PMSTPCOL NPEmails

From: Joseph, Stacy
Sent: Thursday, June 17, 2010 6:23 AM
To: STPCOL
Subject: FW: STP 3&4 FSAR Ch 6 ACRS Presentation - DRAFT
Attachments: ACRS SC Presentation Ch 06_DRAFT.pdf

From: Chappell, Coley [mailto:ccchappell@STPEGS.COM]
Sent: Wednesday, June 16, 2010 3:09 PM
To: Joseph, Stacy
Cc: Wunder, George; Wunder, George; Tomkins, James
Subject: STP 3&4 FSAR Ch 6 ACRS Presentation - DRAFT

Stacy and Adrian,

A draft Chapter 6 presentation for ACRS is provided as requested, non-proprietary portion only.
Proprietary slides associated with pool swell are not included (see Slide 23 in attached, which refers to these).
If you should have any questions, please contact me.

Regards,

Coley Chappell
STP 3&4 Licensing

Hearing Identifier: SouthTexas34NonPublic_EX
Email Number: 3017

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From: Joseph, Stacy

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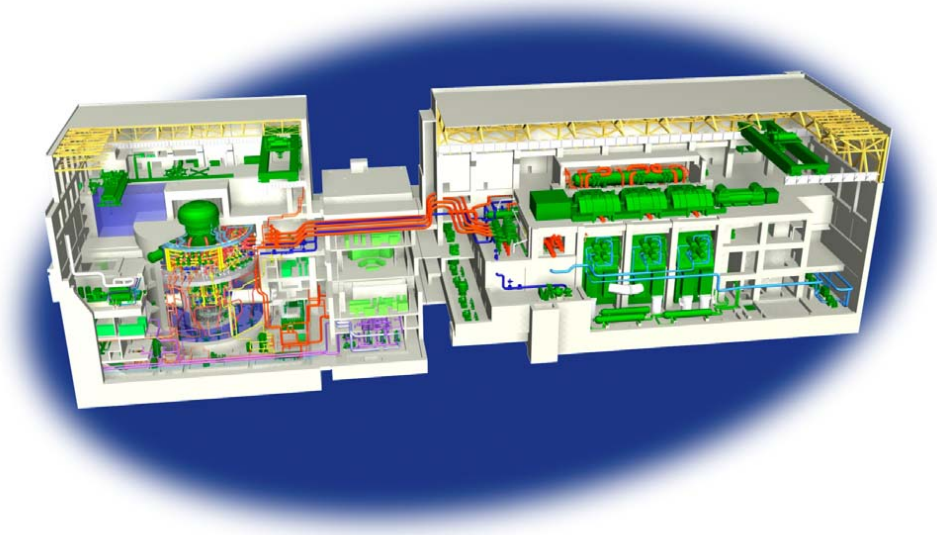
South Texas Project Units 3 & 4
Presentation to ACRS Subcommittee

Chapter 6
Engineered Safety Features



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Agenda

- Introduction
- Attendees
- Chapter 6 Overview
- Contents of FSAR Chapter 6
  - Summary of Changes to Chapter
  - Departure Information
  - COL License Information Items
  - Site-Specific Supplements
- ITAAC/DAC
- Conclusion

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Attendees

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Chapter 6 Overview

- Four Chapter 6 based departures
- Significant changes due to containment re-analysis (6.2) and revised ECCS suction strainers (6C)
- All COL Information Items completed
- No DAC in Chapter 6

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Contents of Chapter 6 (Sections)

- 6.1 Engineered Safety Feature Materials
- 6.2 Containment Systems
- 6.3 Emergency Core Cooling Systems
- 6.4 Habitability Systems
- 6.5 Fission Products Removal and Control Systems
- 6.6 Preservice and Inservice Inspection/Testing of Class 2 and 3 Components and Piping
- 6.7 High Pressure Nitrogen Gas Supply System

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Contents of Chapter 6 (Appendices)

- 6A RG 1.52, Section C, Compliance Assessment
- 6B SRP 6.5.1 Compliance
- 6C Containment Debris Protection for ECCS Strainers
- 6D HPCF Analysis Outlines
- 6E Additional Bypass Leakage Considerations

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Summary of Changes to Chapter 6

