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

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Regulatory History

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

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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

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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

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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

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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

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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

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Research

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

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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

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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

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Commission Briefing on GSI-191

Industry Perspectives on GSI-191

October 25, 2006

NEI

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

NEI

Examples of Bounding Assumptions

- Instantaneous double-ended break of largest pipe at worst location (< 1 E-7/yr)
  - Maximize head loss
  - No credit for Leak Before Break
- Spherical zone of influence (up to 28.6 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

NEI

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 1st 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

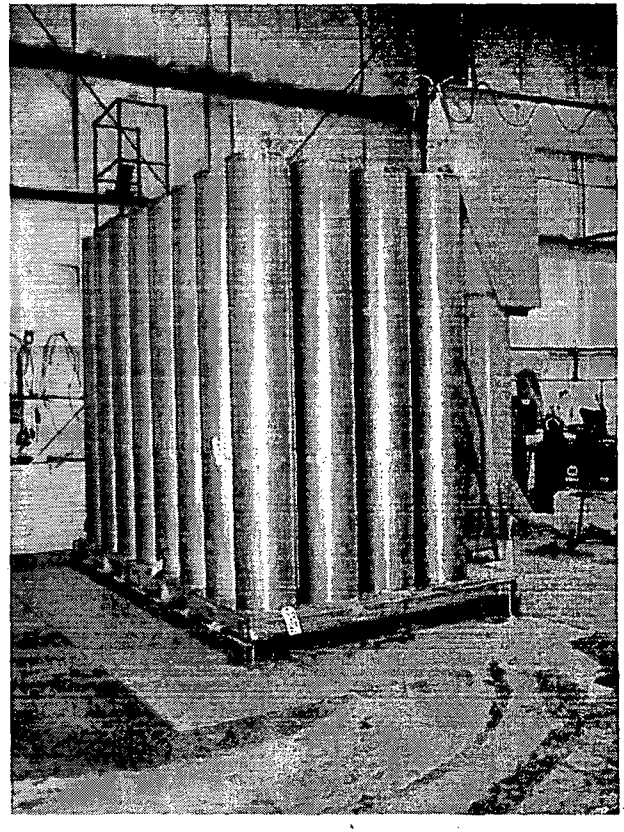
- Industry guidance documents have been developed to address
  - Debris generation and transport
  - Downstream effects evaluation
  - Chemical effects
  - Alternate buffers
- Conservative treatment of individual phenomena and operational parameters
  - Overall result is highly conservative

Progress Energy Activities

- Crystal River
  - Original sump screen:
    - Design: Wire mesh with 1/4" square openings
    - Size: 86 ft^2
  - Replacement sump screen:
    - Design: Concentric rolled and perforated plates (tophat design) with 1/8" diameter holes
    - Size: 1140 ft^2 (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

