Nuclear Operating Company
South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

September 28, 2009
U7-C-STP-NRC-090141

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Response to Requests for Additional Information

Attached are responses to NRC staff questions included in Request for Additional Information (RAI) letter numbers 260, 261, and 262 related to Combined License Application (COLA) Part 2, Tier 2, Appendix 6C. This letter completes the response to letter number 260.

Attachments 1 through 9 address the responses to the RAI questions listed below.

RAI 06.02.02-2	RAI 06.02.02-7
RAI 06.02.02-3	RAI 06.02.02-8
RAI 06.02.02-4	RAI 06.02.02-9
RAI 06.02.02-5	RAI 06.02.02-10
RAI 06.02.02-6	

There are no commitments in this letter.

If you have any questions regarding these responses, please contact me at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

D091
NRO

STI 32533223

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 9/28/09

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

jet

Attachments:

1. Question 06.02.02-2
2. Question 06.02.02-3
3. Question 06.02.02-4
4. Question 06.02.02-5
5. Question 06.02.02-6
6. Question 06.02.02-7
7. Question 06.02.02-8
8. Question 06.02.02-9
9. Question 06.02.02-10

cc: w/o attachment except*
(paper copy)

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RAI 06.02.02-2:

QUESTION:

Section 6C.1 of the STP FSAR Rev 2 states that the ABWR Design has committed to following the guidance provided in Regulatory Guide 1.82 Rev. 3 and the Utility Resolution Guide NEDO-32686. In the STP FSAR Section 6C.3, the applicant stated: "If required, downstream effects of material predicted to pass through the suction strainers will be evaluated in accordance with RG 1.82".

In RAI Question 06.02.02-1, the staff requested that STP describe how they will address the additional issues identified in RG 1.82 Rev 3 (including downstream effects). In STP response letter U7-C-STP-NRC-090038 (ML091270491), STP stated that an evaluation of downstream effects on fuel will be included in a future license amendment for fuel. During the June 30 – July 1 2009 audit of the STP suction strainers, STP stated that they planned to revise this approach. Please provide the following or describe how you plan to address the following items related to downstream fuel effects in the STP FSAR:

1) Provide an evaluation of the effects of debris that passes through the ECCS pumps suction strainer during long term cooling. Quantify the effects of downstream debris flow. Show what analyses have been completed or will be completed for debris in the core, and within valves or other restricting components, including fuel bundle debris filters. The debris may include chemical products, latent debris, or insulation that has passed through the suppression pool debris strainers. In this analysis, report the thermal conductivity and thickness of potential chemical products and debris on fuel rods and the increase in fuel rod temperature due to deposition and blockage in the core.

2) Report the change in the core flow with bounding blockages of valves and other components.

(a) Submit the flow blockage calculation results for the reactor fuel used in STP showing the critical power as a function of percent strainer blockage. Identify the percent blockage the fuel elements will experience at full power and what the effect on MCPR/PCT would be. Provide a figure showing CPR vs. fuel channel orifice flow area.

(b) Provide a list of assumptions made in the calculation of MCPR/PCT vs. % flow blockage.

RESPONSE:

STPNOC has not taken any departure from the design of the fuel as specified in the ABWR Design Control Document (DCD). STPNOC has taken a departure (STD DEP 6C-1) with respect to the Emergency Core Cooling System (ECCS) suction strainers in the wetwell of the containment suppression pool. This change will reduce the amount of debris entering the ECCS, largely because of the greatly increased strainer surface area for filtering debris and state-of-the-art strainer design. Therefore, the departure will have the effect of improving the performance of the fuel as specified in the DCD.

STPNOC anticipates that it will request that a license amendment be issued after issuance of the COL to use a more current fuel design. Given the finality of the fuel design as specified in the ABWR DCD, and given the expected post-COL change in the fuel design, there is no value in performing the types of analyses requested in the RAI at this time. The analyses will be performed by STPNOC and reviewed by the NRC as part of the license amendment request.

Nevertheless, to address this RAI, STPNOC will agree to a COL license condition, stating that at least 18 months prior to fuel load, an evaluation will be submitted to the NRC as part of a license amendment request confirming that the fuel for the initial fuel load satisfies the acceptance criteria related to the downstream effects of containment debris on the reactor fuel. That evaluation will address the information items requested in this RAI, as well as reflect the results of testing based on the STP 3&4 as-designed containment configuration, suction strainer size, ECCS flow rates and fuel design. The STP 3&4 design strainer bypass testing will be performed and used to confirm that downstream effects will not impair the functioning of critical components in the ECCS flow loop, such as pumps, valves and instrument lines as well as ensure that adequate flow exists to cool the core. Acceptance criteria for this testing will include: (1) adequate flow rate through the core region to cool the core for the required mission time, (2) proper functioning of pump and no evidence of significant wear on pump internals (seals, impeller blades, etc) based on post-test inspection, (3) proper functioning of valves and no evidence of significant wear on critical valve internals based on a post-test inspection, (4) no major blockages in the core region, including the fuel filter, lower core support plate, and core flow channels, (5) no major blockages in other regions of the recirculation flow loop, including instrument lines, heat exchanger tubes, valves, etc., and (6) no buildup of debris layer on fuel surfaces which would prevent adequate heat transfer to cool the core.

It is important to note that, even without the information requested by the RAI, the ABWR design as applied to the STP 3&4 plants provides reasonable assurance that downstream effects as a result of debris bypassing the ECCS suction strainers will not have a deleterious effect on critical components, such as fuel rods, valves and pumps downstream of the suction strainers. The basis for this assurance is discussed in the following paragraphs.

Latent Debris Generation

Relative to the generation of latent debris, the ABWR contains a number of design features and controls which reduce the likelihood of such debris being generated as compared with operating BWR and PWR plants. Access to the containment during power operation is prohibited as the containment is inerted, thereby eliminating the likelihood of latent debris generation due to work being performed during power operation. In addition, in the unlikely event that latent debris exists in the suppression pool during power operation, the suppression pool cleanup (SPCU) system provides on-going cleanup. This system is run during power operation and provides an early indication of any deterioration of the suppression pool water quality. The suction pressure of the SPCU pump is monitored and provides an alarm on low pressure. During refueling outages, when latent debris could be generated by workers inside the containment, temporary filters are used during post-construction systems testing in accordance with plant housekeeping and foreign material exclusion procedures, further reducing the potential for introducing debris to the suppression pool. STP 3&4 will also implement an operational program for suppression pool cleanliness, to be documented in accordance with Section 13.4S of the FSAR, which will provide for periodic inspections of the suppression pool for cleanliness during outage periods. This operational program is described in Subsection 6.2.1.7.1. Maintenance procedures will provide procedure steps for removing, at periodic intervals, sediment and floating or sunk debris from the suppression pool that the suppression pool cleanup system does not remove. (Refer to RAI Response to 06.02.02-5 for a description of the suppression pool cleanliness operational program.) Quarterly surveillance tests of Residual Heat Removal (RHR), High Pressure Core Flooder (HPCF) and Reactor Core Isolation (RCIC) systems will provide further assurance that there is no blockage due to debris in the pump suction. Finally, the use of a stainless steel liner in the ABWR as opposed to carbon steel, which has been used in earlier version BWR suppression pools, significantly lowers the amount of corrosion products which can accumulate at the bottom of the suppression pool.

LOCA-Generated Debris

Relative to the generation of debris from a postulated pipe break, the ABWR design contains a number of improvements from earlier BWR designs. The elimination of the recirculation piping removed a significant source of insulation debris from the containment and also reduced the likelihood of a large high energy pipe break which could lead to debris generation. For the STP 3&4 design, there will be no fibrous insulation or calcium silicate on piping systems, including small bore piping, inside the containment. All thermal insulation material will be a Reflective Metallic Insulation (RMI) design. RMI breaks up into shards nearly all of which are large enough such that they will not pass through the ECCS suction strainers which have a 2.1 mm hole size.

