BWR OWNERS' GROUP

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BWROG-09047
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Project 691

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U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Boiling Water Reactor Owners' Group
BWROG Plans for Addressing NRC Concerns Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors

Reference: BWROG Letter 09024 to NRC dated April 13, 2009

The purpose of this letter is to respond to NRC's request for schedule and planning information related to BWROG resolution of ECCS Suction Strainer issues. NRC issues for consideration by the BWROG were outlined in your letter to me dated April 10, 2008, "Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors." This letter describes actions completed, underway, and planned by the BWROG and provides a schedule for these actions. We look forward to meetings with the NRC staff on July 23 and July 30 to address, respectively, plans for addressing downstream in-vessel effects of containment debris on fuel, and plans for addressing other ECCS Suction Strainer issues of concern to the NRC.

BACKGROUND

Relevant background information was provided in the referenced letter and is not repeated here. Significant improvements to PWR ECCS sump strainers have been made, and final actions to close out GL 2004-02 are in progress. The BWROG has developed programs to address the issues of concern to NRC as well as undertaking a broad assessment of the actions summarized in the BWROG URG (NEDO-32686-A, October 1998) against the actions undertaken to address PWR Sump Strainer issues. This assessment, referred to as the BWROG Strainer Evaluation Program, will systematically address the potential sources of debris; debris generation, transport, erosion, and depletion; chemical effects; strainer head loss; and downstream effects. Elements of this program have been discussed previously in various meetings between the NRC and the BWROG.

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BWROG STRAINER EVALUATION PROGRAM

As noted in the referenced letter, the resolution schedule for the completion of these actions is consistent with the current understanding of the safety significance of these issues and the schedule for the resolution of similar, and more significant, safety matters. Since BWRs have already implemented significantly larger passive strainers, the safety significance of this effort is less than that of the original strainer redesign for either the BWRs or the PWRs. This is further explained in the referenced letter.

The BWROG program elements discussed in this letter are as follows:

1. General Program
2. Source Term Characterization
3. Downstream Effects - Fuel
4. Downstream Effects - Components
5. Strainer Head Loss

Please note that program elements 2 through 5 correspond to the four Subcommittees of the BWROG ECCS Suction Strainers Committee. The specific activities and schedules for each of these areas are detailed in Enclosure 1.

General Program

The BWROG is currently updating the Program Plan to reflect the current status of all of the BWROG Committee and Subcommittee activities. This extensive Program Plan revision should be completed by August 10, and will be provided to NRC at that time. The specific program plan elements and activities are detailed in Enclosure 1, and the current status of these activities will be presented in meetings with you and your staff on July 23 (Downstream Effects - Fuels) and July 30 (the remaining Subcommittees).

The BWROG intends to obtain NRC approval for portions of its resolution plans, prior to implementation, via the Licensing Topical Report (LTR) process. The BWROG is also observing closely the resolution of PWR sump strainer issues and intends to utilize the PWR lessons learned in the resolution of BWR issues with NRC. Prior to the commitment of significant funds for test programs and other initiatives, the resolution of certain issues (such as Downstream Effects-Fuels) must take into account both NRC responses to BWROG LTRs and NRC review of similar PWR topical reports (i.e. RAIs and Safety Evaluations).

We propose that status meetings (similar to those being conducted in July) be held semiannually, with periodic telephone conferences held as necessary to provide significant updates in plans and schedules.

Source Term Characterization

The results of this key activity impact the actions to be taken within the other BWROG subcommittees. Suitable definitions of the drywell and suppression pool/torus debris source terms are necessary to analyze for head loss, chemical effects, strainer bypass fraction and thus determine impacts on components and the potential for fuel blockage. The BWROG is collecting design basis source term information through a URG-based survey of the US BWRs that will be confirmed by walkdowns of varied scope. This data will be used to develop a representative source term.

The original test plan for the BWROG addressed full containment inventory walkdowns within the fleet. During planning and implementation, it has been recognized that specific plants within the fleet may have met criteria that will allow them to limit portions of the walkdown, thereby saving manpower, outage schedules and dose. A "decision tree" (i.e., criteria) is being added to the BWROG ECCS Suction Strainer Project Plan. The purpose of the decision tree is to identify criteria for determining the scope of individual plant walkdowns. The criteria will consider each of the elements of BWROG technical product, "Containment Walkdown Procedure for Potential Strainer Debris Sources at BWR Nuclear Power Plant." Several facilities within the BWR fleet have performed varying scopes of the full-scale walkdown during Spring 2009 outages. All containment inventory walkdowns related to the ECCS Suction Strainer debris source term issue are scheduled to be performed prior to or during the Spring 2011 outage cycle. As walkdown data becomes available and prior to the 2011 scheduled completion of walkdowns, the BWROG will develop debris source term information to best represent the fleet, noting that this may require more than one debris source term value due to varying degrees of fiber and particulate at plants within the BWR fleet.

