

**Pressurized Water Reactor Owners Group
(PWROG)
Meeting with NRC on Staggered Integrated
ESF/LOOP Testing Topical Report
(WCAP-15830)**

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White Flint - Rockville, MD

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**Staggered Integrated ESF/LOOP Testing, WCAP-15830
Agenda**

- Introduction
- Assumptions
- Overview of Methodology and Approach
- Review of Issues and Proposed Response
- Summary

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Introduction

- Introductions
- Purpose of Meeting
 - Discuss the April 06' PWROG response to address the staff's concerns,
 - Respond to additional staff questions,
 - Reach agreement on acceptable resolution to each issue.
- Meeting Format
 - Restate each RAI,
 - Explain how PWROG proposes to address the RAI,
 - Question and Answers.
- Meeting Goals
 - Obtain agreement that the PWROG response satisfies staff concerns
 - Outline a plan to complete NRC review process for WCAP-15830, incorporate required changes and obtain final document approval.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Assumptions

- Proposed change for use at plants with 18 month refueling cycle. (Note 1)
- Resolution of these issues will be applied to similar generic methodology being developed for W-NSSS units (WCAP-16354).

Note 1:

Methodology may also be applied to 24 month refueling cycle plants, but additional analyses would be required.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Review of Methodology and Approach

Program Objective:

- Develop a generic methodology that individual plants may use as a model to apply staggering ESF/LOOP testing at their plant,
 - Extend the test interval of Surveillance Requirements typically addressed by the Integrated ESF/LOOP test to every other refueling outage on a staggered basis.
- Provide plant specific demonstrations as a proof of principle,
- Obtain NRC approval of the Generic Methodology and Approach.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Review of Methodology and Approach

Industry Benefits:

- Dose / radiation exposure reduction
- Reduced human performance challenges
- Reduction in safety-related equipment wear and tear
- Reduction in RCS mass addition challenges
- Reduced outage time

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Review of Methodology and Approach

Methodology:

- Apply a Risk-Informed approach, based on RG 1.174 to demonstrate that any change in risk will be negligible.
- Use a balanced approach between Risk-Informed and Deterministic assessments

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Review of Methodology and Approach

Approach:

1. Review TS Surveillance procedures (for demonstration plants) to identify overlap in component and functional testing with the integrated ESF/LOOP test
2. Categorize components (A, B or C)
 - (See next slide for definitions)
3. Perform a Risk analysis to quantify the associated change in plant risk
 - Analyze Category A components
 - Adjust Risk Model as necessary
 - Recalculate and evaluate the change in risk

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Review of Methodology and Approach

Approach: (continued)

- Category A
 - Component/function tested solely by IESF test
 - Risk significant and addressed (or should be addressed) by PSA model
- Category B
 - Component/function tested solely by IESF test
 - Not Risk significant and not addressed by PSA model
- Category C
 - Component/function not tested solely by IESF test
 - Other equivalent testing performed within the RO interval

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Review of Methodology and Approach

Approach: (continued)

4. Perform a deterministic based evaluation to confirm the conclusions of the risk analyses,
 - Consisting of a plant specific Failure Modes and Effect Analysis (FMEA) performed on systems/equipment that may only be tested during integrated ESF/LOOP testing,
 - Show that there are no failures for these components that have a non-constant failure rate and a MTBF greater than test interval (36 months),
 - Show that the change in test interval will not degrade the performance of either train of the ESF system and will not invalidate any assumptions in the plant licensing basis.
5. Evaluate Analyses results per RG 1.174 criteria.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Deterministic Issues and Proposed Response

1. How will the requirements of General Design Criterion (GDC) 17, GDC 18, acceptance guidelines of Regulatory Guide (RG) 1.9, RG 1.108, and Institute of Electrical and Electronics Engineers (IEEE) Std 387 continued to be met? [RAI 1 (1.1.1, 1.1.3), RAI 2 (1.1.2)] and [RAI 15 (2.0), RAI 17 (2.0), RAI 18 (2.0) and RAI 19 (2.0)] :
 - How will sufficient safety margins and defense-in-depth be maintained?
 - How will the WCAP ensure that the reliability of components and functions tested only by the integrated ESF tests is not reduced ? (RAI 18)
 - How will the WCAP ensure that the likelihood of undetected component and function failures is not increased ? (RAI 19)
- **Response:**
 - To address these concerns, additional work was performed, which is summarized on the following three slides.
 - This is in support of Section 5 of WCAP-15830, which is the deterministic evaluation.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Generic Deterministic Evaluation

Scope of Additional Evaluation:

- Perform generic Failure Modes and Effect Analysis (FMEA) on representative Category A components using information from several demonstration plants.
- Show that there are no time dependent failure modes.
- Use deterministic analysis to confirm assumptions of Risk-Informed analysis.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Generic Deterministic Evaluation

Methodology:

- Confirm and evaluate overlap in testing
- Analyze functions tested by all TS Chapter 8 Refueling Interval SRs
- Review key EDG related systems and components requiring routine operability verifications
- Demonstrate FMEA and No significant Hazards analysis on possible Cat A components
 - Failure Mode,
 - Failure Mechanism (cause),
 - Failure Effects and Consequences
 - Safety Significance and impact on margin of safety