Chemical Effects Debris

An assessment of the impact of chemical effects has been performed. (See response to RAI 06.02.02-9). This assessment was based on the guidelines in Regulatory Guide 1.82 and reflects the fact that the STP 3&4 containments will contain no fibrous insulation. In addition, reactive materials such as aluminum, phosphates and calcium silicate will not be used in the STP 3&4 containments. The STP 3&4 containment cleanliness and FME program (see responses to RAIs 06.02.02-4 and -5) will ensure that quantities of latent debris, which might include aluminum or fiber, are kept to a minimum. Because there is a chance that small quantities of these materials might be introduced inside the primary containment during the life of STP 3&4, these materials were evaluated for potential chemical effects.

There are two potential water chemistries for the ABWR: (1) normal operation water chemistry in the suppression pool which is pure water with a neutral pH, and (2) post-LOCA manual actuation of the Standby Liquid Control (SLC) system, which injects sodium pentaborate into the reactor vessel that eventually reaches the suppression pool. The effect of the sodium pentaborate is to slightly elevate the pH in the suppression pool above neutral. Toshiba conducted bench-top testing of several materials, including the materials that might be introduced in small quantities as latent, loose debris in both the normal and SLC water chemistries. Results of those tests concluded that no reactions would occur in the normal water chemistry, and there is only slight evidence of corrosion or chemical reaction in the SLC water chemistry for some materials, e.g., aluminum (which is prohibited from primary containment). The documentation and submittal of these test results to the NRC is discussed in the response to RAI 06.02.02-9.

Debris Transport

The ABWR contains design features which minimize the transport of accident-generated debris to the suction strainers. The wetwell, which is the chamber in direct contact with the suppression pool, is largely empty with the only significant components/structures being an access tunnel, a grated catwalk and the SRV discharge piping. There are no normal operating high energy piping systems in the wetwell which could break and lead to debris generation. The high energy piping in the ABWR, which consists largely of the main steam, Reactor Water Cleanup (RWCU) system and feedwater piping under normal operating conditions, is located in the upper drywell area. Any debris which is generated by a break in these systems would need to pass through a circuitous route involving any one of the ten drywell connecting vents (DCVs) and then through any one of the thirty horizontal vents before reaching the suppression pool. The DCVs have horizontal steel plates located above the openings that will prevent any material falling in the drywell from directly entering the vertical leg of the DCVs. Vertically oriented trash rack construction will be installed around the periphery of the horizontal steel plate to intercept debris. In order for debris to enter the DCV it would have to travel horizontally through the trash rack prior to falling into the vertical leg of the connecting vents. Thus the ABWR is resistant to the transport of debris from the drywell to the wetwell.

Suction Strainer Design

In addition to these mitigating features, the downstream effects are minimized by the suction strainers, themselves. The strainers are designed to protect the ECCS pumps to allow them to function long-term after an accident. As a result, they are designed so that 100% of the ECCS flow is routed through them and filtered such that particles of 2.1 mm or larger will be captured by the strainer. STP 3&4 has committed to implement Rev 3 of Regulatory Guide 1.82. Section 2.1.2.1 of that Regulatory Guide states that:

> "The possibility of debris clogging flow restrictions downstream of the strainers should be assessed to ensure adequate long-term ECCS performance. The size of openings in the suppression pool suction strainers should be based on the minimum restrictions found in systems served by the suppression pool...... Consideration should be given to the buildup of debris at the following downstream locations: spray nozzle openings, throttle valves, coolant channel openings in the core fuel assemblies, fuel assembly inlet debris screens, ECCS pump seals, bearings, and impeller running clearances."

STP 3&4 will be implementing this Regulatory Guide using a state-of-the-art CCI cassette type strainer with a maximum hole size in this strainer of 1/12 inch (2.1mm).

Diversity of ECCS Delivery Locations to the Core

The ABWR has diversification of ECCS delivery points which helps to minimize the consequences of downstream blockage. Should any blockages occur in the lower core region, such as the fuel filter, which could limit the effectiveness of systems like RHR, the HPCF will still be effective at providing cooling water as it delivers water through spargers located above the core. Should all of the ECCS suction strainers become plugged, the alternate AC (Alternating Current) independent water addition mode of RHR allows water from the Fire Protection System to be pumped to the vessel to maintain cooling of the fuel.

Related Test and Analysis

Regarding acceptance criteria for blockage of small clearances, it is noted that there will be no fiber downstream of the STP 3&4 suction strainers because the only fiber potentially inside primary containment (latent loose debris) will not be degraded during the pipe break and will not be small enough to pass through the 1/12-inch diameter holes in the CCI cassette-type suction strainers. Preliminary data from testing conducted by Westinghouse (WEC) to resolve GSI-191 has not identified any coagulation of particulate debris until after fiber is introduced to the flow stream. Therefore, blockage of small clearances in downstream components is not likely for the STP 3&4 downstream components. The analysis of the effects of debris on downstream components such as pumps, valves and heat exchangers in PWR's was documented in WCAP-16406, which was approved by the NRC. It is expected that the analysis results which showed acceptable performance of these components will apply to BWR's due to similarity in materials and clearances to the PWR components.

As noted in the third paragraph of this response, STP 3&4 design strainer bypass testing will be performed to confirm that downstream effects will not impair the functioning of critical components in the ECCS flow loop, such as pumps, valves and instrument lines as well as ensure that adequate flow exists to cool the core.

Response Summary

In summary, STPNOC is agreeing to a license condition to provide the information sought by the RAI as part of a license amendment request for the initial fuel load. This will include the flow blockage calculation results as well as the list of assumptions as requested in Items 2(a) and 2(b) of this RAI.

In addition, there is reasonable assurance that the downstream effects of material passing through the suction strainers will not adversely affect the fuel. This conclusion is based upon the low potential for generating debris in the ABWR, the tortuous path for any debris to enter the wetwell from the drywell, the cleanup provisions for the water in the wetwell, the low potential for formation of chemical debris, the small size of the holes in the suction strainers that will filter out most debris, quarterly/periodic surveillance of HPCF, RHR, and RCIC systems which will provide further assurance of the absence of debris which could affect their readiness for water injection capability, diversity of injection points for ECCS into the core, and preliminary data from PWR test results which show little impact on head loss in the fuel region from particulate only debris.

The following subsection will be added to COLA Appendix 6C.

6C. 3.1 Downstream and Chemical Effects Discussion

The ABWR design provides reasonable assurance that downstream effects as a result of debris bypassing the strainers will not have a deleterious effect on critical components such as fuel rods, valves and pumps downstream of the suction strainers. The basis of this assurance is provided in the following:

6C.3.1.1 Latent Debris Generation

Relative to the generation of latent debris, the ABWR contains a number of design features and controls which reduce the likelihood of such debris being generated as compared with operating BWR and PWR plants. Access to the containment during power operation is prohibited as the containment is inerted, thereby eliminating the likelihood of latent debris generation due to work being performed during power operation. In addition, in the unlikely event that latent debris exists in the suppression pool during power operation, the suppression pool cleanup (SPCU) system provides on-going cleanup. This system is run on an intermittent basis during power operation and provides an early indication of any deterioration of the suppression pool water quality. The suction pressure of the SPCU pump is monitored and provides an alarm on low pressure. During refueling outages, when latent debris could be generated by workers inside the containment, temporary filters are used during post-construction systems testing in accordance with plant housekeeping and foreign material exclusion procedures, further reducing the potential for introducing debris to the suppression pool. STP 3&4 is also implementing an operational program for suppression pool cleanliness, to be documented in accordance with Section 13.4S of the FSAR, which provides for periodic inspections of the suppression pool for cleanliness during outage periods. This operational program is described in Subsection 6.2.1.7.1. Maintenance procedures provide procedure steps for removing, at periodic intervals, sediment and floating or sunk debris from the suppression pool that is not removed by the suppression pool cleanup system. Quarterly surveillance tests of Residual Heat Removal (RHR), High Pressure Core Flooder (HPCF), and Reactor Core Isolation Cooling (RCIC) systems provide further assurance that there is no blockage due to debris in the pump suction. Finally, the use of a stainless steel liner in the ABWR as opposed to carbon steel, which has been used in earlier version BWR suppression pools, significantly lowers the amount of corrosion products which can accumulate at the bottom of the suppression pool.

