



**GENERIC SAFETY ISSUE  
(GSI) 191, Debris-Induced  
PWR Sump Clogging  
Office of Nuclear Reactor  
Regulation  
October 25, 2006**

**Agenda**

- **Regulatory history**
- **Generic Letter (GL) 2004-02 status**
- **Key technical issues**
- **Research status**
- **Conclusions**

## **Regulatory History**

- **BWR strainer clogging issues addressed in 1990s**
- **Bulletin 2003-01**
- **Generic Letter (GL) 2004-02**
- **Chemical effects testing results – 2005/2006**

3

## **GL 2004-02 Status**

- **Licensees are making major modifications to sumps**
- **Staff auditing licensee actions on a sampling basis**
- **Strainer vendors conducting head loss testing**
- **Staff and industry discussing water management initiatives**

4

## **Extension Requests**

- **Acceptance criteria in SECY-06-0078**
- **Staff has approved 10 extensions, all for relatively short durations**
- **All include relatively large strainers in place before 12/31/07**

5

## **Chemical Effects**

- **Tests indicate chemical effects are a potential issue**
- **May need to refine chemical loadings and/or other measures**
- **Solutions may involve more than adding screen area**

6

## **Coatings**

- **NRC testing indicates “chip” forms not expected to transport**
- **Industry needs to show validity of visual coatings examinations**
- **Joint (with EPRI) coating condition assessment program**

7

## **Downstream Effects**

- **Improved strainers appear to pass very little debris**
- **Licensees modifying systems to reduce susceptibility of downstream components**
- **Owners Group developing topical report on in-vessel effects**

8

## **Research**

- **NRC-sponsored research results are documented in numerous NUREGs**
- **Review of licensee submittals may lead to additional, focused confirmatory research**

9

## **Conclusions**

- **Installing larger strainers adds substantial safety margin**
- **Licensees removing problem materials**
- **Resolution path identified**
- **Chemical effects issue complex**
- **Staff will decide on future research**
- **Anticipate closing the GSI in 2008**

10

## **Acronyms**

**BWR – boiling water reactor**

**EPRI – Electric Power Research Institute**

**GL – Generic Letter**

**GSI – Generic Safety Issue**

**NRC – Nuclear Regulatory Commission**

**PWR – pressurized water reactor**



**Commission Briefing on GSI-191**

**Industry Perspectives  
on GSI-191**

October 25, 2006





# Industry Panel

- **Tony Pietrangelo**  
VP Regulatory Affairs, NEI
- **Joe Donahue**  
VP Nuclear Engineering and Services, Progress Energy  
Chairman, PWR Owners Group Executive Committee
- **Amir Shahkarami**  
Sr. VP Engineering and Technical Services, Exelon



# Overview

- A highly conservative, deterministic approach was developed to address GSI-191
- Conservative test methods are also being applied
- Licensees are moving forward with significant design and operational enhancements
- Industry wants to achieve closure expeditiously





## **Evaluation Methodology (NEI-04-07)**

- Developed as a conservative screening tool to identify areas for licensee action
- Necessary to bound spectrum of plant configurations and materials
- Did not include guidance on chemical effects and downstream effects
  - Resolution activities initiated in parallel with joint industry/NRC chemical effects testing

# Examples of Bounding Assumptions

- Instantaneous double-ended break of largest pipe at worst location ( $< 1 \text{ E-7/yr}$ )
  - Maximize head loss
  - No credit for Leak Before Break
- Spherical zone of influence (up to  $28.6 \text{ D}$ )
- All non-qualified coatings inside containment assumed to fail
- 100% transport to screens

# Chemical Effects

- Joint industry/NRC tests demonstrated need to consider chemical precipitants
- PWROG developed guidance for plant-specific chemical effects treatment
  - Conservative estimation of precipitant formation
  - Neglects inhibition effects
- Combination of high fiber load, high precipitant formation leads to prediction of high head loss
- Industry pursuing range of actions to resolve
  - Combination of refinements to methodology, test protocols and design changes

# Industry Resolution Activities

- Analysis and mock-up testing being performed in support of strainer replacements
- Plant activities extend well beyond installation of larger strainers
- Plant-specific designs are a driver in the resolution path taken
- Installation of new screens has begun and will continue to 1<sup>st</sup> Quarter 2008



# Licensee Actions Taken or Considered

- Install very large screens
- Utilize alternate buffers
- Install trash racks/debris interceptors
- Remove fibrous insulation
- Numerous compensatory actions
- Water management initiative

