PMSTPCOL PEmails

From: Norato, Michael
Sent: Thursday, April 01, 2010 3:35 PM
To: STPCOL
Subject: FW: Revised DE/CIB2 input for STP 6.2
Attachments: STP 6_2 Makar Mar29.doc

From: Makar, Gregory
Sent: Monday, March 29, 2010 3:54 PM
To: Kallan, Paul
Cc: Wagage, Hanry; McKirgan, John; Norato, Michael
Subject: Revised DE/CIB2 input for STP 6.2

Paul,

The attached document contains our (CIB2) part of the 6.2 SER input, which is the coatings, chemical effects, and downstream effects on components part of the STD DEP 6.C-1 review. I've also included the conclusion section (6.2.1.5) and the References. I deleted everything else.

Here is what I changed:

1. I revised the text to address the OGC comments. That led to a lot of revision. You can use a document compare to see how this version compares with previous ones. I was going crazy trying to work on the document with all the comments and changes tracked.
2. I added references, which are highlighted in green in the text. They are numbered for temporary using a lower case pending final editing of the document, because the numbers could change.
3. I added a statement in the Conclusions section saying that this departure (STD DEP 6.C-1) conforms to the guidance pending resolution of the open and confirmatory items. There may be a better way to say it, but need to make a conclusion in the conclusions section for each thing we reviewed.

Greg

Hearing Identifier:	SouthTexas34Public_EX
Email Number:	2064

Mail Envelope Properties (ED827D914C9CA74BA644EA1C796CCD74D89587EE)

Subject:	FW: Revised DE/CIB2 input for STP 6.2
Sent Date:	4/1/2010 3:35:08 PM
Received Date:	4/1/2010 3:35:18 PM
From:	Norato, Michael

Created By: Michael.Norato@nrc.gov

Recipients:
"STPCOL" <STP.COL@nrc.gov>
Tracking Status: None

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Files	**Size**	**Date & Time**
MESSAGE	1322	4/1/2010 3:35:18 PM
STP 6_2 Makar Mar29.doc	91642	

Options	
Priority:	Standard
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Protective coatings (i.e., paints) are a potential source of LOCA-generated debris in containment. Such debris could potentially contribute to plugging of ECCS suction strainers, downstream components, and fuel. The amount and size of the debris depends on the type, location, and condition of the coating. The potential for such debris to degrade emergency core cooling has been discussed in NRC documents, including GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss of Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment." As stated in COL FSAR Section 6C.1, the ABWR committed to following the guidance related to ECCS blockage in RG 1.82 and Topical Report NEDO-32686-A ("Utility Resolution Guidance for ECCS Suction Strainer Blockage").

The staff reviewed the applicant's information on protective coatings debris using the guidance in RG 1.82, Rev. 3, Section 2.3.1.4, and the staff's guidance on using NEDO-32686-A ("the URG"). The staff's guidance on the URG was documented in an SER dated September 3, 1998 (Reference 6.2-a). In addition, the staff used coatings evaluation guidance issued in March 2008 for resolution of Generic Letter 2004-02 regarding potential debris blockage of PWR emergency recirculation (Reference 6.2-b). This document supplements the RG 1.82 and URG on several topics, including coating debris particle size. Conforming to this guidance provides one acceptable way to meet the requirements of 10 CFR 50.46 and address the concerns expressed in GL 2004-02 related to coatings debris.

In a response to RAI 06.02.02-1 on how STP Units 3 & 4 would conform to the guidance in RG 1.82, Rev. 3, the applicant stated that STP assumes a coatings debris quantity of 85 pounds based on the URG guidance for inorganic zinc with epoxy topcoat. This quantity, appropriately scaled, was used in the head loss testing for the reference Japanese ABWR.

However, the applicant did not state whether the URG was conservative for STP 3 & 4 or describe a size distribution for the coatings. The need to determine coating debris size for BWRs is listed in Position 2.3.1.4 of RG 1.82 (position 2.3.1.4). For evaluating suction strainers, the URG assumes epoxy coatings are in chip form. In RAI 06.02.02-8, the staff asked the applicant to provide additional information about the determination of the amount of coating debris and the particle size distribution.

