ENCLOSURE 5

Closed Meeting - Containment, Ventilation, and Main Control Room Topics – July 23, 2014

(Non-Proprietary)

This is the Non-Proprietary version of the document.

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Closed Meeting – Containment, Ventilation, and Main Control Room Topics – July 23, 2014

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Topics Covered

- Containment Peak Pressure Reanalysis
- Main Control Room Dose
- Main Control Room Heat Up
- Hydrogen Igniter Additions
- Hydrogen Venting in the PXS Compartment
- Containment Debris (Status Update)

AP1000® Containment Analysis

Debra Ohkawa
Containment & Radiological Analysis
EE&MP Safety Analysis & Licensing

July 23, 2014

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Agenda

- Background
- Status
- Technical Discussion
- Licensing Impact
- Schedule

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Background

- Westinghouse is proposing to update the Chapter 6 containment response analyses for the loss of coolant accident (LOCA) and steamline break (SLB) events to reflect the finalized detailed design

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Containment Reanalysis Flow Chart

[a,c

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Containment Reanalysis Summary

- Technical work is in the final stages of updating WGOTHIC input, LOCA mass/energy releases, and SLB mass/energy releases for consistency with the final design

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Technical Discussion Topics

1. Heat Sinks
2. Control Volumes and Flow Paths
3. Crane Girder Heat Transfer
4. WGOTHIC Evaluation Model
5. WGOTHIC Code Update
6. LOCA Mass/Energy Releases
7. SLB Mass/Energy Releases

Heat Sinks in DCD Rev. 19

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Our Mission in Recalculation of Heat Sinks

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Heat Sinks Methodology

[a,c]

Structures Added as Thermal Conductors in WGOTHIC

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Structures Removed as Thermal Conductors in WGOTHIC

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Changes to Previously-Quantified Structures

[a,c]

Heat Sinks Turned Off

a,c

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Which Heat Sinks Turned On/Off for Heat Transfer

[ ]a,c

Requantified Heat Sinks Summary

[a,c]

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Heat Sink Materials

[a,c]

Steel Properties

[a,c]

Steel Properties (Continued)

[ ]a,c

Maximizing Heat Sinks

[a,c]

Summary of Heat Sink Changes

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Control Volumes
Flow Paths
Crane Girder Heat Transfer

Megan Genuske

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Control Volumes in DCD Rev. 19

[a,c

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Re-quantified Control Volume Summary

[

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Nodalization Changes- Pressurizer Compartment

[a,c]

Flow Paths in DCD Rev. 19 vs. Updated Calculations

[a,c]

Crane Girder Heat Transfer

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Crane Girder Heat Transfer (Continued)

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WGOTHIC Evaluation Model

Mike Patterson

WGOTHIC Evaluation Model Updates - Overview

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Insulated Enclosure(s)

a,c

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Insulated Enclosure(s) (Continued)

[a,c]

Insulated Enclosure(s) (Continued)

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Attachment Plates

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Coatings

[a,c]

Air Baffle

a,c

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PCS Flow Maldistribution

[a,c]

Interface with Other Analyses

[a,c]

WGOTHIC Code Update

Debra Ohkawa

WGOTHIC Code Update

[a,c]

Evaporation-Limited PCS Flow

[a,c]

Iteration / Post-Processing of Evaporation-Limited PCS Flow

[a,c]

Evaporation-Limited PCS Flow in WGOTHIC

[ ] a,c

LOCA Mass & Energy Releases

Megan Genuske

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LOCA Mass/Energy Release

[a,c]

LOCA Mass/Energy Release- DEHL

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SLB Mass & Energy Releases

Debra Ohkawa

SLB Mass/Energy Release

[a,c]

SLB Mass/Energy Release

[a,c]

Containment Reanalysis Summary

- Technical work is in the final stages of updating WGOTHIC input, LOCA mass/energy releases, and SLB mass/energy releases for consistency with the final design

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Licensing

Korey Hosack

Licensing Impact

- Section 6.2, *Containment Systems*, presents conservative analyses based on the ***AP1000*** plant design:
  - WCAP-15846, *WGOTHIC Application to AP600 and AP1000, Revision 1* (2004) is referenced for the methodology, inputs, and results of these analyses, including peak pressure:

Table 6.2.1.1-1

SUMMARY OF CALCULATED PRESSURES AND TEMPERATURES

Break	Peak Pressure (psig)	Available[1] Margin (psi)	Peak Temperature (°F)
Double-ended hot leg guillotine	50.4	8.6	411.3
Double-ended cold leg guillotine	58.3	0.7	295.7
Full main steam line DER, 30% power, MSIV failure	58.2	0.8	373.2
Full main steam line DER, 101% power, MSIV failure	54.2	4.8	374.7

Implementation of Licensing Basis Changes

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List of Proposed Licensing Impacts (Preliminary)

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Licensing Basis Changes – Tier 2*

Table 6.2.1.1-10

[DATA FOR ADDITIONAL HEAT SINKS CREDITED IN THE CONTAINMENT PEAK PRESSURE EVALUATION]*

Containment Subcompartment	*Minimum Required Surface Area (ft^2)*	*Minimum Required Volume (ft^3)*
Vertical Access Tunnel	*865*	*15.1*
PXS-A	*1153*	*20.2*
PXS-B	*1681*	*29.4*
SG East	*1228*	*34.0*
SG West	*1752*	*60.7*
CMT	*12477*	*303.7*
Above Operating Deck	*4068*	*71.1*

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Simplification of WCAP-15846

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New Revision of WCAP-15846

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NRC Interactions

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Timeline

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Questions?

Backup Slides

Vessel Air Baffle Panel Arrangement

[a,c]

AP1000® Post-Accident Main Control Room Operator Dose

Aaron Wilmot

Technical Projects Integration

New Plant Engineering

July 23, 2014

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Agenda

- Background
- Status
- Technical Discussion
- Licensing Impact
- Schedule

Background

- Revision 19 of the DCD presents a licensing basis summary of calculations for operator doses considering post-accident conditions.
  - Shown in Tier 2 (Table 15.6.5-3) for post-LOCA conditions.
  - Considers radiation contributions from several sources.
  - Operator doses for other accidents also presented in Tier 2 (Section 6.4).

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Status

- Design changes to address this issue have been defined and are in the approval phase
- Calculations providing supporting analyses have been initiated.
  - Preliminary calculations were performed.
  - Detailed, formal calculations have been initiated and are in process.
- LAR is planned

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Direct Radiation

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Direct Radiation

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Filter Shine

[a,c]

Location of VES Filter with Respect to MCRE

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VES Filtration Unit in SM1

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Radiation Setpoint Values

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Working Solutions Part 1

[a,c]

VBS Setpoints

[a,c]

Working Solutions Part 2

[a,c]

Preliminary Results

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Licensing

Korey Hosack

Licensing Basis Changes

- As a result of working solutions, impacts to Tier 1, Tier 2, Tech Specs, and Tech Specs Bases are identified as:

- T1 Section 2.7.1
- T2 Section 1A
- T2 Section 1.9.4.2.3
- T2 Section 3.1.2
- T2 Section 6.4
- T2 Section 6.4.3.2
- T2 Section 6.4.4
- T2 Table 6.4-2
- T2 Figure 7.2-1
- T2 Section 7.3.1.2.17
- T2 Table 7.3-1
- T2 Section 9.2.6.1
- T2 Section 9.4.1.1
- T2 Section 9.4.1.1.2
- T2 Section 9.4.1.2.3.1
- T2 Figure 9.4.1-1
- T2 Section 11.5.1.1
- T2 Section 11.5.2.3.1
- T2 Table 14.3-7
- T2 Section 15.6.5.3.5
- T2 Section 15.6.5.3.8.2
- T2 Table 15.6.5-2
- T2 Table 15.6.5-3
- TS Bases 3.3.2
- TS Bases 3.7.6
- TS Table 3.3.2-1

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Timeline

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Questions?