6C.3.1.2 LOCA-Generated Debris

Relative to the generation of debris from a postulated pipe break, the ABWR design contains a number of improvements from earlier BWR designs. The elimination of the recirculation piping removed a significant source of insulation debris from the containment and also reduced the likelihood of a large high energy pipe break which could lead to debris generation. For the STP 3&4 design, there is no fibrous insulation or calcium silicate on piping systems, including small bore piping, inside the containment. All thermal insulation material is a Reflective Metallic

Insulation (RMI) design. RMI breaks up into shards which are large enough such that they will not pass through the ECCS suction strainers which have a 2.1 mm hole size.

6C.3.1.3 Chemical Effects Debris

An assessment of the impact of chemical effects has been performed. This assessment was based on the guidelines in Regulatory Guide 1.82 and reflects the fact that the STP 3&4 containments contain no fibrous insulation. In addition, reactive materials such as aluminum, phosphates and calcium silicate are not used in the STP 3&4 containments. The STP 3&4 containment cleanliness and FME program in Subsection 6.2.1.7.1 ensure that quantities of latent debris, which might include aluminum or fiber, are kept to a minimum. Because there is a chance that small quantities of these materials might be introduced inside the primary containment during the life of STP 3&4, these materials were evaluated for potential chemical effects.

There are two potential water chemistries for the ABWR: (1) normal operation water chemistry in the suppression pool which is pure water with a neutral pH, and (2) post-LOCA manual actuation of the Standby Liquid Control (SLC) system, which injects sodium pentaborate into the reactor vessel that eventually reaches the suppression pool. The effect of the sodium pentaborate is to slightly elevate the pH in the suppression pool above neutral. Toshiba conducted bench-top testing of several materials, including the materials that might be introduced in small quantities as latent, loose debris in both the normal and SLC water chemistries. Results of those tests concluded that no reactions would occur in the normal water chemistry, and there is only slight evidence of corrosion or chemical reaction in the SLC water chemistry for some materials, e.g., aluminum (which is prohibited from primary containment).

6C.3.1.4 Debris Transport

The ABWR contains design features which minimize the transport of accident-generated debris to the suction strainers. The wetwell, which is the chamber in direct contact with the suppression pool, is largely empty with the only significant components/structures being an access tunnel, a grated catwalk and the SRV discharge piping. There are no normal operating high energy piping systems in the wetwell which could break and lead to debris generation. The high energy piping in the ABWR, which consists largely of the main steam, Reactor Water Cleanup (RWCU) system and feedwater piping under normal operating conditions, is located in the upper drywell area. Any debris which is generated by a break in these systems would need to pass through a circuitous route involving any one of the ten drywell connecting vents (DCVs) and then through any one of the thirty horizontal vents before reaching the suppression pool. The DCVs have horizontal steel plates located above the openings that prevent any material falling in the drywell from directly entering the vertical leg of the DCVs. A vertically oriented trash rack is installed around the periphery of the horizontal steel plate to intercept debris. In order for debris to enter the DCV it would have to travel horizontally through the trash rack prior to falling into the vertical leg of the connecting vents. Thus the ABWR is resistant to the transport of debris from the drywell to the wetwell.

6C.3.1.5 Suction Strainer Design

In addition to these mitigating features, the downstream effects are minimized by the suction strainers themselves. The strainers are designed to protect the ECCS pumps to allow them to function long-term after an accident. As a result, they are designed so that 100% of the ECCS flow is routed through them and filtered such that particles of 2.1 mm or larger are captured by the strainer. STP 3&4 has committed to implement Rev 3 of Regulatory Guide 1.82. Section 2.1.2.1 of that Regulatory Guide states that:

> "The possibility of debris clogging flow restrictions downstream of the strainers should be assessed to ensure adequate long-term ECCS performance. The size of openings in the suppression pool suction strainers should be based on the minimum restrictions found in systems served by the suppression pool…… Consideration should be given to the buildup of debris at the following downstream locations: spray nozzle openings, throttle valves, coolant channel openings in the core fuel assemblies, fuel assembly inlet debris screens, ECCS pump seals, bearings, and impeller running clearances."

STP 3&4 is implementing this Regulatory Guide using a state-of-the-art CCI cassette type strainer with a maximum hole size in this strainer of 1/12 inch (2.1mm).

6C.3.1.6 Diversity of ECCS Delivery Locations to the Core

The ABWR has diversification of ECCS delivery points which helps to minimize the consequences of downstream blockage. Should any blockages occur in the lower core region, such as the fuel filter, which could limit the effectiveness of systems like RHR, the HPCF will still be effective at providing cooling water as it delivers water through spargers located above the core. Should all of the ECCS suction strainers become plugged, the alternate AC (Alternating Current) independent water addition mode of RHR allows water from the Fire Protection System to be pumped to the vessel to maintain cooling of the fuel.

6C.3.1.7 Summary

AS described in this COLA Section, there is reasonable assurance that the downstream effects of material passing through the suction strainers will not adversely affect the fuel or other components. This conclusion is based upon the low potential for generating debris in the ABWR, the tortuous path for any debris to enter the wetwell from the drywell, the cleanup provisions for the water in the wetwell, the low potential for chemical debris , the small size of the holes in the suction strainers that filter out most debris, quarterly/periodic surveillance of HPCF, RHR, and RCIC systems which provides further assurance of the absence of debris which could affect their readiness for water injection capability, diversity of injection points for ECCS into the core, and preliminary data from PWR test results which show little impact on head loss in the fuel region from particulate only debris.

RAI 06.02.02-3:

QUESTION:

Section 6C.2 of STP 3 & 4 FSAR states the following:

> The ABWR design also has additional features not utilized in earlier designs that could be used in the highly improbable event that all suppression pool suction strainers were to become plugged. The alternate AC (Alternating Current) independent water addition mode of RHR allows water from the Fire Protection System to be pumped to the vessel and sprayed in the wetwell and drywell from diverse water sources to maintain cooling of the fuel and containment.

In this situation, describe how you would account for the pressurization of the containment from a decrease in free volume as a result of continuous addition of water into the containment, if the above feature is used in the long term.

RESPONSE:

The pressurization of the containment associated with the operation of the AC-Independent Water Addition mode of RHR for reactor vessel injection and drywell spray is analyzed in Appendix 19E.2.2 of the ABWR DCD. The operator actions associated with reactor pressure vessel and primary containment level control and injection from sources external to the primary containment, e.g. ACIWA system, are included in the Emergency Procedure Guidelines (EPGs) presented in FSAR Appendix 18A. These operator actions included in the EPGs include precautions to maintain primary containment water level and pressure low enough to preclude primary containment failure and to terminate injection when required.

