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

NRC Public Meeting

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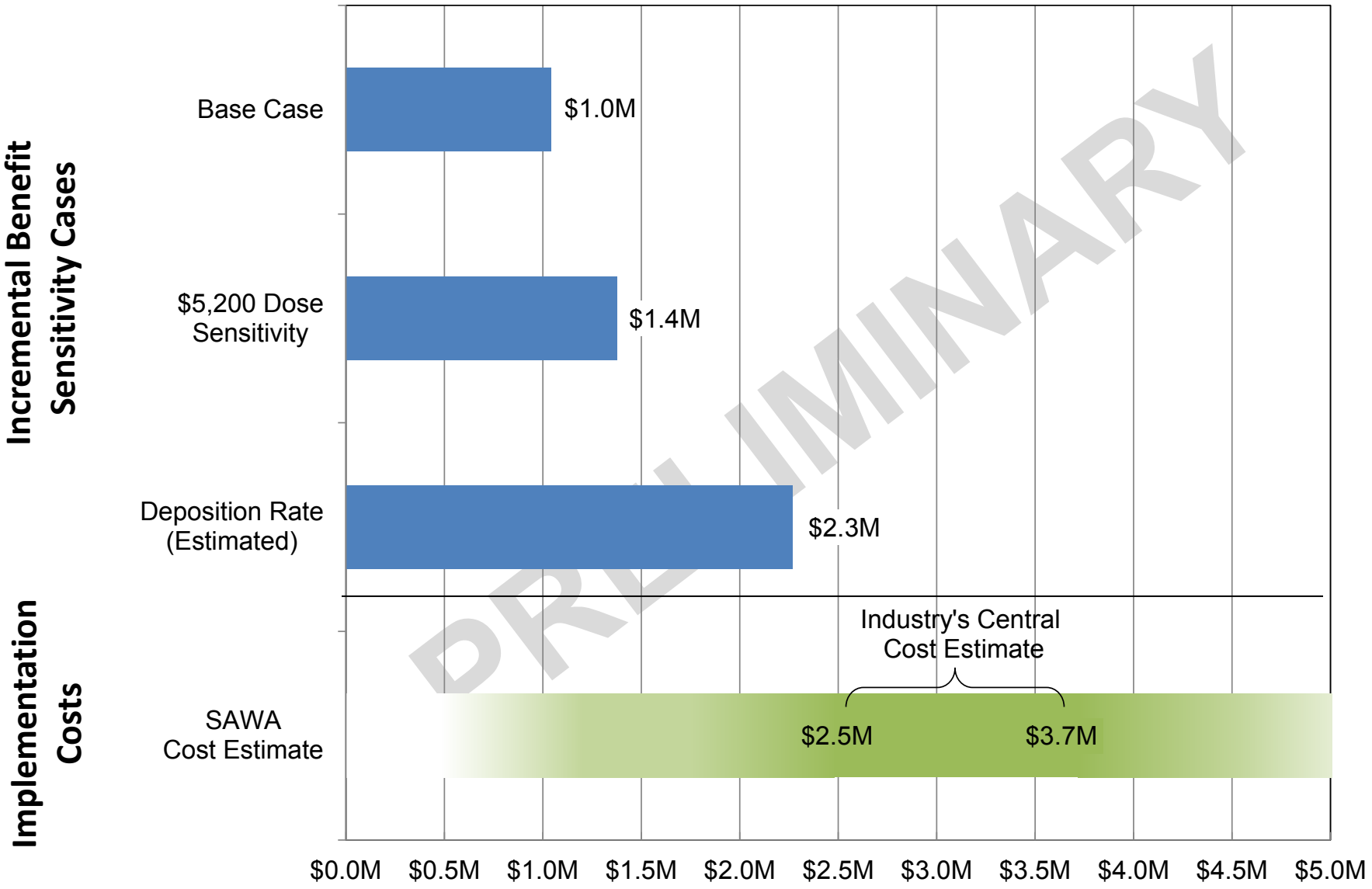
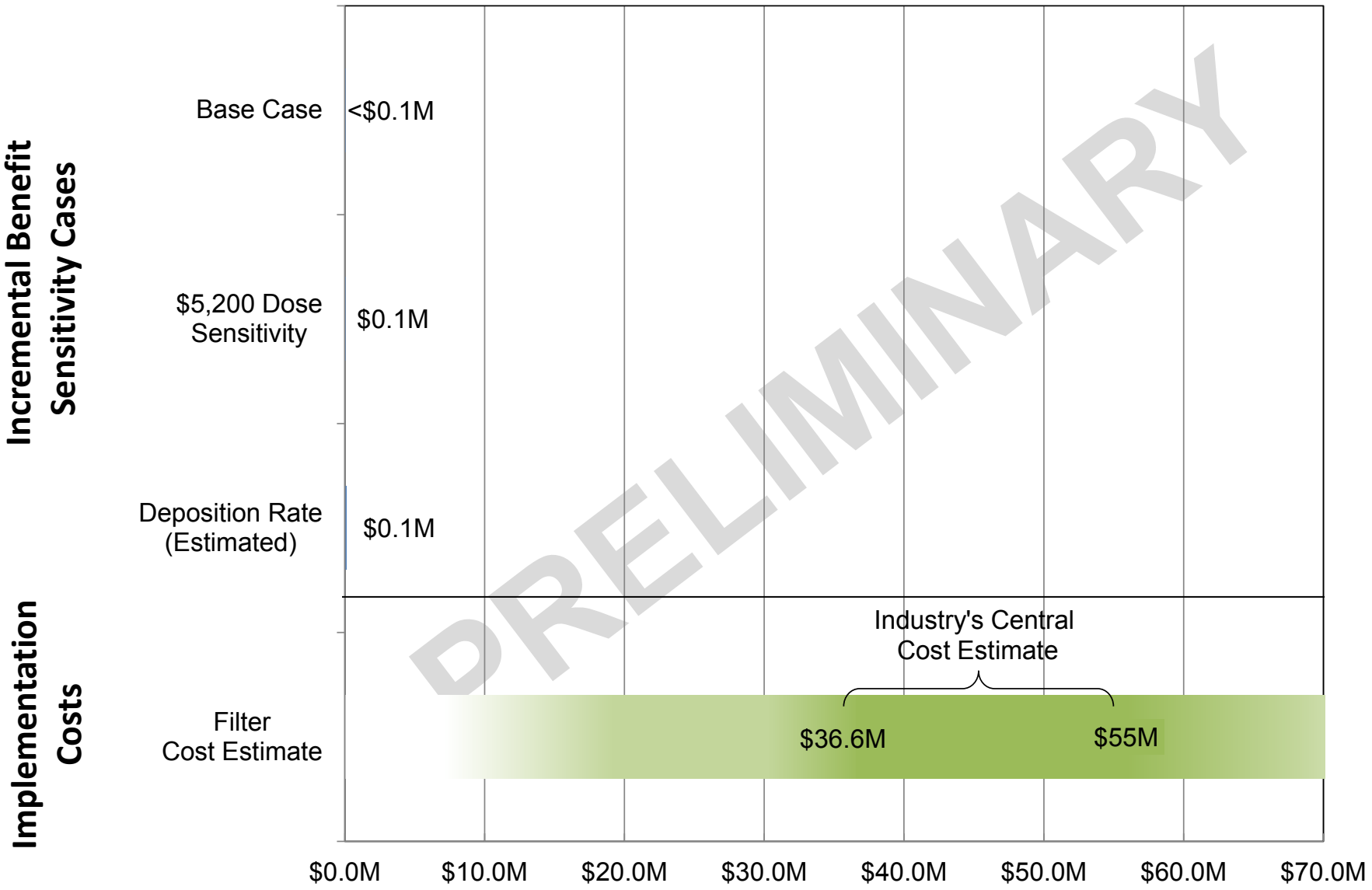
NUCLEAR ENERGY INSTITUTE