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
EDG surveillance test vs. component/function being tested

Type of Test	Component/Function tested
Start and stop test	SI, UVR signals, Governor
Load test in parallel mode	VR, governor
LOOP test	VR, governor
SI actuation signal test	SI signal
LOOP with SIAS test	VR, governor, SI signal
Single load rejection test	VR, governor
Endurance test	All EDG systems
Synchronization test	Governor, synch check relay
Hot restart test	Governor

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Components address in generic FMEA and Significant
Hazards Analysis

- Components addressed in generic FMEA and Significant Hazards Analysis
 - Under Voltage Relays 27
 - EDG or Load Circuit Breakers
 - SIAS Actuation Relays
 - EDG Safety Injection and Shutdown Load Sequencers
 - EDG Control Circuits
 - EDG voltage regulator,
 - EDG governor,
 - EDG fuel transfer system,
 - EDG breaker synchronization check relays

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Generic Deterministic Evaluation

Conclusions:

- Generic analysis did not identify any components that may have a failure mode with a hazard rate that will change with the proposed increase in the Integrated ESF/LOOP test interval.
- The analysis did not show any correlation of equipment and control circuits identified failures with the integrated ESF/LOOP test interval.
- Similar plant specific FMEA should show that there are no time dependent failure modes.
- If any time-dependent failure modes are subsequently identified:
 - Plant must ensure a preventive maintenance program to remove the time dependent failure mode to assure that the component's hazard rate remains constant.
 - The time dependent failure mode must be included the plant risk model.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Deterministic Issues and Proposed Response

1. How will the requirements of General Design Criterion (GDC) 17, GDC 18, acceptance guidelines of Regulatory Guide (RG) 1.9, RG 1.108, and Institute of Electrical and Electronics Engineers (IEEE) Std 387 continued to be met? [RAI 1 (1.1.1, 1.1.3), RAI 2 (1.1.2)] and [RAI 15 (2.0), RAI 17 (2.0), RAI 18 (2.0) and RAI 19 (2.0)] :
 - How will sufficient safety margins and defense-in-depth be maintained?
 - How will the WCAP ensure that the reliability of components and functions tested only by the integrated ESF tests is not reduced ? (RAI 18)
 - How will the WCAP ensure that the likelihood of undetected component and function failures is not increased ? (RAI 19)

Deterministic Evaluation Shows:

- Availability of a single train of ESF not affected (assuming a two train system),
- Defense-in-depth not affected
 - No change in physical plant design or operating procedures.
- No non-constant failure rates and MTBFs greater than test interval (36 months),
- No increase in the likelihood of an undetected component and or functional failure.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Deterministic Issues and Proposed Response

2. What other more frequently performed tests are, when combined together, functionally equivalent to SR 3.8.1.18 (sequencer timing verifications) and SR 3.8.1.16 (restoration of offsite power) requirements? [RAI 16 (2.0)]

Response:

- SR 3.8.1.18 no longer generically included in the proposed change,
 - Sequencer design, calibration and functional test is highly plant specific.
 - Additional plant specific evaluation would be required to justify changing the current test program.
 - Sequencer testing may be combined with IESF test if acceptable based on plant specific drift analysis.
- SR 3.8.1.16 does not involve equipment with any time dependent failure mode,
 - Functionality not significantly different from other more frequently performed testing on sync-check relays.

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Deterministic Issues and Proposed Response

3. Once approved, can a plant implement staggered ESF/LOOP testing based on WCAP 15830 alone, without first doing a plant specific analyses and requesting a Licensing Amendment for the affected TS surveillance test interval changes? [RAI 3 (1.1.4)]

Response:

- No,
- Each applicant must perform plant specific Risk Analyses and Deterministic Evaluation,
- Each applicant must submit plant specific LAR for NRC approval.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Deterministic Issues and Proposed Response

4. How will the WCAP ensure that users monitor the impact of the proposed change after it is implemented? [RAI 4 (1.1.5)]

Response:

- Each applicant must have administrative program in place to monitor/trend performance of Category A components,
- Each applicant must address Category A components as 'Risk Significant' IAW Maintenance Rule,
- Each applicant must ensure IESF test procedure address potential failure of Category A components IAW plant Corrective Action Program.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Deterministic Issues and Proposed Response

5. What action is required if any failures are detected during the scheduled test of a given ESF train using the staggered testing approach? [RAI 7 (1.2.2-4)]

Response:

Note: The following guidance applies to equipment failures only, not test or human performance related failures.