The ABWR EPGs are developed based upon the BWROG EPGs Revision 4, which have been approved by the NRC. Operator instructions and strategies using ABWR design features, such as the ACIWA system, have been incorporated into the ABWR EPGs. Major differences, including the approach to primary containment flooding as presented in FSAR Appendix 18B, were evaluated by the NRC in NUREG-1503, Final Safety Evaluation Report Related to the Certification of the ABWR Design (FSER), and found to be acceptable (Section 18.8.5).

No COLA change is required as a result of this RAI response.

RAI 06.02.02-4:

QUESTION:

During STP ABWR Units 3 and 4 audit conducted on June 30 and July 1, STP stated in a presentation titled "12 Issues from GSI-191, STP 3&4 ECCS Strainer Audit, June 30, 2009." that the plant would eliminate all fiber in primary containment . STP plans to provide head loss calculations in accordance with 10 CFR 50.46 to show sufficient NPSH margin using zero fiber. Provide evidence that the INPO and EPRI guidance for cleanliness and Foreign Material Exclusion (FME) will maintain zero fiber. If the program cannot demonstrate zero fiber, provide a maximum amount of fiber that would be expected as a result of implementing the cleanliness and FME program.

RESPONSE:

Although the design specifications for STP 3&4 prohibit the use of fibrous insulation in primary containment, to provide operational flexibility for the plant, a small amount of latent fiber, e.g., threads from a cloth, will be assumed in the ECCS suction strainer sizing evaluations. The amount of latent fiber assumed will be based on operational experience, including the experience at STP 1&2, STPNOC's operating PWR units, and with the Japanese ABWR Kashiwazaki-Kariwa Units 6&7 (K6&7).

STP 3&4 is planning to implement a rigorous containment cleanliness program consistent with the existing program at STP 1&2, and in accordance with INPO and EPRI guidance for FME—see Response to RAI 06.02.02-5.

STP 1&2 have two procedures they use to assure that any loose debris in the primary containment is identified and evaluated for its potential impact on the recirculation sump strainers, and is removed:

- STP 1&2 procedure 0PSP03-XC-0002, "Initial Containment Inspection to Establish Integrity"
- STP 1&2 procedure 0PSP03-XC-0002a, "Containment Entry and Partial Inspection (Containment Integrity Established)"

STPNOC writes condition reports (CRs) on items found following containment entries and evaluates whether the materials discovered have the potential to block more than a pre-established acceptable surface area of the sump strainers. Results from CRs written on both Units 1 and 2 over the last two years were reviewed to determine the types and quantities of latent debris discovered in containment. Note that ABWR containments are inerted during operation and are only entered during refueling outages (RFOs). In contrast, PWR containments can be entered several times per year, and each entry is an opportunity for a worker to accidentally leave behind an item, e.g., a tie wrap.

Items identified in both STP 1&2 during at-power containment entries over the past two years include the following fibrous types of debris: cotton glove liner, cleaning cloths, and fibrous insulation materials. Note that fibrous insulation materials will not be allowed inside the STP 3&4 primary containments, so the fibrous insulation found in the STP 1&2 containments is not applicable to STP 3&4.

In addition to the experience with containment cleanliness for STP 1&2 (a PWR), the operating utility (TEPCO) of the oldest Japanese ABWRs, Kashiwazaki-Kariwa Units 6&7 (K6&7) was requested to provide their experience with post-outage inspections of the primary containment. (The primary containment is only entered during outages.) TEPCO recovered three short (15 cm or less) lengths of rope from the K7 suppression pool during an inspection in 2004. No other fibrous-type items were found. This supports the conclusion that latent fiber inside an ABWR primary containment would be minimal.

For conservatism, and for operational margin, a volume of $0.03m^3$ ($\sim 1\ ft^3$) latent fibers will be assumed in the strainer head loss evaluation for STP 3&4.

Incorporation of this information in the COLA is discussed in the response to RAI 06.02.02-6.

RAI 06.02.02-5:

QUESTION:

During STP ABWR Units 3 and 4 audit conducted on June 30 and July 1, STP stated in a presentation titled "12 Issues from GSI-191, STP 3&4 ECCS Strainer Audit, June 30, 2009" that the plant would eliminate all fiber in primary containment and minimize other debris by adopting INPO and EPRI guidance for cleanliness and foreign material exclusion (FME). Any change in that amount of assumed latent debris or zero fiber may impact NPSH calculations in support of 10 CFR 50.46. Please provide INPO and EPRI guidance in a cleanliness program, and also include it as an operational program and fully describe its implementation in FSAR Section 13.4 in accordance with Section C.IV.4.4 of Regulatory Guide 1.206.

RESPONSE:

STPNOC intends to eliminate all fiber in the primary containment and will minimize other debris through an aggressive suppression pool cleanliness program. The Suppression Pool Cleanliness Program is provided in Subsection 6.2.1.7.1 and is included as an operational program in 13.4S. This program is based on industry guidance from INPO and EPRI and will be of comparable quality to the program for ECCS Sump Cleanliness used by STP Units 1 and 2. The markups to reflect these changes are provided in the following, with changes highlighted by gray shading.

The following markup to Subsection 6.2.1.7 will be made.

In addition to the ABWR design features, the control of the suppression pool cleanliness is a significant element of minimizing the potential for strainer plugging. ~~The COL applicant will review the issue of maintaining the suppression pool cleanliness, and propose to the NRC Staff an acceptable method for assuring that the suppression pool cleanliness is maintained. Methods shall be considered for removing, at periodic intervals, sediment and floating or sunk debris from the suppression pool that the SPCU does not remove. See Subsection 6.2.7.3 for COL license information.~~

~~Refer to Appendix 6C for additional information on BWR design guidelines.~~

6.2.1.7.1 Suppression Pool Cleanliness Program

6.2.1.7.1.1 Purpose

This operational program is to ensure that the primary containment is free from debris that could become dislodged in an accident and be transported to the ECCS suction strainers and interfere with their proper functioning during a design basis event.

6.2.1.7.1.2 Scope

This program applies to the primary containment, including the drywell and suppression pool, for STP Units 3 and 4. This program has design, maintenance and operational elements. This program is comprised of: (1) design change control to ensure that material whose susceptibility to damage resulting in uncontrolled debris is limited and cannot be replaced with material with greater susceptibility; (2) restricted access to primary containment during reactor operations and refueling periods; (3) suppression pool cleanup system operation to maintain S/P cleanliness ; (4) foreign material exclusion and housekeeping requirements to ensure that foreign material that could be detrimental to ECCS strainer operation if left in primary containment is removed prior to containment close out; and (5) drywell , S/P, and strainer inspections following outages to ensure that no debris is present prior to the containment being closed out in preparation for operation.

The program is based on ABWR Operating Experience, Electric Power Research Institute (EPRI) guidelines contained in EPRI TR 1016315, "Nuclear Maintenance Applications Center: Foreign Material Exclusion Guidelines" and Institute of Nuclear Power Operations (INPO) guidance in INPO 07-008, "Guidelines for Achieving Excellence in Foreign Material Exclusion (FME)."

6.2.1.7.1.3 Responsibilities

The operations and maintenance organizations have overall responsibility for the procedures that implement this program. There is a suppression pool cleanliness program owner, whose responsibility is to have overview of all aspects of this program, including reviewing procedures, training station personnel, being aware of industry operating experience, and on an ongoing basis assessing the overall effectiveness of the program.

6.2.1.7.1.4 Standards

There will be no fibrous or calcium silicate insulation inside the primary containment. All thermal insulation will be RMI-type which will not pass through the ECCS suction strainers. Design change control will ensure that the RMI is not replaced with fibrous or calcium silicate insulation.

The primary containment will be designated as a Foreign Material Exclusion (FME) Zone 1 in accordance with the INPO Definition. This is an area where loss of FME could result in personnel injury, nuclear fuel failure, reduced safety system or station availability, or an outage extension or significant cost for recovery and is the highest level of FME defined by INPO. All activities associated with suppression pool cleanliness will be done in accordance with the STP 3 & 4 Quality Assurance Program.

