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Nuclear Generation Group

February 29, 2008

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Docket No. 50-244

Supplementary Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

REFERENCES:

(a) Letter from Patrick D. Milano (NRC) to Mary G. Korsnick (Ginna LLC), dated February 9, 2006, R. E. Ginna Nuclear Power Plant Request for Additional Information RE: Response to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

(b) NRC Generic Letter 2004-02: "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" dated September 13, 2004

(c) Letter from Mary G. Korsnick (Ginna LLC) to Document Control Desk (NRC), dated August 31, 2005, Response to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

(d) Letter from Mary G. Korsnick (Ginna LLC) to Document Control Desk (NRC), dated July 27, 2006, Request for Extension for Completing Corrective Actions for Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

(e) Letter from William H. Ruland (NRC) to Anthony Pietrangelo (NEI), dated August 15, 2007, Content Guide for Generic Letter 2004-02 Supplemental Responses

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(f) NEI Paper dated October 20, 2007, Generic Letter 2004-02 Supplemental Responses Questions and Answers

(g) Letter from Patrick D. Milano (NRC) to Mary G. Korsnick (Ginna LLC), dated October 4, 2006, R.E. Ginna Nuclear Power Plant – Approval of Extension Request for Completions of Corrective Actions in Response to Generic Letter 2004-02

The purpose of this letter is to forward the response for R. E. Ginna Nuclear Power Plant, LLC (Ginna LLC) to the Nuclear Regulatory Commission (NRC) Request for Additional Information (Reference (a)) concerning NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" (Reference (b)).

Generic Letter (GL) 2004-02 was initially issued on September 13, 2004. Ginna replied on August 31, 2005 with the requested information (Reference (c)). At that time, Ginna planned to modify existing sump screens with new General Electric active self-cleaning strainers. Due to impracticalities in the active strainer design, the decision was made to upgrade sump protection by enhancing the passive strainer system. Ginna communicated this change in plan to the NRC in Reference (d).

The Request for Additional Information (RAI) requested supplemental input regarding final actions to resolve Generic Letter 2004-02 issues. This response was generated following the guidance provided in References (e) and (f) and contains all requested information available at this time. Chemical Effects Head Loss testing is still in progress with anticipated completion and review exceeding the February 29 deadline. Additional information regarding Chemical Effects and the completion of the physical sump upgrade will be submitted in accordance with Reference (f) based on Ginna's approved extension request (Reference (g)).

The response to the Request for Additional Information is provided in Attachment (1).

Should you have questions regarding the information in this submittal, please contact Mr. Brian Weaver at (585) 771-5219 or at Brian.Weaver@Constellation.com.

Very truly yours,

John Carlin

STATE OF NEW YORK :
: **TO WIT:**
COUNTY OF WAYNE :

I, John Carlin, being duly sworn, state that I am Vice President, R.E. Ginna Nuclear Power Plant, LLC (Ginna LLC), and that I am duly authorized to execute and file this request on behalf of Ginna LLC. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other Ginna LLC employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

[signature]

Subscribed and sworn before me, a Notary Public in and for the State of New York and County of Wayne, this 29th day of February, 2008.

WITNESS my Hand and Notarial Seal: [signature]
Notary Public

My Commission Expires: 29 February 2008
Date

RICHARD A. JOHNSON
NOTARY PUBLIC, STATE OF NEW YORK
No. 01JO6082344
QUALIFIED IN WAYNE COUNTY
MY COMMISSION EXPIRES Oct 21, 2010

Attachments: (1)

cc: S. J. Collins, NRC
D. V. Pickett, NRC
Resident Inspector, NRC (Ginna)
P.D. Eddy, NYSDPS
J. P. Spath, NYSERDA

ATTACHMENT (1)

REGNPP GL 2004-02 RAI RESPONSE

OVERALL COMPLIANCE

***NRC Issue* 1:**

Provide information requested in GL 2004-02, "Requested Information." Item 2(a) regarding compliance with regulations. That is, provide confirmation that the ECCS and CSS recirculation functions under debris loading conditions are or will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this generic letter. This submittal should address the configuration of the plant that will exist once all modifications required for regulatory compliance have been made and this licensing basis has been updated to reflect the results of the analysis described above.