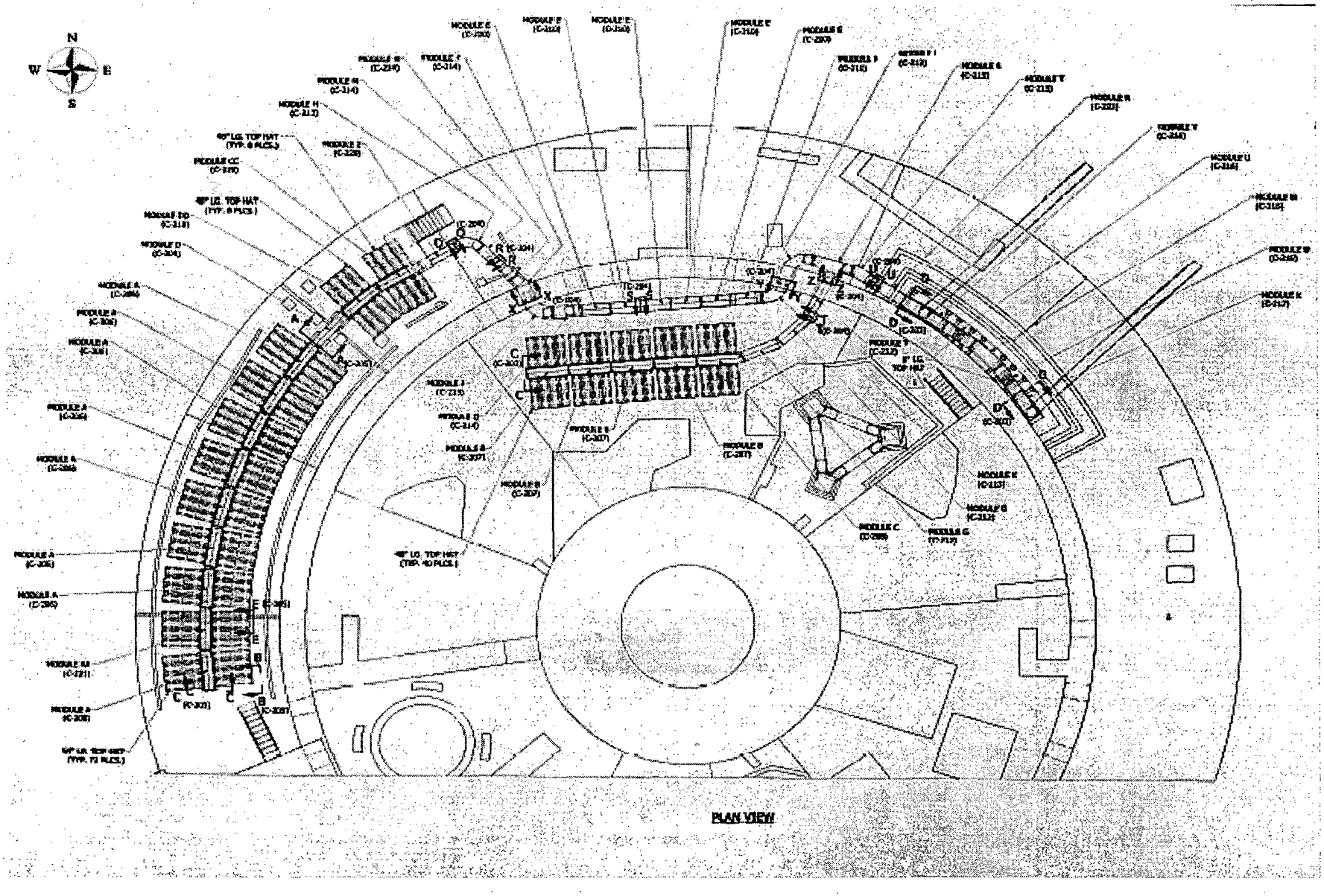
Crystal River Tophat Strainers



Progress Energy Activities

- H. B. Robinson
  - Original sump screen:
    - Design: Wire mesh with 7/32" square openings
    - Size: 116 ft^2
  - Replacement sump screen:
    - Design: Tophat with 3/32" diameter holes and integral woven mesh to minimize debris penetration
    - Size: 4200 ft^2 (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



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

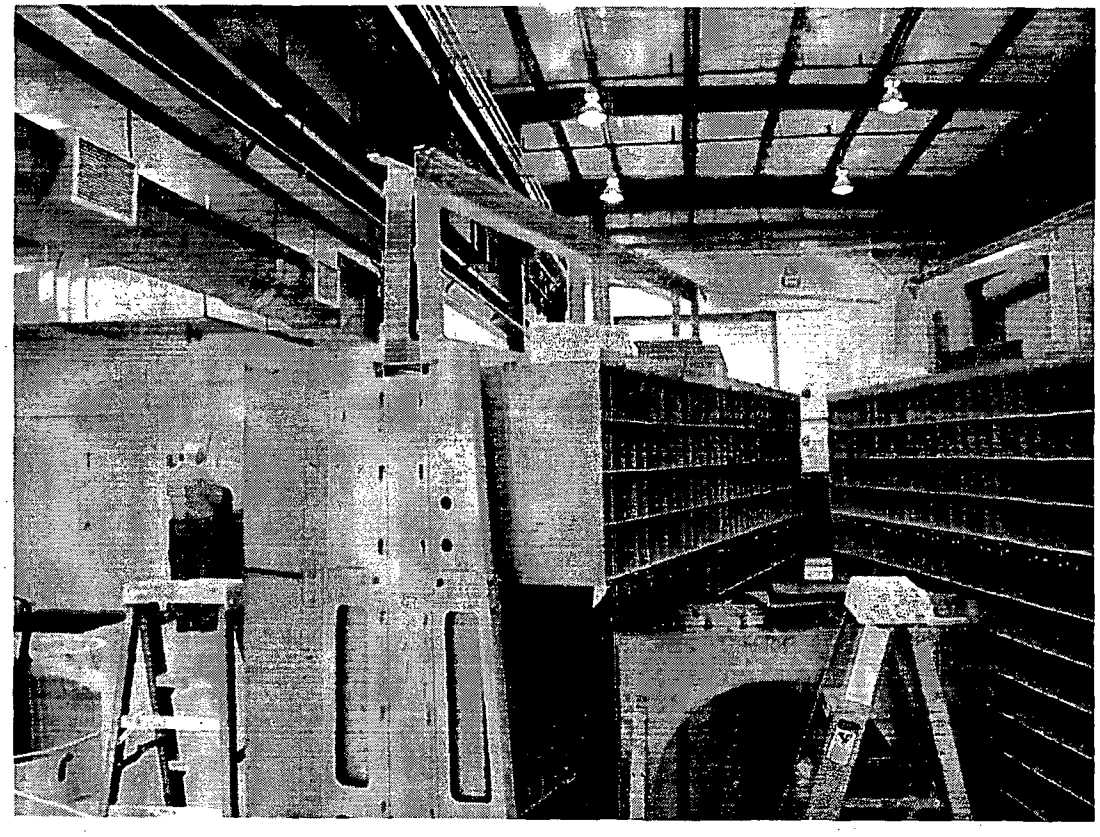
- Byron & Braidwood Stations
  - Original sump screen:
    - Design: Wire mesh with 3/16" square openings
    - Size: 150 ft^2 total both sumps
  - Replacement sump screen
    - Design: "Pocket" design with 1/12" holes
    - Size: 3000 ft^2/sump, 6000 ft^2 total
    - Design complete including head loss 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