In a response dated September 22, 2009, the applicant clarified the basis for assuming 85 pounds coating debris. In addition to being approved by the NRC for BWRs in the staff's SER on the URG, the applicant stated that it is conservative for South Texas 3 & 4 because 85 pounds applies to epoxy/inorganic coating systems while the ABWR will use epoxy only. Since the potential for blockage increases with the amount of debris, the staff determined that 85 pounds is more conservative than the 71-pound value in the URG guidance for epoxy-only, the type of coating systems specified in the ABWR DCD. Therefore, the staff finds this coating debris quantity acceptable because the applicant's analysis conforms to the URG guidance for coatings quantity.

With respect to the particle size, the head loss testing for the ECCS screens assumed 85 pounds of coating debris in chip form, which is acceptable because it is consistent with the assumptions in the URG and the small amount of fiber. For downstream effects, the applicant provided more information in its February 22, 2010, response to RAI 04.04-3 on downstream effects testing for fuel assemblies. In the response, the applicant stated that the 85 pounds coating debris is assumed to be entirely fine particles. This approach assumes that all coating debris will pass through the ECCS strainers and reach the fuel assemblies. Therefore, the particles may be trapped on a fiber bed at the fuel assembly. The staff's March 2008 guidance

(Reference 6.2-b), states that where there is a possibility of forming a thin fiber bed, coatings debris should be treated as fine particles (which can be trapped by the bed and contribute to head loss). Since fiber will be included in the fuel assembly testing for STP 3 & 4, but it is not yet known whether a thin fiber bed will form, the applicant's assumption of coatings debris as fine particulate conforms to the staff's guidance and is conservative for fuel assembly testing.

The supplemental response to RAI 04.04-3 included a proposed revision to FSAR Section 6C.3.1.8.3, which states that the coatings debris for downstream fuel effects testing will be small particles assumed to pass through the ECCS strainers. This testing is required by **License Condition X**. The proposed FSAR revision includes a table that identifies the coating debris quantity for the testing, which the applicant determined from scaling the coating debris quantity for the plant (85 pounds) down to a single fuel assembly and then adding a 10-percent margin. The staff confirmed that the coating debris quantity identified for the testing was calculated according to the applicant's description. The staff finds the particle size distribution acceptable because the applicant's approach of assuming the coating debris distribution to be entirely fine particles is conforms to the staff's guidance in Reference 6.2-b that supplements RG 1.82 and the URG. staff's guidance, as described above. The proposed changes to the FSAR are being tracked as **Confirmatory Item 6.2-Y**.

Therefore, for the reasons described above, the staff finds the applicant's treatment of coatings debris acceptable, including the coatings debris quantity and assumed particle size because it conforms to RG 1.82, Rev. 3 and the URG, as well as the supplemental guidance on coating particle size.

The term "chemical effects" refers to the possibility that interactions of materials in the containment environment will generate chemical precipitate debris that may contribute to blockage and head loss. RG 1.82, Rev. 3, Section 2.3.1.8 states that debris created from the thermal and chemical conditions in the containment pool should be considered in evaluations of long-term recirculation capability. The NRC staff published detailed guidance in March 2008 for PWR licensees to evaluate plant-specific chemical effects (Reference 6.2-c). This includes guidance on using WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191" (Reference 6.2-d). Separately, the staff issued an SER to approve, with limitations and conditions, the use of WCAP-16530-NP to evaluate chemical effects in PWR post-LOCA containment fluids. Conforming to this guidance provides one acceptable way to meet the requirements of 10 CFR 50.46 as they relate to chemical debris effects on the ECCS.

The staff has not issued comparable guidance to BWR licensees (or applicants). For STP 3 & 4, the applicant's principal approach to chemical effects is to exclude the materials most likely to be chemical debris sources. Testing in the GSI-191 program for PWRs identified several insulation materials and other materials as key contributors to chemical effects, including aluminum, calcium silicate insulation, and phosphate pH buffer.