- Sections 6.0, 6.7 and Appendices 6A, 6E are incorporated by reference
- Section 6.2 and Appendix 6C have significant changes
- Sixteen (16) Departures impact the chapter
  - Four departures are Chapter 6 based
  - Six Tier 1, six Tier 2
- Fifteen (15) COL Information Items completed
- One site-specific supplement for Reactor Service Water materials

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Chapter 6 Based Departures

- Containment Re-analysis (STD DEP 6.2-2)
- ECCS Suction Strainers (STD DEP 6C-1)
- Containment Penetrations (STD DEP 6.2-3)
- PSI/ISI Inspection and Testing of Class 2 and 3 Components and Piping (STD DEP 6.6-1)

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Containment Pressure Temperature (P/T) and Pool Swell Re-analyses

- Background
- Comparison of ABWR and BWR Mark III Containments
- Containment P/T Model
  - Development
  - Benchmarking
  - Analysis Results and Conclusions
- Pool Swell Model
  - Development
  - Benchmarking
  - Analysis Results and Conclusions

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Containment Analysis Background

Even though there were no changes to the ABWR containment design, the ABWR DCD containment analysis could not be incorporated by reference into the STP 3&4 COLA due to corrections required in the DCD containment modeling and analysis

- Corrections identified by GE in NEDO-33372
  - Incorrect vent loss coefficient modeling
  - Non-conservative mass and energy releases
  - Non-conservative decay heat
- Additional non-conservatism identified – wetwell pool level assumption for peak pressure calculation

Background *(continued)*

- As a result, STPNOC had to re-perform the containment P/T analysis for the STP 3 & 4 COLA
- Resulting increases in pressure loads required that STPNOC also re-perform the pool swell analysis for the STP 3 & 4 COLA

Comparison of ABWR Containment to BWR Mark III Containment

ABWR

- Upper & lower drywell
- 10 vertical vents each feeding 3 horizontal vents (30 total vents)
- Annular suppression pool
- Compact wetwell airspace

BWR Mark III

- Single drywell space
- Vertical annulus feeding 3x40 horizontal vents (120 vents total)
- Annular suppression pool
- Very large wetwell airspace

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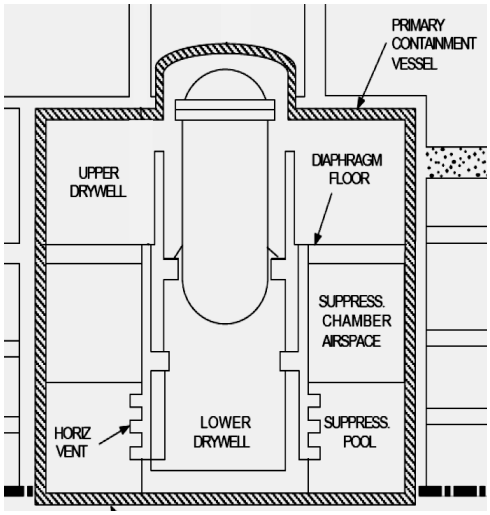
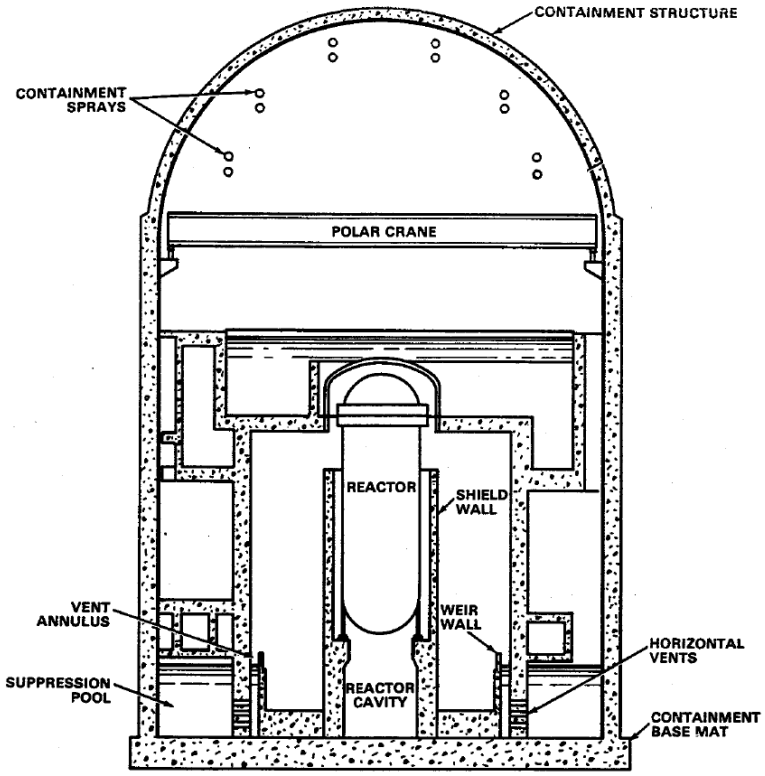
ABWR Containment



