PMSTPCOL PEmails

From: Norato, Michael
Sent: Thursday, April 01, 2010 3:33 PM
To: STPCOL
Subject: FW: For concurrence: revised SER input for STP 6.2
Attachments: STP 6 C supp CIB2.doc

From: Makar, Gregory
Sent: Monday, March 22, 2010 8:57 AM
To: Norato, Michael
Subject: For concurrence: revised SER input for STP 6.2

Mike,

Here's my revision to the SER input. This is not concurrence on the final document, but concurrence to move it forward into our discussions with John' s branch and then projects and OGC. We can discuss as needed.

Thank you,
Greg

Hearing Identifier: SouthTexas34Public_EX
Email Number: 2068

Mail Envelope Properties (ED827D914C9CA74BA644EA1C796CCD74D89587E5)

Subject: FW: For concurrence: revised SER input for STP 6.2
Sent Date: 4/1/2010 3:32:59 PM
Received Date: 4/1/2010 3:33:01 PM
From: Norato, Michael

Created By: Michael.Norato@nrc.gov

Recipients:
"STPCOL" <STP.COL@nrc.gov>
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Coatings

A postulated LOCA can generate debris from protective coatings (i.e., paints) 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 various NRC documents, such as 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 according to 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 (NUDOCS 9809100159). ~~For BWRs, the BWROG developed guidance in Topical Report NEDO-32686, “Utility Resolution Guidance for ECCS Suction Strainer Blockage.” This guidance is often called “the URG.” In 1998, the NRC staff issued a safety evaluation on this report.~~ 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 X). Conforming to this guidance meets the requirements of 10 CFR 50.46 and GDC 35 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, t~~T~~he applicant stated that STP~~STP evaluation~~ assumes~~is assuming~~ a coatings debris quantity of 85 pounds based on the URG guidance for inorganic zinc with epoxy topcoat. This quantity ~~used~~ was ~~applied to~~represented in the head loss testing for the Reference Japanese ABWR ~~and is more conservative than the 71-pound value in the URG guidance for epoxy-only, the type of coating systems as specified in the ABWR DCD (epoxy only)~~.

~~The applicant stated in response to RAI 06.02.02-1 that there was no reason to consider 85 pounds unconservative.~~ However, the applicant did not ~~provide the basis for this statement or state whether the URG guidance was conservative for STP 3 & 4 or~~ describe a size distribution for the coatings. ~~Although not addressed in the URG guidance, the size of the coating debris is an important variable in GSI-191 evaluations for operating PWRs~~ ~~and the d~~Determination of coating debris size is lis~~t~~ted in RG 1.82 (position 2.3.1.4 for BWRs) as an important feature, and detailed guidance used for GSI-191 evaluations for operating PWRs is provided in Reference X. Therefore, i~~I~~n RAI 06.02.02-8, the staff asked the applicant to provide~~for~~ additional information about the determination of the amount of coating debris, the zone of influence (ZOI) for coatings, 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. ~~As stated above, the URG guidance for epoxy only is 71 pounds of debris.~~ In addition, the applicant stated that the URG calculation was based on a LOCA-jet zone of influence of 10 pipe diameters (10D), while the staff’s current guidance (March 2008) is 4D for epoxy coatings. ~~Further, the amount of surface area calculated based on 10D ZOI was doubled before calculating the weight of the coating corresponding to that surface area (i.e., 85 pounds for~~

epoxy/IOZ). The diameter of the pipe break assumed in the URG guidance (24 inch diameter) is less than that used to determine the insulation ZOI for STP (28 inch diameter). However, the staff finds it acceptable to use 85 pounds of debris coating because the larger pipe diameter has a small effect compared to using the large ZOI (10D vs. 4D), and because 85 pounds is higher than the URG guidance for epoxy coatings (71 pounds). Since the potential for blockage increases with the amount of debris, the staff agreed 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. The staff also agreed that using a coatings debris quantity based on a 10D ZOI is more conservative than the staff's current guidance of 4D because a larger ZOI would generate more coatings debris. Therefore, the staff finds this ZOI approach and quantitymass of coatings debris acceptable because the applicant analysis conforms to the staff-guidance.