The BWROG has discussed chemical effects issues to allow for a consistent approach across the fleet of BWR plants. The BWROG intends to address chemical effects source terms by performing chemical dissolution bench testing (similar to the PWR approach) and to develop a template for utility and BWROG application of the laboratory results. Plants that have adopted alternative source term (AST) are being surveyed to address the design basis for injection of sodium pentaborate during a postulated accident. The BWROG is preparing a white paper on the consideration of sodium pentaborate and will discuss our conclusions with the NRC.

The BWROG performed considerable testing during the development of the URG analysis. During that time, air-jet testing was performed to conservatively determine Zone of Influence size, pursuant to debris source term inspections and inventories at each plant. PWR testing under NEI 04-07 has been performed at subcooled water conditions. In addition to the URG, additional reports have documented the conservatism of using the single-phase air-jet testing approach. Relative to steam and two-phase jets, the BWROG plans to confirm the conservatism of the air-jet testing documented in the URG.

The BWR containment walkdowns currently underway will ultimately supply valuable data for final characterization of a BWR source term. However, the BWROG will not wait for all of the walkdowns to be completed before establishing an input source term(s) to be used in the other

activities. As noted in the referenced letter, the results of the walkdowns will be carefully analyzed relative to the GSI-191 lessons learned, as applied to BWRs, for inputs into debris generation, strainer head loss, chemical effects, and downstream debris effects.

Downstream Effects - Fuel

The BWROG intends to address this issue first for BWR fuel bundles designed by Global Nuclear Fuel (GNF). First, we will submit an LTR prepared by GE-Hitachi (GEH) that generically analyzes blockage effects with the GNF fuel bundle design. An independent third party will be selected to compare the results of the GEH analysis with fuel bundle designs provided by the three BWR fuel vendors (GNF, AREVA, and Westinghouse). This independent evaluation will determine whether the generic analysis results can be applied to all BWR fuel bundle designs. If the results are seen to apply, the actual blockage testing could be performed on only the GNF fuel bundle design. Following testing, we will then supplement the topical report with confirmatory test design information and actual test results. The outline for this LTR is provided as Enclosure 2.

If it is determined that testing should be performed for the AREVA and Westinghouse BWR fuel bundle designs, separate topical reports will be prepared and submitted for each of these fuel bundle designs.

As noted above, before committing significant funds to design of the test and its implementation, the BWROG will await completion of NRC review of the LTR.

Downstream Effects – Components

The BWROG intends to develop an LTR to either adapt WCAP-16406P or develop new guidance to the BWR fleet. In addition, the BWROG has collected survey information from the US PWRs that will be used in the assessment of this area. Commercial discussions are underway to begin this task, and the schedule for performance of this task will be finalized once these discussions are complete.

The BWROG believes the methodology document to evaluate Downstream Effects on ECCS Components can be started toward the end of 2009 and finished in 2011. Then generic component evaluations will also be performed in 2011 with the LTR issued to NRC for review in mid-2011. This scheduling is based on the following:

1. The PWRs evaluated Downstream Effects on ECCS Components using WCAP-16406P. A survey of the PWRs was conducted by the BWROG to understand the impact of this evaluation and resulting plant changes. Many of the PWR plants did not require any changes. For the most part, the plant changes that were made involved change-out of pump seal face materials and throttle valve trim. Potential concerns with wear on centrifugal pumps did not require any internal modifications, and postulated pump performance changes were found to be of small magnitude and did not adversely impact ECCS system post-LOCA operation.

An initial overview of the BWR fleet indicates the majority of ECCS pumps are very similar centrifugal types. The large multi-stage pumps in the PWR fleet, e.g. Safety Injection or Charging Pumps are not needed for the lower head requirements of BWR injection. Some PWR plants identified blockage concerns with small valves ($\leq$ 2" size) used in some systems for balance of flow to each of the hot and/or cold legs of the primary RCS. BWR ECCS valves generally are much larger and typically would not be expected to exhibit similar blockage concerns. Furthermore, a blockage evaluation was performed by the BWROG in the 1990s (see URG Volume III Tab 5).

