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0CAN091001

September 29, 2010

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Generic Letter 2004-02 Revision to the Final Supplemental Response and Requests for Additional Information
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

Reference:

1. Entergy letter dated April 8, 2010 (0CAN041001), Generic Letter (GL) 2004-02 Supplemental Information
2. Entergy letter dated September 24, 2009 (0CAN090901), GL 2004-02 Final Supplemental Response Request for Additional Information
3. Entergy letter dated September 15, 2008 (0CAN090801), GL 2004-02 Final Supplemental Response

Dear Sir or Madam:

By letter dated April 8, 2010 (Reference 1), Entergy Operations, Inc. (Entergy) committed to provide a submittal that reflects the changes to the previously submitted information in the final supplemental response (Reference 3) and requests for additional information (RAIs) (Reference 2) for Arkansas Nuclear One (ANO) due to required analyses revisions. Attachments 1 and 2 provide revision to the final supplemental responses (including RAIs) to GL 2004-02 for ANO-1 and ANO-2, respectively. Based on the information provided in this response, the RAI responses (Reference 2), and the final supplemental responses (Reference 3), Entergy believes that sufficient margin exists for resolution of GL 2004-02 issues for both of the ANO units.

There are no new commitments contained in this submittal. Should you have any questions concerning this submittal, please contact Ms. Stephenie Pyle at 479.858.4704.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 29, 2010.

Sincerely,

Original signed by Dale E. James for Brad L. Berryman

BLB/nbm

Attachments: 1. ANO-1 Revised Final Supplemental Response including RAIs
2. ANO-2 Revised Final Supplemental Response including RAIs

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Attachment 1 to

0CAN091001

ANO-1 Revised Final Supplemental Response including Requests for Additional Information

ANO-1 Revised Final Supplemental Response including Requests for Additional Information

In Entergy Operations, Inc. (Entergy's) letter dated September 24, 2009 (0CAN090901), responses to requests for additional information (RAIs) were provided, and in the preface to those RAI responses, Entergy summarized conservatisms included in the analyses for Arkansas Nuclear One, Unit 1 (ANO-1). The reanalysis resulted in the need for several changes to this information, thus, a revised summary is provided.

Debris Generation:

- The calcium-silicate zone-of-influence (ZOI) for lagging fastened with sheet metal screws originally credited a 25D ZOI based on Westinghouse testing conducted for ANO but has since been revised to credit all unshadowed material based on absence of an approved ZOI reference source. Shadowing was credited as allowed per NRC-approved Nuclear Energy Institute (NEI) 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- The calcium-silicate ZOI of 5.45D for banded lagging was based on testing performed on weaker aluminum lagging compared to the stainless steel (SS) lagging installed at ANO.

- A ZOI of 25D was originally credited combined with a credited high degree of destruction (100% fines or small shreds) for high-density fiberglass (HDFG) insulation, but has since been revised to credit all unshadowed HDFG material becoming debris (100% fines or small shreds) based on absence of an approved ZOI reference source for this type insulation and covering. Shadowing was credited as allowed per NEI 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- The Transco Thermal-Wrap fiber insulation covered with SS lagging fastened with screws originally credited a 25D ZOI consistent with that applied to other insulation types having screwed lagging based on Westinghouse testing conducted for ANO. This has been revised to credit the 17D ZOI in NEI 04-07 for jacketed or unjacketed Nukon insulation, since Transco Thermal-Wrap is acknowledged as equivalent insulation in NEI 04-07.

Debris Transport:

- 100% transport of all fibers, calcium-silicate, coatings, and latent debris to the strainers was originally applied. The revised analysis continues to credit 100% transport of all fiber fines, calcium-silicate, coatings, and latent debris to the strainers but does not credit transport or erosion of 40% of the Transco Thermal-Wrap and Temp-Mat insulation remaining as large pieces trapped in the fabric covers, consistent with the guidance in NEI 04-07.

<u>Head Loss Testing:</u>

- Fiber was added as fines and very small shreds, separated into multiple containers to avoid agglomeration, and slowly poured into a flowing flume to maximize even distribution.
- Near-field settling was not credited and was avoided by stirring of the test flume.
- Testing was conducted for an extended time period (330+ hours) to ensure bounding head loss effects were captured.
- Thin-bed conditions were established in the test with vertical debris distribution throughout the strainer pockets (i.e., including upper pockets) significantly more uniform than would be expected in the plant, based on pouring debris in increments into the top of a flowing flume and stirring of any settled debris materials to re-suspend them.
- Testing included an excess of debris material types above those calculated to ensure margin is available to address small changes in analysis, as-found conditions, or installed configurations. The tested quantity exceeded the maximum amount for any debris type for any break (i.e., highest coating particulate from one break combined with highest fiber from a second break and highest calcium-silicate from a third break). The debris loading for strainer head loss testing expressed as an approximate percentage of the amount identified in the revised debris generation calculation for the limiting break is as follows: total fiber – 117% (lb basis); calcium-silicate – 142%; coatings – 119%; latent particulate – 162%; miscellaneous foreign material – 179% ("tested" as allowance for blockage).

<u>Head Loss Analysis:</u>

- Strainer test head loss measured at room temperature remains acceptable without applying viscosity correction; however, the revised pump net positive suction head (NPSH) analysis credits a viscosity-corrected strainer head loss value reflecting the elevated temperatures associated with the limiting pump NPSH value. Strainer testing included flow adjustment checks to verify that jetting or blow-hole conditions would not inhibit the expected head loss reduction associated with reduced viscosity. The strainer head loss associated with chemical effects does not include a viscosity correction.
- Peak head loss associated with limiting NPSH values are only applicable at elevated sump water temperatures, which occurs relatively early in accident response and not all of the debris would be expected to have eroded and transported to the strainer during this time period; however, the strainer debris loading assumes 100% of the transported non-chemical precipitate debris totals at time zero and does not credit time-dependent transport.
- Bounding flows were used for two-train operation of reactor building spray (RBS) and injection pumps although securing one or both trains of RBS pumps would be expected prior to the formation of chemical effects precipitates at lower sump temperatures.

While not all of the above conservatisms have readily quantifiable impacts to the head loss test results, the aggregate effect of these conservatisms provides a very high degree of confidence that evaluated test results are well bounding for any credible or design bases accident that requires sump recirculation. These multiple stacked conservatisms provide defense-in-depth to ensure that the systems and components needed to respond to a loss-of-coolant accident (LOCA) requiring sump recirculation would be able to perform their design function.

Given the very limited amounts of potentially detrimental remaining debris that could be present during a LOCA, combined with the large surface area strainer installed above the sump pit, the expected outcome for the incredible occurrence of a design bases double-ended guillotine break of the reactor coolant system (RCS) piping at the most limiting location relative to potentially affected debris sources, is that open screen would remain and thin-bed filtration conditions would not develop. In the unlikely event of such a break combined with the assumed conservative insulation destruction, debris transport, and uniform strainer debris distribution, the resulting strainer head loss including upstream and downstream effects remains acceptable as noted in the September 15, 2008, final supplemental response, September 24, 2009, RAI responses, and updates provided in this submittal.

Specific Revisions

The following provides the areas in which the final supplemental response dated September 15, 2008 (0CAN090801), and the RAI responses dated September 24, 2009 (0CAN090901), are revised. In addition, please note that RAIs B22-B50 are no longer applicable to ANO-1.

1. Overall Compliance and

2. General Description of and Schedule for Corrective Actions

No changes to these sections.

3. Specific Information Regarding Methodology for Demonstrating Compliance

3.a Break Selection

3.a.1 Baseline Break Selection and

3.a.2 Secondary Line Breaks

No changes to these sections.

3.a.3 Size and Location Conclusion

The revised debris generation analysis resulted in slight changes to which breaks produced the most debris, but the conclusion that the south cavity S4 break (upper hot leg) is the most limiting break remains valid. Updated debris generation totals are included in Section 3.b.4.