# PWROG Activities

- Industry guidance documents have been developed to address
  - Debris generation and transport
  - Downstream effects evaluation
  - Chemical effects
  - Alternate buffers
- Conservative treatment of individual phenomena and operational parameters
  - Overall result is highly conservative

# Progress Energy Activities

## ■ Crystal River

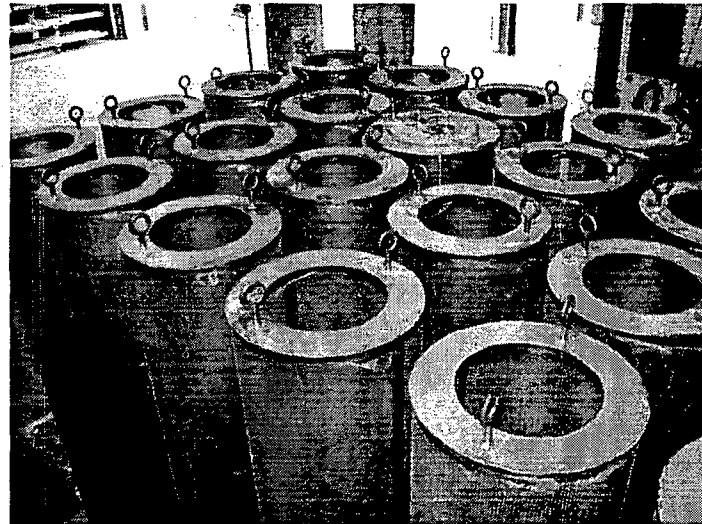
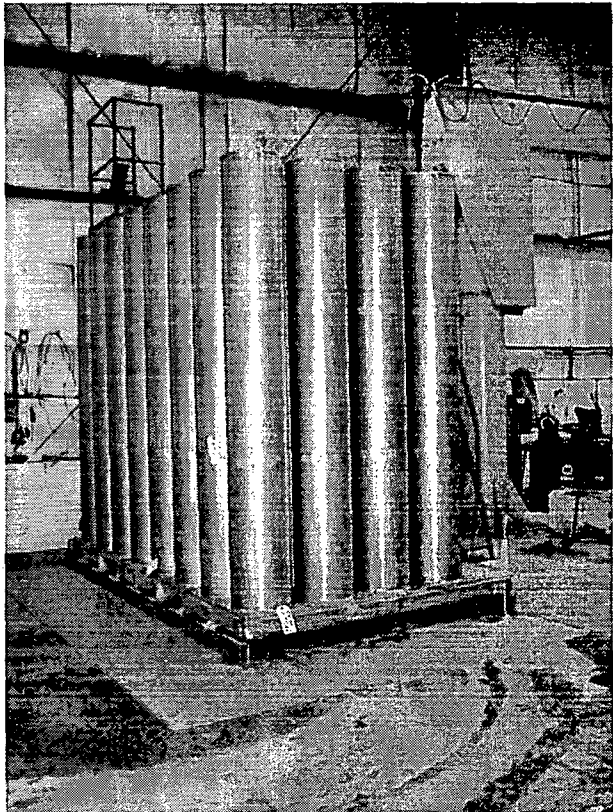
- Original sump screen:
  - ◆ Design: Wire mesh with 1/4" square openings
  - ◆ Size: 86 ft<sup>2</sup>
- Replacement sump screen:
  - ◆ Design: Concentric rolled and perforated plates (tophat design) with 1/8" diameter holes
  - ◆ Size: 1140 ft<sup>2</sup> (thirteen times larger than original)
  - ◆ 50% screen head loss margin reserved for chemical effects
- Separate flow diverter and debris interceptor upstream of screen
- Status: Installed in fall 2005