At R.E. Ginna Nuclear Power Plant (REGNPP), an emergency recirculation sump is provided. The Emergency Core Cooling System (ECCS) sump serves both trains of the ECCS and the Containment Spray (CS) systems. In response to the Nuclear Regulatory Commission (NRC) Generic Letter (GL) 2004-02, Ginna is significantly modifying the containment ECCS sump strainer with a passive strainer system designed, manufactured and tested by Control Components, Incorporated (CCI) of Winterthur, Switzerland. This system is presently planned to increase the strainer surface area from approximately 600 ft^2 to approximately 4,000 ft^2. The sump strainer system is designed to ensure its allowable head loss is not exceeded following a Loss-of-Coolant Accident (LOCA), thereby not impacting the operability of the ECCS and CS system.

The Ginna containment sump strainer system will be installed during Ginna's April 2008 refueling outage. The planned system utilizes sixteen strainer modules. These are connected to a central water duct that discharges directly into the Ginna Sump "B", which houses the two Residual Heat Removal (RHR) pump suction lines. Each strainer module has a series of strainer cartridges constructed of perforated stainless steel plate. Following a LOCA event, all liquid in the containment recirculation pool must pass through these strainer cartridge perforations or similar sized strainer system gaps prior to entering Sump "B". The strainer in Containment is sized for the expected full design basis debris load.

In order to limit the debris transport to the strainer rear modules along the containment walls, a Debris Interceptor (DI) system has been developed to function as an integral part of the strainer system. The DI system utilizes plates with 1/16" perforations to limit the flow of fiber to the rear of the strainer modules (see section 3.f). The chemical head loss testing scheduled during February 2008 incorporates the DI plates.

Ginna's methodology for establishing the limiting case LOCA that generates the largest quantity of debris is discussed in the Break Selection section, 3.a. For each of the break locations selected, the debris type generated is discussed in section 3.b, Debris Generated / ZOI. Assumptions and the basis for selecting the surrogate debris type are listed in 3.b.1. Debris characterization and latent debris are discussed in sections 3.c and 3.d.

Debris transported to the strainer sump following a LOCA event is conducted using computational fluid dynamics (CFD) methodology. The Ginna containment CFD model was developed and CFD analysis conducted for the limiting LOCA breaks to establish the debris transported to the sump strainer. Debris transport analysis and the resulting transport to the sump strainer system are discussed in the Debris Transport section 3e.

There are no currently identified licensing actions or exemption requests needed to support changes to the plant-licensing basis as a result of the Generic Safety Issue (GSI)-191 improvements.

GENERAL DESCRIPTION OF AND SCHEDULE FOR CORRECTIVE ACTIONS

NRC Issue 2:

Provide a general description of actions taken or planned, and dates for each. For actions planned beyond December 31, 2007, reference approved extension requests or explain how regulatory requirements will be met as per "Requested Information" Item 2(b). That is provide a general description of and implementation schedule for all corrective actions, including any plant modifications, that you identified while responding to this generic letter. Efforts to implement the identified actions should be initiated no later than the first refueling outage starting after April 1, 2006. All actions should be completed by December 31, 2007. Provide justification for not implementing the identified actions during the first refueling outage starting after April 1, 2006. If all corrective actions will not be completed by December 31, 2007, describe how the regulatory requirements discussed in the Applicable Regulatory Requirements section will be met until the corrective actions are completed.

As of December 31, 2007, Ginna has completed the following GL 2004-02 actions, analyses and modifications.

- Latent debris walkdowns
- Debris generation analysis
- Containment debris transport analysis
- Detailed structural analysis of the new strainers
- Chemical effects analysis
- Thin bed tests
- Bypass tests
- Initial Head loss tests
- Hydraulic model of ECCS (to establish Net Positive Suction Head margin)
- Recirculation pool pH analysis
- Downstream effects analysis

As of December 31, 2007, the following activities were completed on behalf of REGNPP. However, based on the initial test results, additional testing will be performed prior to the Spring 2008 outage. This additional testing affects completion of certain required analyses and activities as noted.

- Chemical Effects Head Loss Testing
- Final Head loss analysis

Ginna strainer system head loss testing is being conducted in accordance with the NEI guidance letter for debris head loss testing. Strainer head loss tests are being conducted at CCI's multi functional test loop (MFTL) facility in Winterthur, Switzerland. Tests completed in June of 2007 demonstrated the inability to develop a thin bed.

Ginna has scheduled chemical effects head loss tests to be completed prior to the 2008 refueling outage. These tests will conform to the Westinghouse WCAP-16530-NP methodology. The chemical effects precipitate will be generated outside the test loop in accordance with the WCAP.