3.b Debris Generation/ZOI (excluding coatings)

3.b.1 ZOI Methodology including RAIs A1, A2, and A3

The following changes to the ZOI methodology are provided:

- The ZOI for calcium-silicate insulation with screwed SS lagging previously credited a 25D ZOI based on Westinghouse tests documented in WCAP-16836. The revised debris generation analysis accounts for all unshadowed calcium-silicate insulation covered with screwed lagging as debris due to the absence of an approved ZOI reference source. Shadowing was credited as allowed per NEI 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- In the September 15, 2008, submittal a ZOI of 25D was credited for HDFG insulation with screwed SS lagging based on Westinghouse tests documented in WCAP-16836. The revised debris generation analysis credits all unshadowed HDFG insulation as debris due to absence of an approved ZOI reference source. Shadowing was credited as allowed per NEI 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- The previous analysis for Transco Temp-Mat insulation, which is located in a few small sections with the Transco reflective metal insulation (RMI) instead of the reflective metal foil, credited the 2.0D ZOI from NEI 04-07 associated with the surrounding Transco RMI lagging and fasteners as applicable since the interior insulation would not be released unless the outer jacketing was first dislodged. This was discussed in the RAI A3 response. The revised debris generation analysis has applied the 11.7D ZOI for Temp-Mat consistent with NEI 04-07.

3.b.2 Destruction ZOI and Basis including RAIs A1, A2, and A3

Revised Table 3.b.2-1 is updated to reflect the previous and revised debris generation analysis insulation ZOIs.

Revised Table 3.b.2-1 Destruction ZOIs and Basis

Debris Sources	**Previous Analysis**		**Revised Analysis**	
	ZOI	**Basis**	**ZOI**	**Basis**
Transco RMI	2.0D	NEI 04-07	2.0D	NEI 04-07
Temp-Mat	2.0D	See 3.b.1	11.7D	NEI 04-07
Thermal-Wrap Fiber	25D	WCAP-16836	17D	NEI 04-07
Thermal-Wrap Fiber (SS cladding, SS banding)	5.45D	Adapted from NEI 04-07, See RAI A1	5.45D	NEI 04-07, See RAI A1
HDFG	25D	WCAP-16836	All	See 3.b.1
Calcium-Silicate (SS cladding, SS banding)	5.45D	NEI 04-07	5.45D	NEI 04-07
Calcium-Silicate (SS cladding with screws)	25D	WCAP-16836	All	See 3.b.1

3.b.3 Destruction Testing

Entergy previously credited insulation destructive testing for ANO-1 conducted by Westinghouse per WCAP-16836. As noted in Section 3.b.1, this testing is no longer credited in the revised debris generation analysis.

3.b.4 Debris Type Quantity including RAI A8

Revised Table 3.b.4-1 and the clarification provided in RAI A8 are changed to reflect the revised debris generation analysis as follows:

Revised Table 3.b.4-1 Summary of LOCA-Generated Debris

Debris Type	**Units**	**South Break S1**	**South Break S4**	**South Break S5**	**North Break S1**	**Strainer Test**
Transco RMI Foil	ft^2	11019	4959	1032	11263	0
Calcium-Silicate	ft^3	6.9	10.2	9.5	4.42	14.5
Fiber Sources						
Transco Temp-Mat	ft^3	1.65	1.65	0	1.2	
HDFG	ft^3	6.0	12.4	12.4	4.3	
Thermal-Wrap Insulation	ft^3	1.9	0.0	5.1	0.0	
Cera-Fiber Insulation	ft^3	0.22	0.31	0.28	0.12	
Penetration Blanket Fiber (Note 1)	lbs	2	2	2	1.5	
Total Fiber w/o latent (Note 2)	lbs	54.8	79.8	72.3	36	
Total Fiber w/latent fiber	lbs	73.3	98.3	90.8	54.5	115

Note 1: Fabric blankets are installed over the RCS cold leg pipe penetrations into the SG cavities with 10% of the blanket weight credited as becoming fiber fines.

Note 2: The fiber densities used to determine total fiber mass are 11.8 lb/ft^3 for Temp-Mat, 4.5 lb/ft^3 for HDFG, 2.4 lb/ft^3 for Thermal-Wrap, and 8 lb/ft^3 for Cera-Fiber.

3.b.5 Miscellaneous Materials

The total surface area of transportable signs, placards, tags, tape, and similar foreign materials in the reactor building following efforts to remove these potential debris sources was reported as less than 100 ft^2. The revised analysis for these materials assumes 148.2 ft^2 of gross surface area with 111.2 ft^2 of net strainer blockage, which remains well below the 200 ft^2 allowance for net surface area blockage.

3.c Debris Characteristics

3.c.1 Size Distribution including RAI A4

The size distribution for Transco Thermal-Wrap and Temp-Mat fiber insulations previously used 100% fines size distribution due to having applied smaller ZOIs than those in NEI 04-07, which provided the basis for the 60% fines and 40% large pieces size distribution. Based on the revised debris generation analysis using the NEI 04-07 specified ZOI values, the fiber size distribution has also been changed to 60% fines and 40% large pieces per NEI 04-07.

3.c.2 Bulk Densities and

3.c.3 Surface Areas

No changes to these sections.

3.c.4 Debris Characterization Deviations

The previous response stated that 100% transport of all insulation and coating debris was assumed. This was based upon the insulation size distribution all being credited as 100% fines. As noted in the change to Section 3.c.1, the size distribution for Temp-Mat and Thermal-Wrap fiber insulation has been changed in the new analysis to 60% fines and 40% large pieces in conjunction with the change in credited ZOIs for these materials to those in NEI 04-07. The analysis continues to assume transport of all fiber fines but not transport or erosion of the 40% large pieces of Temp-Mat and Thermal-Wrap fiber that remain trapped inside their fabric covers, consistent with NEI 04-07 guidance.

3.d Latent Debris

3.d.1 Latent Debris Methodology including RAI A5,

3.d.2 Basis for Assumptions,

3.d.3 Evaluation Results, and

3.d.4 Sacrificial Strainer Surface Area

No changes to these sections and associated RAI.

3.e Debris Transport

3.e.1 Debris Transport Methodology

Similar to the update to Section 3.c.4, the previous response stated that 100% transport of all insulation debris was assumed. This was based upon the insulation size distribution all credited as 100% fines. As noted in the change to Section 3.c.1, the size distribution for Temp-Mat and Thermal-Wrap fiber insulation has been changed in the new analysis to 60% fines and 40% large pieces in conjunction with the change in credited ZOIs for these materials to those in NEI 04-07. The analysis continues to assume transport of all fiber fines but not transport or erosion of the 40% large pieces of Temp-Mat and Thermal-Wrap fiber that remain trapped inside their fabric covers, consistent with NEI 04-07 guidance.

3.e.2 Deviations

No changes to this section.

3.e.3 Computational Fluid Dyanmics (CFD) Codes

The September 15, 2008, submittal response stated that a CFD code was used to evaluate flow velocities in the reactor building basement, but it was not subsequently used to justify reductions in debris transport analysis. The revised analysis for miscellaneous foreign material debris does credit the CFD velocities in conjunction with the transport and lift velocities in NUREG 6808 to preclude high density materials not having a high surface area to mass ratio from transport to the sump strainer. The CFD model was not used to limit the transport of coatings, latent debris, calcium-silicate, or fiber fines insulation.

3.e.4 Debris Interceptors

No changes to this section.

3.e.5 Settling

The September 15, 2008, submittal response stated that the debris transport fraction for insulation and coating debris was assumed to be 100% and that no credit was taken for settling of insulation or coating debris. This is clarified with respect to the Transco Thermal-Wrap and Temp-Mat insulation in the revised analysis which includes 40% large pieces that remain trapped inside the fabric covers per NEI 04-07 guidance. These sections of fabric-covered fiber insulation are not transported to the strainer. Remaining materials continue to credit 100% transport.

3.e.6 Debris Transport Fractions

Same clarification as Sections 3.e.1 and 3.e.5 regarding transport of Thermal-Wrap and Temp-Mat fiber large pieces trapped in fabric cover. Remaining materials continue to credit 100% transport.

3.f Head Loss and Vortexing

3.f.1 Schematic Diagrams,

3.f.2 Minimum Submergence including RAI A7,

3.f.3 Vortexing Evaluation, and

3.f.4 Head Loss Testing including RAI A6

No changes to these sections and associated RAIs.