The S/P cleanup system will be operated as necessary to maintain the water chemistry in the S/P comparable to that required for refueling water.

The primary containment atmosphere is inerted during reactor operations. Therefore, access to the primary containment is effectively prohibited.

6.2.1.7.1.5 Key Elements of the Suppression Pool Cleanliness Program

During refueling outages, the containment is a FME Zone 1 area. In addition, strict house keeping controls are in place to ensure that only needed material is brought into containment and that work areas are restored to their original conditions following completion of the work. Prior to entry into the containment during scheduled or unscheduled outages, all material will be accounted for and documented.

Following each refueling outage, a detailed visual inspection is performed of the primary containment to identify and remove any loose debris. This detailed inspection is controlled by plant procedures in accordance with the Procedure Development Program. All debris identified will be documented and entered into the corrective action program for trending and potential action.

In addition a remote visual inspection will be performed of the Residual Heat Removal (RHR), Reactor Core Isolation Cooling (RCIC), and High Pressure Core Flooder (HPCF) suction strainers and the S/P floor to ensure there is no debris present. This inspection will be focused on the presence of debris in the suction strainers but will also look for any structural gaps that would allow debris to bypass the strainer flow holes. Results of these inspections will be documented in the procedure and in the corrective action program. Debris that is identified will be removed and any strainer structure gaps will be assessed and repaired if necessary.

The S/P cleanup system will normally be operated in alignment with a train of the fuel pool cleanup filter/demineralizers to ensure S/P water quality. Floating debris and sediment in the suppression pool not removed by the Suppression Pool Cleanup System will be removed during refueling outages.

In the unlikely event of a primary containment entry during the operating cycle, a close-out inspection will be performed prior to the return to operation.

6.2.1.7.1.6 Acceptance Criteria

Procedures related to suppression pool cleanliness will have defined acceptance criteria that must be met prior to closing containment and returning to power. Acceptance criteria will be absence of debris in the primary containment non suppression pool areas. For the strainers themselves, the acceptance criteria will be that the strainer inlets are not restricted, the strainer screens are not plugged, and the strainer structure does not have any structural gaps. For the suppression pool, the acceptance criteria will be the absence of debris and sediment.

There is a documented close-out of containment following completion of all cleanliness inspections and prior to resumption of power operation.

6.2.1.7.1.7 Procedural Controls

Station procedures that implement the suppression pool cleanliness program will be developed in accordance with the Procedure Development Plan described in Section 13.5. These procedures will address control of materials, access to the containment, inspection and cleanup of containment, inspection and cleanup of the strainers, and inspection and cleanup of the suppression pool. These procedures will be complete and available for NRC review 60-days prior to startup testing (COM 6.2-1).

6.2.1.7.1.8 Implementation

The suppression pool cleanliness program will be implemented prior to the initiation of the startup test program.

6.2.1.7.1.9 Corrective Action Program

Adverse conditions from the containment and strainer inspections will be documented in the STP 3 & 4 corrective action program to ensure they are properly addressed and to allow trending and analysis of results.

6.2.1.7.1.10 Audits

Periodic audits will be performed by the STP 3 & 4 Quality Assurance department on this program.

6.2.1.7.1.11 Operating Experience

Operating experience at other plants will be periodically assessed for lessons learned that could be applied to the STP 3 & 4 program.

6.2.7.3 Suppression Pool Cleanliness

The following standard supplement addresses COL License Information Item 6.4.

~~Appendix 6C provides a discussion of suppression pool cleanliness in support of preventing ECCS suction strainer plugging in accordance with Subsection 6.2.1.7. Periodic inspections of the suppression pool for cleanliness are performed during outage periods. Maintenance procedures provide procedure steps for removing, at periodic intervals, sediment and floating or sunk debris from the suppression pool that the SPCU does not remove.~~ Subsection 6.2.1.7.1 provides a description of the operational program for Suppression Pool Cleanliness. This program will be implemented prior to Plant Startup as described in Table 13.4S-1 of Section 13.4S.

6.2.8 References

STD DEP 6.2-2

6.2-5 "Implementation of GE NEDO-20533 Methodology with GOTHIC for ABWR Containment Design Analyses," WCAP-17058, Westinghouse Electric Company, LLC, June 2009.

6.2-6 EPRI TR 1016315, "Nuclear Maintenance Applications Center: Foreign Material Exclusion Guidelines", Electric Power Research Institute, July 2008.

6.2-7 INPO 07-008, "Guidelines for Achieving Excellence in Foreign Materials Exclusion (FME)", Institute of Nuclear Power Operations, December 2007.

The following markup will be made to Section 13.4S to add Suppression Pool Cleanliness as an operational program. Changes to COLA Revision 3 are shown in gray shading.

13.4S-1, Operational Programs Required by NRC Regulation and Program Implementation

Item	Program Title	Program Source	FSAR (SRP) Section	Milestone	Requirement
19	Initial Test Program	10CFR 50.34 10CFR 52.79 9(a)(28)	14.2S	Prior to Startup Test Program	License Condition
20	Suppression Pool Cleanliness	10CFR 50.46	6.2	Prior to Startup Test Program	License Condition

RAI 06.02.02-6:

QUESTION:

This is RAI 2042 Supplement 1.

During an audit conducted at Westinghouse Office in Rockville, MD, on June 30 and July 1, 2009, the staff reviewed a summary report of the analyses Toshiba prepared for the replacement of ECCS suction strainers at a Japanese ABWR as stated in STP response to RAI 2042. The staff reviewed the following documents, including the summary report (the first one listed):

- The Evaluation Report for Net Positive Suction Head of Pump in Emergency core Cooling System, Proprietary, STP Doc. U7-RHR-M-RPT-DESN-0001, Rev. A, May 27, 2009.
- The Supplementary Documentation for the Head Loss Evaluation Report of Japanese ABWR ECCS Suction Strainer, Proprietary, STP Doc. U7-RHR-M-RPT-DESN-0002, Rev. A, June 24, 2009.
- The Evaluation Example of the Head Loss of the ECCS Suction Strainer and Pipe in the ECCS Pump Run-out Flow Condition, Proprietary, STP Doc. U7-RHR-M-RPT-DESN-0003, Rev. A, May 27, 2009.

The above documents lack sufficient details for the staff to complete its review. The staff expects relevant details to be provided as stated in Revised Content Guide for Generic Letter 2004-02 Supplemental Responses, November 21, 2007 (NRC Agencywide Documents Access and Management System (ADAMS) package Accession No. ML073110278) and Revised Content Guide for Generic Letter 2004-02 Supplemental Responses, March 28, 2008 (ADAMS Package Accession No. ML080230234).

A. Submit a calculation report on sizing of suppression pool recirculation pumps suction debris strainers for the staff review to determine that they meet the guidance of Regulatory Guide 1.82, Revision 3. This document should provide sufficient design details as requested in the guidance documents stated above. Or, justify an alternative approach.
B. The documents that the staff reviewed during the audit did not account for miscellaneous debris (equipment tags, tape, and stickers or placards affixed by adhesives) that was considered during the resolution of GSI 191 program. Describe how you accounted for miscellaneous debris.
C. During the audit STP stated that subsequent to RAI 2042 response, Toshiba had decided to eliminate all fiber insulation from STP 3 & 4 primary containment. As the staff stated during the audit, STP should account for the possibility of having some fiber in the containment in terms of latent debris or confirm with a foreign material exclusion program that would eliminate all fiber from the STP 3 & 4 primary containment.
D. During the audit STP stated that the thermal insulation in STP 3 & 4 primary containment will be all stainless steel RMI. STP should account in the debris strainer design a

possibility that it may not be able to use RMI for some small bore piping because of their locations, and thus, may have to use small quantities of other types of insulation like CalSil and fiber.