- Category A component failures:
 - Initiate failure analyses to determine failure mode and time dependency IAW plant Corrective Action Program,
 - If a common-mode failure, immediately test same component/function in opposite train (IAW plant specific test procedures),
 - If there is no way to individually test the opposite train component, then perform a full IESF test on the opposite train during the outage,
 - Correct failure and perform component specific test (IAW plant specific test procedures).
 - If there is no way to individually test the repaired component, then perform a full IESF retest on the affected train,
 - Procedures for re-running TS surveillance tests are plant specific

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Deterministic Issues and Proposed Response

5. Response: (continued)

- Non-Category A component failures:
 - Initiate failure analyses to determine failure mode, IAW plant Corrective Action Program,
 - If a common-mode failure, immediately test same component/function in opposite train to demonstrate availability,
 - Correct failure and perform component specific test on affected train to demonstrate availability.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Probabilistic Issues and Proposed Response

1. How will the WCAP ensure users of the WCAP re-assess previous risk-informed approvals to determine how the selective omission of the Category A-4 components affects the conclusions of their supporting risk evaluations? [RAI 5 (1.2.2.4)]

Response:

- Plant-Specific LARs Associated with WCAP-15830 are Risk-Informed Applications
 - Will need to Comply with RG 1.200 and ASME PRA Standard WRT PRA Technical Adequacy Expectations
 - RA-Sb-2005, Item 5.2 (d), Requires Re-evaluation of past RI applications when PRA is modified
- Modify WCAP to Explicitly Require Plants To Re-assess Previous RI Applications.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Probabilistic Issues and Proposed Response

2. How will the WCAP justify that the two probabilistic models (binomial failure model and the standby failure rate model) used in the report are appropriate for this application? [RAI 6 (1.2.2)]

Response:

- We use the 'Standby Failure Rate' model.
- 'Binomial Failure' model is not appropriate for this application.
- All reference to the 'Binomial Failure' model will be removed from WCAP-15830.

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Staggered Integrated ESF/LOOP Testing, WCAP-15830
Probabilistic Issues and Proposed Response

3. How will the WCAP demonstrate that use of dummy events to capture the impact on CCF is appropriate? [RAI 8 (1.2.2-4)]

Response:

- Modify WCAP to include specific requirements for plant-specific implementation:
 - For Alpha-model- use the staggered test interval equations to calculate Common Cause unavailability,
 - For full Multiple Greek Letter (MGL) model - use equivalent equations or use Alpha model equations and then convert back to MGL,
 - For Simplified MGL model with modules – replace modules with basic event with probability calculated off-line using the appropriate equations.

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Probabilistic Issues and Proposed Response

4. How will staff concerns about PRA technical adequacy, such as the impact on LERF, be addressed? [RAI 9 (1.2.3)] and [RAI 13 (1.3-2)]

Response:

- Plant-Specific LARs Associated with WCAP-15830 are Risk-Informed Applications
 - Will need to Comply with RG 1.200 and ASME PRA Standard WRT PRA Technical Adequacy Expectations
- WCAP will be modified to provide specific guidance with respect to key areas of technical adequacy for Plant specific applicants:
 - Summary of results of NEI 00-02 peer review
 - Summary of results of gap analysis per RG 1.200, Appendix B
 - Status of all “A” and “B” Facts & Observations (F&Os)
 - For any open “A” or “B” F&Os, an assessment of potential impact of the unresolved issue on the application

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Probabilistic Issues and Proposed Response

5. How will provisions for performing sensitivity or uncertainty evaluations of CDF and LERF be incorporated into the WCAP based on the three key assumptions used in the WCAP? [RAI 10 (1.2.4)]

Response:

- WCAP will be modified to include explicit requirements for plant-specific applicants to include changes in both CDF and LERF, and to include a numerical uncertainty analysis for CDF and LERF
 - LERF will be based on a simplified LERF model (Per NUREG/CR-6595)
- Two Sensitivity Analyses Proposed
 - Unavailability based on combined binomial/standby failure rate model with a demand failure probability of 10% of the base failure rate,
 - Factor of 2 increase in hazard rate from 24 to 30 months and Factor of 6 increase in hazard rate for 30 to 36 months.

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Probabilistic Issues and Proposed Response

6. How will mapping of cause-effect relationships onto PRA model elements be provided for review? [RAI 12 (1.3-1)]

Response:

- Spreadsheet used to document components/functions addressed by the test, document overlap in testing and to justify category selection (A,B or C),
- Spreadsheet used to document sub-categorization of Category A components (A-1, A-2, A-3 and A-4) and the bases, including how the component was addressed in the plant specific PRA model, if required,
- Examples of spreadsheets will be provided to illustrate the process.

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Probabilistic Issues and Proposed Response

7. How will staff concerns about documentation of the significant peer review findings and progress made towards resolving them be addressed? [RAI-14 (1.3-3)] and [RAI 11 (1.3)]

Response:

- Plant-specific submittals will provide details of peer review results
 - Status of A & B level F&Os,
 - Evaluation of potential impact of any unresolved A&B F&Os with respect to the model elements affected by the application.
- WCAP will include guidance on areas to address the key elements affected by the model.

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Summary

- High priority Industry program.
- PWROG has been responsive to NRC concerns.
- Looking to obtain agreement from NRC that the PWROG responses satisfy the Staff's concerns.
- PWROG will revise the WCAP and resubmit to the NRC for final review and approval.

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