Ginna has utilized the WCAP-16406-P topical report downstream effects methodology to assess the impact of the debris injected into the ECCS and CSS components. Analysis of impacted components has demonstrated that these systems will continue to function without compromising long term cooling requirements. Efforts are underway to address the long term cooling requirements outlined in WCAP-16793.

Ginna has requested (Letter from Mary G. Korsnick, Ginna LLC) to Document Control Desk (NRC), dated July 27, 2006) and received approval for (Letter from Patrick D. Milano (NRC) to Mary G. Korsnick, Ginna LLC), dated October 4, 2006) an extension until after the Spring 2008 outage for the completion of the additional testing identified above and the physical installation of the sump strainer.

3.a **Break Selection**

NRC Issue 3a:

Break Selection

The objective of the break selection process is to identify the break size and location that present the greatest challenge to post-accident sump performance.

1. *Describe and provide the basis for the break selection criteria used in the evaluation.*
2. *State whether secondary line breaks were considered in the evaluation (e.g., main steam and feedwater lines) and briefly explain why or why not.*
3. *Discuss the basis for reaching the conclusion that the break size(s) and locations chosen present the greatest challenge to post-accident sump performance.*

The objective of the break selection process is to determine the break size and possible locations that would result in the greatest debris generation and/or the debris generation and transport combination that present the greatest challenge to post-accident sump performance. Additionally, breaks that would cause a "thin-bed" effect are given consideration since these also have the potential to significantly impair sump screen performance. The following break locations were analyzed for Ginna:

- Break Criterion No. 1: Locations in the Reactor Coolant System with the largest potential for debris generation.
- Break Criterion No. 2: Locations with two or more different types of debris.
- Break Criterion No. 3: Locations with the most direct path to the sump.
- Break Criterion No. 4: Locations with the largest potential particulate debris to insulation ratio.
- Break Criterion No. 5: Locations that would generate debris that could potentially form a thin-bed – high particulate with 1/8" fiber bed.

The spectrum of breaks considered is consistent with that recommended in the Safety Evaluation Report (SER)and is also consistent with regulatory position 1.3.2.3 of Regulatory Guide 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," Revision 3.

Ginna considered breaks in the primary coolant system piping having the potential for reliance on Emergency Core Cooling System (ECCS) sump recirculation. The review determined that a primary coolant system piping large break loss of coolant accident (LBLOCA) and certain primary coolant system piping small break LOCAs (SBLOCA) would require ECCS sump recirculation. Ginna considered other high energy line breaks (e.g., secondary side breaks) and determined that sump operation was not required.

For small breaks, only piping that is 2" in diameter and larger was considered. This is consistent with the Section 3.3.4.1 of the SER, which states that breaks less than 2" in diameter need not be considered. SER Section 3.3.5.2 advocates break selection at 5-ft intervals along a pipe in question but clarifies that "the concept of equal increments is only a reminder to be systematic and thorough". It further qualifies that recommendation by noting that a more discrete approach driven by the comparison of debris source term and transport potential can be effective at placing postulated breaks. The key difference between many breaks (especially large breaks) will not be the exact location along the pipe, but rather the envelope of containment material targets that is affected. A more comprehensive approach was taken for break selection which accounts for the overall placement and target density of the various insulation types of concern at Ginna.

The evaluation identified break locations that provided limiting conditions for each of the 5 break selection criteria above.

Break criterion No. 1: Largest potential for debris generation

The largest quantity of insulation in containment is located in the two steam generator (SG) compartments. Due to the size of the primary RCS loop piping and the large quantity of insulation in close proximity to these pipes, a double-ended guillotine break of one of the primary loop pipes presents the limiting case for SBLOCAs and LBLOCAs within the SG compartments at Ginna. The outer diameters of the primary RCS pipes are 27.5 inches for the cold legs, 29 inches for the hot legs, and 31 inches for the intermediate legs. Clearly, a break in one of the 31-inch intermediate legs would create the largest ZOI. However, depending on the exact location of various types of insulation, a break in the smaller hot or cold legs could result in the generation of a larger quantity of debris. Therefore, to analyze this scenario, the worst case break location and corresponding debris generation must be considered for both loops.

The break in SG Compartment A will be referred to as Case 1, and the break in SG Compartment B will be referred to as Case 2.

Break Criterion No. 2: Locations with two or more different types of debris

Both the Case 1 and Case 2 breaks discussed above encompass this break scenario since multiple types of debris are present in each SG compartment.

Break Criterion No. 3: Locations with the most direct path to the sump

Since the ECCS recirculation sump is directly in front of the entrance to SG Compartment B, the postulated Case 2 break would have a direct path to the sump, satisfying the guidance in this regard.