E. The STP's RAI 2042 response states that "the latent debris defined in the URG (which was used for the Hamaoka 5 testing) is considered bounding for STP 3 & 4." The URG proposed generic values were based on operating experience of boiling water reactors. Considering that ABWR is a newer plant of which operating experience was not considered in determining the URG proposed values, STP should confirm the valued used in the design with operating experience of ABWRs or propose a plan to confirm these values later.
F. The documents that the staff reviewed during the audit showed latent debris assumed in the design of the debris strainers include 195 lb of sludge. However, the STP's presentation on Downstream Effects at the audit included only four types of debris considered for downstream effects (fibrous debris, paint chips, concrete dust, and RMI shard), which does not include sludge. Justify not considering sludge as a downstream component of debris.
G. Provide a table listing how the STP ECCS suction debris strainer meets each regulatory position for BWRs that is stated in Regulatory Guide 1.82, Revision 3, or justify an alternative approach.
H. STP should provide summary information of the calculation report stated in item A above in STP 3 & 4 FSAR and incorporate it by reference in the FSAR.
I. Update FSAR as needed to reflect the response to this RAI (e.g., the commitment to use stainless steel reflective metallic insulation).

RESPONSE:

Responses corresponding to each letter item are provided below.

Response to Item A: As noted in the RAI, the NRC Staff reviewed three (3) documents during the June 30-July 1, 2009 strainer audit at the Westinghouse Office in Rockville. The purpose of each report and its relevance to the STP 3&4 strainers is as follows:

1. STP Document U7-RHR-M-RPT-DESN-0001: This report is the English translation of the report prepared for the Japanese regulatory agency to describe the bases for replacement suction strainers in the RHR and HPCF systems in the Reference Japanese ABWR in 2005. At that time, the U.S. regulatory guidance for operating BWRs was based on the requirements in the BWROG's Utility Resolution Guideline (URG), NEDO-32686, which is currently referenced by Regulatory Guide (RG) 1.82, Rev. 3, for debris generation and transport evaluations. The URG methodology was used for sizing the replacement ECCS strainers for the Reference Japanese ABWR. Note that although some additional considerations have been added to the BWR regulatory positions in RG 1.82, Rev. 3 since the Reference Japanese ABWR strainer sizing evaluation, e.g., consideration of chemical effects, the basic methodology for ECCS suction strainer sizing is still defined in the URG. Note that chemical effects are discussed in the response to RAI 06.02.02-9, and downstream effects are discussed in the response to RAI 06.02.02-2.

2. STP Document U7-RHR-M-RPT-DESN-0002: This report was prepared to provide additional information on the evaluations for the Reference Japanese ABWR ECCS strainer. For example, additional details are provided about the selection of the postulated pipe break locations that would result in large amounts of insulation damage and subsequently the largest head loss at the suction strainers.

3. STP Document U7-RHR-M-RPT-DESN-0003: This report was prepared to evaluate the impact of the difference in RHR and HPCF pump flow rates considered in the Reference Japanese ABWR evaluations (which used these pumps' design flow rates) and the runout flow rates, which will be required for the final strainer sizing calculations for STP 3&4.

The ECCS suction strainers for STP 3&4 are the same design as for the Reference Japanese ABWR, and they will be at least as large as the Reference Japanese ABWR strainers. Therefore, these reports provide the bases for concluding that the Reference Japanese ECCS strainers bound the size of CCI cassette-type strainers required for the STP 3&4 ECCS systems. For example, the Reference Japanese ABWR primary containment includes fibrous and calcium silicate thermal insulation, both of which are significant contributors to strainer head loss. For STP 3&4, the only type of thermal insulation allowed inside primary containment is all stainless steel reflective metal insulation (RMI). Therefore, the head loss due to material destroyed in the ZOI will be much less for STP 3&4 compared to the Reference Japanese ABWR. A summary of conservatisms and non-conservatisms in the Reference Japanese ABWR and STP 3&4 designs, with respect to strainer head loss factors, is summarized in the Table 1:

Table 1

Row	Characteristic	Reference Japanese ABWR	STP 3&4	Significance of Difference
1	Fibrous insulation	Fiber (due to insulation on small bore piping within ZOI) transported to suppression pool	No fibrous insulation allowed in primary containment; for operational flexibility, 0.03 m^3 (~1 ft^3) of latent debris will be assumed in strainer head loss calculation (See response to RAI 06.02.02-4)	The fiber in the Reference Japanese ABWR (coupled with particulate debris) results in at least twice the head loss of a thin bed fiber case. Head loss due to RMI without fiber is nearly zero. Therefore, STP 3&4 would have a significant reduction in required strainer surface area, if other factors remain the same (see Row 7)

Row	Characteristic	Reference Japanese ABWR	STP 3&4	Significance of Difference
2	Calcium silicate insulation	Some calcium silicate insulation is transported to suppression pool	Only RMI is allowed for thermal insulation inside primary containment	Calcium silicate is a significant contributor to head loss, so STP 3&4 will eliminate that head loss contributor inside primary containment
3	Latent debris: paint chips	URG quantity of 85 lbs (39 kg) is assumed	URG value of 39 kg will be assumed	No change from Reference Japanese ABWR assumption (See response to RAI 06.02.02-8 for discussion of why this is conservative)
4	Latent debris: rust flakes and sludge	URG quantity of 50 lbs (23 kg) rust flakes and 195 lbs (89 kg) sludge assumed. ("Sludge" is generally considered corrosion products in U.S. BWR suppression pools)	URG values for rust flakes and sludge will be assumed for STP 3&4 (Note that unlike operating U.S. BWRs, only qualified coatings are allowed in the STP 3&4 primary containment. Also, the STP 3&4 suppression pool is lined with stainless steel, so minimal corrosion products are predicted, i.e., less than the URG values.)	No change from Reference Japanese ABWR assumption (STPNOC is requesting operational information from TEPCO on quantities of material obtained from the Suppression Pool Cleanup (SPCU) systems at the Kashiwazaki-Kariwa (K6&7) units, which are the oldest ABWRs. The conservatism of the latent debris sludge assumption will be confirmed based on the K6&7 information.)
5	Latent debris: dust	URG quantity of 150 lbs (68 kg) is assumed	URG quantity of 150 lbs (68 kg) will be assumed for STP 3&4	No change from Reference Japanese ABWR assumption (The assumption of 150 lbs of dust accumulating in the drywell and getting washed down into the suppression pool was judged to be conservative by both the BWROG and the NRC during development of the URG.)

Row	Characteristic	Reference Japanese ABWR	STP 3&4	Significance of Difference
6	Latent debris: miscellaneous loose debris	URG did not have any requirements for miscellaneous latent debris	Based on operating experience at STP 1&2 (operating PWR), each strainer will be assumed to have the openings of 2 cassettes blocked by miscellaneous debris, e.g., small pieces of plastic, tape, sheets of paper, HP low dose sign. (Each strainer cassette has an opening of 17.5 cm x 36.5 cm (approx. 7 in x 14 in), and a depth of between 20 cm – 24 cm.)	An assumption that 2 cassettes are blocked on each of the STP 3&4 strainers is more conservative than the assumption used in the Reference Japanese ABWR (consistent with the URG) that no individual cassettes are blocked by miscellaneous latent debris.
7	Pump flow rates	RG 1.82, Rev. 3, Reg. Position 2.3.3.4 states that "the NPSH available to the ECC pumps should be determined using the conditions specified in the plant's licensing basis," which is the pump design flow rate for the Reference Japanese ABWR	The U.S. ABWR DCD specifies that ECC pump runout flow rates will be used for the ECCS strainer head loss and pump NPSH evaluations. Therefore, STP 3&4 must use a very conservative assumption that the ECCS pumps operate at runout flow concurrent with the peak suppression pool temperature when calculating available NPSH.	The use of runout flow both increases the required pump NPSH and the debris adherence to the strainers for the STP 3&4 strainers, but Toshiba has already evaluated the impact of the higher flow rate on the strainers sized for the Reference Japanese ABWR (and planned for use at STP 3&4). This evaluation shows that, with STP 3&4 using all RMI thermal insulation, NPSH available exceeds NPSH required.