As forWith respect to the particle size distribution, the applicant provided more information in atheir February 22, 2010, response to RAI 04.04-3 on downstream effects testing for fuel assemblies. In the response, the applicant stated the coating debris is assumed to be entirely fine particles. This approach assumes that all coating debris will pass through the Emergency Core Cooling System strainers and reach the fuel assembly. Therefore, the particles may be trapped on a fiber bed at the fuel assembly, which is a conservative approach. As stated in the staff's March 2008 guidance (Reference X) (reference), when there is a possibility of forming a filtering fiber bed downstream it is conservative to assume coatings debris is in the form of fine particles (which can be trapped by the bed and contribute to head loss). In athe supplemental response to RAI 04.04-3, the applicant also stated that the 85 pounds of protective coating debris used in the downstream fuel effects testing will be a fine particulate.

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 will be performed in accordance with **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 conservative and conforms to the staff's guidance, as described above. The proposed changes to the FSAR are being tracked as **Confirmatory Item 6.X-Y**.

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Therefore, for the reasons described above, the staff finds the applicant's treatment of coatings debris acceptable, including the coatings debris quantity, ZOI, and assumed particle size.

Chemical effects

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 (ML080230234). This includes guidance on using WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191" (Reference Y, ML060890501). 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 meets the requirements of 10 CFR 50.46 and GDC 35 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, tThe 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 water chemistry in post-LOCA BWR containments is considered less likely than those of PWRs to generate chemical debris, The generation of chemical debris in the water chemistry representative of a BWR post-LOCA environment but this has not been thoroughly studied. Since chemical debris generation may be sensitive todepend 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 Z). The staff determined that this information did not thoroughly address the potential chemical effects. 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. The staff finds it acceptable to exclude these materials from further consideration since they are not present in sufficient quantities to contribute to chemical debris generation. The staff has not completed its review of the applicant's chemical effects evaluation. 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**.

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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. Nonetheless, 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" (Argonne National Laboratory report to the NRC, September 19, 2008, ML091610696). This 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 has not completed its review of the applicant's calculations and proposed FSAR revisions. Therefore, 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 the staff's guidance for evaluating chemical effects, ~~inapplying~~ including application of WCAP-16530-NP to the aluminum corrosion computation and based on the appropriate use of aluminum solubility data to determine if precipitation occurs.

Downstream effects on components

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. Although not listed in RG 1.82, Rev. 3, a downstream effects evaluation for the ECCS and is necessary to address the concerns discussed in GL 2004-02 on GSI-191. 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~~September 21~~, 2009, response to RAI 06.02.02-1, the applicant stated it~~they~~ 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 meets the requirements of 10 CFR 50.46, GDC 35, and GDC 38 as they relate to downstream effects on components.

In a September 28, 2009, response to RAI 06.02.02-10, the applicant justified the use of the WCAP-16406-P methodology and acceptance criteria ~~and that this was~~ 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. ~~(ML073520767, December 2007).~~ 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 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 h~~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 extensively 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 Safety Evaluation Report 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. ~~In~~ WCAP-16406-P~~the WCAP~~ includes a wear evaluation for ~~,~~all valves ~~are evaluated for wear (gate, globe, check, butterfly, diaphragm). The WCAP describes~~ 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. ~~The wear evaluation also references the guidance of NRC Information Notice 97-76 on cavitation-induced erosion, which conforms to the staff's SER of NEI 04-07.~~

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 requirement is compliant with IN 96-27.~~ 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 ~~nearly~~ all valves, except those ~~are evaluated for wear and plugging,~~ 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 can meet the requirements related to downstream components by meeting the acceptance criteria in the WCAP. In addition to proposing a revision to FSAR Section 6C.3.2, t~~T~~he 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 conform with the NRC guidance, and the timing support~~allow~~s completion of design details, the applicant's evaluation, and the staff's confirmatory review prior to fuel load. ~~to be completed while still permitting the staff's verification.~~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, 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.X-Z**.

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