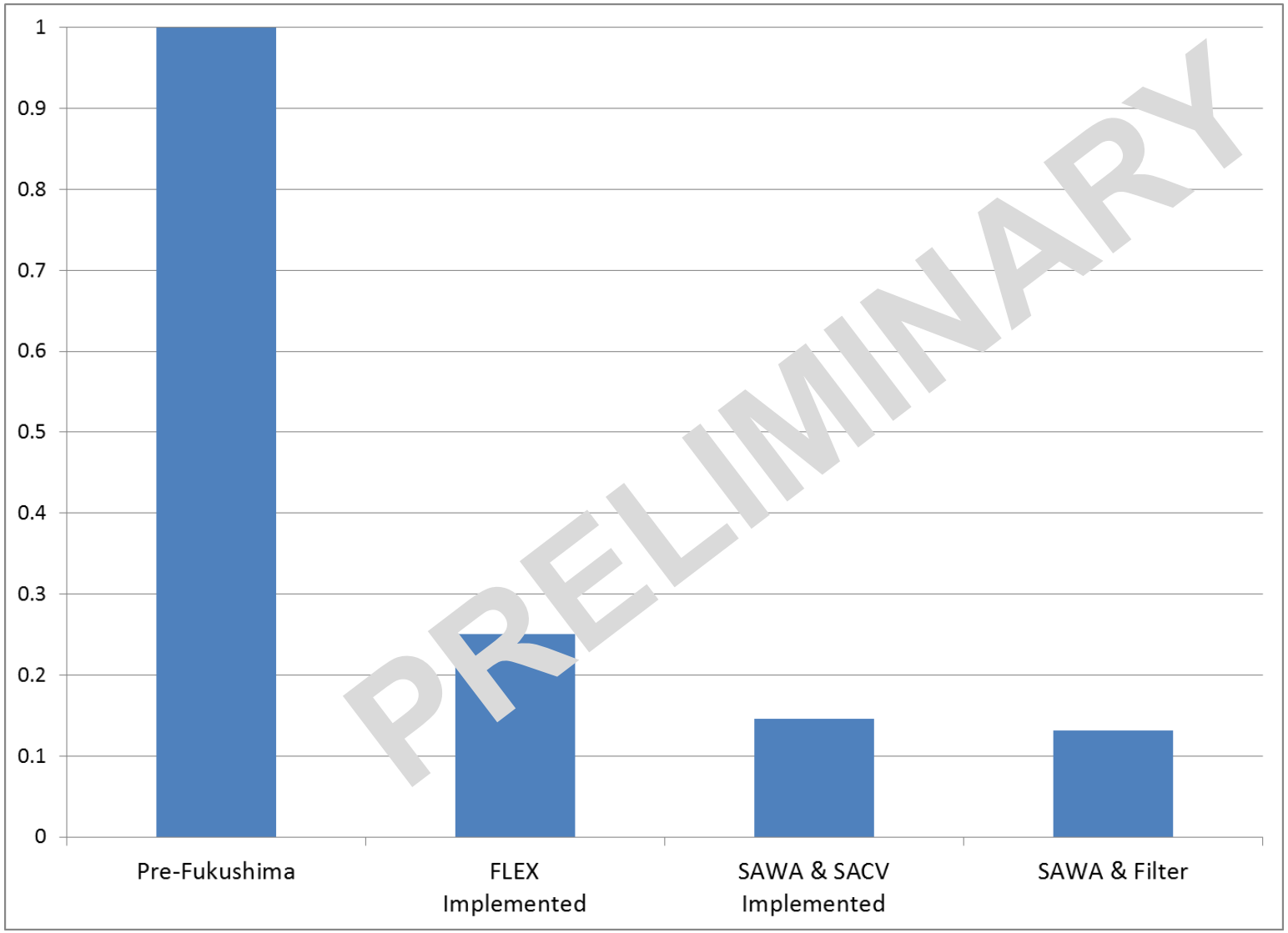
Incremental Cost & Benefit of Severe Accident Water Addition (SAWA)