2. The debris source term downstream of the strainers is a necessary input for component specific evaluations. The walkdown verifications could change the current knowledge base of types and amounts of debris postulated to reach the strainers. Consequently, it is prudent to schedule the conclusion of the DSE methodology to coincide with receipt of walkdown information as it becomes available. (Walkdowns are expected to conclude in 2011.)

In summary, the BWROG believes scheduling of this portion of the work to conclude in the late 2011 timeframe is appropriate because of the reasons stated above, and because the results of this work are largely stand-alone and not specifically needed as input for other subject areas discussed herein in this letter.

With regard to the bypass fraction, the BWROG is currently reviewing existing information to determine whether analysis of existing BWR strainer designs can provide appropriate bypass fractions for the principal debris types (fiber and particulate) in the BWR fleet.

Strainer Head Loss

Since the manufacturers developed head loss correlations for their specific strainer designs, the BWROG plans to elicit the assistance of each of them (GEH, PCI, Westinghouse, ABB, and Enercon), as required. Test data will be reviewed to ensure that the supporting database is adequate. This review will include maximum debris loading conditions as well as formation of thin beds. Consideration will be given to time-dependent effects of head loss, and how those effects impact NPSH margins. The need for additional head loss testing is currently indeterminate; it will depend on review findings, chemical effects testing, latent debris quantities, and confirmatory walkdowns.

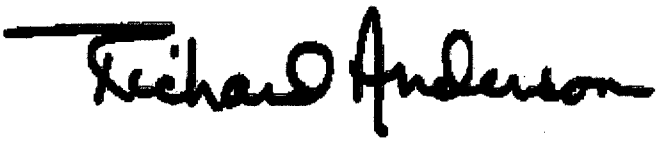
CONCLUSIONS

As discussed in the referenced letter, the BWROG shares a common goal with the NRC to address strainer performance issues with an appropriate level of rigor to ensure the safety of the BWRs is properly assessed. We have developed a comprehensive evaluation plan and will continue to update the NRC at regular intervals on our progress and the results of walkdowns

and evaluations. While the actions described in this letter represent the intent of the members of the BWROG, they should not be considered a commitment on the part of any specific licensee.

We look forward to continued progress and resolution of these issues.

Respectfully,



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Enclosure 1

Table 1
BWROG Activity Summary
Response to BWR ECCS Suction Strainer Issues
July 15, 2009

Activity	Status	Current Schedule
General Program		
Track PWROG interactions with NRC	Participating in most NEI meetings and calls related to GSI-191	Ongoing
Program plan	Developing Revision D	August 10, 2009
NRC briefings	Plan to conduct these semiannually in the future, with telecons as required to update status	July 23, 2009 (DSE-Fuels) July 30, 2009 (General)
Analysis of gaps between URG and NEI 04-07	1. Draft BWROG report being reviewed 2. NRC assessment of gaps to be considered 3. Final report 4. Additional actions to close gaps beyond those previously identified.	1. July 7, 2009 2. July 30 – August 31, 2009 3. August 31, 2009 4. TBD
Source Term Characterization		
Determine debris source term	1. Review PWR results 2. Complete surveys of debris source terms at BWR plants 3. Review surveys 4. Develop source term(s)	1. TBD 2. July 15, 2009 3. August 31, 2009 4. TBD
Determine strainer bypass fraction (consider PWR results)	1. Develop recommendation for Committee on whether analysis or testing is required to develop bypass fractions 2. Action plan for analysis or testing 3. Funding for analysis or testing 4. Conduct analysis or testing	1. July 22, 2009 2. TBD 3. TBD 4. TBD
Chemical effects	1. Collect survey results related to chemical effects 2. Develop a white paper to address chemical effects with regard to AST plants' design basis 3. Develop a Chemical Dissolution	1. July 15, 2009 2. September 30, 2009 3. September 30, 2009