BWR Mark III Containment



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Containment P/T Model – Development

- Developed methodology consistent with ABWR DCD, which uses NEDO-20533
- Methodology implemented using GOTHIC code
  - Variables / settings in GOTHIC made to mimic DCD method
  - Approved Mark I GOTHIC methodology was used to supplement the DCD methodology where necessary
- Model benchmarked against DCD results

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Containment P/T Model - Benchmarking

- Benchmarked using DCD analysis results (uncorrected) for both Feedwater Line Break (FWLB) and Main Steam Line Break (MSLB) accidents
- GOTHIC implementation of DCD containment analysis method showed excellent comparison to DCD results (examples follow)

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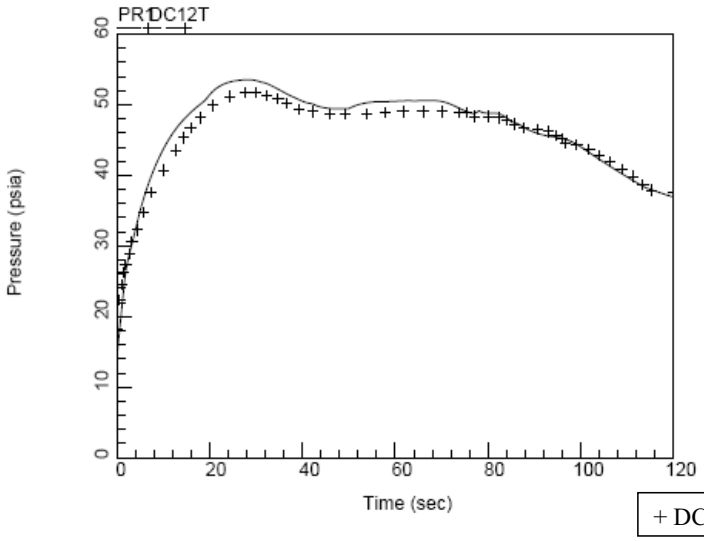
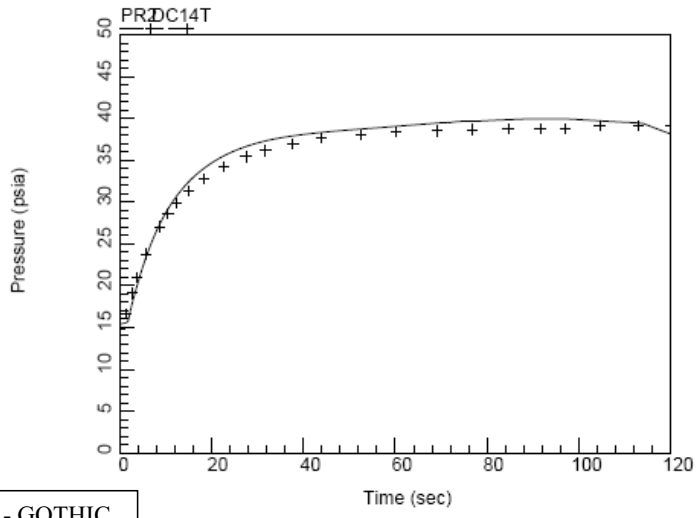
Benchmarking Results – Pressure Due to FWLB