3.f.5 Debris Loading including RAI A8

Revised Table 3.f.5-1 and the clarification provided in RAI A8 are changed to reflect the revised debris generation analysis as follows:

Revised Table 3.f.5-1 Comparison of Debris Generation to Strainer Test Debris Loads

Debris Type	Units	South Break S1	South Break S4	South Break S5	North Break S1	Strainer Test
Latent Fiber	lbs	18.5	18.5	18.5	18.5	30
Total Fiber (including Latent)	lbs	73.3	98.3	90.8	54.5	115
Calcium-Silicate	ft^3	6.9	10.2	9.5	4.42	14.5
Coatings (qual. and unqual.)	ft^3	3.56	3.56	2.40	3.56	4.25
Latent Particulate	lbs	105	105	105	105	170

3.f.6 Thin-Bed Effect

No changes to these sections.

3.f.7 Maximum Head Loss

The term "NPSH margin" used in the September 15, 2008, submittal for strainer allowable head loss is clarified as clean strainer NPSH margin, not strainer debris bed head loss-corrected NPSH margin.

3.f.8 Margins

The following changes to the conservatisms and margins described in the September 15, 2008, submittal are provided per the revised analysis:

- The September 15, 2008, submittal stated 100% of fiber debris was assumed to be reduced to fines or very small pieces, which were credited with 100% transport. This remains true for most of the fiber sources, although as noted previously the revised analysis for Thermal-Wrap and Temp-Mat uses the NEI 04-07 ZOI and size distribution guidance, and therefore 40% of these materials are not reduced to fines, due to remaining trapped inside their fabric covers, and are not transported to the strainer.

- The calcium-silicate debris generation no longer credits a 25D ZOI for un-banded material (screwed lagging) due to discontinued credit for WCAP-16836. This ZOI has been replaced with a more conservative credit of all unshadowed calcium-silicate not having banded lagging as becoming debris.

- The September 15, 2008, submittal stated that a viscosity correction was not applied to the head loss measured at ambient temperature used for comparison with NPSH head loss limits. The revised analysis credits application of a viscosity correction to the strainer head loss for comparison with elevated temperature NPSH head loss limits.

3.f.9 Clean Strainer Head Loss,

3.f.10 Debris Head Loss Analysis,

3.f.11 Submergence/Venting, and

3.f.12 Near-Field Settling

No changes to these sections.

3.f.13 Head Loss Scaling

The September 15, 2008, submittal stated that a viscosity correction was not applied to the head loss measured at ambient temperature used for comparison with NPSH head loss limits. The revised analysis does apply a viscosity correction to the strainer head loss applicable to elevated temperature conditions. The September 15, 2008, submittal included the justification for application of a viscosity correction, even though one was not initially applied.

3.f.14 Accident Pressure Credit

The September 15, 2008, response remains accurate. Based upon the revised analysis' application of a viscosity correction to the strainer head loss conditions applicable to elevated temperatures, the credited viscosity scaled head loss of 0.32 feet (3.84 inches) remains below the minimum of seven inches of submergence available. Thus, credit for a small amount of post-accident overpressure as discussed in the September 15, 2008, submittal, while still accurately described, is not required to avoid the potential for flashing across the strainer.

3.g Net Positive Suction Head

3.g.1 Flow Rates, Temperature, and Water Level,

3.g.2 Assumptions,

3.g.3 NPSHr Basis,

3.g.4 Friction and Other Flow Losses,

3.g.5 System Response, and

3.g.6 Pump Status

No changes to these sections.

3.g.7 Single Failure Assumptions

The systems referred to in the September 15, 2008, submittal response to 3.g.7 are designed to perform their required function assuming an active single failure.

3.g.8 Sump Water Level,

3.g.9 Conservative Assumptions,

3.g.10 Volumes,

3.g.11 Water Displacement, and

3.g.12 Water Sources,

No changes to these sections.

3.g.13 Reactor Building Accident Pressure,

3.g.14 Reactor Building Accident Pressure Assumptions, and

3.g.15 Vapor Pressure

The responses to 3.g.13 and 3.g.14 in the September 15, 2008, submittal are to be taken in context with the response to 3.g.15.

3.g.16 NPSH Margin Results

The data in revised Table 3.g.16-1 was provided for clean strainer conditions in the September 15, 2008, submittal and is updated to reflect the viscosity-corrected strainer head loss NPSH margins.

Revised Table 3.g.16-1 NPSH Margin

Pump	**Clean Strainer NPSH Margin (ft)**	**Debris-Loaded Strainer NPSH Margin (ft)**
A Train Low-Pressure Injection (LPI)	5.26	4.94
B Train LPI	4.76	4.44
A Train Reactor Building Spray (RBS)	5.96	5.64
B Train RBS	4.09	3.77

3.h Coatings Evaluation

3.h.1 Coating Systems in the Reactor Building,

3.h.2 Assumptions in Post-LOCA Paint Debris Transport,

3.h.3 Suction Strainer Head Loss Testing, and

3.h.4 Surrogates

No changes to these sections.

3.h.5 Coatings Debris Generation Assumptions

Entergy previously utilized WCAP 16568-P, "Jet Impingement Testing to Determine the ZOI for DBA-Qualified/Acceptable Coatings," for determining both epoxy and primer qualified coatings ZOI values. Per the revised NRC coating ZOI guidance issued April 6, 2010, the continued use of a 4D ZOI for qualified epoxy coating from WCAP-16568 remains acceptable, but the ZOI for primer coatings is changed from 5D (from WCAP-16568) to 10D (per NEI 04-07). The revised debris generation analysis for ANO-1 no longer credits a 5D ZOI for surfaces with only a qualified primer coating, with the 10D value noted as the accepted ZOI. The application of inorganic zinc primer without an epoxy topcoat is not common. Inspections are performed to track primer-only coating locations and surface areas within the SG cavities.

3.h.7 Coating Condition Assessment Programs

No changes to this section.

3.i Debris Source Term

3.i.1 Reactor Building Debris Generation Assumptions,

3.i.2 Foreign Material Exclusion Programmatic Controls including RAI A10,

3.i.3 Permanent Plant Changes Inside the Reactor Building,

3.i.4 Maintenance Rule,

3.i.5 Reactor Building Insulation Change-Outs,

3.i.6 Existing Insulation Modification,

3.i.7 Equipment/System Modification, and

3.i.8 Reactor Building Coatings Program Modification

No changes to these sections and associated RAI.

3.j <u>Screen Modification Package</u>

3.j.1 <u>Sump Screen Design Modification and</u>

3.j.2 <u>Related Modifications including RAI A12</u>

No changes to these sections and associated RAI.

3.k <u>Sump Structural Analysis</u>

3.k.1 <u>Design Inputs, Design Codes, Loads, and Load Combinations including RAI A13</u>,

3.k.2 <u>Structural Qualification Results</u>,

3.k.3 <u>Dynamic Effects including RAI A14, and</u>

3.k.4 <u>Back-Flushing</u>

No changes to these sections and associated RAIs.

3.l <u>Upstream Effects</u>

3.l.1 <u>Choke Points</u>,

3.l.2 <u>Choke Point Mitigation</u>,

3.l.3 <u>Water Holdup, and</u>

3.l.4 <u>Reactor/Refueling Cavity Drain Blockage including RAI A11</u>

No changes to these sections and associated RAI.

3.m <u>Downstream Effects - Components and Systems</u>

3.m.1 <u>NRC-Approved Methods</u>,

3.m.2 <u>Downstream Evaluations, and</u>

3.m.3 <u>Design/Operational Changes</u>

No changes to these sections.

3.n <u>Downstream Effects - Fuel and Vessel</u>

3.n.1 <u>In-vessel Effects including RAI A15</u>

No changes to this section and associated RAI.