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
• Measure of containment defense in depth • Performance criteria for conditional metrics are problematic	• Specific criterion not practical due to conditional nature • Reasonable indicator of defense-in-depth

Decontamination Factor

Considerations	Industry Position
• Measure of release reduction • Highly scenario-specific	• Not useful due to scenario dependency

Equipment and Procedure Availability

Considerations	Industry Position
• Specifies capability based on risk insights • Consistent with EA 12-049, EA 12-051, EA 13-109, & 10CFR50.54hh	• Consistent with past practice for beyond design basis considerations • Practical measure for implementation, but not a performance criteria that supports option selection

Total Population Dose

Considerations	Industry Position
• A factor in public health and safety • Already explicitly accounted for in the cost-benefit evaluation	• Not needed. Would constitute double-counting a specific factor in cost-benefit.

“Practically” Eliminate Long-Term Relocation

Considerations	Industry Position
• Measure of off-site land contamination • Land contamination impacts directly accounted for in the cost-benefit evaluation	• Concur with recent Commission position • Would constitute double-counting a specific factor in cost-benefit.

Margin to the Quantitative Health Objectives

Considerations	Industry Position
• Measure of influence on public health and safety • Used by NRC Staff on Expedited SFP Transfer	• Useful screening tool focusing directly on public health and safety

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