The generation of chemical debris in the water chemistry representative of a BWR post-LOCA environment has not been thoroughly studied. Since chemical debris generation may depend on pH, it is important to consider all sources of acids and bases. Examples include sodium pentaborate, potentially added for reactivity control, cesium hydroxide produced by fission, hydrochloric acid generated by radiolysis of cable insulation, and nitric acid generated by radiolysis of water and air. The applicant also provided the NRC with access to proprietary chemical effects test results performed by Toshiba Corporation for the Japanese reference BWR (Reference 6.2-e). The staff determined that this information did not thoroughly address the potential chemical effects in accordance with RG 1.82 because it did not address all potential environmental conditions. Therefore, the staff issued several related requests to better understand the applicant's evaluation of chemical effects and how the materials in the operating plant are bounded by the testing and analysis (RAIs 06.02.02-9, -11, -12). These RAIs requested the following:

- An explanation of how the chemical effects evaluation was comprehensive with respect to all of the potential combinations of design materials, latent debris, acids and bases, and temperatures.
- Test data and analyses used to support the chemical effects evaluation.
- Demonstration that materials important in debris generation (e.g., aluminum) will not exceed the limits imposed in the licensing basis.

The applicant responded in letters dated September 28, 2009 (ML092730448), December 22, 2009 (ML093580193), January 28, 2010 (ML100330402), and February 22, 2010 (ML100560113). These responses stated there will be no calcium, silicon, or phosphate in the insulation in containment. The response explained that a portion of the coated concrete on the floor of the upper drywell is in the ZOI, but that any dissolution would be inconsequential due to the absence of phosphate and silicon. However, since concrete dissolution can generate elements affecting chemical precipitates (e.g., sodium aluminum silicate), the staff requested that the applicant address the contribution of exposed concrete to chemical debris formation as part of **RAI 06.02.02-X**. Therefore, the significance of calcium and silicon dissolved from exposed concrete within the coatings ZOI is being tracked as part of **Open Item 6.2-X**.

The February 22, 2010 response described calculations performed to support the approach of assuming no chemical precipitation. The response also included a proposed revision to FSAR Section 6C.3. The FSAR revision states that aluminum is prohibited in purchase specifications; therefore, no aluminum is expected in containment. However, the proposed revision includes an assumption that 4.5 square feet of aluminum is present as latent debris (i.e., trash). The applicant determined this surface area based on calculations to evaluate aluminum corrosion and precipitation. These calculations assumed corrosion of the aluminum according to the release rate equations in WCAP-16530-NP. The calculations also compared the total amount of dissolved aluminum to the solubility limit to determine if it would remain dissolved or precipitate as solids at the applicable pH and temperature. This part of the evaluation was based on the solubility data in the report, "Aluminum Solubility in Boron Containing Solutions as a Function of pH and Temperature" (Reference 6.2-e). The Applicant's approach generated a value for the surface area of aluminum that would, when corroded (dissolved), remain below the solubility limit and not precipitate as chemical debris for the 30 days following a LOCA.

The corrosion and solubility calculations were performed for pH values between 5.3 and 8.9, corresponding to the LOCA conditions described in DCD Section 3I.3.2.3. The calculations were based on a final suppression pool temperature of 35°C and a large enough mass of aluminum to ensure it was available to dissolve throughout the 30-day period. The value of 4.5 square feet proposed in the FSAR corresponds to the pH 5.3 condition, which had the lowest solubility limit. The evaluations for higher pH values, and for pH 5.3 with a higher final suppression pool temperature (45°C), produced aluminum surface areas as high as 3000 square feet. Therefore, the proposed FSAR revision states that the implementation of the suppression pool cleanliness and foreign material exclusion programs will ensure that the quantity of latent aluminum will be less than 4.5 square feet.