3.o <u>Chemical Effects</u>

3.o.1 <u>Evaluation Results</u>,

3.o.2.1.i <u>Sufficient 'Clean' Strainer Area</u>,

3.o.2.2.i <u>Debris Bed Formation including RAI A9</u>,

3.o.2.3.i <u>Plant-Specific Materials and Buffers</u>,

3.o.2.4.i <u>Chemical Source Term</u>,

3.o.2.5.i <u>Separate Effects Decision</u>,

3.o.2.6 <u>AECL Model</u>,

3.o.2.7.i <u>WCAP Base Model Deviation</u>,

3.o.2.7.ii <u>WCAP Base Model Precipitates</u>,

3.o.2.8.i <u>WCAP Refinements</u>,

3.o.2.9.i <u>Solubility Refinements</u>,

3.o.2.9.ii <u>Crediting Aluminum Inhibition</u>,

3.o.2.9.iii <u>Solubility Credit</u>,

3.o.2.9.iv <u>Predicted Plant-Specific Precipitates</u>,

3.o.2.10.i <u>Precipitate Generation</u>,

3.o.2.11.i <u>Chemical Injection Precipitate Volume</u>,

3.o.2.11.ii <u>Injected Chemicals</u>,

3.o.2.11.iii <u>Added Precipitate</u>,

3.o.2.12.i <u>Pre-Mix in Tank</u>,

3.o.2.13.i <u>Near-Field Settlement</u>,

3.o.2.14.i <u>Near-Field Settlement Values</u>,

3.o.2.14.ii <u>Surrogate Chemical Debris Settlement</u>,

3.o.2.15.i <u>Debris/Precipitate Without Near-Field Settlement Credit</u>,

3.o.2.15.ii <u>Precipitate Values Without Near-Field Settlement Credit</u>,

3.o.2.16.i <u>Test Termination Criteria</u>,

3.o.2.17.i <u>Pressure Drop Curve as a Function of Time</u>,

3.o.2.17.ii <u>Extrapolation Methods</u>,

3.o.2.18.i <u>Integral Generation (Alion)</u>,

3.o.2.19.i <u>Scaling Factors</u>,

3.o.2.19.ii <u>Bed Formation</u>,

3.o.2.20.i <u>Tank Transport</u>,

3.o.2.21.i <u>30-Day Integrated Head Loss Test Conditions</u>,

3.o.2.21.ii <u>Pressure Drop Curve as a Function of Time, and</u>

3.o.2.22.i <u>Bump-Up Factor</u>

No changes to these sections and associated RAI.

3.p **Licensing Basis**

The ANO-1 Final Safety Analysis Report is being revised in accordance with the ANO engineering change process to reflect the revised analysis.

Attachment 2 to

0CAN091001

ANO-2 Revised Final Supplemental Response including Requests for Additional Information

ANO-2 Revised Final Supplemental Response including Requests for Additional Information

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Debris Generation:

- Calcium-silicate zone-of-influence (ZOI) for lagging fastened with sheet metal screws originally credited a 25D ZOI based on Westinghouse testing conducted for ANO but has since been revised to credit all unshadowed material based on absence of an approved ZOI reference source. Shadowing was credited as allowed per NRC-approved Nuclear Energy Institute (NEI) 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- Calcium-silicate ZOI of 5.45D for banded lagging was based on testing performed on weaker aluminum lagging compared to the stainless steel (SS) lagging installed at ANO.

Debris Transport:

- 100% transport of all fibers, coatings, calcium-silicate fines, and latent debris to the strainers was originally applied. The revised analysis continues to credit 100% transport of all fiber fines, calcium-silicate fines, coatings, and latent debris but does not credit transport or erosion of 40% of the Transco Thermal-Wrap insulation remaining as large pieces trapped in the fabric covers, consistent with the guidance in NEI 04-07.

Head Loss Testing:

- Fiber was added as all fines and very small shreds, separated into multiple containers to avoid agglomeration, and slowly poured into a flowing flume to maximize even distribution.

- Near-field settling was not credited and was avoided by stirring of the test flume.

- Testing was conducted for an extended time period (330+ hours) to ensure bounding head loss effects were captured.

- Thin-bed conditions were established in the test with vertical debris distribution throughout the strainer pockets (i.e., including upper pockets) significantly more uniform than would be expected in the plant, based on pouring debris in increments into the top of a flowing flume and stirring of any settled debris materials to re-suspend them.

- The credited strainer head loss test for ANO-2 has been changed since the September 15, 2008, submittal and September 24, 2009, RAI responses were provided, consistent with the contingency actions described in RAI B2. The strainer testing included an excess of debris material types above those calculated to ensure margin is available to address small changes in analysis, as-found conditions, or installed configurations. The tested quantity exceeded the maximum amount for any debris type for any break (i.e., highest coating particulate from one break combined with highest fiber from a second break and highest calcium-silicate from a third break). The debris loading for strainer head loss testing expressed as an approximate percentage of the amount at the strainer in the debris generation calculation for the limiting break is as follows: non-latent fiber – 243% (lb basis); calcium-silicate – 106%; coatings – 162%; latent debris – 143%; miscellaneous foreign material – 218% ("tested" as allowance for blockage).

Head Loss Analysis:

- Strainer test head loss measured at room temperature remains acceptable without applying viscosity correction; however, the revised pump net positive suction head (NPSH) analysis credits a viscosity-corrected strainer head loss value reflecting the elevated temperatures associated with the limiting pump NPSH value. Strainer testing included flow adjustment checks to verify that jetting or blow-hole conditions would not inhibit the expected head loss reduction associated with reduced viscosity. The strainer head loss associated with chemical effects does not include a viscosity correction.

- Peak head loss values were used versus more representative steady-state values.

- Peak head loss associated with limiting NPSH values are only applicable at elevated sump water temperatures, which occurs relatively early in accident response and not all of the debris would be expected to have eroded and transported to the strainer during this time period. The strainer debris loading assumes 100% of the transported non-chemical precipitate debris totals at time zero and does not credit time-dependent transport.

- Bounding flows were used for two-train operation of the containment spray system (CSS) and injection pumps although securing one or both trains of CSS pumps would be expected prior to the formation of chemical effects precipitates at lower sump temperatures.

While not all of the above conservatisms have readily quantifiable impacts to the head loss test results, the aggregate effect of these conservatisms provides a very high degree of confidence that evaluated test results are well bounding for any credible or design bases accident that requires sump recirculation. These multiple stacked conservatisms provide defense-in-depth to ensure that the systems and components needed to respond to a loss-of-coolant accident (LOCA) requiring sump recirculation would be able to perform their design function.

Given the very limited amounts of potentially detrimental remaining debris that could be present during a LOCA, combined with the large surface area strainer installed above the sump pit, the expected outcome for the incredible occurrence of a design bases double-ended guillotine break of the reactor coolant system (RCS) piping at the most limiting location relative to potentially affected debris sources, is that open screen would remain and thin-bed filtration conditions would not develop. In the unlikely event of such a break combined with the assumed conservative insulation destruction, debris transport, and uniform strainer debris distribution, the resulting strainer head loss including upstream and downstream effects remains acceptable as noted in the September 15, 2008, final supplemental response, September 24, 2009, RAI responses, and updates provided in this submittal.

Specific Revisions

The following provides the areas in which the final supplemental response dated September 15, 2008 (0CAN090801), and the RAI responses dated September 24, 2009 (0CAN090901), are revised. In addition, please note that RAIs B22-B50 are no longer applicable to ANO-2.

1. Overall Compliance and

2. General Description of and Schedule for Corrective Actions

No changes to these sections.

3. Specific Information Regarding Methodology for Demonstrating Compliance

3.a Break Selection

3.a.1 Baseline Break Selection,

3.a.2 Secondary Line Breaks, and

3.a.3 Size and Location Conclusion

No changes to these sections.

3.b Debris Generation/ZOI (excluding coatings)

3.b.1 ZOI Methodology

The following changes to the ZOI methodology are provided:

- The ZOI for calcium-silicate insulation with screwed SS lagging previously used a 25D ZOI based on Westinghouse tests documented in WCAP-16836. The revised debris generation analysis assumes that all unshadowed calcium-silicate insulation covered with screwed lagging becomes debris due to the absence of an approved ZOI reference source. Shadowing was credited as allowed per NEI 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- The ZOI for Transco Thermal-Wrap blankets previously credited a 7D ZOI based on Westinghouse tests documented in WCAP-16836. The revised debris generation analysis credits a ZOI of 17D based on NEI 04-07 guidance for jacketed or unjacketed Nukon which is an equivalent insulation.