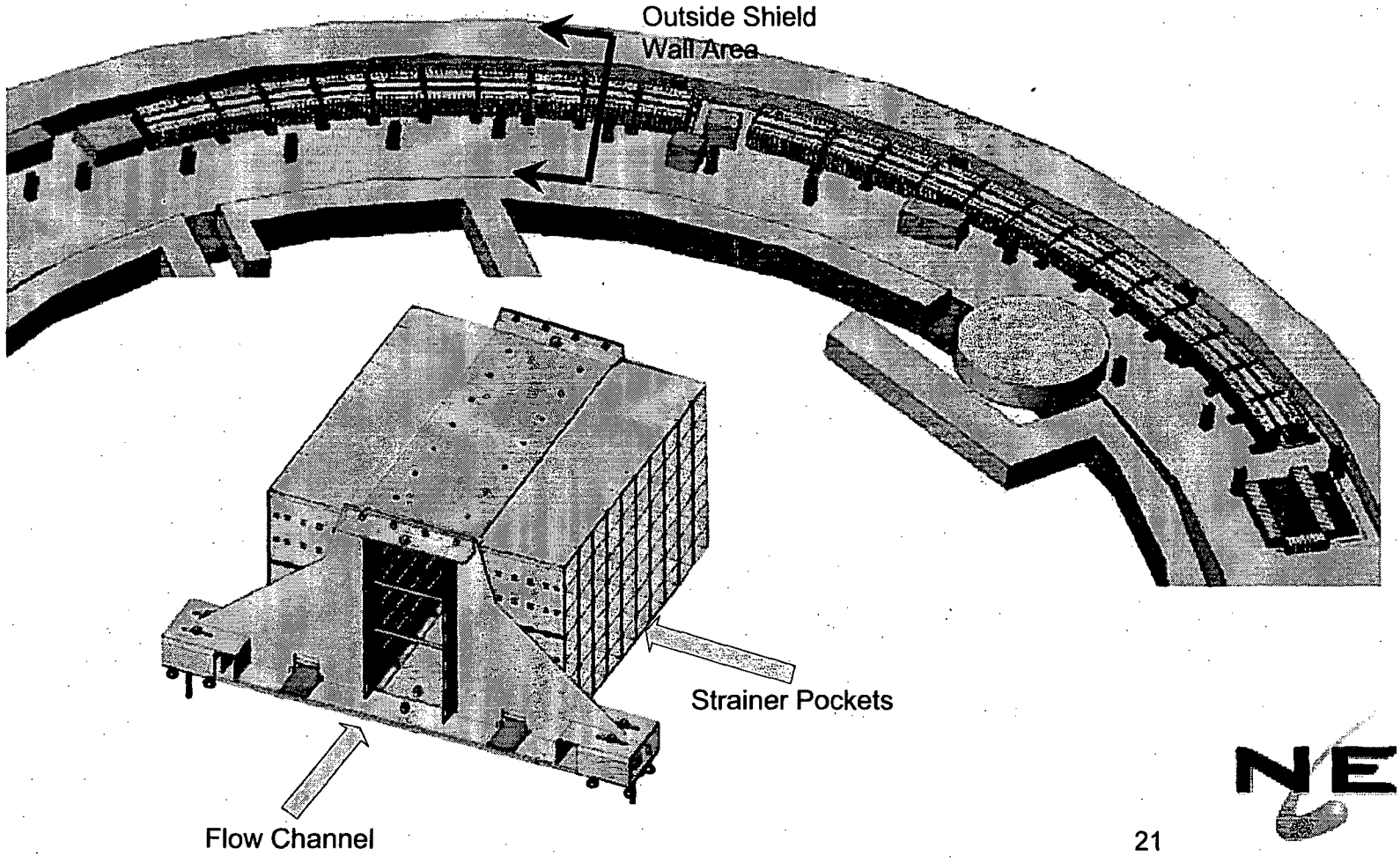
EXELON Activities

- Salem Units 1 and 2
  - Original sump screen:
    - Design: Wire mesh with 1/8"x1/8" square openings
    - Size: 85 ft^2
  - Replacement sump screen
    - Design: "Pocket" design with 1/12" holes
    - Size: 5000 ft^2 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