

Clarification of NRC Safety Evaluation for WCAP- 17100-P/NP

June 8, 2011

Jeff Stone, PWROG RMSC Chairman

Bob Lutz, Bill Mendez, Jason Sinkhorn, Westinghouse

Agenda

Time	Topic	Lead
0900 – 0910	Introduction	Jeff Stone
0910 – 0920	NRC Remarks	NRC
0920 - 1000	Discussion of Testing for Non-93A RCPs	Jason Sinkhorn
1000 – 1030	Discussion of Other SE Limitations	Bob Lutz
1030 - 1045	Summary of Actions Items	Bob Lutz / NRC
1045 - 1100	Concluding Remarks	All



Introduction

Jeff Stone, PWROG RMSC Chairman

Purpose

- The NRC Safety Evaluation of WCAP-17100-P/NP contained 8 limitations and several other requirements concerning vendor recommendations
- The PWROG and Westinghouse want to clarify the NRC's expectations for several of the limitations items in order to:
 - Understand the NRC's expectations for additional testing and submittals for the non-93A RCP Shutdown Seal
 - Westinghouse is beginning the testing regime and needs assurance that the testing will be adequate
 - Provide guidance to the PWROG licensees implementing the Shutdown Seal

Need for Clarification

- The Shutdown Seal represents a significant safety advancement for prevention of uncontrolled RCS inventory loss
 - Plants are waiting for NRC approval before committing to installation of the Shutdown Seal
- The Shutdown Seal has become more significant as part of a coping strategies for extended station blackout

History of Project

- The WCAP-17100-P/NP Submittal requested NRC review and approval of the PRA and deterministic models for RCP seal behavior for plants implementing the Westinghouse Shutdown Seal
- There is a history of good communication between the PWROG and the NRC so that expectations were addressed
- This meeting is a continuation of that excellent communication to identify the expectations for addressing the limitations in the NRC Final Safety Evaluation (SE)

PWROG / NRC Interactions

Date	Interaction
May 14, 2009	Pre-submittal PWROG / NRC Meeting
July 17, 2009	WCAP-17100 Submittal to NRC
July 29, 2009	Post-submittal PWROG / NRC Meeting
Sept 15, 2009	Teleconference on NRC Review Questions
Oct 22, 2009	Teleconference on NRC Review Questions
Nov, 4, 2009	Discussion of NRC Preliminary RAIs
Nov 30, 2009	NRC RAI Set #1
Dec 17, 2009	Teleconference on PWROG Response to RAIs
Jan 27, 2010	PWROG RAI Responses Submitted to NRC
Feb 24, 2010	WCAP17100-Rev. 1 Submitted to NRC
April 1, 2010	Teleconference on NRC Review Questions
April 14, 2010	NRC RAI Set #2
May 19, 2010	PWROG RAI Responses Submitted to NRC
Dec 28, 2010	Draft SE Received
Jan 18, 2011	WCAP-17100 Rev. 1 Markup Submitted to NRC
Jan 21 2011	PWROG Comments on Draft SE Submitted to NRC
April 29, 2011	Final SE Received
June 8, 2011	Meeting with NRC to Clarify SE Limitations

SE Limitations for Further Discussion

1. The NRC expectation for submittals for non-93A RCP Shutdown Seal models
3. Level 2 PRA model changes
6. PRA model for inadvertent seal actuation
 - Diagnosis of a loss of seal cooling event requiring RCP trip
 - Training on abnormal seal behavior.

Westinghouse Planned Testing of non-93A RCP Model Shutdown Seal

Bill Mendez, Jason Sinkhorn, Westinghouse

Test Plan Summary

Test from WCAP-17100-NP Revision 1	Pump Model			
	93	93A	93A-1	100
Sealing endurance	x	x	x	x
Polymer ring extrusion		x		
Polymer ring radiation	x	x	x	x
Retracting (actuator only)		x		
Seal assembly actuation/full scale	x	x	x	x
Oven testing (actuator only)		x		
Radiation testing (actuator only)		x		
Actuator temperature		x		
Thermal piston soak		x		
Shaft movement from thermal expansion	x	x	x	x
Shaft rotation		x		
Shaft flaw	x	x	x	x
No. 1 insert	x	x	x	x
Vibration		x		
RCS chemistry		x		
CRUD		x		
Vacuum		x		

Notes:

1. Model 93A-1 and 100 tests to be combined into one set of tests
2. Test program summary matrix assumes same retracting actuator design used as model 93A
3. If a new retracting actuator is used for any of the pump models all retracting actuator tests will be repeated

Design Differences by Pump Model

Pump Model	#1 Insert to Sealing Surface Distance vs. 93A	Shaft or Shaft Sleeve Sealing Surface
93	Significantly larger	Shaft
93A-1	Marginally larger	Shaft
100	Marginally larger	Shaft

Model 93 RCP Shutdown Seal

- Uses same retracting actuator as model 93A
- Shutdown seal will have same key dimensions as model 93A shutdown seal
- Westinghouse testing will include:
 - Endurance testing for long term survivability using 93A survivability documented in WCAP-17100-P/NP as a minimum
 - Full assembly testing to demonstrate demand failures documented in WCAP-17100-P/NP are applicable
 - Additional model 93 considerations
 - Differential thermal expansion of shaft and seal housing
 - Tolerance of shaft flaws

Model 93A-1 RCP Shutdown Seal

- Uses same retracting actuator as model 93A
- Shutdown seal will have same key dimensions as model 93A shutdown seal
 - Completed tests have demonstrated model 93A shutdown seal can operate with the larger extrusion gap of the model 93A-1
- Westinghouse testing will include:
 - Endurance testing for long term survivability using 93A survivability documented in WCAP-17100-P/NP as a minimum
 - Full assembly testing to demonstrate demand failures documented in WCAP-17100-P/NP are applicable
 - Additional model 93A-1 considerations
 - Differential thermal expansion of shaft and seal housing