AP1000® Main Control Room Heat-up

Jonathan Durfee
Steven Leighty

July 23, 2014

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Agenda

- Background
- Issue Status
- Description of Proposed Changes
- Licensing Impacts
- Schedule

Background

- Throughout the design evolution of the Main Control Room (MCR) design, the size and quantity of equipment has increased
- The current design analysis for the MCR Heat up needs to be updated based on the following considerations
  - Additional heat sources added through design finalization
  - Updated layout of the MCR
  - Identification of a more limiting transient than previously assumed

Issue Resolution Status

- Design Change Proposal has been approved and applicable design documents are being updated
- Updated analysis is in the process of being verified

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Design Requirements

- The MCR bulk air temperature must remain at or below 95°F dry bulb during Main Control Room Emergency Habitability System (VES) operating time 72 hour operation
  - This is a Licensing, Human Factors and Equipment Qualification limit
  - Limit for "Reliable Human Performance" for 72 hour accident period per DCD Tier 2, Section 6.4.3.2
  - Achieved through VES operation (safety-related equipment)

- The MCR bulk air temperature must remain at or below 115 °F dry bulb during post-72 hour operation
  - This is a Licensing and Equipment Qualification limit
  - Achieved through available onsite non-safety equipment (Nuclear Island nonradioactive ventilation system (VBS)/Ancillary Fans)
  - Post-7 day operation, offsite support through available safety-related connections (consistent with other system commitments).

Sequence

[a,c]

Proposed Design Changes

- Addition of an Automatic, safety-related, MCR heat load de-energization scheme

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- Modification of the current MCR Isolation Engineering Safety Function

- Additional Tech Spec Surveillance Requirements to support initial conditions assumed in the analysis.

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Proposed Design Changes

- Updated MCR Heat Load Total

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- New GOTHIC Model

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- Confirmed or updated Equipment Environmental Conditions

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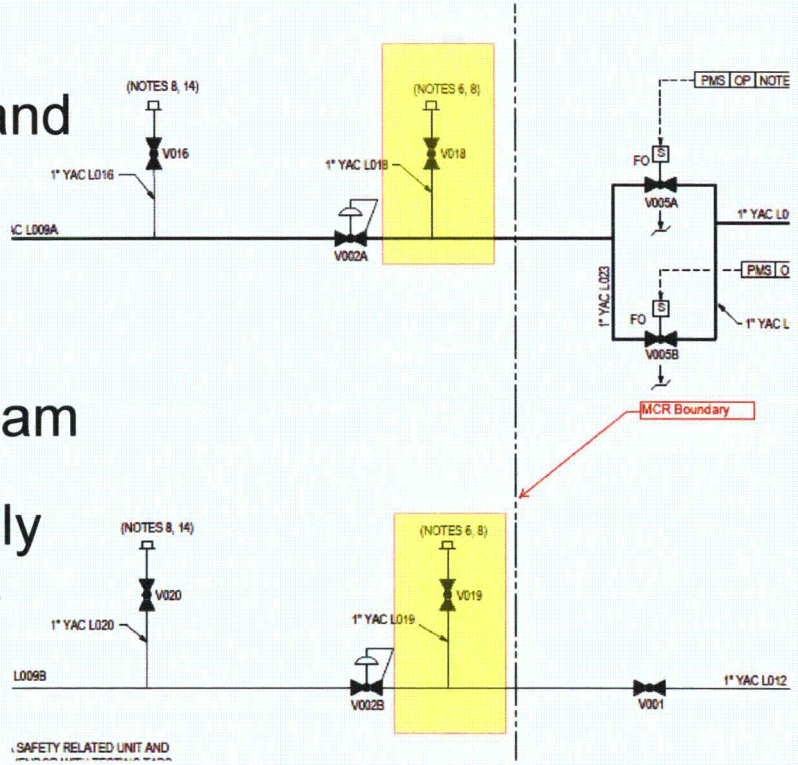
Proposed Design Changes

- Ensure MCR Environment can be maintained with offsite support
- Two pre-existing VES valves (V018 and V019) are identified as the safety-related, connection point for post-72 hour supplemental air.
- Selected instead of the valves upstream of the pressure regulating valve because the regulating valves are only qualified for two weeks post-accident (and the makeup connection is designed for 30 days).



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Previous Design State (No Shedding)

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Timeline (automatic actuation, Design Basis)

[ ] a,c

Timeline (Manual Actuation)

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Proposed Design (With Load Shedding)

[a,c]