Activity	Status	Current Schedule
	test protocol and submit to NRC for comment prior to performing bench tests 4. Incorporate NRC comments into test protocol and send out for competitive bid by vendors 5. Select a vendor to perform chemical dissolution bench tests 6. Perform bench tests 7. Select a vendor and develop a template for application to individual BWR plants	 4. October 30, 2009 5. December 15, 2009 6. April 30, 2010 7. August 31, 2010
Zone of Influence	1. Develop a BWROG position regarding conservatism of air jet testing versus steam and two-phase flow tests 2. Select a vendor to independently address position paper to be presented in NRC requested format.	1. Complete 2. August 31, 2009
Conduct containment walkdowns to confirm source terms	1. Guidance and checklist provided for utility use 2. Template for sharing walkdown results 3. Guidance for addressing operability issues 4. Summary of walkdown schedules 5. Walkdowns being conducted	1. Complete 2. September 15, 2009 3. July 31, 2009 4. August 15, 2009 5. Refueling outages between Spring 2009 and Spring 2011
Downstream Effects - Fuel		
Develop and submit LTR	Underway	February 28, 2010
Perform thermal-hydraulic analysis of potential fuel bundle blockage scenarios to develop limiting conditions for generic BWR fuel bundle	1. Reflood scenario (lower tie plate) 2. Remaining scenarios (core spray, natural circulation, bypass region)	1. Complete 2. August 31, 2009
Address BWR product line differences		Begin September 2009 Complete December 2009

Integrate GNF fuel bundle information with analysis results		August 31, 2009
Evaluate analysis results for GNF fuel bundle		August 31, 2009
Develop test recommendations for GNF fuel		October 31, 2009
Early assessment of need for testing AREVA and Westinghouse BWR fuel bundles	Proposed: Independent 3rd-party assessment of analysis results to AREVA and Westinghouse BWR fuel bundle designs	October 31, 2009
Downstream Effects - Components		
Adapt WCAP-16406	1. Select a vendor to perform this adaptation 2. Complete survey of PWR treatment of downstream effects on components	1. Vendor selection and schedule determination in progress 2. Complete
Survey of PWR treatment/results of downstream effects on components	Complete	Complete
Work Scope Specification	Issued February 15, 2009	Complete
Contractor selection	Ongoing	September 2009
Assemble input information on component population for each BWR product line.		December 2009
Contractor Start Work		December 2009
Contractor Issue Final Methodology Report to BWROG		December 2010
Contractor perform "generic" evaluations for major BWR equipment		May 2011
BWROG issue LTR for NRC Staff Review		July 2011
NRC Staff Review concludes		October 2011
BWROG Respond to RAIs		December 2011
BWROG issue final report		January 2012
BWR Plants evaluate if bounded by Generic Component evaluations		2012 and beyond

Determine strainer bypass fraction (consider PWR results)	1. Develop recommendation for Committee on whether analysis or testing is required to develop bypass fractions 2. Action plan for analysis or testing 3. Funding for analysis or testing 4. Conduct analysis or testing	1. July 22, 2009 2. TBD 3. TBD 4. TBD
Strainer Head Loss		
Manufacturers and utilities revisit their prototype testing for thin bed effects, adequacy of debris source terms, and maximum debris loading.		Dependent on walk downs to some extent
Utilities identify those plants that still have calcium silicate or micro-porous (e.g., min-K, Microtherm) insulations.	Plant surveys being prepared.	July 15, 2009
Utilities determine whether original pipe break selection may have omitted microporous debris contributing to high head loss or low-debris generating breaks that could cause thin-beds on strainers.		TBD
BWROG integrate changes to debris source terms identified by Chemical Effects		TBD by Chemical Effects
BWROG assess appropriate, related concerns/gaps on debris erosion/transport, latent debris quantities, and coatings		Ongoing, depends on walkdowns for latent debris & coatings.
BWROG assess the results of steps above, and decide whether additional evaluation or testing is required to validate head loss correlations		TBD
Manufacturers/plants perform evaluations and testing, as required		TBD
BWROG document results for NRC		TBD