Break Criterion No. 4: Locations with the largest potential particulate debris to insulation ratio

The Ginna debris spreadsheet identified the following types of insulation within containment:

- Thermal-Wrap™
- Temp-Mat™
- Reflective Metal Insulation (RMI)
- Cal-Sil
- Asbestos

Of these types of insulation, Cal-Sil and Asbestos are predominantly particulate insulation materials (although they contain some fiber as well). This insulation is on various lines in the two SG compartments, as well as in the pressurizer compartment. Since a large quantity of Cal-Sil/Asbestos would be destroyed in either Case 1 or Case 2, it is likely that these cases are bounding for this break scenario. However, there is a significant quantity of Cal-Sil/Asbestos in the pressurizer compartment (21.9 ft^3) and only a small quantity of fibrous insulation (10.5 ft^3 of Temp-Mat™), which could make this case bounding. Therefore, an SBLOCA in the pressurizer compartment was analyzed as potentially the largest particulate to insulation ratio break. This break is referred to as Case 3.

Other specific small breaks outside of the steam generator and pressurizer compartments were not analyzed since information on the insulated lines and equipment outside of this area was not included in the Ginna debris spreadsheet.

Break Criterion No. 5: Locations that would generate debris that could potentially form a thin-bed – high particulate with 1/8" fiber bed

This scenario addresses the generation of a small quantity of fibrous debris that, after its transport to the sump screen, could form a uniform thin bed that would subsequently cause sufficient particulate debris deposition to create a relatively high head loss. It takes a relatively small quantity of debris to form a thin bed; the amount is dependent on both the insulation materials and the screen size.

Many possible LOCAs at Ginna could be postulated where a small quantity of fibrous debris would be generated and transported to the sump followed by the wash down of latent particulate debris, potentially resulting in the thin-bed effect. Rather than postulating specific LOCAs that could cause a thin-bed in this analysis, the thin-bed effect is addressed in the Ginna sump screen head loss calculation. CCI results showed no formation of a closed layer during testing.

Conclusions

Based on the criteria presented above and testing performed, the following conclusions can be drawn for debris generation in the Ginna containment building:

- A break in the intermediate leg piping at the base of the steam generator in either compartment would destroy virtually all of the fibrous and particulate insulation within the compartment.
- In terms of overall quantities of debris generated, a break in Compartment B would be worse than a break in Compartment A. This is due to the greater quantity of Cal-Sil/Asbestos and fiberglass located in Compartment B, as well as the destruction of fiberglass insulation in the adjoining pressurizer compartment. See debris generation results Tables 3.b.1 and 3.b.2.
- In relation to Cal-Sil destruction, a break at the intake or discharge of the reactor coolant pumps generates the highest total debris load.
- A small break in the pressurizer compartment would generate only a small quantity of debris compared to the large breaks analyzed. However, the ratio of particulate to

fiber for this case is high, which could be problematic in terms of sump screen head loss.

3.b Debris Generation/ZOI

NRC Issue 3b:

Debris Generation/Zone of Influence (zone of influence) (excluding coatings)

The objective of the debris generation/zone of influence process is to determine, for each postulated break location: (1) the zone within which the break jet forces would be sufficient to damage materials and create debris; and (2) the amount of debris generated by the break jet forces.

1. *Describe the methodology used to determine the zone of influences for generating debris. Identify which debris analyses used approved methodology default values. For debris with zone of influences not defined in the guidance report (GR)/safety evaluation (SE), or if using other than default values, discuss method(s) used to determine zone of influence and the basis for each.*
2. *Provide destruction zone of influences and the basis for the zone of influences for each applicable debris constituent.*
3. *Identify if destruction testing was conducted to determine zone of influences. If such testing has not been previously submitted to the NRC for review or information, describe the test procedure and results with reference to the test report(s).*
4. *Provide the quantity of each debris type generated for each break location evaluated. If more than four break locations were evaluated, provide data only for the four most limiting locations.*
5. *Provide total surface area of all signs, placards, tags, tape, and similar miscellaneous materials in containment.*

3.b.1 Assumptions

The following are the major assumptions made in the debris generation analysis:

1) Thermal-Wrap™ was assumed to have the same destruction pressure as Nukon™, since both are low-density fiberglass insulation products with similar material properties. This is supported by the SER in Section 3.4.3.2.[i].
2) Asbestos was assumed to have the same destruction pressure as Cal-Sil. There is no available test data for Asbestos at this time. However, the Guidance Report (Table 3-2) shows that Asbestos insulation has similar properties to Cal-Sil [ii].
3) It was assumed that the size distribution for Mirror™ Reflective Metal Insulation (RMI) can be applied to the stainless steel Transco RMI at Ginna. This is considered to be conservative since the destruction pressure for Mirror™ RMI is significantly lower than for Transco RMI[i].
4) It was assumed that buckles, straps, and wires securing insulation would not transport, and therefore can be excluded from the debris source term. These materials are often metal based, and would readily sink to the floor. Also, the volume of these materials is negligible compared to the insulation volume[iii].