The staff reviewed the applicant's analysis (Supplemental response #2 to RAI 06.02.02-11) and determined the response is not complete. The aluminum corrosion calculations and solubility data used to analyze chemical effects were based on boron-containing solutions. These analysis tools do not apply directly to boron-free BWR coolant. In addition, the analysis did not include all relevant chemical debris sources. Therefore, the staff requested the following information in **RAI 06.02.02-X**:

- Analysis of aluminum chemical effects using corrosion and solubility data applicable to the post-LOCA ECCS fluid at STP 3&4.
- If the pH is expected to vary with time during the postulated 30-day post-LOCA period, provide an analysis of the chemical effects based on the predicted transient or explain how your approach is bounding. (For example, addition of sodium pentaborate from the standby liquid control system would increase pH over some time period.)
- Discuss your plans to address chemical effects not considered in the initial analysis, such as:
    - Constituents dissolved from concrete in the coatings zone of influence (ZOI), since the NRC coatings guidance assumes removal of the coating within the ZOI. Concrete dissolution generates elements that can form chemical precipitates, including precipitates containing aluminum (e.g., sodium aluminum silicate).
    - Zinc, which corroded at a low rate in testing related to PWRs but would be expected to corrode at higher rates in neutral and acidic solutions. This may result in levels of zinc particulate, zinc corrosion products, and zinc in solution that could contribute to other chemical precipitates.
    - Corrosion products (iron oxide) resulting from iron or steel corrosion prior to or following a LOCA
    - Any other material present in containment that would be exposed to the post-LOCA fluid and has not been addressed by an integrated chemical effects analysis for the ABWR environment.
- If your analysis predicts the formation of chemical debris, discuss your plans for addressing the impact of this debris on the ECCS strainers and fuel assemblies (e.g., integrated strainer testing or a simplified approach that relies on significant clean screen area).

Since the staff has not completed its review of the applicant's calculations and proposed FSAR revisions this item is being tracked as part of **Open Item 6.2-X**. The staff will determine if the applicant's evaluation is acceptable based on conformance to RG 1.82, Section 2.3.1.8, on chemical debris formation from the chemical and thermal environment in the containment pool.

<u>Downstream effects on components</u>

Evaluation of ECCS components downstream of the suction strainers is meant to addresses blockage of flow paths, wear, and abrasion (e.g., valves, pumps components and heat exchanger tubes), and blockage of fuel assembly flow channels. RG 1.82, Rev. 3, Section 2.1.2.2 addresses the need to prevent clogging of flow restrictions and damage from fine particles downstream of passive strainers. In an SER dated December 2007, the staff accepted, with certain limitations and conditions, the methodology and acceptance criteria described in WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191." In an April 29, 2009, response to RAI 06.02.02-1, the applicant stated it would evaluate downstream components for STP 3 & 4 in accordance with WCAP-16406-P, “Evaluation of Downstream Sump Debris Effects in Support of GSI-191,” and that this evaluation would be performed during the detail design phase of the plant. The staff reviewed the applicant’s proposal to assess the applicability of WCAP-16406-P to STP 3 & 4 and conformance to the staff’s accompanying SER. Conforming to this guidance provides one acceptable way to meet the requirements of 10 CFR 50.46 as it relates to downstream effects on components.

Since WCAP-16406-P was developed for PWRs, the staff, in RAI 06.02.02-10, asked the applicant to justify applying it to a BWR. In a September 28, 2009, response, the applicant stated that the WCAP-16406-P methodology was applicable to STP 3 & 4 based on the similar materials and clearances for BWR and PWR downstream components. In a December 21, 2009, response to RAI 06.02.02-13, the applicant stated that the analysis will be performed using the acceptance criteria in the WCAP and the accompanying NRC staff safety evaluation. (Reference 6.2-f). The response included a corresponding revision to FSAR Section 6.C.3.2. The staff’s review focused on the applicability of WCAP-16406-P to the analysis of downstream effects.

