



**EPRI**

ELECTRIC POWER  
RESEARCH INSTITUTE

# Development of an Advanced Shielding Material for Permanent Installation



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# Background <sup>(1)</sup>

- Many US stations have implemented the use of permanent shielding
  - Most are NOT directly on piping or components
  - Subject to high-energy line breaks in an accident scenario
- Introduction of new, advanced shielding technologies has been very limited
- Interest in alternate shielding mechanisms has increased
  - Complex shielding challenges such as dissimilar metal / Alloy 600 tasks
  - Advanced reactor detailed design efforts

# Background <sup>(2)</sup>

- Installations are affected by GSI-191- sump debris issue
  - Jet impingement during a design basis accident
    - Obstructing containment sump
    - Wear damage downstream-of-recirculating sumps (e.g., valves, pumps, seals, or fuel)
- Limiting factors
  - Shielding material integrity
  - Engineering support resources
  - Cost to qualify

# Background <sup>(3)</sup>

- 2008 a flexible impregnated, layered matrix material became available – “Silflex”
  - Tungsten product HVL = .5” thickness
- One site was working with that vendor on permanent application
- Site and vendor volunteered to work with EPRI on material qualification

# Project Objectives

- Work with manufacturer and host site to develop permanent shielding that can be qualified for installation directly on high-energy line
- Secondary objectives include reductions in
  - regulatory related challenges to permanent installations
  - the level of effort required to approve permanent installations for other reactors
  - personnel exposure
  - program costs
  - industrial safety incidents related to heavy lifting
  - plant equipment damage or operability challenges associated with temporary shielding material movement
- 2010 – demonstrate at a host site
- Easier said than done!

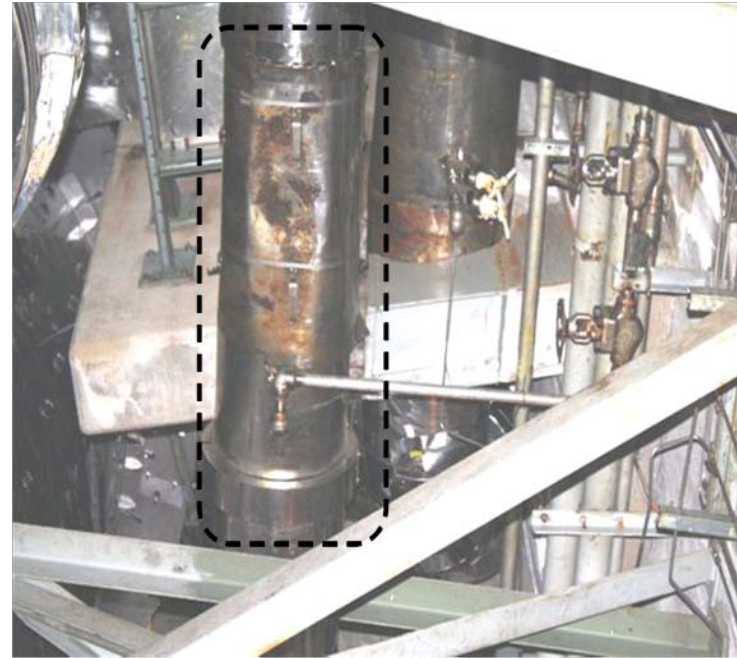
# The Plan

- ANO and Absorbtek volunteered for project
- Developed evaluation matrix for GAP analysis
- Identified 2 locations in the lower elevation of Unit 1
  - 28" OD reactor coolant pump (RCP) suction piping
  - Pressurizer surge line
- Contact dose rates average ~50 mR/hr
- General area dose rates of ~35 mR/hr
- Selected based on high occupancy rates
  - Extensive scaffold builds in this area

# Location Photos



28" OD reactor coolant pump  
suction piping



Pressurizer surge line  
(looking up)