5) It was assumed that all steel surfaces in containment are coated with one 3-mil thick coat of Inorganic Zinc (IOZ) paint and three 6-mil thick coats of phenolic paint. It was also assumed that all concrete surfaces are coated with three 6-mil thick coats of phenolic paint. These assumptions are conservatively based on plant data and vendor data sheets.

6) All coatings within the ZOI will be assumed to fail as 10 micron particulate.

7) The response to Generic Letter 98-04 related to protective coatings in containment indicates that the quantity of unqualified coatings at Ginna is negligible [iv]. However, degraded qualified coatings have been recently identified. Since these coatings could potentially fail and contribute to the debris quantities, the paint quantities generated were conservatively increased to account for this and the small amount of unqualified coatings(see Section 3.h).

8) It was assumed that all jacketed insulation outside of the ZOI would not undergo any significant erosion by either break or spray flows (i.e. no insulation debris would be generated outside of the postulated ZOIs). This assumption is considered acceptable by the NRC as stated in the SER Section 3.4.3.2.[i].

9) For purposes of defining the size distribution of insulation debris, insulation targets were mapped in a 3D CAD model so that their proximity to the break locations could be accurately calculated.

10) Other detailed assumptions are discussed in the methodology and analysis sections as they are used.

3.b.2 Case 1—LBLOCA in Compartment A

Figure 3.b.2.1 through Figure 3.b.2.5 show the ZOIs for each type of insulation in Compartment A for a break in the 31-inch intermediate leg at the base of the steam generator. This was determined to be the worst case break location within the compartment since the intermediate leg is the largest piping, and a break right at the base of the steam generator would destroy more overall insulation (due to the ZOI reaching a larger portion of the steam generator) than a break closer to the reactor coolant pump. It is possible that a break in a slightly different location could generate a larger quantity of a specific type of debris. However, conservative assumptions were applied (as described in the remainder of this section) to ensure that this case is bounding for other LBLOCAs in Compartment A. The compartment is almost completely enclosed by walls, which were credited as robust barriers (i.e., the ZOI was truncated at the walls).

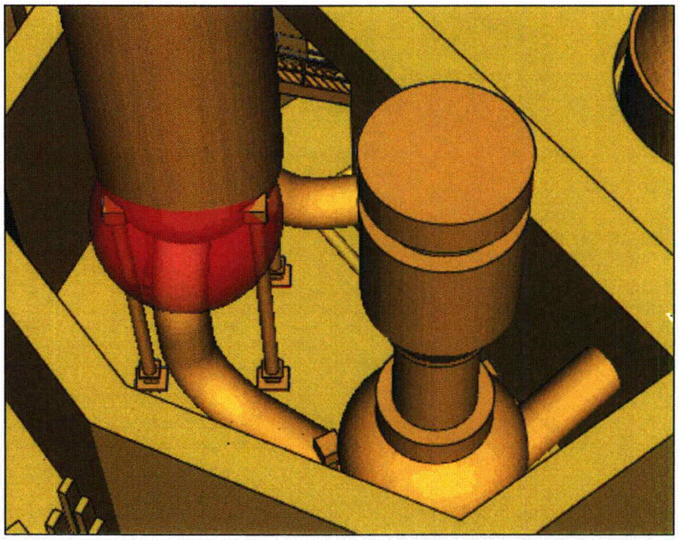


Figure 3.b.2.1 – Case 1 RMI ZOI (2.0D)