The staff compared WCAP-16406-P to ABWR design information to confirm that the WCAP addresses the types of components and materials used in the ABWR ECCS systems. The ABWR DCD states that ECCS pumps are centrifugal pumps and valves are conventional gate, globe, and check valves for nuclear service. Section 5.4 of the ABWR DCD states that RHR pumps are centrifugal pumps, and that the valves are conventional gate, globe, and check valves for nuclear service. RHR heat exchangers are the shell and tube type. DCD Table 6.1-1 indicates the valve and heat exchanger materials are conventional carbon and stainless steels, same as or similar to the materials listed in the WCAP. Since these component types are addressed by WCAP-16406-P, the staff determined that it is appropriate for the applicant to use that methodology for its analysis of downstream components. The basis for the staff’s acceptance of WCAP-16406-P is discussed in more detail below for each of these component types.

Centrifugal pumps for emergency core cooling systems are covered in WCAP-16406-P and the staff’s corresponding safety evaluation. The analysis considers how wear of internal pump components affects hydraulic performance (head and flow), mechanical performance (vibration), and pressure boundary performance (shaft seal integrity). In its SER on the WCAP, the NRC staff found the pump evaluation methodology acceptable based on its use of conservative assumptions, use of standard engineering evaluation, and consistency conformance with the staff’s SER on NEI 04-07. The staff’s SER on WCAP-16406-P also identified limitations and conditions related to ECCS pumps, such as confirmation that the assumed mission time of 720 hours in the WCAP bounds the plant’s mission time.

As stated above, valves in the ABWR ECCS are conventional gate, globe, and check valves for nuclear service. WCAP-16406-P includes a wear evaluation for all valves and a description of the significance of wear on each valve type and size. The evaluation includes calculation of the flow area increase due to of wear. For valves considered to be critically sensitive to wear, the WCAP requires that licensees contact the manufacturer for a flow effect assessment if the evaluation indicates that wear causes a flow area increase of more than three percent. The NRC determined, in its Safety Evaluation Report on the WCAP, that the steps in the evaluation are acceptable because they are based on standard engineering practices. The SER also found the value of three percent flow area acceptable because it is within valve manufacturing and fluid-flow calculation tolerances.

All valves over 1.5 inches, and nearly all valves smaller than that, are evaluated for plugging. Some valves are in the closed position during the event and therefore require no plugging evaluation. The evaluation guidance is according to valve type and size, with vendor input required to determine the flow area for certain valves. The staff found this acceptable in the Safety Evaluation for WCAP-16406-P because it conforms to the staff's SER of for NEI 04-07. To summarize for valves, since WCAP-16406-P requires plugging and wear evaluations for all valves, except those in the closed position during the event, the WCAP-16406-P analysis is applicable to STP Units 3 & 4.

For shell and tube heat exchangers, the WCAP addresses both wear and blockage. It addresses wear through standard industry methods for evaluating the consequences of tube wall thinning. For tube plugging, the WCAP states that a plant-specific evaluation is needed if the tube inside diameter is less than the size of the largest expected debris particle. The staff found this approach acceptable in its SE for the WCAP because the wear evaluation conforms to standard industry practice and particles smaller than the tubes should not cause blockage. The WCAP states that debris settling in heat exchangers is not a concern based on the expected velocity exceeding the settling velocity; however, the staff's SER stated that licensees should confirm this and evaluate heat exchanger plugging if the velocity is less than the settling velocity.

For the reasons discussed above, the staff determined that WCAP-16406-P is applicable to the evaluation of downstream components for STP 3 & 4. Therefore, the applicant conforms to RG 1.82, Rev. 3, Section 2.1.2.2 related to downstream components by meeting the acceptance criteria in the WCAP. In addition to proposing a revision to FSAR Section 6C.3.2, the applicant's response to RAI 06.02.02-11 also added a new commitment, COM 6.C-1, to submit the analysis to the NRC at least 18 months prior to fuel load. The proposed commitment states the following:

> Downstream effects analysis for components (pumps, valves, and heat exchangers) will be performed in accordance with WCAP-16406-P and the accompanying SER, and the evaluation submitted to the NRC.

The commitment to provide the evaluation 18 months prior to fuel load is acceptable because the evaluation will be available for the staff's verification prior to fuel load. The proposed revisions to FSAR Section 6C.3.2 are acceptable because the description of the evaluation of downstream components is consistent with WCAP-16406-P and the staff's accompanying SER, and because it identifies the commitment and timing for completing the evaluation.