- The ZOI for ceramic fiber that was used at elbows, hangers, and fittings on some calcium-silicate insulated pipes continues to credit having the same ZOI as the adjacent calcium-silicate insulated pipe as stated in the September 15, 2008, submittal. The ZOI for some of the calcium-silicate insulation has been changed as described in the first bullet above.

3.b.2 Destruction ZOI and Basis

Revised Table 3.b.2-1 is updated to reflect the previous and revised debris generation analysis insulation ZOIs.

Revised Table 3.b.2-1 Destruction ZOIs and Basis

Debris Sources	**Previous Analysis**		**Revised Analysis**	
	ZOI	Basis	ZOI	Basis
Mirror foil	28.6D	NEI 04-07	28.6D	NEI 04-07
Transco Reflective Metal Insulation (RMI)	2.0D	NEI 04-07	2.0D	NEI 04-07
Calcium-Silicate[1] (unbanded)	25D	WCAP-16836	All	See 3.b.1
Calcium-Silicate[1] (banded)	5.45D	NEI 04-07	5.45D	NEI 04-07
Transco Thermal-Wrap	7D	WCAP-16836	17D	NEI 04-07

Note 1: ZOI applies to any sections of cera-fiber insulation in these lines.

3.b.3 Destruction Testing including RAIs B1, B2, B3a, B3b, and B3c

Entergy previously credited insulation destructive testing for ANO-2 conducted by Westinghouse per WCAP-16836. As noted in Section 3.b.1, this testing is not credited in the revised debris generation analysis.

3.b.4 Debris Type Quantity and associated RAI B14

Revised Table 3.b.4-1 and the clarification provided in RAI B14 are changed to reflect the revised debris generation analysis as follows:

Revised Table 3.b.4-1 Quantity of Debris at Strainer for Break Locations

Insulation Debris Type[2] (within ZOI)	**Units**	**South Break S1**	**North Break S2**	**South Break S4**	**South Break S6**
Mirror foil[1]	ft^2	52,542	43,220	18,147	53,635
Transco RMI foil[1]	ft^2	6,064	6,064	0	5,094
Calcium-Silicate	ft^3	23.0	16.4	23.2	25.2
Transco Thermal-Wrap	ft^3	24.6	0	28.0	0
Cera-Fiber Insulation	ft^3	0.56	0.36	1.01	1.01

[1] Foils were measured by surface area.

[2] Other breaks were bounded by those shown in the table.

3.b.5 Miscellaneous Materials

The total surface area of transportable signs, placards, tags, tape, and similar foreign materials in containment following efforts to remove these potential debris sources was reported as less than 100 ft^2. The revised analysis for these materials credits 122.3 ft^2 of gross surface area with 91.8 ft^2 of net strainer blockage, which remains well below the 200 ft^2 allowance for net surface area blockage.

3.c Debris Characteristics

3.c.1 Size Distribution including RAI B4

The size distribution for Transco Thermal-Wrap fiber insulations previously used 100% fines size distribution due to having applied a smaller ZOI than the NEI 04-07 guidance which provided the basis for the 60% fines and 40% large pieces size distribution. Based on the revised debris generation analysis using the NEI 04-07 specified ZOI of 17D for Thermal-Wrap, the fiber size distribution has been changed to 60% fines and 40% large pieces per NEI 04-07.

3.c.2 Bulk Densities and

3.c.3 Surface Areas

No changes to these sections.

3.c.4 Debris Characterization Deviations including RAI B6

The previous response stated that 100% transport of fiber was assumed. This was based upon the insulation size distribution being credited as 100% fines. As noted in the change to Section 3.c.1, the size distribution for Thermal-Wrap fiber insulation has been changed in the new analysis to 60% fines and 40% large pieces in conjunction with the change in the credited ZOI to that in NEI 04-07. The analysis continues to credit 100% transport of all fiber fines but does not credit transport of the 40% large pieces of Thermal-Wrap fiber that remains trapped inside their fabric covers which is consistent with the NEI 04-07 guidance.

3.d Latent Debris

3.d.1 Quantity Estimate including RAI B5 and

3.d.2 Basis for Assumptions

No changes to these sections.

3.d.3 Evaluation Results

Since the latent debris walkdown discussed in the September 15, 2008, submittal and RAI B5 response, a subsequent latent debris survey has been conducted. The latent debris total from the most recent survey is 139.7 lbs.

3.d.4 Sacrificial Strainer Surface Area

No changes to this section.

3.e Debris Transport

3.e.1 Debris Transport Methodology including RAI B6

Similar to the update to Section 3.c.4, the previous response stated that 100% fiber transport was assumed. This was based upon the insulation size distribution of 100% fines. As noted in the change to Section 3.c.1, the size distribution for Thermal-Wrap fiber insulation has been changed in the new analysis to 60% fines and 40% large pieces in conjunction with the change in the credited ZOIs to that in NEI 04-07. The analysis continues to credit 100% transport of all fiber fines, but does not credit transport of the 40% large pieces of Thermal-Wrap fiber that remain trapped inside their fabric covers which is consistent with the NEI 04-07 guidance.

The September 15, 2008, submittal stated, *"Downstream effects analysis credited 75% transport of Transco RMI and 1.6% of Mirror RMI to the strainer."* The revised downstream effects analysis has credited 100% transport of Transco and Mirror RMI to the strainer.

3.e.2 Deviations

No changes to this section.

3.e.3 Computational Fluid Dyanmics Codes including RAI B8

A change to the RAI B8 response regarding the transport applied to fiber is the same as the clarification provided in Section 3.e.1.

3.e.4 Debris Interceptors

No changes to this section.

3.e.5 Settling including RAI B6

No changes to this section and associated RAI.

3.e.6 Debris Transport Fractions and Total Quantities including RAI B10

The debris transport data in the September 15, 2008, submittal and RAI B10 is updated as follows:

Revised Table 3.e.6-1 Debris Fraction at Sump

Debris Type	**Debris Fraction at Sump**
SS Mirror RMI Foil	N/A[1]
SS Transco RMI Foil	N/A[1]
Calcium-Silicate (break-generated)	0.58[2]
Calcium-Silicate (spray-generated)	0.30[2]
Thermal-Wrap fiber	0.60[3]
Cera-Fiber	1.00
Qualified Coatings	1.00
Unqualified Coatings	1.00
Foreign Materials	1.00[4]
Latent Debris	1.00

1 RMI debris was not included in strainer testing due to non-conservative debris bed impacts.

2 Corresponds to total fraction of calcium-silicate fines generated with 100% fines transport as detailed in RAI B6 and B7 responses.

3 Corresponds to 60% fines, credited with 100% transport and 40% large pieces that remain trapped inside fabric covers.

4 Future sources of potential foreign material debris may be evaluated for transport reduction as noted in the September 15, 2008, Section 3.e.1 submittal response.

3.f Head Loss and Vortexing

3.f.1 Schematic Diagrams,

3.f.2 Minimum Submergence, and

3.f.3 Vortexing Evaluation

No changes to these sections.

3.f.4 Head Loss Testing including RAI B14

The credited strainer head loss test for ANO-2 has been changed to address the revised debris loading associated with discontinued credit for WCAP-16836. The description in the September 15, 2008, submittal stated the strainer test addressed three distinct test conditions; however, the strainer test credited by the revised analysis credits only two distinct test conditions. The first condition includes all of the strainer debris other than chemical effects, while the second condition includes chemical effects precipitates. The test loop flow with non-chemical debris bounded the maximum two-train flow plus a low-pressure safety injection (LPSI) pump to address the potential single failure condition. The flow was reduced after the chemical precipitate head loss increased but to a value that continued to bound the two-train maximum flow.

The credited strainer head loss test results remain within the available NPSH margin and the structural design limits. The results of strainer head loss testing with and without chemical effects are provided from the Section 3.o.2.17.i response of Attachment 1 (ANO-1) in the September 15 2008, submittal.