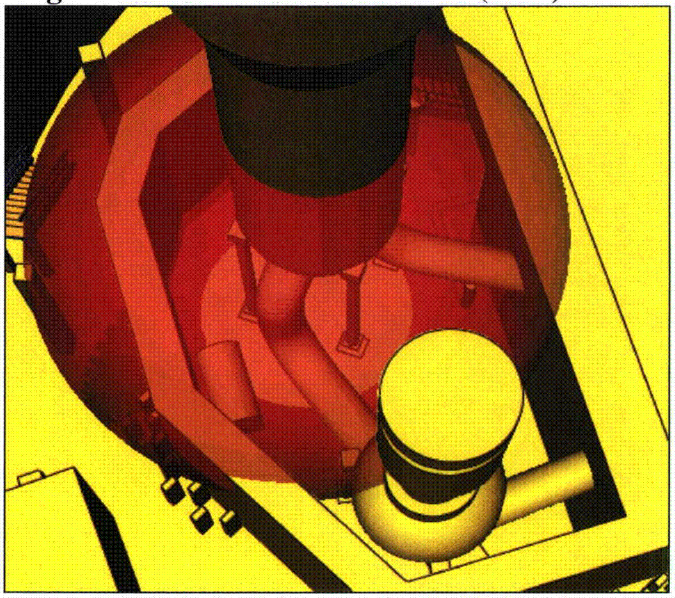


Figure 3.b.2.2 – Case 1 Cal-Sil ZOI (6.4D)

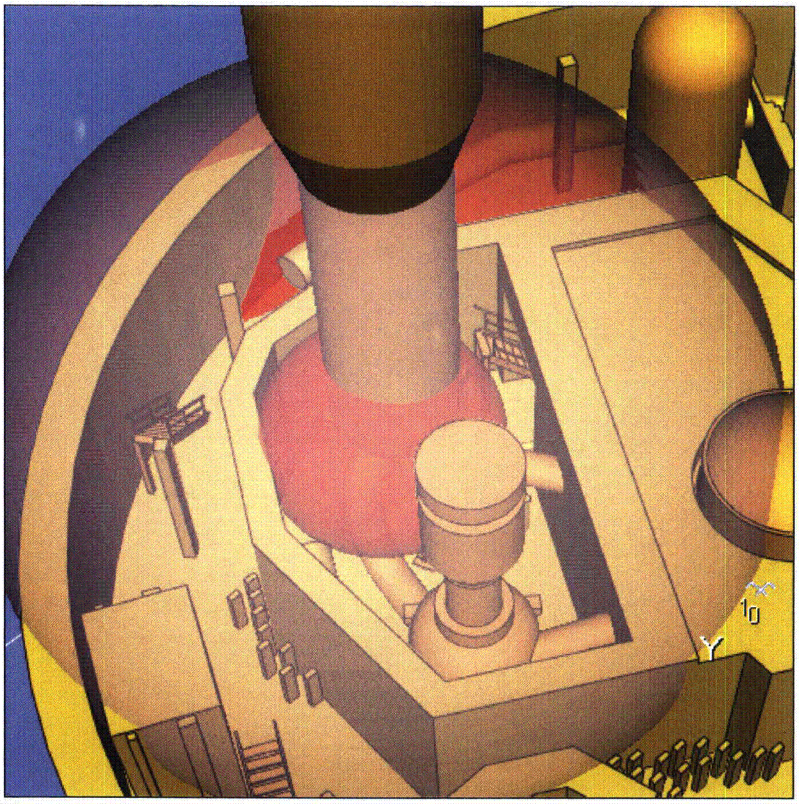


Figure 3.b.2.3 – Case 1 Temp-Mat™ ZOI (3.7D and 11.7D)