As stated in the commitment, the applicant will perform the WCAP-16406-P analysis in accordance with the staff's accompanying SER. Therefore, in accordance with COM 6.C-1, the applicant will need to review the staff's evaluation of the WCAP and determine if limitations and conditions apply. The proposed revisions, including FSAR Section 6C.3.2 and COM 6.C-1 are being tracked as **Confirmatory Item 6.2-x**.

~~6.2.1.5~~6.2.1.3 *Post Combined License Activities*

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There are no post COL activities related to this section.

~~6.2.1.6~~6.2.1.4 Conclusion

The NRC staff's finding related to information incorporated by reference is in NUREG–1503. The staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant has addressed the required information relating to the containment functional design. With the exception of the above open items, no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to Part 52 Appendix A Section VI.B.1, all nuclear safety issues relating to the containment functional design that were incorporated by reference have been resolved.

The staff's review found that the applicant is in compliance with the relevant NRC regulations, including the acceptance criteria outlined in NUREG–0800, Section 6.2.1 and in other NRC regulatory guides. The applicant has adequately addressed COL License Information Items 6.4 and 6.5.

The staff concurred with the applicant's Tier 2 departures not requiring prior NRC approval per 10 CFR 52 Appendix A, Section VIII.B.5.

Pending resolution of Open Items 6.2-X and 6.2-X, and Confirmatory Items 6.2-X and 6.2-Y, the staff concluded that STP DEP 6.C-1 conforms to the guidance in RG 1.82, Rev. 3 and Topical Report NEDO-32686-A, "Utility Resolution Guidance for ECCS Suction Strainer Blockage."

However, as a result of the above open items, the staff was unable to finalize the conclusions relating to containment functional design, in accordance with the NRC requirements.

~~6.2.1.7~~6.2.1.5 References

6.2-1 W. J. Bilanin, "The General Electric Mark III Pressure Suppression Containment System Analytical Model," Licensing Topical Report, NEDO-20533, June 1974.

6.2-2 Westinghouse Electric Company, LLC, "Implementation of ABWR DCD Methodology Using GOTHIC for STP 3 and 4 Containment Design Analyses." WCAP-17058, June 2009.

6.2-3 General Electric Energy Nuclear, "ABWR Containment Analysis," Licensing Topical Report, NEDO-33372, September 2007.

6.2-a Safety Evaluation by The Office of Nuclear Reactor Regulation Related to NRC Bulletin 96-03, Boiling Water Reactor Owners Group Topical Report NEDO-32686, "Utility Resolution Guidance for ECCS Suction Strainer Blockage," August 20, 1998, NUDOCS Accession No.. 9809100159.

6.2-b NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Coatings Evaluation, Enclosure 2 to "Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02," March 28, 2008, ADAMS Accession No. ML080230462.

6.2-c NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Chemical Effects Evaluations, Enclosure 2 to "Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02," March 28, 2008, ADAMS Accession No. ML080380214.

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Comment [jab1]: This is an open item above – how can you come to a conclusion on this?

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6.2-d WCAP-16530-NP, “Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191,” February 28, 2006, ADAMS Accession No. ML060890501.

6.2-e C. B. Bahn, K.E. Kasza, W. J. Shack, and K. Natesean, Aluminum Solubility in Boron Containing Solutions as a Function of pH and Temperature, Argonne National Laboratory Contract Report to the NRC, September 19, 2008, ADAMS Accession No. ML091610696.

6.2-f Safety Evaluation by the Office of Nuclear Reactor Regulation Topical Report (TR) WCAP-16406-P, Revision 1, “Evaluation of Downstream Sump Debris Effects in Support of GSI-191,” December 27, 2007, ADAMS Accession No. ML073520295

6.2-4 “Validation Suppression Pool Modeling for Westinghouse ABWR,” NAI-1397-002.

6.2-5 Toshiba Corporation, “ABWR Pool Swell Calculation Methodology Using GOTHIC,” UTLR-0005, September 2009.