Drywell Pressure



Wetwell Pressure

+ DCD, - GOTHIC

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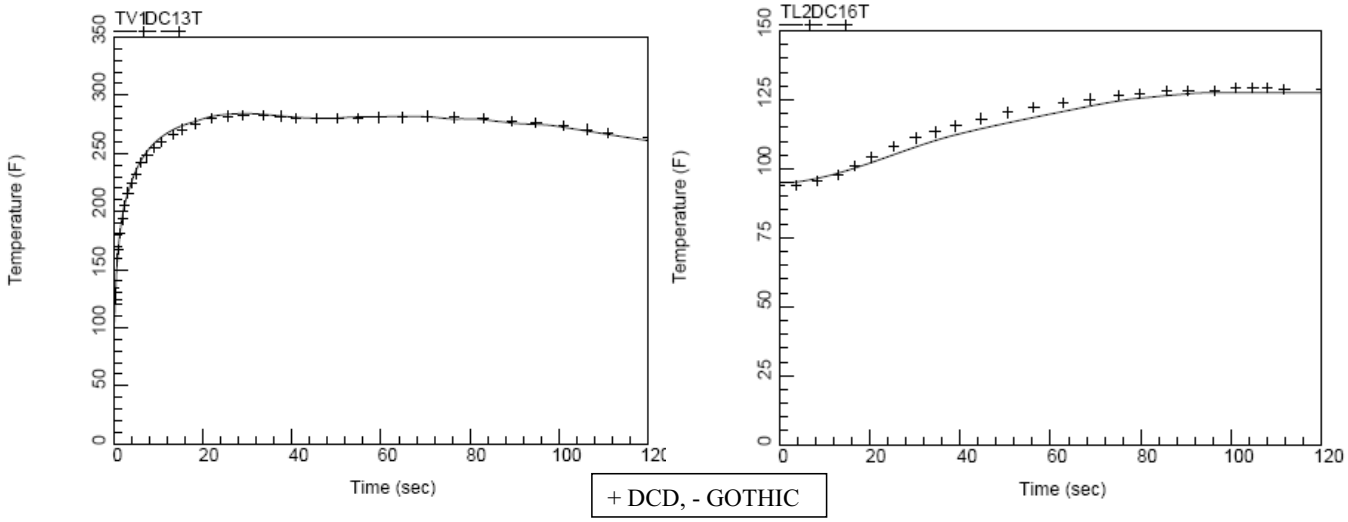
Benchmarking Results – Temperature Due to FWLB



Drywell Temperature

Pool Temperature

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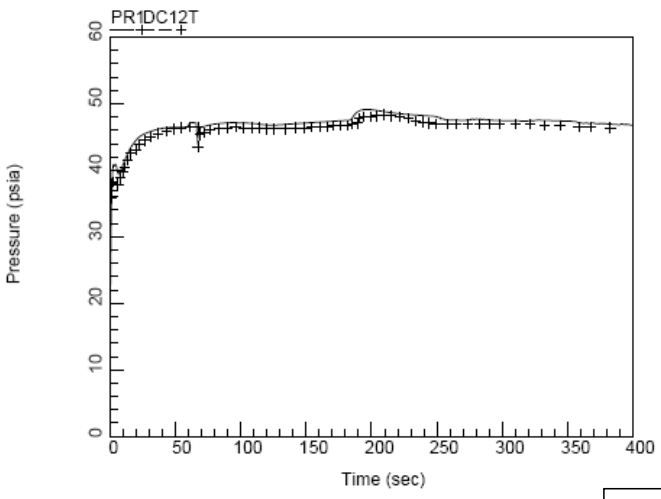
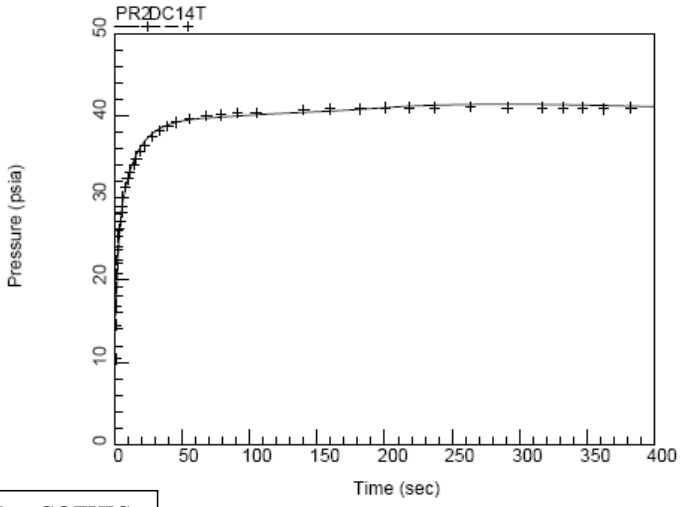
Benchmarking Results – Pressure Due to MSLB