# Progress Energy Activities

## Crystal River Tophat Strainers



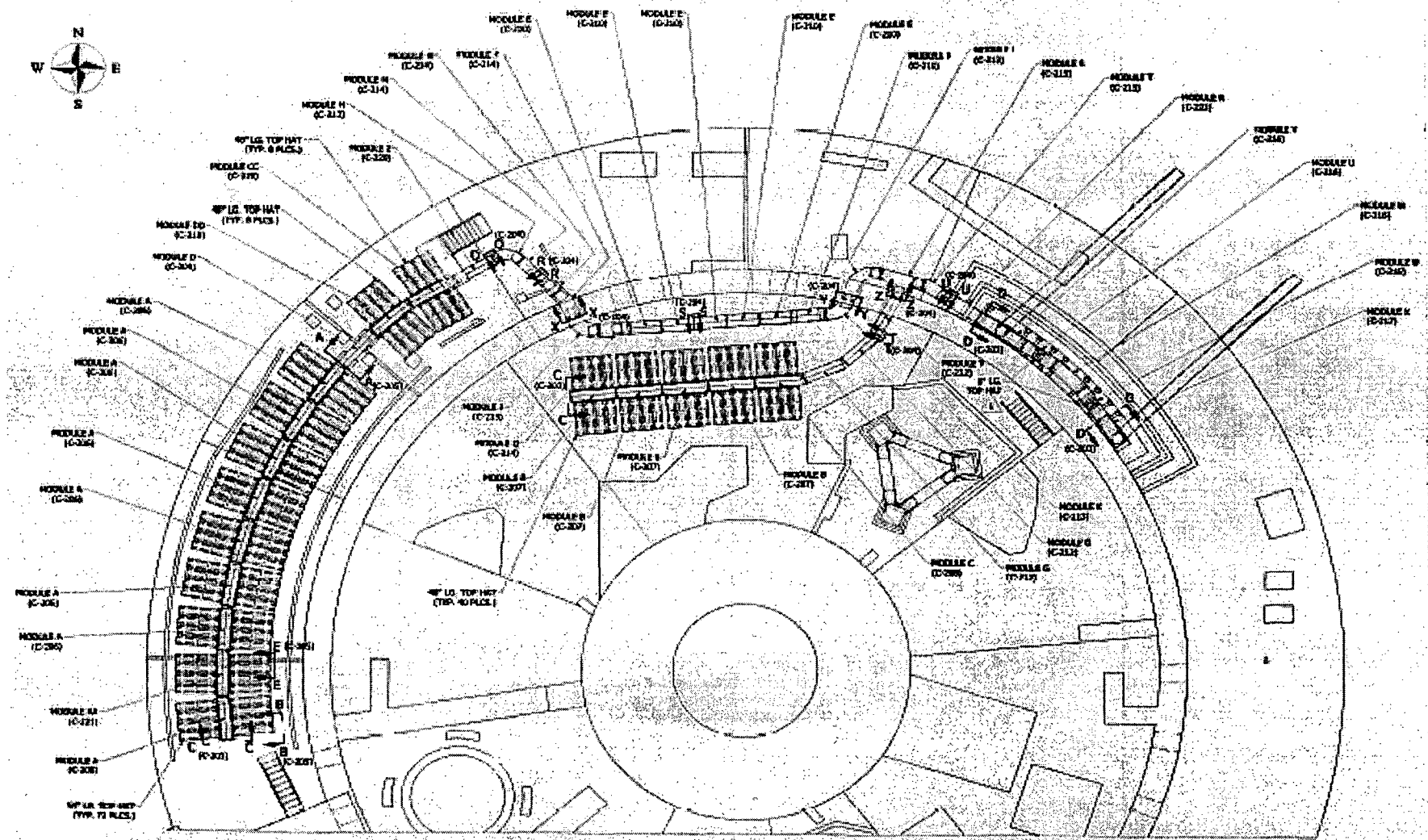
# Progress Energy Activities

## ■ H. B. Robinson

- Original sump screen:
  - ◆ Design: Wire mesh with 7/32" square openings
  - ◆ Size: 116 ft<sup>2</sup>
- Replacement sump screen:
  - ◆ Design: Tophat with 3/32" diameter holes and integral woven mesh to minimize debris penetration
  - ◆ Size: 4200 ft<sup>2</sup> (thirty-six times larger than original)
  - ◆ >50% screen head loss margin reserved for chemical effects
- Status: Will be installed in spring 2007



# H. B. Robinson Strainer Layout



PLAN VIEW

# Progress Energy Activities

- Material head loss testing
- Screen penetration testing
- Coating destruction pressure (ZOI) testing
- Chemical effects
  - Working closely with NEI and PWROG to resolve chemical effects issue
  - Additional testing may be required to quantify head loss impact
  - Using industry predictive spreadsheet to identify actions most effective in reducing chemical precipitates





# **EXELON PWRs**

- Byron Station Units 1 and 2
- Braidwood Station Units 1 and 2
- Three Mile Island Unit 1
  