Proposed Licensing Basis Changes

- Tier 1 Table 2.5.2-3
- Tier 1 Table 2.5.2-4
- Tier 1 Table 2.2.5-1
- Tier 1 Table 2.2.5-4
- Tier 2 Table 3.7.3-1
- Tier 2 Table 3.9-12
- Tier 2 Table 3.9-16
- Tier 2 Table 3.11-1
- Tier 2 Table 3D.5-1
- Tier 2 Table 3I.6-2
- Tier 2 Table 3I.6-3
- Tier 2 Section 6.4
- Tier 2 Table 6.4-3
- Tier 2 Figure 7.2-1
- Tier 2 Section 7.3.1.2.17
- Tier 2 Table 7.3-1
- Tier 2 Table 7.3-3
- Tier 2 Table 7.5-1
- Tier 2 Table 7.5-7
- Tier 2 Section 9.4.1
- Tier 2 Section 14.2
- Tier 2 Table 14.3-7
- Tech Specs

Proposed Licensing Basis Changes

- Proposed Tier 1 Table 2.2.5-4 Changes

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Proposed Licensing Basis Changes

- Proposed TS 3.3.2 changes

ESFAS Instrumentation
3.3.2

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One required division inoperable.	D.1 Restore required division to OPERABLE status.	6 hours
E. One switch or switch set inoperable.	E.1 Restore switch and switch set to OPERABLE status.	48 hours
F. One channel inoperable.	F.1 Restore channel to OPERABLE status.	72 hours
	OR	
	F.2.1 Verify alternate radiation monitors are OPERABLE.	72 hours
	AND	
	F.2.2 Verify control room isolation and air supply initiation manual controls are OPERABLE.	72 hours

Change to: "main control room isolation, air supply initiation and electrical load de-energization"

Proposed Licensing Basis Changes

- Proposed TS 3.7.6 changes

CONDITION		REQUIRED ACTION		COMPLETION TIME
A.	One valve or damper inoperable.	A.1	Restore valve or damper to OPERABLE status.	7 days
B.	One or more MCR Load-shed Panel(s) inoperable with load-shed function maintained.	B.1	Restore MCR Load-shed Panel(s) to OPERABLE status.	7 days
C.	MCRE air temperature not within limit.	C.1	Restore MCRE air temperature to within limit.	24 hours
D.	One or more required air temperature limits not maintained	D.1	Restore required air temperature to within limits.	24 hours

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Proposed Licensing Basis Changes

- Proposed Surveillance Requirement changes

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.7.6.1	Verify MCRE air temperature is ≤ 75°F.	24 hours
SR 3.7.6.2	Verify that the compressed air storage tanks contain greater than 327,574 scf of compressed air.	24 hours
SR 3.7.6.3	Verify the average air temperature of rooms 12201, 12202, 12203, 12204, 12205, 12207, 12300, 12301, 12302, 12303, 12304, 12305, 12313, and 12412, is ≤ 85°F.	24 hours
SR 3.7.6.4	Verify the average air temperature of room 12501, is ≤ 85°F.	24 hours

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Estimated Schedule

- Schedule is still under development

Back Up Slides

Revised GOTHIC: MCR Area

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Revised GOTHIC: Breakroom & SM Office

[a,c]

Revised GOTHIC: Finned Ceiling Thermal Conductor Type

[a,c]

Revised GOTHIC:
Finned Ceiling Thermal Conductor Type (cont.)

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Revised GOTHIC: VBS Model

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MCR Heat Load Profile

[a,c]

Revised GOTHIC: VES Model

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GOTHIC Model Consistency

[a,c]

MCR Heat Load Profile

[a,c]

Hydrogen Igniter Design Changes

Steven Leighty

23 July 2014

Agenda

- Background
- Issue Status
- Description of Proposed Changes
- Licensing Impacts
- Schedule

Hydrogen Ignition Design

- Hydrogen igniters are a subsystem of the Containment Hydrogen Control System (VLS)
- 64 igniters distributed throughout containment
- Provide global hydrogen control for beyond design basis accidents
- Two groups of 32 igniters. Each group is powered by separate nonsafety batteries
- The igniters are manually controlled by the Plant Control System (PLS) with the Diverse Actuation System (DAS) providing an alternate means of actuation
- Manually actuated at elevated core exit temperature (>1200°F)

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Hydrogen Ignition Design

- Current design meets the requirements of 10 CFR 50.34(f) and 50.44
  - Global hydrogen concentrations are kept below 10% volume assuming 100% fuel clad melt
- Analysis using current placement of the 64 igniters throughout containment has shown that the global hydrogen concentration will not exceed 10% volume

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Background

- In the event that hydrogen is vented into the In-Reactor Water Storage Tank (IRWST), the IRWST is designed to open at a low pressure and vent hydrogen through roof vents located near the Steam Generator Wall