+ DCD, - GOTHIC

Drywell Pressure

Wetwell Pressure

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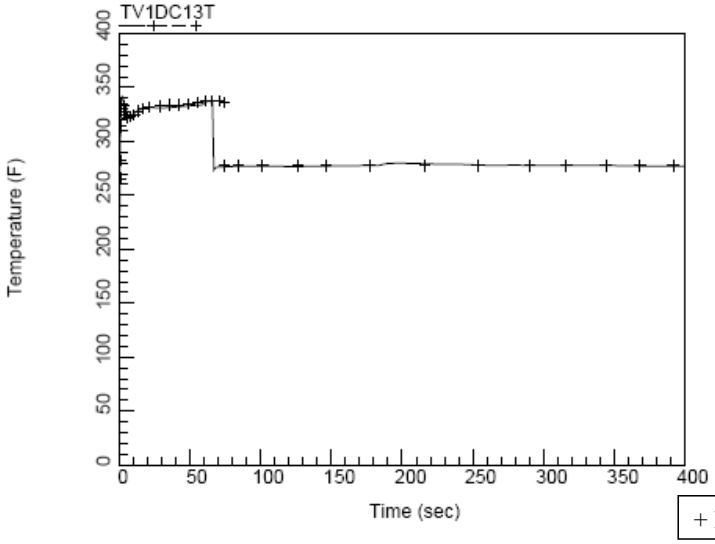
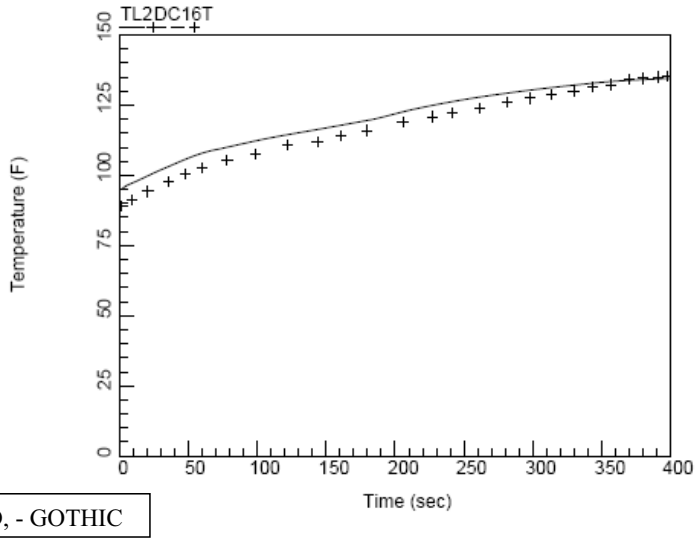
Benchmarking Results – Temperature Due to MSLB





+ DCD, - GOTHIC

Drywell Temperature

Pool Temperature

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P/T Analysis Results

- Corrected Drywell Connecting Vent (DCV) loss coefficient, feedwater flow assumptions, and decay heat and addressed suppression pool level assumption and performed analyses
- Analysis results submitted in Westinghouse Technical Report WCAP-17058 (June 2009)
- Revised containment analysis results in higher pressure and temperature
- Revised containment analysis results meet acceptance criteria

Containment Reanalysis Results

Parameter	DCD Value	Calculated Value	Limit
Peak Drywell Pressure	268.7 kPaG (39.0 psig)	281.8 kPaG (40.9 psig)	309.9 kPaG (45.0 psig)
Peak Drywell Temperature	170 °C (338 °F)	173.2 °C (343.8 °F)[1]	171.1 °C (340 °F)
Wetwell Pressure	179.5 kPaG (26.1 psig)	217.2 kPaG (31.5 psig)	309.9 kPaG (45.0 psig)
Wetwell air Temperature	98.9 °C (210.0 °F)	98.6 °C (209.5 °F)	104 °C (219.2 °F)
Suppression Pool Temperature	96.9 °C (206.4 °F)	99.56 °C (211.2 °F)	100 °C (212 °F)

Note: (1) Drywell temperature exceeds limit for less than 2 seconds. Due to thermal inertia, drywell component temperature remains below limit.