The STP 3&4 strainers will be sized based on the bounding calculation from the Reference Japanese ABWR, as summarized above and in the three Toshiba reports.

The strainer sizing calculation will be confirmed after completion of detailed system design in the 1st quarter of 2011.

The three Toshiba reports that represent the licensing basis for STP 3 & 4 strainer sizing will be provided to the NRC by October 30, 2009.

Response to Item B: See Row 6 in Table 1 above.

Response to Item C: See Response to RAI 06.02.02-4 and Row 1 in Table 1 above.

Response to Item D: STP 3&4 is being designed using state-of-the-art 3D computer-aided design/drafting tools, so all piping arrangements, including small-bore piping, are designed to account for needed clearances for thermal insulation. Although the outside diameter of RMI is larger than fibrous or other non-RMI types of insulation for the same insulating properties, this can easily be accommodated during the design stage. Therefore, STPNOC does not need to account for non-RMI thermal insulation in the STP 3&4 primary containment.

Response to Item E: See Rows 1, 4, 5, and 6 in Table 1 above.

Response to Item F: The downstream effects presentation during the strainer audit inadvertently omitted sludge from the particulate materials that will be evaluated in component and fuel downstream effects evaluations. PWRs do not have BWR "sludge" because they have dry sumps instead of continuously wet suppression pools. Therefore, the current PWR methodologies for downstream effects evaluations do not discuss "sludge." For STP 3&4, the quantity of sludge assumed by the URG (which will be confirmed as conservative based on experience from K 6&7, with its use of the suppression pool cleanup system—see Row 4 in Table 1) will be added to the quantity of particulate debris used in component wear and blockage potential evaluations.

Response to Item G: The three design reports provide the majority of the information that will be included in the RG 1.82, Rev. 3 Compliance Table. Responses to other RAIs, e.g., RAI 06.02.02-9 on chemical effects, provide additional information needed for the Compliance Table. The RG 1.82, Rev. 3 Compliance Table will be provided as part of a supplemental RAI response on October 30, 2009.

Response to Item H: See response to Item A. The proposed revisions to the STP 3&4 COLA will be provided in a supplemental RAI response on October 30, 2009.

Response to Item I: A COLA markup committing to the use of only RMI insulation in the primary containment is provided in the response to RAI 06.02.02-2. Any additional COLA markups needed will be included in the supplemental RAI response on October 30, 2009.

RAI 06.02.02-7:

QUESTION:

STP 3 & 4 FSAR Section 6.2.7.3 states that "[p]eriodic inspections of the suppression pool for cleanliness are performed during outage periods. Maintenance procedures provide procedure steps for removing, at periodic intervals, sediment and floating or sunk debris from the suppression pool that the [suppression pool cleanup unit] does not remove."

State the frequency at which periodic inspections of the suppression pool cleanliness are performed and include these inspections as TS Surveillance Criteria. .

RESPONSE:

Suppression pool cleanliness will be an operational program that is listed in Section 13.4S, and will be implemented prior to startup testing. This program is fully described in FSAR Subsection 6.2.1.7.1. See RAI Response 06.02.02-5 for the operational program description. Inspections for suppression pool cleanliness will be performed at the end of each refueling outage and following any containment entries during the operating cycle. NUREG-1434, "BWR Standard Technical Specifications, General Electric Plants BWR/6 "does not include a surveillance on suppression pool cleanliness and STPNOC believes that an Operational Program as described in FSAR Subsection 6.2.1.7.1 is adequate to ensure suppression pool cleanliness.

The COLA changes required as a part of this response are provided in the response to RAI 06.02.02-5.

RAI 06.02.02-8:

QUESTION:

Please provide the following information about the potential effects of protective coatings debris on the ECCS strainers for STP Units 3&4:

a. According to FSAR Section 6C.1, the design will follow the guidance in RG 1.82 and the Utility Resolution Guidance (URG) NEDO-32686. The response to RAI 06.02.02-1 for coatings debris (Part B, Item 8 in the table) states there was no indication that 85 pounds (based on the URG) is unconservative. This implies, based on RG 1.82 Position 2.3.1.4, that the amount of coatings debris in the designated zone of influence is less than 85 pounds. Please describe how you determined a ZOI for coatings and corresponding debris quantity to determine the amount of coatings debris is conservative.

b. Please discuss your evaluation of the particle size distribution for containment coatings debris, including all coating types and locations (RG 1.82 Position 2.3.1.4). Discuss how the coating particle size distribution was used in your evaluation of debris transport, downstream effects, and head loss.

RESPONSE:

As noted in the response to RAI 06.02.02-6, the Reference Japanese ABWR strainer sizing evaluation was performed prior to the coatings evaluation criteria developed during the U.S. PWR GSI-191 program. Therefore, the URG default value of 85 lbs (39 kg) was used in the Reference Japanese ABWR strainer evaluation.

Section 4 of Reference 21 of the URG ("Performance of Containment Coatings during a Loss of Coolant Accident," November 10, 1994) explains the basis for determining that 85 lbs of debris from qualified coatings is a conservative value. (Only qualified coatings are allowed inside the STP 3&4 primary containments.) In the reference URG report, it is assumed that a 24-inch diameter pipe break removes 100% of the qualified containment coating from the drywell wall at a distance of 20 feet (10 pipe diameters) from the break. Over 300 ft^2 of drywell coating surface area was estimated to be within the zone of influence (ZOI) of the break, and this value was conservatively doubled to over 600 ft^2 to account for coating on pipe hangers, etc., which could be within the ZOI. The mass of debris from 600 ft^2 of three qualified coatings systems was estimated as 47 lbs for inorganic zinc coating, 71 lbs for 100% epoxy coating, and 85 lbs for inorganic zinc with an epoxy topcoat. The 85 lbs of inorganic zinc with epoxy topcoat is expected to consist of epoxy paint chips ranging in size up to 0.125 inches across, and some loose zinc particles, according to the URG reference.

The NRC has accepted more recent coatings testing by Westinghouse (WEC) and Areva for qualified coatings ZOIs of 4 and 5D, which indicates that the 10D assumption in the URG reference is conservative. (See "NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Coatings Evaluation," March 2008.)

In accordance with the URG, all 85 lbs (39 kg) of paint chips are assumed to be transported to the Reference Japanese ABWR ECCS strainers and are evaluated in the strainer head loss calculations and confirmatory testing along with other LOCA-generated and latent debris. No credit is taken for paint chips or coating debris sticking on any surfaces located between the postulated break location and the suction strainers. The consideration of downstream effects is addressed in the response to RAI 06.02.02-2, Section on Related Test and Analysis.

The final quantity and size distribution of coatings debris (paint chips) will be confirmed in the final strainer sizing calculation for STP 3&4 in the first quarter of 2011.

There are no COLA changes as a result of this response.