- Hydrogen is preferentially burned as it exits these vents as it mixes with oxygen

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Background

- DCD/UFSAR Table 6.2.4-6 provides criteria for placement of igniters. One of these criteria states:
  - *In locations where the potential hydrogen release location can be defined (i.e. above the IRWST spargers, at IRWST vents, etc) igniter coverage is provided* as *close to the source* as *feasible*

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Proposed Solution

- Igniters are proposed to be placed at the vent exits
- Hydrogen is burned at the exit of the IRWST vents
- Eliminates potential for localized deflagration to detonation transition of a hydrogen plume upon exiting the IRWST
- Enhances capability of the system to control local hydrogen accumulation

Other Proposed Changes

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LAR Status

- Proposes addition of 2 hydrogen igniters
- Clarifies the minimum surface temperature of the hydrogen igniters
- Clarifies the control requirements for igniter operation
- LAR is currently being drafted

Proposed Licensing Basis Changes

- Proposed Tier 1 Changes
  - Table 2.2.3-6
  - Table 2.3.9-2
  - Table 2.3.9-3
  - Table 2.5.2-5
  - Table 2.5.4-1
  - Table 3.7-1
- Proposed Tier 2 Changes
  - Section 6.2.4.2.3
  - Section 6.2.4.5.1
  - Section 6.2.4.5.2
  - Table 6.2.4-3
  - Table 6.2.4-6
  - Table 6.2.4-7
  - Figure 6.2.4-10
  - Section 14.2.9.1.11
  - Table 14.3-6
  - Table 14.3-8
  - Table 17.4-1
  - Table 18.12.2-1

Proposed Licensing Basis Changes

- Proposed changes to ITAACs to reflect the new number of hydrogen igniters and clarify minimum surface temperature of the igniters

Table 2.3.9-3
Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The VLS provides the nonsafety-related function to control the containment hydrogen concentration for beyond design basis accidents.	i) Inspection for the number of igniters will be performed. ii) Operability testing will be performed on the igniters. iii) An inspection of the as-built containment internal structures will be performed.	i) At least 66 hydrogen igniters are provided inside containment at the locations specified in Table 2.3.9-2. ii) The surface temperature of the igniter meets or exceeds 1700°F. iii) The minimum distance between the primary openings through the ceilings of the passive core cooling system valve/accumulator rooms (11206, 11207) and the containment shell is at least 19 feet. Primary openings are those that constitute 98% of the opening area. Other openings through the ceilings of these rooms must be at least 3 feet from the containment shell.

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Proposed Licensing Basis Changes

- Proposed changes to Figure 6.2.4-10 to show the new igniters

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Proposed Licensing Basis Changes

- Proposed changes to clarify the igniter controls

Table 2.5.4-1 (cont.)
Minimum Inventory of Controls, Displays, and Alerts at the RSW

Manual Containment Hydrogen Igniter (Nonsafety-related) (2)	Yes	-	-

Note: Dash (-) indicates not applicable.

1. These parameters are used to generate visual alerts that identify challenges to the critical safety functions. For the RSW, the visual alerts are embedded in the nonsafety-related displays as visual signals.

2. Containment hydrogen igniter control is provided as a "soft" control.

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Estimated Schedule

[a,c]

Hydrogen Venting

Jim Scobel
Steven Leighty

July 23, 2014

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Agenda

- Background
- Issue Status
- Description of Proposed Changes
- Licensing Impacts
- Schedule

Background

- The design of the Chemical and Volume Control System (CVS) and Passive Core Cooling System (PXS) compartments allows for venting of hydrogen into the Core Makeup Tank (CMT) rooms above
- Vent layout is designed so hydrogen burns away from the containment shell
- Acceptance Criteria in Tier 1 Table 2.3.9-3 requires 98% of the primary openings must be a minimum of 19 feet away from the containment shell and all other openings must be 3 feet away.
- This criteria needs to be revised based on proposed layout redesigns and related analysis