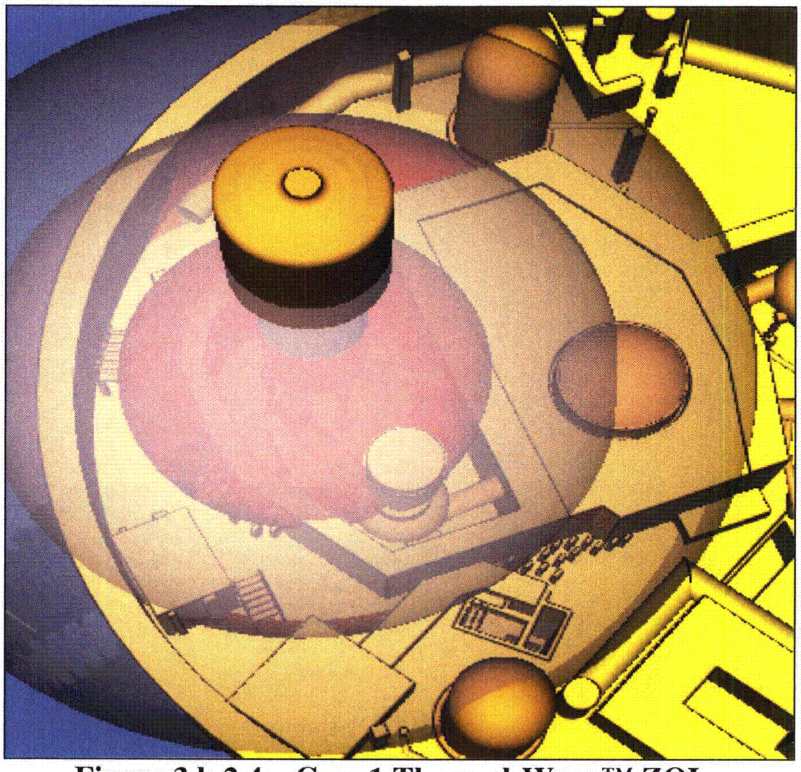


Figure 3.b.2.4 – Case 1 Thermal-Wrap™ ZOI
(7.0D, 11.9D, 17.0D)

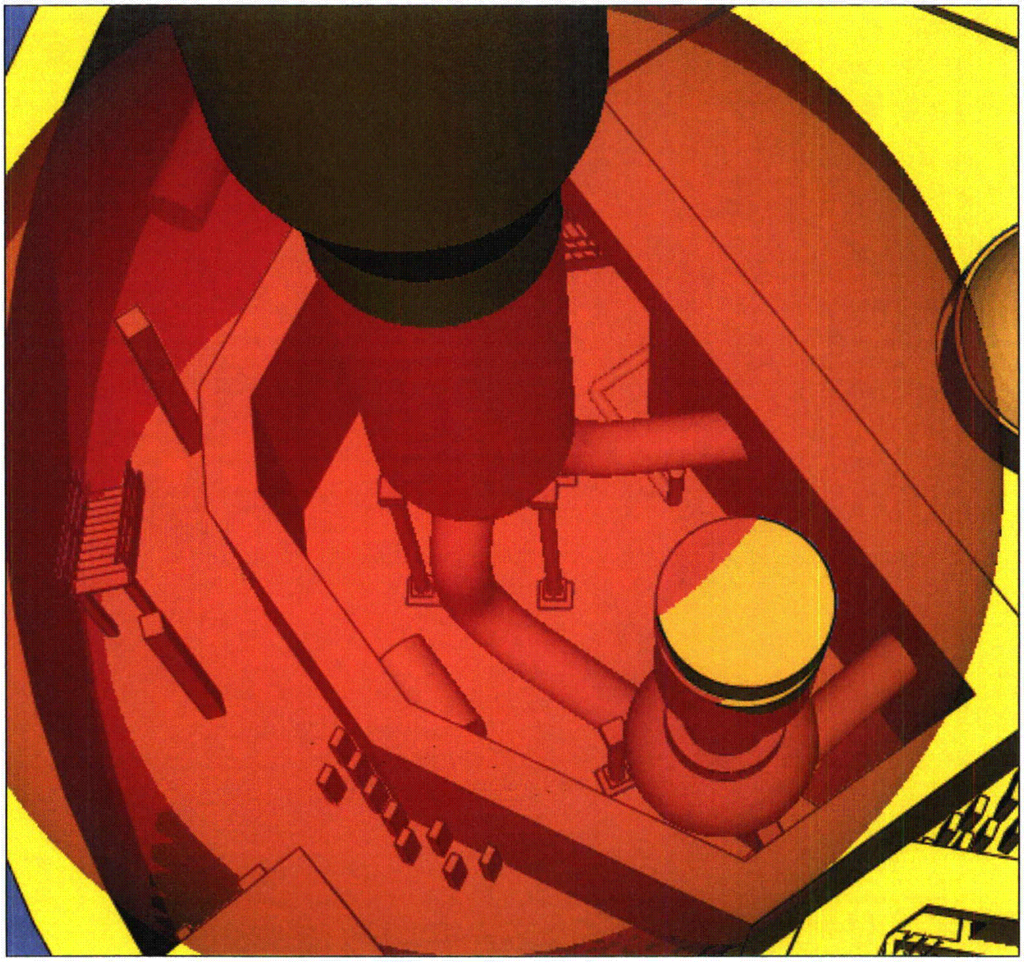


Figure 3.b.2.5 – Case 1 Coatings 10.0D ZOI (10.0D)

3.b.2.1 RMI

According to the debris spreadsheet, the RMI in Compartment A is located on the bottom of the steam generator (EMS01A) and on the reactor coolant pump. As shown in Figure 3.b.2.1, the postulated break at the base of the steam generator would destroy most of the RMI on the steam generator, but would not affect the RMI on the pump. A break could be postulated next to the pump, which would destroy a larger quantity of RMI. However, given the fact that RMI has been shown to be less significant in terms of head loss than other types of insulation debris, the worst break location is relatively insensitive to the quantity of RMI generated.

