PWR Owners Group-NRC Pre-Submittal Meeting

WCAP-17261-P, "Justification for a TS Action for Two Inoperable RTS or ESFAS Instrumentation Channels"

March 2, 2011

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Agenda

- Objective of the Program
- Background
- Need for the Change
- Technical Specification Change
- RTS and ESFAS Functions of Interest
- Overall Approach
- Impact on Defense-in-Depth
- Impact on Safety Margins
- Risk Analysis and Results
- Monitoring Requirements
- Functions used for Control and Protection
- Limitations and Conditions
- Open Discussion

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Objective of Program

- Develop the technical justification to support adding an Action for two inoperable reactor trip signal (RTS) or engineered safety features actuation signal (ESFAS) channels.
- Applicable only to those RTS and ESFAS functions with a two-out-of-four actuation logic.

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Background

- Three or four channels are used to develop actuation signals
- Typically logic is two-out-of-three
- Two-out-of-four is used when:
  - The parameter is used for a control function
  - Additional redundancy is required
- With two-out-of-three or two-out-of-four logic one channel can be inoperable for up to 72 hours
  - Two-out-of-three logic goes to two-out-of-two
  - Two-out-of-four logic goes to two-out-of-three
- With a two-out-of-four logic, two inoperable channels results in a two-out-of-two logic, however, since TS Condition does not exist, LCO 3.0.3 must be entered

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Need for the Change

- Entering LCO 3.0.3 can result in unnecessary plant shutdowns or require a Notice of Enforcement Discretion (NOED)
- A number of plants have experienced this situation
  - RWST level channels – two disabled by lightning, July 1998
  - RWST level channels – two disabled by freezing, January 2003
  - RWST level channels – two disabled by lightning, August 2003
  - Containment pressure – one failed transmitter, a second could be impacted by repair activity, September 2004
  - RCP under frequency channels - repair activities could impact two channels – November 2007
- A number of instances have occurred that could have easily been addressed by including an Action for two inoperable channels

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Need for the Change (Cont'd)

- This will only be used to address an emergent condition as opposed to operational necessity for routine pre-planned testing and maintenance
- Adding this Action will avoid a potential unit shutdown or a request for enforcement discretion

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Technical Specification Change Request

Condition	Required Action	Completion Time
Two channels inoperable	Place one channel in trip	24 hours

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RTS (TS 3.3.1) Functions of Interest

2.a	Power Range Neutron Flux – High
2.b	Power Range Neutron Flux – Low
3.a	Power Range Neutron Flux Rate – High Positive Rate
3.b	Power Range Neutron Flux Rate – High Negative Rate
6	Overtemperature ΔT
7	Overpower ΔT
8.a	Pressurizer Pressure – Low
8.b	Pressurizer Pressure - High
14	Steam Generator Water Level – Low Low

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ESFAS (TS 3.3.2) Functions of Interest

LCO	Function	
Safety Injection	1.d	Pressurizer Pressure – Low
Containment Spray	2.c	Containment Pressure – High 3 (High High)
Containment Isolation – Phase B	3.b(3)	Containment Pressure – High 3
Steamline Isolation	4.c	Containment Pressure – High 2
Turbine Trip and Feedwater Isolation	5.b	Steam Generator Water Level – High High
Auxiliary Feedwater	6.c	Steam Generator Water Level – Low Low
Automatic Switchover to Containment Sump	7.b	RWST Level – Low Low Coincident with Safety Injection
Automatic Switchover to Containment Sump	7.c	RWST Level – Low Low Coincident with Safety Injection and coincident with Containment Sump Level - High

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Overall Approach

- Risk-Informed approach consistent with RG 1.174 and 1.177
- Addressed impact on defense-in-depth and safety margins
- Assessed impact on CDF and LERF
- Calculated ICCDP and ICLERP to demonstrate risk metrics are met
- Similar to the approach used in WCAP-14333-P-A and WCAP-15376-P-A (TSTF-418 and TSTF-411)
- Addressed control/protection functions

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Overall Approach (Cont'd)

- Developed detailed fault tree models for a number of the actuation signals
- Used a representative, at-power W NSSS plant PRA model
- Internal event risk impact addressed quantitatively
- External event risk impact addressed qualitatively
- Credit taken for:
  - Backup or alternate signals
  - Backup operator actions
- Analysis is applicable to all W NSSS plants

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Impact on Defense-in-Depth

- Addressed the criteria in RG 1.174
  - A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation
  - Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided
  - System redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences of challenges to systems, and uncertainties
  - Defenses against potential common cause failures are preserved, and the potential for introduction of new common cause failure mechanisms is assessed
  - Independence of barriers is not degraded
  - Defenses against human errors are preserved
  - The intent of the General Design Criteria in Appendix A to 10 CFR Part 50 is maintained
- The proposed change meets these elements of defense-in-depth

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Impact on Safety Margins

- The protection function is maintained with two channels inoperable
- Single failure criterion – two inoperable channels do not conflict with IEEE Std. 279 or IEEE Std. 603
- Monitoring requirements have been established to ensure consistency with the risk analysis
- The probabilistic measure of safety margin (CDF and LERF impact) is consistent with RG 1.174

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Risk Analysis - Fault Tree Models

- Signal fault trees based on WCAP-15376-P-A models
- Fault tree models include:
  - Random component failures
  - Common cause component failures
  - Unavailability due to testing
  - Unavailability due to maintenance
- Added unavailability for multiple combinations of two channels being inoperable
  - 24 hour Completion Time plus 6 hours to be in Mode 3
  - Occurrence of once per five years