Revised Table 3.f.4-1 Strainer Test Peak Head Losses Measured

	Time (sec)	**Head Loss (psid)**
LPSI + Two-train flow (without chemical precipitation)	66436	0.386 (214.51 gpm)
Two-train flow (with chemical precipitation)	949680	1.36 (101.27 gpm)

The most limiting head loss was determined by comparing the head loss and test loop flow and adjusting the test loop flow by the scaling factor of 85.97:1 to obtain the equivalent plant strainer flow. The revised tables below provide comparisons of measured head loss and flows to the credited head losses corrected for maximum design flow and viscosity, as well as the maximum allowable head losses.

Revised Table 3.f.4-2 Strainer Test Head Losses Credited

	Measured Head Loss (ft)	**Equivalent Flow (gpm)**	**Equivalent Head Loss at Max Design Flow (ft)**	**Credited Viscosity Corrected Equivalent Head Loss at Max Design Flow (ft)**	**Maximum Design Flow (gpm)**
LPSI Flow	0.892	18,440	0.62	0.23	12,765
Two-Train Flow (without chemicals)	0.892	18,440	0.342	0.13	7065
Two-Train Flow (with chemical precipitation)	3.14	8706	2.6	n/a (note 1)	7065

Note 1 Viscosity correction is not applied to chemical effects debris head loss.

Revised Table 3.f.4-3 Credited Strainer Head Losses and Allowable Limits

	Credited Head Loss (ft)	**Allowable Limit (ft)**
LPSI Flow without chemicals	0.23	0.984
Two-Train Flow without chemicals	0.13	1.8
Two-Train Flow with chemical effects debris load	2.6	6.1

3.f.5 Debris Loading including RAIs B13 and B14

The data in Table 3.f.5-1 provided comparison of the debris total in the credited strainer head loss test and the debris generation analysis total for each material. This information was clarified with more specific values in the RAI B14 response. This data has subsequently been impacted by both the change in credited strainer test as well as the changes to the debris generation analysis associated with the ZOI changes as shown in revised Table 3.f.5-1. The strainer continues to be capable of handling the entire debris load with the exception of RMI foils, as stated in the September 15, 2008, submittal.

Revised Table 3.f.5-1 - Comparison of Debris Generation to Strainer Test Debris Loads

Material	Debris Generation Analysis – Material at Strainer	Strainer Test
Non-Latent Fiber	75.3 lbs	183 lbs
Latent Debris	139.7 lbs	200 lbs
Calcium-Silicate	25.2 ft^3	26.68 ft^3
Coating Total (Note 1)	5.34 ft^3	8.66 ft^3

Note 1: Coating total includes ZOI-generated qualified coatings, degraded qualified coatings, and unqualified coatings.

The RAI B13 response regarding debris addition sequence is modified slightly to address the change in strainer test credited for ANO-2, but the overall conclusion remains unchanged. The sixth paragraph of the RAI B13 response is replaced with the following to reflect the change in credited strainer tests:

> The fiber layer initially established in the strainer was thin (i.e., < 1/8") and appeared to remain at least partially porous for some period of time based on the murky water condition and the strainer head loss building gradually over several hours of recirculation with repeated stirring of the test loop. The debris bed would achieve brief periods of peak head loss during periods of stirring, followed by gradual declines after stirring was stopped to a lower stable value. The test loop was recirculated and stirred for several hours and left running over night with additional stirring performed of the settled material the following morning. After having run overnight, the test flume was stirred causing the head loss to increase to a peak value comparable to that seen the previous day, which although not a sustained or stable value was the credited head loss for non-chemical precipitate conditions. The test loop was in operation over 20 hours prior to the initial addition of chemical precipitates and no additional insulation, coating, or particulate debris was added to the test loop after the chemical precipitates were added during the qualification test.

3.f.6 Thin-Bed Effect

No changes to this section.

3.f.7 Maximum Head Loss

The term "NPSH margin" used in the September 15, 2008, submittal for strainer allowable head loss is clarified as clean strainer NPSH margin, not strainer debris bed head loss-corrected NPSH margin.

3.f.8 Margins

The more significant margins and conservatisms used in the strainer head loss testing and analysis presented in the September 15, 2008, submittal are adjusted as follows:

- Debris generation analysis was previously described as conservatively using a 25D ZOI for calcium-silicate insulation installed with screwed lagging rather than banding. This was stated as being conservative based on a jet impingement test that did not release any material. This test is no longer credited, and calcium-silicate insulation installed with screwed lagging is currently credited as all being affected unless shadowed from the break. Shadowing was credited as allowed per NEI 04-07 methodology for piping or components shielded by large obstructions such as the steam generator (including pedestal), pressurizer, and concrete walls.

- Debris transport was described as being conservatively treated with all fiber, coatings, and latent debris 100% transporting to the strainers with sizes intended to maximize head loss. The treatment of Thermal-Wrap fiber transport has been adjusted consistent with the guidance in NEI 04-07. Since the ZOI of 17D from NEI 04-07 is currently used, the size distribution of 40% of the affected Thermal-Wrap as non-eroded large pieces trapped inside their fabric cover is also used. The Thermal-Wrap fiber fines continue to use 100% transport. Other fiber sources are credited with 100% transport.

- The September 15, 2008, submittal stated:

  "*Even with 100% destruction of fiber materials to fines, and 100% transport, and perfectly even distribution, all of which were very conservative assumptions individually, the reduced amount of fiber material available in ANO-2 only supports formation of a thin-bed fiber layer*."

  As noted above, the debris generation analysis for fiber has been to be changed to be consistent with the guidance in NEI 04-07, which does not include 100% destruction of Thermal-Wrap fiber to fines (60% fines and 40% large pieces). However, the conclusion that this volume of fiber material only supports formation of a thin-bed fiber layer remains accurate.

- The September 15, 2008, submittal stated:

  "No *viscosity correction was applied to the elevated temperature head loss used for comparison with NPSH head loss limits, although the NPSH limit was only applicable to sump temperatures of 200°F or higher. The debris bed head loss response to flow changes indicates that a viscosity correction could be applied (i.e., no adverse jetting or blow through effects), although it was excluded as a conservative approach.*"

  This conservatism is no longer applied. Viscosity corrections are used by the pump NPSH analysis but not for the chemical effects head loss results. This conservative treatment of the strainer head loss results was intended to address uncertainties associated with use of debris generation ZOIs smaller than those in NEI 04-07, even though the changes were based upon jet impingement testing that was considered consistent with methodologies previously used and accepted by the NRC. Due to issues with these jet impingement tests, they are no longer credited and the larger ZOI values from NEI 04-07 have been applied to the debris generation analysis. Thus, the added conservatism of not crediting viscosity corrections has been removed.

The remaining conservatisms and margins in the September 15, 2008, submittal continue to apply.

3.f.9 Clean Strainer Head Loss including RAI B12,

3.f.11 Submergence/Venting including RAI B11, and

3.f.12 Near-Field Settling

No changes to these section and associated RAIs.

3.f.13 Scaling

Viscosity corrections have been applied to the strainer head loss test results used for elevated temperature comparisons (i.e., NPSH margins). The September 15, 2008, submittal included the justification for application of a viscosity correction as noted below even though one was not initially applied:

"*Strainer tests with large head losses typically exhibit blow-holes or jetting streams of water through the strainer, which can affect the head loss response to velocity changes. Velocity changes were made during the credited qualification test to evaluate the responsiveness of the debris bed to head loss. Poor head loss responsiveness to velocity change indicates that a similar lack of responsiveness to reduced viscosity may also exist and therefore the test results would not be suitable for viscosity correction. Most of the lower head loss tests did not exhibit this perforated debris bed jetting, and their head loss was responsive to flow changes. The debris only test results were considered acceptable for application of viscosity corrections based on both visual observation during the test (i.e., lack of blowholes) and the responsiveness of the debris bed head loss to flow changes. Since chemical effects were credited to occur at lower temperatures, a viscosity correction was not applicable. The chemical effects debris bed head loss was responsive to flow changes in spite of the presence of jetting through the bed*."

The strainer test flow was reduced by 50% after the maximum head loss was reached applicable to the pump NPSH margins. The decrease in strainer flow was accompanied by a comparable decrease in strainer head loss, which combined with visual observations not indicating jetting issues, supports the application of viscosity correction to the test data. The viscosity correction was limited to 200°F, although the most limiting NPSH margin occurs at 206.6°F.