RAI 06.02.02-9:

QUESTION:

Please provide the following information about the potential effects of chemical debris on the ECCS strainers for STP Units 3&4:

a. Discuss the controls in place to ensure that materials important in chemical debris generation (e.g., aluminum) will not exceed the limits imposed in your licensing basis.

b. Discuss how the chemical effects evaluation addresses the interactions between all chemical reactants, including all acid and base sources (e.g., sodium pentaborate, nitric acid, hydrochloric acid), insulation material, latent debris, and any other debris sources. Discuss how the evaluation includes the effects over time of the environment on degradation (e.g., corrosion of metals and dissolution of concrete), and formation of chemical debris.

c. Provide the analyses and test data used to evaluate chemical debris effects for STP 3&4. For test data include at least the following information: test description, materials tested, materials description, test conditions, detailed test procedures, results, and conclusions.

RESPONSE:

Responses corresponding to each letter item are provided below.

Response to Item a: The STP 3&4 design specification for insulation materials does not allow the following types of thermal insulation inside primary containment: aluminum, calcium silicate insulation, fibrous insulation (a source of calcium).

The STP 3&4 containment cleanliness and FME program (see responses to RAIs 06.02.02-4 and -5) will ensure that quantities of latent (loose) debris, which might include aluminum or fiber, are kept to a minimum. Because there is a chance that small quantities of these materials might be introduced inside the primary containment during the life of STP 3&4, these materials were evaluated for potential chemical effects—see response to Item c, below.

Response to Item b: There are two (2) potential water chemistries for the ABWR: (1) normal operation water chemistry in the suppression pool is pure water with a neutral pH, and (2) post-LOCA manual actuation of the Standby Liquid Control (SLC) system, which injects sodium pentaborate into the reactor vessel that eventually reaches the suppression pool. The effect of the sodium pentaborate is to slightly elevate the pH in the suppression pool above neutral. Although small amounts of nitric acid and hydrochloric acid might be formed in the post-LOCA radiation levels in the primary containment, the change in pH is judged to be offset by the raising of the pH due to the addition of sodium pentaborate from the SLC system.

Toshiba conducted bench-top testing of several materials, including the materials that might be introduced in small quantities as latent, loose debris (discussed in Item a, above) in both the normal and post-LOCA SLC water chemistries. Results of these tests concluded that no reactions would occur in the normal water chemistry, and there is only slight evidence of corrosion or chemical reaction in the SLC water chemistry for some materials, e.g., aluminum (which is prohibited from primary containment). See Item c, below, for more details on the Toshiba bench-top testing.

Response to Item c: Toshiba chemical effects bench-top testing was reviewed with the NRC during the strainer audit on June 30-July 1, 2009. STPNOC will docket this proprietary material by October 31, 2009.

Detailed test procedures are not available, but a summary of the information in the report of the bench-top chemical effects testing is as follows:

- Two types of tests were conducted: dissolution tests and precipitation tests. These tests are similar to the formal testing described in WCAP-16530-NP-A, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191."
- Materials tested include: glass wool (Japanese) insulation, mineral wool (rock wool) insulation, calcium silicate insulation, uncoated carbon steel, aluminum, zinc plating iron (e.g., HVAC duct metal), and a combination of glass wool and aluminum.
- Test conditions: in the dissolution test, the materials were dissolved in 97°C water, and then for the precipitation test sodium pentaborate is added to half of the solution from the dissolution test and the test samples are allowed to cool to the reference temperature.
- The pH of the test solutions is measured before and after the tests, and the mass loss of the specimens and material concentrations are measured.
- Test results:
  - The results of the dissolution tests were that the dissolution concentrations were low or imperceptible, except a small amount of iron was detected in the uncoated carbon steel solution and the zinc in the zinc-plated iron dissolved slightly.
  - The results of the precipitation tests were that only the uncoated carbon steel exhibited any visual precipitation.

  Neither the dissolution levels or precipitation levels were considered significant enough to adversely affect the strainer head loss evaluation.

Therefore, the bench-top testing, along with the minimal quantities of materials that could potentially react in the suppression pool water chemistry, leads to the conclusion that the impact of chemical effects on the STP 3&4 ECCS suction strainers is minimal.

There are no COLA changes as a result of this response.

RAI 06.02.02-10:

QUESTION:

Section 6C.1 of STP FSAR Revision 2 states that the ABWR design has committed to following the guidance provided in Regulatory Guide 1.82 Rev 3 and the Utility Resolution Guide NEDO-32686-A.

In RAI Question 06.02.02-1, the staff requested that STP describe how they will address the additional issues identified in RG 1.82 Rev 3 (including downstream effects). In STP Response letter U7-C-STP-NRC-090038 (ML091270491), STP stated that Toshiba will select and evaluate downstream components consistent with the methodology in WCAP-16406, as adapted by the BWROG for BWRs. However, the staff understands that the BWROG has not yet determined if it is appropriate to take this approach.

Please clarify your plans for evaluating the effects of debris on downstream components for STP 3&4, including a discussion of the methodology and the acceptance criteria. If planning to use WCAP-16406, please describe why this methodology is appropriate for BWR evaluations. This information has to be provided in sufficient detail in the COL application for the staff to make a reasonable assurance finding.

RESPONSE:

STPNOC plans to use the methodology described in WCAP-16406 "Evaluation of Downstream Sump Debris Effects in Support of GSI-191" for determining the effects of debris passing through the STP 3&4 strainers on downstream components. The WCAP, which has been approved by the NRC for evaluation of debris on PWR downstream components, includes equations for determining wear on surfaces exposed to the fluid stream due to various types of debris, e.g., paint chips or RMI shards. Methodologies for evaluating the potential for blockage of small clearances due to downstream debris are also included in the WCAP. The materials and clearances for the valves, pumps and heat exchangers downstream of the BWR ECCS suction strainers are essentially the same as the materials and clearances for the valves, pumps and heat exchangers downstream of the PWR containment sump suction strainers. Therefore, the application of the WCAP methodology for the BWR is considered appropriate.

Regarding acceptance criteria, acceptable wear rates over the 30 day mission time of the ECC systems will be determined based on the specific component, e.g., valve, pump or heat exchanger, being evaluated.

The acceptance criteria for clearance within downstream components are that there will be no blockage of downstream components due to debris formation which could prevent that component from its intended function for providing long term cooling after a LOCA. For example, pumps would need to provide the required core flow, valves would need to be in the proper position and able to pass the required flow, heat exchangers would need to be able to provide the required cooling.

The evaluation of downstream effects on components as well as identification of acceptance criteria will be documented in accordance with the WCAP methodology and will be submitted as part of the overall downstream effects evaluation to be provided to the NRC at least 18 months prior to fuel load (See response to RAI 06.02.02-2).

As a result of this response, the STP 3&4 COLA Part 2 Tier 2 Section 6C.3 will be revised in a future revision to add subsection 6C.3.2 as shown below. Changes to Rev 3 of the COLA are highlighted with gray shading.

6C.3.2 Downstream Effects on Pumps, Valves and Heat Exchangers

The evaluation of the downstream effects on components, such as valves, pumps and heat exchangers will be performed in accordance with methodologies developed in WCAP-16406 which has been approved by the NRC for evaluation of debris on PWR components. The materials and clearances for the valves, pumps and heat exchangers downstream of the BWR ECCS suction strainers are essentially the same materials and clearances as for the valves, pumps and heat exchangers downstream of the PWR containment sump suction strainers. Therefore, the application of the WCAP-16406 methodology is appropriate.

Regarding acceptance criteria, acceptable wear rates over the 30 day mission time of the ECC systems will be determined based on the specific component, e.g., valve, pump or heat exchanger, being evaluated.

The acceptance criteria for clearance within downstream components are that there will be no blockage of downstream components due to debris formation which could prevent that component from its intended function for providing long term cooling after a LOCA. For example, pumps would need to provide the required core flow, valves would need to be in the proper position and able to pass the required flow, heat exchangers would need to be able to provide the required cooling.