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Risk Analysis - Fault Tree Models (Cont'd)

- Fault trees developed for:

Function	Signal
Reactor Trip	Overtemperature ΔT and Steam Generator Level – Low Low
Safety Injection	Pressurizer Pressure – Low
Containment Spray	Containment Pressure High-3 (High High)
Containment Isolation – Phase B	Containment Pressure High-3 (High High)
Steamline Isolation	Containment Pressure – High 2
Turbine Trip and Feedwater Isolation	Steam Generator Water Level – High High
Auxiliary Feedwater	Steam Generator Water Level – Low Low
Automatic Switchover to Containment Sump	RWST Level – Low Low Coincident with Safety Injection and coincident with Containment Sump Level - High

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Risk Analysis – Internal Events

- Representative four-loop W NSSS plant PRA model
- Recent peer review assessment
- Model included channel to signal dependencies, that is, how one channel can impact multiple signals
- Performed detailed assessment of signals available for event mitigation
- Operator actions credited as backup to signals

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Risk Analysis – Internal Events

- Operator Actions Credited as Backup to Signals
- HRA Actions
  - Trip the reactor from the main control board
  - Start ECCS from the main control board
  - Start AFW
  - Switchover from RWST to containment sump
  - Initiate containment spray

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Risk Analysis – Internal Events – Results

Acceptance criteria

- ΔCDF < 1E-06/yr, ΔLERF < 1E-07/yr
- ICCDP < 5E-07, ICLERP < 5E-08

Channel	ΔCDF (/yr)	ΔLERF (/yr)	ICCDP	ICLERP
SG Water Level	6.0E-08	1.2E-09	1.6E-08	9.3E-10
Pressurizer Pressure	5.0E-09	1.9E-09	6.9E-09	2.1E-09
Containment Pressure	<1E-09	<1E-10	7.8E-10	8.2E-12
RWST Level	<1E-09	<1E-10	2.5E-10	2.5E-11
Containment Sump Level	<1E-09	<1E-10	2.5E-10	2.5E-11
Total	7.1E-08	3.1E-09	NA	NA

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Risk Analysis – External Events

- The proposed change does not impact the physical characteristics of the RPS components.
- Therefore, the proposed change does not impact the seismic or high wind fragility of the reactor protection system components or its susceptibility to fire or flooding events.
- Potential impact due to the signal unavailability change related to the mitigation of external events
- Considered the following external events
  - Seismic
  - Fire
  - Other external events (high winds, external flooding)

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Risk Analysis – External Events – Seismic

- Seismic event can result in small LOCAs or loss of offsite power (LOOP) events
- IPEEEs did not identify small LOCAs, due to pipe breaks, as significant contributors
- Small LOCAs due to RCP seal LOCAs are potentially significant contributors, however they are mitigated by operator actions
- Seismically induced LOOP events are significantly lower in frequency than other LOOP events
- Based on the above, the risk increase due to the proposed change from seismic events is concluded to be very small

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Risk Analysis – External Events – Fire

- IPEEE indicated that the dominant fire scenarios result in a plant transient (e.g., loss of feedwater, main steam isolation valve closure, LOOP, and loss of support systems)
- Fire induced LOCA events are not significant contributors to risk
- Fire events typically cause a plant trip and compromise safety related equipment
- Several ways to actuate decay heat removal – ESFAS, AMSAC, OA
- The frequency of fire induced transients is significantly lower than internal transient events
- Small LOCAs due to RCP seal LOCAs are potentially significant contributors, however they are mitigated by operator actions
- The frequency of fire induced LOOP is significantly lower in frequency than other LOOP events
- Based on the above, the risk increase due to the proposed change from fire events is concluded to be very small

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Risk Analysis – External Events – Other

- Other external events considered include high winds, external flooding, etc.
- The IPEEE identified that the dominant scenarios are related to LOOP with possible additional failures that lead to RCP seal LOCAs
- Frequencies of such events are low compared to typical transient events
- Recovery from such events is not highly dependent on the RPS, but on operator actions
- Based on the above, the risk increase due to the proposed change from other external events is concluded to be very small

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Monitoring Requirements

- To ensure no adverse safety degradation occurs due to the proposed change
- Key parameter changes (assumptions) in the analysis are related to the simultaneous unavailability of two channels
  - 24 hours (CT) + 6 hours (to be in Mode 3)
  - Once per five year frequency
- Therefore, actual average unavailability of two pairs of channels from the channel set will be monitored.

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Control and Protection System Interactions

- Issue: With two channels inoperable, another channel being used for control could fail and cause an event that requires the protective action of that protective function
- To address this issue, the program is limited to:
  - Two-out-of-four functions not used for control OR
  - That have backup instrumentation or operator actions to actuate mitigation equipment
- A detailed assessment was completed on each signal to determine if it met the above criteria
- It was concluded that it is acceptable to apply the proposed change to all functions evaluated in this WCAP

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Limitations and Conditions

- Tier 2 requirement: Confirm the remaining operable channels, in the channel set, are not inoperable due to a common cause across the four channels
- The representative analysis HEPs are applicable
- Monitoring requirements related to two channels of the same function must be implemented
- One channel used for plant control must remain in service or the plant should be placed in manual control
- Tier 3 requirements will be addressed by the plant's Configuration Risk Management Program

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Open Discussion/Questions