional hardware (e.g., external filtration) can further reduce radiological releases, but provides minimal safety benefit and is far from cost effective.

# Technical Insights

- Providing the capability to add water and vent the wetwell of Mark I containments during severe accident conditions has multiple safety benefits:
  - Preserves containment integrity due to over-temperature and over-pressure challenges
  - Cools core debris and reduces the airborne fission products
  - Avoids uncontrolled release of hydrogen to the reactor building which could result in deflagrations
  - Reduces the magnitude of radiological releases from containment



# Technical Insights (Cont.)

- Severe accident water addition (SAWA) has the largest benefit of any individual strategy
- SAWA with a SAC WW vent impacts key safety metrics:
  - Prevents containment failure
  - Increases margin to the USNRC Safety Goal
  - Reduces release magnitude by enhancing containment DF
  - Reduces doses to the public
  - Reduces longer-term offsite impacts

# Technical Insights (Cont.)

- SAWA to the RPV has some advantages over water addition to the drywell:
  - Increases the potential to preserve the reactor pressure vessel (RPV) as a fission product barrier
  - Cools core debris and fission products retained in the RPV thereby reducing releases and minimizing long-term thermal challenges to the drywell
  - Provides ex-vessel debris cooling, if needed, via the debris flow path from the RPV

# Technical Insights (Cont.)

- Addition of an engineered filtration system can reduce the magnitude of controlled (vented) releases from the containment, but the incremental benefit is quite small
  - Filter not effective for uncontrolled releases from containment (i.e., bypass of vent)
- Addition of an engineered filtration system to the containment vent line increases the actions required to manage the accident
  - SAWA still required
  - Manual operation of the vent still required
  - Filter management and maintenance
  - Actions will likely be impacted by external source term

# Technical Insights (Cont.)

- Severe accident water management (SAWM) and vent operation are viable severe accident management strategies that can reduce releases of fission products from containment
  - SAWM can avoid the need to directly vent the drywell, preserving suppression pool scrubbing

# Conclusions

- The adoption of severe accident water addition strategies provides the greatest safety benefit
  - Proposed strategy under NEI 13-02 in response to Phase 2 Option 2 of EA 13-109
  - Other alternatives provide a minimal additional risk reduction
- Manual actions are required to manage the severe accident for all strategies

**INDUSTRY COMMENTS ON NRC  
PROPOSED PERFORMANCE CRITERIA**

# Conditional Containment Failure Probability

Considerations	Industry Position
<ul style="list-style-type: none"><li>• Measure of containment defense in depth</li><li>• Performance criteria for conditional metrics are problematic</li></ul>	<ul style="list-style-type: none"><li>• Specific criterion not practical due to conditional nature</li><li>• Reasonable <u>indicator</u> of defense-in-depth</li></ul>

# Decontamination Factor

<b>Considerations</b>	<b>Industry Position</b>
<ul style="list-style-type: none"><li>• Measure of release reduction</li><li>• Highly scenario-specific</li></ul>	<ul style="list-style-type: none"><li>• Not useful due to scenario dependency</li></ul>



# Equipment and Procedure Availability

<b>Considerations</b>	<b>Industry Position</b>
<ul style="list-style-type: none"><li>• Specifies capability based on risk insights</li><li>• Consistent with EA 12-049, EA 12-051, EA 13-109, &amp; 10CFR50.54hh</li></ul>	<ul style="list-style-type: none"><li>• Consistent with past practice for beyond design basis considerations</li><li>• Practical measure for implementation, but not a performance criteria that supports option selection</li></ul>

# Total Population Dose

<b>Considerations</b>	<b>Industry Position</b>
<ul style="list-style-type: none"><li>• A factor in public health and safety</li><li>• Already explicitly accounted for in the cost-benefit evaluation</li></ul>	<ul style="list-style-type: none"><li>• Not needed. Would constitute double-counting a specific factor in cost-benefit.</li></ul>

# “Practically” Eliminate Long-Term Relocation

<b>Considerations</b>	<b>Industry Position</b>
<ul style="list-style-type: none"><li>• Measure of off-site land contamination</li><li>• Land contamination impacts directly accounted for in the cost-benefit evaluation</li></ul>	<ul style="list-style-type: none"><li>• Concur with recent Commission position</li><li>• Would constitute double-counting a specific factor in cost-benefit.</li></ul>

# Margin to the Quantitative Health Objectives

<b>Considerations</b>	<b>Industry Position</b>
<ul style="list-style-type: none"><li>• Measure of influence on public health and safety</li><li>• Used by NRC Staff on Expedited SFP Transfer</li></ul>	<ul style="list-style-type: none"><li>• Useful screening tool focusing directly on public health and safety</li></ul>

# Conclusion

- Equipment and procedure availability provides a reasonable measure for implementation compliance
- Margin to QHO is a useful screening tool
- Cost-benefit remains an adequate decision criterion for alternatives that don't screen out

Industry supports codification of EA 13-109 requirements and water strategies