- Salem Units 1 and 2



# EXELON Activities

## ■ Byron & Braidwood Stations

- Original sump screen:
  - ◆ Design: Wire mesh with 3/16" square openings
  - ◆ Size: 150 ft<sup>2</sup> total both sumps
- Replacement sump screen
  - ◆ Design: "Pocket" design with 1/12" holes
  - ◆ Size: 3000 ft<sup>2</sup>/sump, 6000 ft<sup>2</sup> total
  - ◆ Design complete including head loss and chemical effects testing
- Status:
  - ◆ Byron – Unit 1 : installed Sept. 2006
  - ◆ Braidwood – Unit 2 : will be installed Oct. 2006
  - ◆ Byron – Unit 2 : will be installed April 2007
  - ◆ Braidwood – Unit 1 : will be installed Oct. 2007



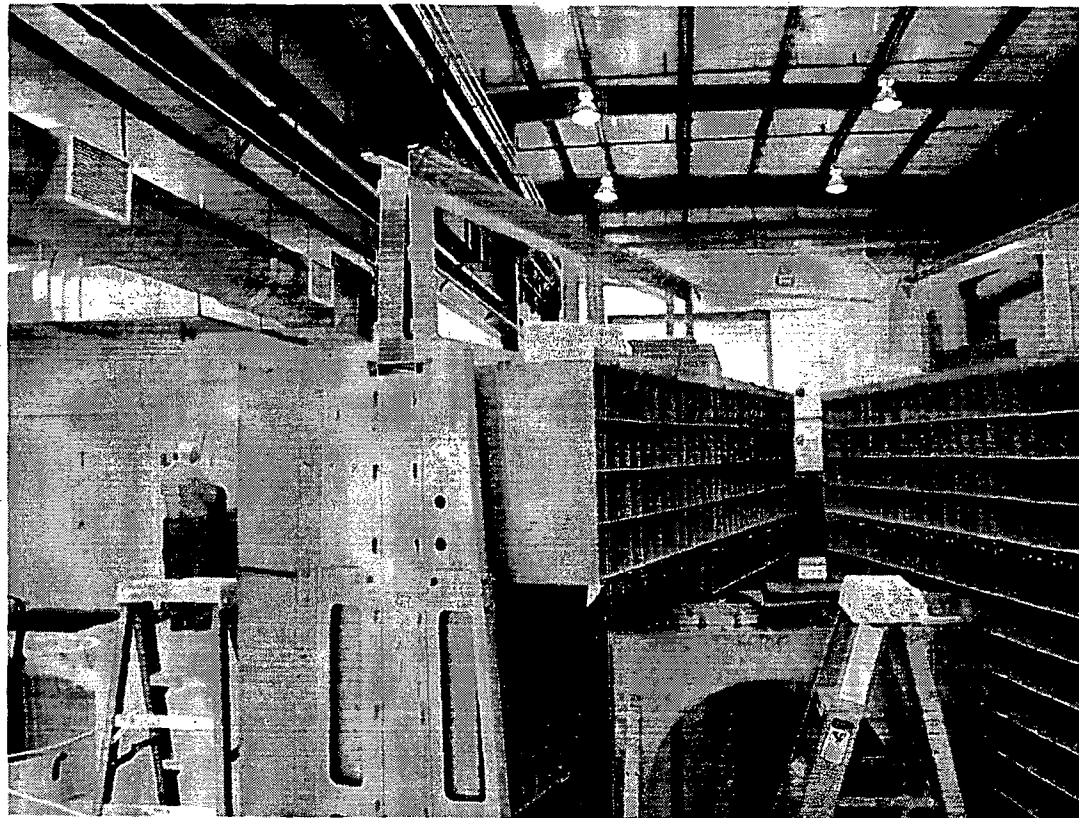
# EXELON Activities

- Byron & Braidwood Stations
  - Additional Hardware Modifications
    - ◆ Remove/replace fiberglass insulation within ZOI with Reflective Metal Insulation
    - ◆ Install trash racks for large debris interception
    - ◆ Replace ECCS throttle valve trim
  - Operational Modifications
    - ◆ Improved loose debris surveillances
    - ◆ EOP changes for increased cool down rates for Small Break LOCA (Bulletin 2003-01)