Enclosure 2

Proposed LTR Outline for Reporting of DSE-Fuel Bundle Analysis and Testing

Executive Summary
Revisions
Acronyms

1. Introduction – Background and Objective
2. Report Content Roadmap – Evaluation, Plant Configurations, Fuel Blockage and Testing
3. Analytical Evaluation Summary – Limiting Results and Conclusion
    a. Inlet Blockage Reference Case Basis (This section will be Proprietary)
        i. Prior to Core Uncovery
        ii. Steam Cooling
        iii. Spray Cooling and Reflood by ECCS
        iv. Top Core Uncovery
    b. Lower Tie Plate Hole Blockage Sensitivity (This section will be Proprietary)
    c. Upper Tie Plate and Spacer Blockage Sensitivity (This section will be Proprietary)
    d. Limiting Blockage Conclusions
        i. Speed of deposition of crud
        ii. Suction source (Amount of crud available for deposition)
        iii. Flow rates (Highest)
        iv. Flow paths
        v. Injection Locations
4. BWR Product Line Distinctions
    a. Reactor Vessel Size
    b. Reactor Vessel Penetrations
        i. Feedwater
        ii. Main Steam Lines
        iii. ECCS Systems
        iv. Reactor Recirculation System
        v. Control Rod Drive System
        vi. Reactor Water Cleanup System
    c. ECCS Systems
        i. Suction Locations
        ii. Injection Locations
        iii. Injection Signals and Logic
    d. LOCA Response By Product Line
        i. Large Break Steamline Short Term Response
        ii. Large Break Steamline Long Term Response
        iii. Large Break Recirculation System Line Short Term Response
        iv. Large Break Recirculation System Line Long Term Response
        v. Small Break Steamline Short Term Response
        vi. Small Break Steamline Long Term Response
        vii. Small Break Recirculation System Line Short Term Response
        viii. Small Break Recirculation System Line Long Term Response
    e. Debris transport characteristics for recirc and steamline breaks

5. BWR Fuel Bundle Information
    a. Critical Fuel Aspects of Limiting Case
        i. Minimum Flow Areas
        ii. Heat Transfer Coefficients
        iii. Counter Current Flow Limits
    b. GNF/GEH (This section will be Proprietary)
        i. Designs in service
        ii. Critical Dimensions
        iii. Selection of Bounding Design
            1. Selection Criteria
            2. Evaluation
            3. Conclusion
6. Evaluation of Full Blockage Bounding Condition – Thermal-Hydraulic analysis of Lower Tie Plate – GNF/GEH Bundle Design
    a. Material deposited
    b. Time to full blockage
    c. Impact on Fuel Cooling
    d. Comparison to existing LOCA/ECCS results
7. Evaluation of Limited Blockage Condition – Thermal-Hydraulic analysis of Lower Tie Plate Holes, Upper Tie Plate and Spacers – GNF/GEH Bundle Design
    a. Material deposited
    b. Time to full blockage
    c. Impact on Fuel Cooling
    d. Comparison to existing LOCA/ECCS results
8. Proposed Confirmatory Fuel Bundle Testing – GNF/GEH
    a. Initial Reflooding Phase Impacts
    b. Core Spray Phase Impacts
    c. Natural Circulation Phase for Covered Core
    d. Bypass Region Flow Path – LTP Backflow Impacts
9. Planned Testing Schedules
    e. GEH Limiting Fuel Bundle Design
    f. AREVA Limiting Fuel Bundle Design (general testing time frame, if required)
    g. Westinghouse Limiting Fuel Bundle Design (general testing time frame, if required)
10. Subsequent Supplements
    h. GNF/GEH Limiting Fuel Bundle Design Test Results
    i. Evaluation of Expansion of Testing
11. Conclusion

Alternate Outline for Analysis Reporting LTR 2

1. AREVA: the following information is to be provided by a third party contractor with support from AREVA to facilitate BWROG and NRC review
    a. Designs in service
    b. Critical Dimensions
    c. Selection of Bounding Design
        1. Selection Criteria
        2. Evaluation
        3. Conclusion
2. Westinghouse: the following information is to be provided by a third party contractor with support from Westinghouse to facilitate BWROG and NRC review
    a. Designs in Service
    b. Critical Dimensions
    c. Selection of Bounding Design
        1. Selection Criteria
        2. Evaluation
        3. Conclusion
3. Evaluation of Bundle Design Differences, provided by a third party contractor with support from AREVA and Westinghouse to facilitate BWROG and NRC review)
4. Evaluation of AREVA and Westinghouse Bounding Conditions with respect to the GNF Bounding Conditions, provided by a third party contractor with support from AREVA and Westinghouse. [This section explains why or why not the AREVA and Westinghouse fuel designs are bounded by the GNF design with respect to blockage. This concludes if additional testing is needed for AREVA or Westinghouse BWR fuel.]
5. Comparisons between Limiting GEH analysis and the other BWR fuel vendors. [This section confirms the applicability of the GEH detailed T-H analysis with the other fuel vendors]
    a. AREVA
    b. Westinghouse
6. Criteria for determining need for AREVA and Westinghouse testing based on GNF/GEH testing
7. Expansion of Testing to AREVA and Westinghouse Fuel Bundles if needed