3.f.14 Accident Pressure Credit

No changes to this section.

3.g Net Positive Suction Head

3.g.1 Flow Rates, Temperature, and Water Level,

3.g.2 Assumptions,

3.g.3 NPSHr Basis,

3.g.4 Friction and Other Flow Losses,

3.g.5 System Response, and

3.g.6 Pump Status

No changes to these sections.

3.g.7 Single Failure Assumptions including RAIs B9a, B9b, and B9c

The RAI responses to B9a and B9b are addressed by the changed strainer test which does not use time-dependent debris transport. Thus, the debris transport for the LPSI pump single failure does not credit any reduction associated with a response time for securing the running LPSI pump, other than it being accomplished prior to the sump water temperature cooling sufficiently to form chemical effects precipitates.

3.g.8 Sump Water Level,

3.g.9 Conservative Assumptions,

3.g.10 Volumes,

3.g.11 Water Displacement,

3.g.12 Water Sources,

3.g.13 Containment Accident Pressure,

3.g.14 Containment Accident Pressure Assumptions, and

3.g.15 Vapor Pressure

No changes to these sections.

3.g.16 NPSH Margin Results

The NPSH margins for the pumps have been updated to reflect both the clean strainer conditions and the viscosity-corrected strainer head loss as follows:

Revised Table 3.g.16-1 NPSH Margins for 'A' Train Pumps (C-High-Pressure Safety Injection (HPSI) aligned to 'A' train) for 'B' LPSI Failure to Trip on Recirculation Actuation Signal (RAS) with Two Trains (CSS and HPSI) in Service

Pump	NPSHa (ft)	NPSHr (ft)	Clean Strainer NPSH Margin (ft)	Viscosity-Corrected Strainer Debris Head Loss (ft)	NPSH Margin (ft)
2P-35A	17.956	11.5	6.456	0.23	6.22
2P-89A	20.976	19.4	1.576	0.23	1.34
2P-89C	19.784	18.8	0.984	0.23	0.75

Revised Table 3.g.16-2 NPSH Margins for 'B' Train Pumps (C-HPSI aligned to 'B' train) for 'A' LPSI Failure to Trip on RAS with Two Trains (CSS and HPSI) in Service

Pump	NPSHa (ft)	NPSHr (ft)	Clean Strainer NPSH Margin (ft)	Viscosity-Corrected Strainer Debris Head Loss (ft)	NPSH Margin (ft)
2P-35B	18.882	12.5	6.382	0.23	6.15
2P-89B	20.963	19.4	1.563	0.23	1.33
2P-89C	20.444	18.8	1.644	0.23	1.41

Revised Table 3.g.16-3 NPSH Margins for Two-Train Alignment - each train with One CSS Pump and One HPSI Pump

Pump	NPSHa (ft)	NPSHr (ft)	Clean Strainer NPSH Margin (ft)	Viscosity-Corrected Strainer Debris Head Loss (ft)	NPSH Margin (ft)
2P-35A	18.773	11.5	7.273	0.13	7.14
2P-35B	19.694	12.5	7.194	0.13	7.06
2P-89A	21.793	19.4	2.393	0.13	2.26
2P-89B	21.777	19.4	2.377	0.13	2.24
2P-89C	20.601	18.8	1.801	0.13	1.67

3.h Coatings Evaluation

3.h.1 Coating Systems in Containment,

3.h.2 Assumptions in Post-LOCA Paint Debris Transport,

3.h.3 Suction Strainer Head Loss Testing with Coatings, and

3.h.4 Surrogates

No changes to these sections.

3.h.5 Coatings Debris Generation Assumptions

The September 15, 2008, submittal stated:

> "*From this report* (WCAP-16568) *ANO has applied …a ZOI of 5D for qualified inorganic zinc coatings*" and "*Since only zinc primer coatings were affected in the region between the 4D and 5D ZOIs, qualified coating steel surfaces were assumed to have only primer in this region.*"

Based upon revised NRC guidance on qualified coatings per letter dated April 6, 2010, the WCAP-16568-P basis for a 5D ZOI for inorganic zinc primer coatings is no longer accepted, with the 10D ZOI value in NEI 04-07 being acceptable. This ZOI change has been incorporated into the ANO debris generation analysis. Due to the uncommon use of primer-only coatings in containment, the methodology for tracking this potential debris source is also changed from a ZOI analysis method to a periodic inspection by the coatings program, with all primer-only surfaces in the SG assumed to be debris regardless of distance from the postulated breaks. While the ANO-2 initial primer-only coating inspection is still pending (first available outage inspection opportunity in Spring 2011, as noted in correspondence dated April 8, 2010 (0CAN041001)), ample margin exists in the analysis for primer-only coatings and licensing commitment actions track the initial inspection per the April 8, 2010, correspondence.

3.h.6 Debris Characteristic Assumptions, and

3.h.7 Coating Condition Assessment Programs

No changes to these sections.

3.i Debris Source Term

3.i.1 Containment Debris Generation Assumptions including RAI B18

The response to RAI B18 regarding the potential for the internal divider plate screen to clog has been incorporated into the downstream effects calculation. The following are minor changes to the information provided in the RAI B18 response:

- The amount of flow potentially passing through the internal divider plate screen in the event of a single failure of an equipment train has been increased from 53%, which is the flow split determined by hydraulic analysis, to 60% to bound the results.
- The associated maximum allowed volume of fiber fines generated was accordingly reduced from 62 ft^3 to 54.9 ft^3.
- The maximum allowable fiber volume to avoid a particulate filtering thin-bed on the divider plate screen has been changed from one reflecting debris generation fiber totals, to an analysis/testing limit used to evaluate the acceptability of the debris generation calculation results.

3.i.2 Foreign Material Exclusion Programmatic Controls including RAI B15,

3.i.3 Permanent Plant Changes Inside Containment,

3.i.4 Maintenance Rule,

3.i.5 Containment Insulation Change-Outs,

3.i.6 Existing Insulation Modification,

3.i.7 Equipment/System Modification, and

3.i.8 Containment Coatings Program Modification

No changes to these sections and associated RAI.

3.j Screen Modification Package

3.j.1 Sump Screen Design Modification and

3.j.2 Related Modifications including RAI B18

No changes to these sections and associated RAI.

3.k Sump Structural Analysis

3.k.1 Design Inputs, Design Codes, Loads, and Load Combinations including RAI B19,

3.k.2 Structural Qualification Results,

3.k.3 Dynamic Effects including RAI B20, and

3.k.4 Back-flushing

No changes to these sections and associated RAIs.

3.l Upstream Effects

3.l.1 Choke Points,

3.l.2 Choke Point Mitigation, and

3.l.3 Water Holdup including RAI B17

No changes to these sections and associated RAI.

3.l.4 Reactor/Refueling Cavity Drain Blockage including RAI B16

The description of the modified refueling canal drain strainer provided in the RAI B16 response remains accurate. The potential sources of debris that could be ejected from the south SG cavity described in the fifth paragraph discussed the Wyle Labs ZOI testing (documented in WCAP-16836) as a basis for the hot leg and cold leg breaks not generating fibrous debris from Thermal-Wrap insulation installed on the pressurizer heads. The WCAP-16836 test results are no longer credited by ANO. The conclusion that the cold leg pipe breaks are not a credible source of Thermal-Wrap fiber insulation from the pressurizer heads remains correct without reliance on WCAP-16836. The hot leg break does affect the Thermal-Wrap on the pressurizer top head in the revised debris generation analysis. This material is not a blockage concern for the refueling canal drain strainer since the Thermal-Wrap fabric covers and large pieces trapped inside (40% per NEI 04-07 guidance) would not be expected to pass through the grating covers on top of the SG cavity, consistent with the response to RAI B16. The grating covers would also limit the ejection of larger loose fiber pieces while fines and small fiber fragments ejected out of the cavity which land in or are washed into the refueling canal do not represent a blockage threat for the large openings (see RAI B16 response) of the refueling canal drain strainer.

3.m Downstream Effects - Components and Systems

3.m.1 NRC-Approved Methods,

3.m.2 Downstream Evaluations, and

3.m.3 Design/Operational Changes

No changes to these sections.