# EXELON Activities

## Byron/Braidwood Replacement Sump Screen





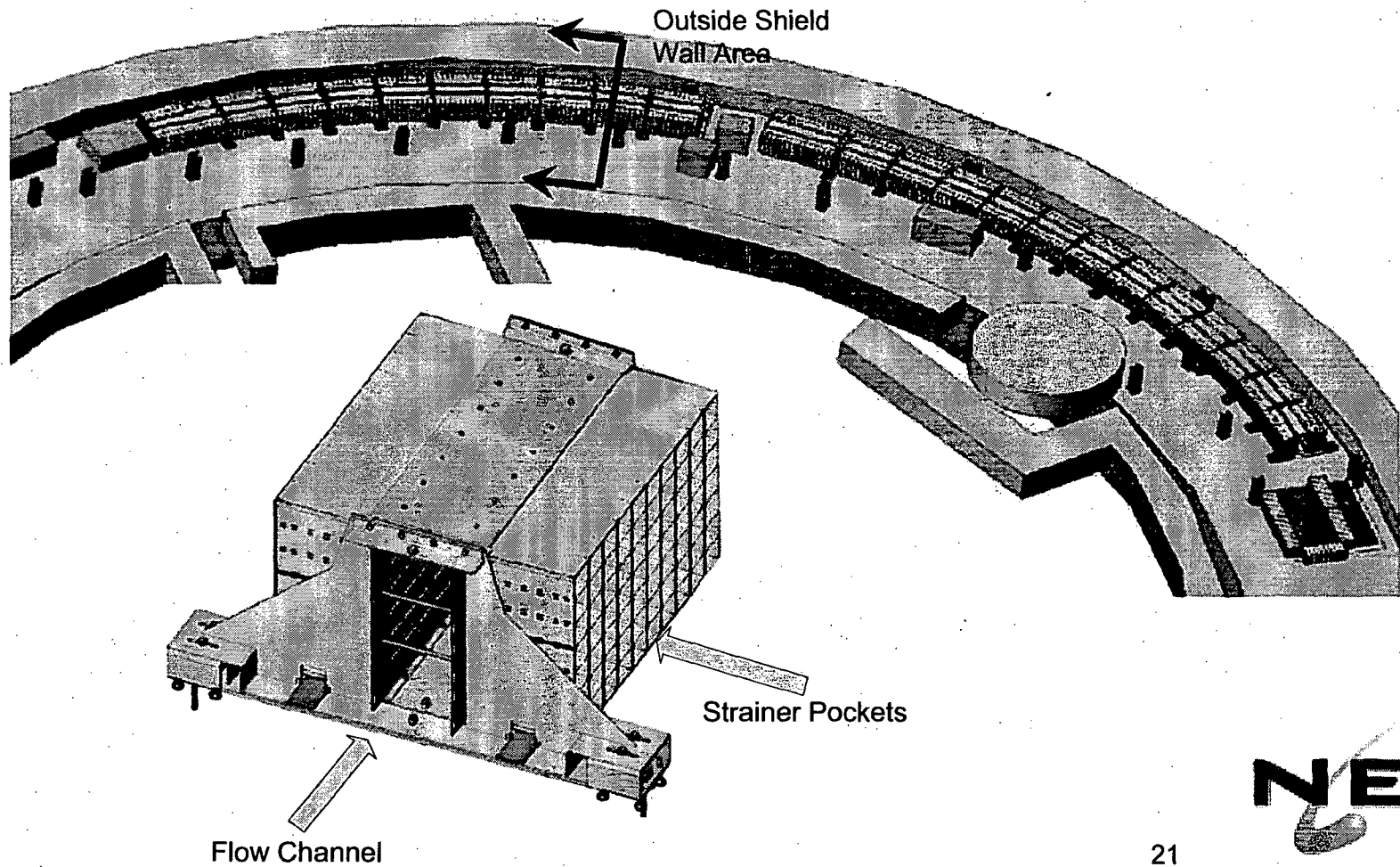
# EXELON Activities

- Salem Units 1 and 2
  - Original sump screen:
    - ◆ Design: Wire mesh with 1/8"x1/8" square openings
    - ◆ Size: 85 ft<sup>2</sup>
  - Replacement sump screen
    - ◆ Design: "Pocket" design with 1/12" holes
    - ◆ Size: 5000 ft<sup>2</sup> total
    - ◆ Screen design complete
    - ◆ Chemical effects testing scheduled for Nov. 2006
  - Status:
    - ◆ Unit 2 will be installed October 2006
    - ◆ Unit 1 will be installed February 2007

# EXELON Activities

- Salem Units 1 and 2
  - Additional Hardware Modifications:
    - ◆ Remove/replace Calcium Silicate and Min K insulation within ZOI with Reflective Metal Insulation
    - ◆ Install trash racks for large debris interception
  - No equipment modifications anticipated to address Downstream Effects

# Salem Replacement Strainers



# Closure = Reasonable Assurance of Long Term Cooling

- GSI-191 in context
  - Low risk significant event
  - Significant safety enhancements
- Chemical effects is the challenge
  - No silver bullet
  - Screens sized with margin
  - Working with staff on more realistic treatment
- Closure is recognition that the above actions achieve reasonable assurance