Pressure Temperature Summary

- P/T analysis re-performed using GOTHIC to correct DCD
- Results confirmed acceptable design of containment

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Pool Swell Analysis

- The Pool Swell Analysis contains information proprietary to Toshiba and will be discussed in a closed session

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ECCS Suction Strainers

- Background
  - RG 1.82 Rev. 3
- Strainer Sizing
- Chemical Effects
- Downstream Effects
- Summary

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STP 3 & 4 Suction Strainers

- Provide debris protection in suppression pool for the following systems following a LOCA:
  - RHR (Residual Heat Removal)
  - HPCF (High Pressure Core Flooder)
  - RCIC (Reactor Core Isolation Cooling)

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Decision to Upgrade Strainers

- US ABWR DCD describes ECCS suction strainers
  - Compliant with RG 1.82, Rev. 1 (1985)
  - Conical strainers on ends of tees
- Reference Japanese ABWR (RJ-ABWR) upgraded ECCS suction strainers to RG 1.82, Rev. 2 requirements in 2005
- STPNOC voluntarily chose to upgrade to RG 1.82, Rev. 3 and use RJ-ABWR strainer designs/sizes for STP 3&4

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RG 1.82 Rev. 3

- RG 1.82, Rev. 2 endorsed BWROG's Utility Resolution Guideline (URG)
- RJ-ABWR replaced original RHR and HPCF strainers in accordance with URG
  - Debris Generation
  - Debris Transport
  - Strainer Head Loss Analysis and Testing
- Rev. 3 = Rev. 2 + downstream and chemical effects evaluations

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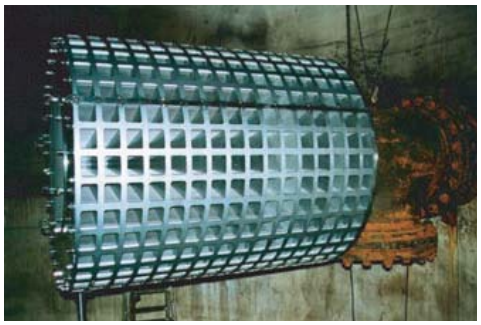
Strainer Sizing

- Based on Reference Japanese ABWR (RJ-ABWR)
- Control Components, Inc. (CCI) (Winterthur, Switzerland) “cassette-type” strainers
  - Full-scale test in EPRI Charlotte facility
  - View into cassette filter pocket



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Strainer Sizing *(continued)*

- Large filter surface area in compact volume
- Convoluted suction surface disrupts formation of debris "thin bed" and protects NPSH margin
  - "Thin bed" effects result in greater head loss than would be intuitively expected
- Maximum hole size 2.1 mm (smaller than DCD 2.4 mm)

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Strainer Sizing *(continued)*

- Several US PWRs using CCI cassette-type strainer to resolve GSI-191
  - ANO
  - Byron & Braidwood
  - Calvert Cliffs
  - D.C. Cook
  - Oconee
  - Palo Verde
  - Salem

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Chemical Effects

- STP 3 & 4 primary containment design prohibits:
  - fibrous insulation (source of calcium and silica)
  - aluminum
  - zinc (except inorganic zinc primer in qualified coatings)
- ABWR water chemistry is essentially distilled water, with post-LOCA scenario:
  - initiation of SLC (addition of sodium pentaborate)

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Chemical Effects *(continued)*

- NRC requested consideration of “latent” aluminum
- Used modified-WCAP methodology to calculate largest amount of “latent” aluminum that would corrode, but not come out of solution
- Considered:
  - pH range 5.3-8.9 (from DCD)
  - post-LOCA temperature profile

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Chemical Effects *(continued)*

- Concluded 4.5 ft^2 "latent" aluminum:
  - Results in small amount of corrosion products, but would not precipitate out of solution
  - Is within ability of Foreign Material Exclusion (FME) and containment cleanliness programs to detect
- Additional evaluations concluded other debris (e.g., zinc primer within Zone of Influence (ZOI) of postulated pipe break) would:
  - Be in particulate form
  - Already evaluated during RJ-ABWR strainer sizing
- Therefore, no additional testing needed for chemical effects