Background

Table 2.3.9-3
Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The VLS provides the nonsafety-related function to control the containment hydrogen concentration for beyond design basis accidents.	i) Inspection for the number of igniters will be performed.	i) At least 64 hydrogen igniters are provided inside containment at the locations specified in Table 2.3.9-2.
	ii) Operability testing will be performed on the igniters.	ii) The surface temperature of the igniter exceeds 1700°F.
	iii) An inspection of the as-built containment internal structures will be performed.	iii) The minimum distance between the primary openings through the ceilings of the passive core cooling system valve/accumulator rooms (11206, 11207) and the containment shell is at least 19 feet. Primary openings are those that constitute 98% of the opening area. Other openings through the ceilings of these rooms must be at least 3 feet from the containment shell.
	iv) An inspection will be performed of the as-built IRWST vents that are located in the roof of the IRWST along the side of the IRWST next to the containment shell.	iv) The discharge from each of these IRWST vents is oriented generally away from the containment shell.

Background

- Issue pertains to beyond-design-basis hydrogen releases
- Purpose is to ensure containment integrity during postulated hydrogen releases from small compartments
  - Keep sustained burning hydrogen plumes away from the containment shell

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Issue Status

- Analysis is in the process of being completed to verify the containment integrity during postulated hydrogen venting from PXS-A
- Upon completion of the analysis, a LAR will be written to revise the ITAAC

Compartment Vents Issue

- PXS-B and CVS compartment vents meet the current ITAAC
- PXS-A CMT discharge penetration violates the ITAAC
  - 24 ft^2 hatch is the primary opening from the PXS-A compartment
  - CMT discharge penetration is ~3 ft^2 (11% of the area) and is closer than 19 ft from the containment shell
- Issue was self-identified during an ITAAC review

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Hydrogen Release Pathways from RCS

[a,c]

Scenario Considerations

[a,c]

Location of Rooms 11206 & 11207

[a,c]

Hydrogen Venting Locations From PXS-A

[a,c]

Hydrogen Venting Location from PXS-B

[a,c]

Hydrogen Venting Location from CVS Room

[a,c]

PXS-A Compartment Vents to CMT Room

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PXS-A Hydrogen Venting Analysis

- Purpose of the analysis is to confirm containment integrity under the conditions of a postulated diffusion flame at the PXS-A vents

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- MAAP4 analyses performed to generate a bounding hydrogen/steam source term
  - Consistent methodology with the PRA severe accident analyses

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PXS-A Hydrogen Venting Analysis

- CFX combustion analysis of the PXS-A vent region

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Proposed Licensing Basis Changes

- Tier 1
  - Table 2.3.9-3
- Tier 2
  - Section 6.2.4.5.1

Estimated Schedule

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AP1000® Containment Debris & Cable Jet Impingement Testing - Update

Tom Kindred

Shayan Sinha

Westinghouse

Containment Debris (Status Update)

- **Background:**
- Two issues related to controlling containment debris:
  1. Non-MRI – Jet Impingement and Submergence Testing to demonstrate specified nonmetallic reactor vessel insulation as a "Suitable Equivalent" to metallic reflective insulation (MRI)
  2. Containment Debris - Cable and other components within AP1000 containment have been identified as potential sources of particulate and fiber debris during a LOCA.
- Jet Impingement Testing will establish acceptable "Zone of Influence" for cables, and will factor into a revised Containment Debris Evaluation.
- Controlling containment debris is important to assure long term core cooling.

Status

- Submergence testing of non-MRI is complete and awaiting analysis of results
- Jet impingement testing of cables is complete (incurred damage at 3 L/D, maintained integrity at 4 L/D); non-MRI is in progress
- Post testing assessments include characterizing cable debris, completing plant cable ZOI evaluations, and evaluating effect on screen performance

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Containment Debris (Status Update)

Potential Technical Changes

- Engineering design changes are being made to mitigate some debris sources

Potential Licensing Impact

- Non-MRI Suitable Equivalency Determination and Containment Debris Assessment will be submitted as Topical Reports. Related Licensing changes include:
  1. Non-MRI – Potential change to Tier 2 wording to clarify design of Reactor Vessel Insulation
  2. Containment Debris – Expected modification to Tier 2* text which states that no fiber sources in containment and addition of Tier 2 information for Cable ZOI

Estimated NRC Submittal Time

- Expected Topical Report Submittal timeframe:
  1. Non-MRI – late October 2014
  2. Containment Debris – January 2015

Testing Background

[a,c]

Facility and Fixture Effects

[a,c]

Testing Video

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Cable Testing Results

[a,c]

Post Testing Assessments

[a,c]