# Engineering Considerations <sup>(1)</sup>

- Selection considered perceived linear line loading limitations
  - A larger bore pipe with more support versus smaller lines with more conservative loading restrictions
- Considered shielding the pressurizer spray line
  - Line supports would not accommodate additional weight
  - Would require substantial support upgrades

# Engineering Considerations <sup>(2)</sup>

- Discussions with engineering were not encouraging
  - Very difficult to qualify new material
  - Still responding to NRC information requests (RAI) for sump mod without complications of new shielding materials
- Referenced ANO Engineering Evaluation EC No. 2243
  - Used to evaluate the post accident debris-related requirements
  - Provided overview of the tests, analysis, and modifications to address NRC Generic Safety Issue 191 (GSI-191) and Generic Letter 2004-02 (GL-04-02)

# Engineering Considerations <sup>(3)</sup>

- Zone of Influence (ZOI) - establishes a boundary area for which materials are expected to degrade and therefore become debris.
- Debris Generation - type, quantity, and mix of debris that produces the maximum head loss across the RB Sump Strainer
- Debris Transport - how much of the debris will transport to the RB Sump Strainer.
- Debris Source Reduction - modifications to reduce the amount of debris generated
- RB Sump Strainer Upgrade - design must be considered in the resolution of GSI-191 and GL 04-02
- Down-Stream Effects (DSE) - components with close tolerance flow passages may be susceptible to excessive wear or blockage from debris entrained in the recirculation flow
- Chemical Effects - Evaluate the effect of chemical precipitates on head loss and core cooling
- Head Loss - Testing to evaluate the head loss across the new RB Sump Strainer when subjected to expected debris loads

# Engineering Considerations <sup>(4)</sup>

- Considered use of WCAP-16727-P
  - “Evaluation of Jet Impingement and High Temperature Soak Tests of Lead Blankets For Use Inside Containment of Westinghouse Pressurized Water Reactors”
- Funded by utility participants
- Developed specifically for Westinghouse reactors
- Could be procured by non-participants at a significant cost
- Unsure of applicability to the ANO B&W reactor

# Material Design

- Focus on goal of direct, on-line installation without mod for support hardware
  - Otherwise no appreciable change from current installs
- Both target locations are insulated
  - Install over, or as a component of, insulation
- Vendor trying to work with Transco and/or off-shore supplier
  - Preliminary engineering analysis indicated stainless jacket would not be sufficient to reduce debris generation
- Evaluating alternate options
  - Alpha-Maritex, SS mesh jacket, other advanced shielding configurations

# Current Status <sup>(1)</sup>

- Permanent installation not implemented-to-date
- Acceptability affected by reactor design, material qualification, and engineering interpretation of requirements
- Sump clogging issue remains major industry challenge (GSI-191)
- Several sites are being challenged and at least one has removed a permanent installation

## Current Status <sup>(2)</sup>

- WCAP-16727-P may be beneficial to participating, funding utilities
  - Listed on the WCAP cover sheet
- A recognized engineering firm contracted to develop a generic 10CFR50.59 screening
  - Permanent shielding installation on a high energy line
  - Included in report

# Generic 10CFR505.59

- Template for performing a 50.59 screening
  - Demonstrate regulatory acceptability of permanent shielding inside containment
- Precautions when using this template:
  - NOT intended to comprehensively cover all of the issues for the 50.59 screening
  - CANNOT be used as a completed 50.59 screening
  - Address issues in the template, along with other general or plant-specific issues
    - Unique nature of each safety analysis report (SAR) and other plant licensing documents
    - Add plant-specific details to the general considerations

# Current Status <sup>(3)</sup>

- Shielding manufacturer continues to evaluate alternate options
  - Material structures, encapsulation, and fabrication techniques
- At least one other material vendor has expressed interest in development of a suitable, cost effective product for similar applications
- Significance of installing permanent shielding for both operating and new reactors clearly makes this effort a worthwhile endeavor

EPRI report will be published this year

**“Development of an Advanced Shielding Material for Permanent Installation at Operating Commercial Reactors”**

Questions?