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Downstream Effects

- ABWR design provides reasonable assurance that debris passing through ECCS suction strainers does not result in detrimental "downstream effects"
- LOCA-generated debris minimized:
  - smaller break sizes (no external recirculation piping)
  - secure restraints on items like equipment tags
- Fibrous material prohibited (but "latent" fiber evaluated)

Downstream Effects *(continued)*

- Latent debris required by URG confirmed applicable to ABWR based on Japanese ABWR operating experience
  - "sludge," rust, dirt/dust, qualified coatings within ZOI
- "Latent" debris assumed for operational flexibility:
  - 1 ft^3 latent fiber (e.g., rags, rope)
  - 4.5 ft^2 latent aluminum (no latent aluminum identified in Japanese ABWR experience)

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Downstream Effects *(continued)*

- Strainer design restricts debris greater than 2.1 mm from reaching:
  - downstream components
  - fuel assemblies
- ABWR has diversification of ECCS delivery points, which reduce consequences of blockages, should they occur

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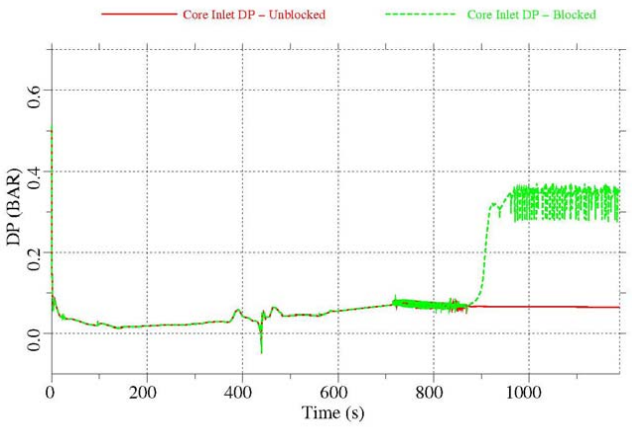
Downstream Effects *(continued)*

- Evaluations of downstream effects on pumps, valves and heat exchangers in PWRs documented in WCAP-16406
  - Results should apply to STP 3 & 4 components due to similarity in materials and clearances
- STPNOC will conduct confirmatory analyses per WCAP methodology when final ECCS downstream components selected

Downstream Effects *(continued)*

- License Condition to test final fuel design for downstream effects
- WEC performed analysis to determine acceptable level of blockage, including: ΔP, flow, void fraction, peak clad temp



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Downstream Effects *(continued)*

- Test plan includes:
- Single fuel assembly description
  - full-scale cross-section
  - shortened assembly length
  - unheated, ambient temperature
- Protocol for introduction of debris
  - fiber added first to promote formation of “mat”
  - particulates added to avoid coagulation (easier to plug interstices in fiber mat)

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Downstream Effects *(continued)*

- 872 fuel assemblies, debris for test is 1/872 total debris predicted to pass through strainers (with 10 % penalty)
  - Coatings, sludge, dust/dirt, rust flakes all prepared to be smaller than 2.1 mm
  - 2% of total RMI destroyed assumed smaller than 2.1 mm (NUREG/CR-6808)
  - Of 1 ft^3 latent fiber (none from destroyed insulation since prohibited) 10% assumed to be destroyed fibrous insulation that could pass through strainers

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Downstream Effects *(continued)*

License Condition

"A downstream fuel effects test will be conducted and the results provided to the NRC no later than 18 months prior to fuel load. The test plan, analysis basis, and debris assumptions are described in Appendix 6C.3.1.8. The test procedure will be provided to the NRC no later than 24 months prior to fuel load. The acceptance criteria for this test will be a fuel assembly inlet steady-state pressure drop less than 5.076 psid."

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Suction Strainer Summary

- STPNOC upgrade of DCD strainer (per RG 1.82, Rev. 1) to current RG 1.82, Rev. 3 requirements assures ECCS strainers perform their safety related functions
- RJ-ABWR strainer design, testing and analyses assure STP 3 & 4 strainers meet URG requirements (per RG 1.82, Rev. 3)
- Additional evaluations of chemical effects and downstream effects show full compliance with RG 1.82, Rev. 3

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Chapter 6 Based Departures

- STD DEP 6.2-3
- Revised containment penetration details as a result of detailed design
  - Corrects penetration elevation, azimuth, offset, diameter, and barrier type information
  - Adds detail regarding CIVs that was not present in DCD