3.n Downstream Effects - Fuel and Vessel

3.n.1 In-vessel Effects including RAI B21

No changes to this section and associated RAI.

3.o Chemical Effects

3.o.1 Evaluation Results

The September 15, 2008, submittal stated:

> "*The strainer qualification testing concluded that the maximum head loss with both chemical effects and debris was < 3.5 feet, which was below the maximum allowable head loss of > 6 feet based on strainer structural limits*."

These values are revised to reflect the new strainer head loss test which has a maximum head loss with both chemical and debris effects of 2.6 feet, which is below the maximum allowable head loss of 6.1 feet based on strainer assembly structural limits.

The September 15, 2008, submittal stated:

> "*The results of the combined debris and chemical precipitate tests indicate that for two-train full flow, unacceptably high head loss may develop if the chemical loading was assumed to be present when sump temperatures were elevated and sump head loss margin was most limited. However, the autoclave test results show that the chemical precipitates occur later in the accident response period when sump temperatures are reduced.*"

The statement that the tests indicate two-train full flow head loss with chemical precipitate produce "unacceptably high head loss" is no longer true, and the chemical debris loads could be shown acceptable for two-train full-flow head loss conditions. However, the analysis assumptions for chemical precipitates at elevated temperature conditions remain unchanged and continue to be applied.

3.o.2.1.i Sufficient 'Clean' Strainer Area

No changes to this section.

3.o.2.2.i Debris Bed Formation

The September 15, 2008, submittal statements in the first paragraph of this section regarding which break produces the largest debris total for particular debris types or combinations have been impacted by the changes in ZOI values for fiber and calcium-silicate as well as crediting a different strainer head loss test for ANO-2. The currently credited strainer head loss test debris total exceeds the maximum debris quantity from any break.

3.o.2.3.i Plant-Specific Materials and Buffers,

3.o.2.4.i Chemical Source Term,

3.o.2.5.i Separate Effects Decision,

3.o.2.6 AECL Model, and

3.o.2.7.i WCAP Base Model

No changes to these sections.

3.o.2.7.ii WCAP Base Model Precipitates

The September 15, 2008, submittal stated:

> *"The chemical effects head loss testing included an amount of sodium aluminum silicate (NAS) precipitate equivalent to 254 kg. The WCAP-16530 spreadsheet was used to convert this quantity of chemical precipitates into an equivalent aluminum area, which was found to be >1300 ft^2."*

The currently credited strainer test for ANO-2 included NAS precipitate equivalent to 379 kg, which when converted into an equivalent aluminum area using the WCAP-16530 spreadsheet was 1957 ft^2.

3.o.2.8.i WCAP Refinements,

3.o.2.9.i Solubility Refinements, and

3.o.2.9.ii Crediting Aluminum Inhibition

No changes to these sections.

3.o.2.9.iii Solubility Credit

The September 15, 2008, submittal stated in the third paragraph of this section:

> "*The autoclave tests included a bounding high aluminum input case originally intended to force chemical precipitates. This case included an aluminum input that greatly exceeds (approximately by a factor of 18) the amount installed in ANO-2, as well as exceeding the elevated aluminum precipitate used in the strainer testing (approximately by a factor of 4.7). The WCAP-16530 model predicted total aluminum release for the bounding high aluminum test case as >120 kg compared to the < 7 kg of aluminum release for the installed ANO-2 aluminum and 26 kg of equivalent aluminum release for the precipitate quantity used in the strainer testing*."

The change in credited strainer head loss test revises the factor at the end of the second sentence from 4.7 to 3.1 and in the third sentence the equivalent aluminum release for the strainer test is increased from 26 kg to 39 kg.

3.o.2.9.iv Predicted Plant Specific Precipitates,

3.o.2.10.i Precipitate Generation,

3.o.2.11.i Chemical Injection Precipitate Volume,

3.o.2.11.ii Injected Chemicals,

3.o.2.11.iii Added Precipitate,

3.o.2.12.i Pre-Mix in Tank,

3.o.2.13.i Settlement,

3.o.2.14.i Near-Field Settlement Values,

3.o.2.14.ii Surrogate Chemical Debris Settlement,

3.o.2.15.i Debris/Precipitate Without Near Field Settlement Credit, and

3.o.2.15.ii Precipitate Values Without Near Field Settlement Credit

No changes to these sections.

3.o.2.16.i Test Termination Criteria

The credited strainer test (CTU1-4) for ANO-2 is the same test credited for ANO-1, with the test termination criteria described in the response to Section 3.o.2.16.i of Attachment 1 (ANO-1) of the September 15, 2008, submittal. A summary of the key points are repeated below:

> *"The peak head loss reading was reached well prior to the end of the test (72 hours earlier) and was followed by additional chemical precipitate and stirring that did not further increase peak strainer head loss. The peak strainer head loss values were used as the test result."*
>
> *"The test duration was not 30 days; however, the test did bound a maximum head loss value, with continued operation resulting in a decrease rather than an increase in head loss. The chemical precipitates were also not added in one batch or over one day. Due to the relatively large amount of chemical precipitate predicted by the WCAP-16530 base model, preparation of 100% of the chemical materials was not practical in a short time period. Autoclave test results indicated that most of the precipitate would not be expected to form until sump temperatures began to cool, thus a more gradual addition was considered more prototypic of plant conditions. Chemical precipitates were added in 5% to 10% increments of the total loading. Early additions provided rapid and significant head loss increases, although the last significant increase occurred when the concentration was raised from 30% to 40% of the total and a peak value was reached between 50% and 60% of the total, with slightly declining head loss afterwards. The test facility loop was run for 14 days during the integrated chemical precipitate testing."*

3.o.2.17.i Pressure Drop Curve as a Function of Time

The strainer qualification head loss test credited for ANO-2 is now the same as the test credited for ANO-1. The pressure drop curves and test data were previously provided in the Section 3.0.2.17.i response of Attachment 1 (ANO-1) of the September 15, 2008, submittal.

3.o.2.17.ii Extrapolation Methods

The measured chemical effects head loss measured at ambient temperatures was not viscosity corrected. The test loop flows significantly exceeded the equivalent maximum two-train flow values for ANO-2. The measured head loss was extrapolated to an equivalent head loss at the maximum flow conditions by comparison of the strainer head loss response to flow adjustments. The strainer head loss response to flow reduction with 25% of the tested chemical loading was approximately directly proportional. After 100% of the chemical loading was added the head loss response was greater than a 1:1 proportion over the range of flow increase tested (approximately 30%). Both the rate of increase in head loss compared to the increase in flow and the rate of decrease in head loss to decrease in flow exceeded 1:1 during the flow adjustments with full chemical precipitate loading. The added table below provides the flow adjustment test data:

Revised Table 3.o.2.17.ii-1 End of Strainer Test Flow Adjustment Data

Time (sec)	Head Loss (psid)	Flow Rate (gpm)	Comments	Ratio of Head Loss Change to Flow Change
1128600 (after)	1.3	110	Initial stable head loss	
1191711	1.78 (dropped to 1.72)	131.58	Stable change of 0.42 psid for 21.6 gpm	32% head loss for 19.6% flow or 1.64:1
1194524	1.98 (dropped to 1.93)	144.74	Stable change from 331 hrs of 0.21 psid for 13.16 gpm	12.2% head loss for 10% flow or 1.22:1
1196259	1.17	113.16	Head loss dropped below initial value w/ flow reduction	
1196727	0.856	94.41		-27% head loss for -17% flow or 1.58:1

In order to conservatively bound the observed rate of head loss decrease with flow reduction, a 1:1 ratio was applied for extrapolation of the measured head loss to an equivalent head loss at lower flow.

3.o.2.18.i Integral Generation,

3.o.2.19.i Scaling Factors,

3.o.2.19.ii Bed Formation,

3.o.2.20.i Tank Transport,

3.o.2.21.i 30-Day Integrated Head Loss Test Conditions,

3.o.2.21.ii Pressure Drop Curve as a Function of Time, and

3.o.2.22.i Bump-Up Factor

No changes to these sections.

3.p Licensing Basis

No changes to this section.