~~Tolerance of shaft flaws~~

Model 100A RCP Shutdown Seal

- Only one site (2 units) in the U.S.
- Same design as model 93A-1 shutdown seal due to seal hardware similarities
 - No additional testing (in addition to the 93A-1 testing) is required
- Operators cannot take credit for timely RCP trip on non-SBO loss of all seal cooling event
 - Westinghouse to provide utilities guidance on operating parameters that ensure timely trip of RCP in a loss of all seal cooling event
- Shutdown seal design modifications to increase operator response time are not planned at this time

Endurance Testing

- Endurance testing for long term survivability using 93A survivability documented in WCAP-17100-P/NP
- Individual set of tests for model 93 polymer ring
- Combined tests for models 93A-1 and 100 polymer ring
- Use irradiated polymer rings to include effects of cumulative exposure
 - Irradiated and non-irradiated polymer rings used in model 93A tests reported in WCAP-17100-P/NP with no measurable difference in performance

Full Scale Testing

- Validates all operational characteristics of shutdown seal
- Mimics plant conditions
 - Uses shutdown seal hardware assembled into #1 insert in same manner as production hardware
 - Sealing begins with activation of shutdown seal on increase in fluid temperature by production retracting actuator
 - Temperature and pressure will be varied to follow simulated fire and station blackout transients
- Sufficient testing to be performed to demonstrate demand failures documented in WCAP-17100-P/NP are applicable
 - Individual set of tests for model 93
 - Combined tests for models 93A-1 and 100

Additional Testing

- Testing for 93A described in WCAP-17100-P/NP for the model 93A will be repeated on a per pump model basis
 - Lateral movement tests will be modified to be specific to geometry and environment
 - Axial movement tests will be modified to be specific to geometry and environment
 - Mimic differential thermal expansion of RCP shaft and seal housing on a per pump model basis

Additional Testing (continued)

- Additional shaft flaw testing will be performed to establish acceptance criteria for sealing area flaws
 - Model 93, 93A-1 and 100 pumps do not have a shaft sleeve at the #1 insert location
 - Separate tests for model 93
 - Combined set of tests for model 93A-1/100
 - Introduce shaft flaw of known size to full scale test mockup similar to that described in WCAP-17100-P/NP
 - Increase shaft flaw size until leak rate exceeds design limit

Tests That Will Not Be Repeated

- **Vibration testing**
 - Same actuator used for all pump models, previous vibration testing demonstrated inadvertent actuation is extremely unlikely
- **Shaft rotation**
 - Principles of operation already demonstrated and are unchanged in future shutdown seal models
- **RCS chemistry**
 - Same materials of construction already proven tolerant of RCS exposure for other models
- **Crud exposure**
 - Principles of operation shown unaffected by crud in model 93A program

Questions?



PWROG Submittals to NRC

Bob Lutz, Westinghouse

Submittals to NRC

- A Supplement to WCAP-17100-P/NP will be submitted to NRC for each RCP Model Shutdown Seal
 - Follows the format of WCAP-17100-P/NP, Rev. 1
 - Provides information on changes to the Shutdown Seal for each pump model
 - Provides summary of testing for each pump model
 - Objective is to show that the conclusions of WCAP-17100-P/NP are valid for each Shutdown Seal model
 - Only addresses deltas from the approved WCAP-17100-P/NP

NRC Review of Submittals

- NRC review process for the Shutdown Seal for non-93A model pumps
 - Time
 - Effort for NRC staff and industry

Discussion of Other Safety Evaluation Limitations

Bob Lutz, Westinghouse

Level 1 and 2 PRA Model Changes

- It is proposed that success actuation of the SDS would conservatively result in zero RCP seal leakage
 - All sequences with successful Shutdown Seal actuation are potentially high pressure sequences; no credit for RCS depressurization through seal leakage
 - For Level 1 sequences, RCS Cooldown and depressurization is more challenging with zero leakage
 - Pressurizer level is maintained and depressurization is more challenging
 - However depressurization is not needed to prevent core damage
 - For Level 2 core damage sequences, high pressure core melt and vessel melt-through is possible (unless other depressurization phenomena are appropriate)

PRA Model for Inadvertent Seal Actuation

- It is proposed that inadvertent Shutdown Seal actuation
 - Is a low probability event
 - Is easily diagnosed
 - Does not result in consequential seal damage
 - Results in a forced shutdown under controlled conditions
- Therefore inadvertent actuation does not need to be modeled in the PRA

PRA Model for Inadvertent Seal Actuation

- Low Probability
 - FMEA has indentified possible means
 - Testing has shown that inadvertent actuation is not expected
- Easily Diagnosed
 - Sudden change in leak-off flow below the allowable lower limit
- No consequential Seal Damage
 - Testing has shown no issues that could result in damage to the No. 2 seal
- Controlled Shutdown
 - Does not increase the frequency of any PRA initiating event

Abnormal Seal Cooling

- Diagnosis of a loss of seal cooling event requiring RCP trip
 - Westinghouse is providing, as part of the vendor instructions, recommendations for pump trip
 - Loss of charging and CCW flow
 - Unexplained increasing RCP seal or CCW temperatures
 - Abnormal No. 1 seal leak-off behavior
- Training on abnormal seal behavior
 - Licensees would be expected to provide training on the Westinghouse recommendations

Conclusions and Action Items

Bob Lutz, Westinghouse

Conclusions and Action Items

- TBD