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Chapter 6 Based Departures PSI/ISI

- STD DEP 6.6-1
- Clarified that 100 % of RHR heat exchanger will be accessible for ISI
- Added requirement that an evaluation for sufficient access must be performed if less than minimum straight length is used in final design

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Other Departures *(continued)*

Tier 1 Departures Affecting Chapter 6

- Deletion of MSIV closure and scram on high radiation (STD DEP T1 2.3-1)
  - Removed Note in Table 6.2-7
  - Not credited in analyses in Chapter 6 or 15
- RHR System and Spent Fuel Cooling (STD DEP T1 2.4-1)
  - No impact on safety analyses

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Other Departures *(continued)*

Tier 1 Departures Affecting Chapter 6

- Feedwater Line Break Mitigation (STD DEP T1 2.4-2)
  - Trips condensate pumps on high differential pressure between 2 FW lines coincident with high drywell pressure
  - Ensures that flow assumptions made in the containment analysis are conservative.

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Other Departures

TIER 1 Departures Impacting Chapter 6

- RCIC Turbine Pump (STD DEP T1 2.4-3)
- Eliminate Hydrogen Recombiners (STD DEP T1 2.14-1)
- Safety Related I & C Architecture (STD DEP T1 3.4-1)
- All of these departures resulted in minor descriptive changes to parts of Chapter 6

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Other Departures *(continued)*

TIER 2 Departures impacting Chapter 6

- Leak Detection and Isolation System Valve Leakage Monitoring (STD DEP 7.3-11)
- HVAC Normal Cooling Water System (HNCW) (STD DEP 9.2-7)
- HNCW Cooling Water System (STD DEP 9.2-9)
- Breathing Air System (STD DEP 9.3-2)

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COL Information Items

- Protective Coatings and Organic Materials (6.1)
- Personnel Safety (6.2.5.6)
- Alternate Hydrogen Control (6.2)
- Administrative Control Containment Isolation (6.3)
- Suppression Pool Cleanliness (6.4)
- Wetwell/Drywell Vacuum Breaker Protection (6.5)
- Containment Penetration Leakage Rate Test (6.5a)

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COL Information Items *(continued)*

- ECCS Performance Results (6.6)
- ECCS Testing Requirements (6.7)
- Limiting Break Results (6.7a)
- Toxic Gases (6.8)
- SGTS Performance (6.9)
- SGTS Exceeding 90 hours operation (6.9a)
- PSI/ISI (6.10)
- Access Requirement (6.11)

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Site-Specific Supplements

- DCD Section 6.1, Table 6.1-1 identified Reactor Building Cooling Water heat exchanger and Reactor Service Water heat exchanger, piping, and valve materials as site dependent
- Materials were provided in RAI response on 1/28/2010
- Table 6.1-1 will be updated in COLA Revision 4

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Containment ITAAC

- Containment Atmospheric Monitoring System (2.3.3)
- Suppression Pool Cooling (2.4.1.4)
- Suppression Pool Cleanup System (2.6.3)

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Containment ITAAC *(continued)*

- Containment Structure (2.14.1)
  - ASME Code document review
  - Structural Integrity Test
  - Containment Pressure Analysis using as-built parameters
  - Integrated Leak Rate Test
  - Inspection of as-built SRVDL quenchers, horizontal vents etc.
  - Analysis of Vacuum Breakers

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Containment ITAAC *(continued)*

- Standby Gas Treatment System (SGTS) (2.14.4)
  - As-built inspections
  - Drawdown test of SGTS performance with as-built containment

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Containment ITAAC *(continued)*

- Atmospheric Control System (2.14.6)
  - Factory test of key components
- Drywell Cooling (2.14.7)
  - Inspection of as-built system
- Suppression Pool Temperature Monitoring (2.14.9)
  - Inspections
  - Logic Tests

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Containment ITAAC *(continued)*

- For RHR, RCIC, and HPCF ITAAC
  - NPSH Test at Facility
    - Suppression pool at minimum level
    - Strainer blockage in accordance with RG 1.82 R3 instead of DCD 50% blockage criteria
    - Suppression pool at 100 deg C

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Containment Design Acceptance Criteria (DAC)

- NONE

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Chapter 6
Engineered Safety Features

Questions and Comments

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