The steam generators were drawn in the Ginna CAD model using a scaled cross-sectional drawing [v]. Based on the CAD model, the bottom of the steam generators can be approximated by a hemisphere with a 5 ft radius. The thickness of the RMI insulation was not provided in the debris spreadsheet. However, as-installed insulation drawings show that the RMI is 4 inches thick [vi]. Assuming an air-gap spacer of 1 inch, the outer surface area of the RMI insulation would be approximately 184 ft^2. The RMI is made up of 0.002 inch stainless steel foils, which are spaced at approximately 3 foils per inch of panel thickness

[vi]. Therefore, multiplying the surface area, thickness and number of foils per inch gives an approximate total foil surface area of 2,208 ft^2. The size distribution would be 75% small pieces (1,656 ft^2) and 25% large pieces (552 ft^2).

3.b.2.2 Cal-Sil/Asbestos

The Cal-Sil/Asbestos is located on a number of miscellaneous lines within Compartment A. The largest quantities (more than 5 ft^3) are on Residual Heat Removal (RHR) piping, Safety Injection (SI) piping, a pressurizer spray line, the Chemical and Volume Control System (CVCS) excess letdown line, and the intermediate leg. There is also Asbestos on the hot and cold leg support penetrations in the compartment. The size distribution for both the Cal-Sil and Asbestos is dependant on the debris source's distance from the break location. Although the limiting break for most debris types was found to be a break in the 31-inch intermediate leg at the base of the steam generator, it was determined that this does not generate the most debris in relation to Cal-Sil. Most of the Cal-Sil insulated pipes are in close proximity to the Reactor Coolant Pumps (RCP). As such, breaks at the intake and discharge of the RCPs were more closely analyzed. This analysis resulted in the conclusion that, for SG Compartment A, a break in the 31-inch intermediate leg at the base of the RCP would produce the greatest amount of Cal-Sil debris. A total quantity of 15.6 ft^3 of Cal-Sil/Asbestos and 0.0 ft^3 of Asbestos is calculated to be destroyed for this break case.

3.b.2.3 Temp-Mat™

Two sub-zones of destruction were defined for Temp-Mat™. Small quantities of Temp-Mat™ are located on the elbows of many of the lines insulated with Cal-Sil. However, the largest quantities of Temp-Mat™ in Compartment A are located on the hot leg and intermediate leg piping. The size distribution for Temp-Mat™ is dependant on the debris source's distance from the break location. Ginna's calculations show a total quantity of 58.8 ft^3 of Temp-Mat™ is destroyed for this break case.

3.b.2.4 Thermal-Wrap™

As shown in Figure 3.b.2.4 above, three sub-zones of destruction were defined for Thermal-Wrap™. Within Compartment A, the Thermal-Wrap™ (denoted in the debris spreadsheet simply as Transco) is located on the SG blowdown lines, the primary loop piping, and the steam generator body. Using the CAD model, the surface area of the steam generator body was estimated to be 2,157 ft^2. The thickness of the Thermal-Wrap™ on the body is 4 inches [vi]. Therefore, the total quantity on the steam generator is approximately 719 ft^3. The first sub-zone would extend 18 ft up from the base of the steam generator encompassing approximately 195 ft^3 of Thermal-Wrap™. The second sub-zone would extend up 31 ft from the base of the steam generator encompassing an additional 161 ft^3 of Thermal-Wrap™. The third sub-zone would extend 44 ft up from the base of the steam generator encompassing an additional 192 ft^3 of Thermal-Wrap™. Since the third sub-zone does not extend all the way to the top of the steam generator, 171 ft^3 of the Thermal-Wrap™ on the steam generator would not be destroyed.

The size distribution for Thermal-Wrap™ is dependant on the debris source's distance from the break location. Debris generation calculations show a total quantity of 629.8 ft^3 of Thermal-Wrap™ is destroyed for this break case.

3.b.2.5 Paint Coatings

For the qualified coatings, the SER recommends using a spherical ZOI for coatings with a radius equal to ten diameters. The total concrete and steel surface area within this ZOI was calculated using the Ginna CAD model. The total concrete surface area, including the compartment floor and walls, was conservatively estimated (crediting only a small area shielded from the break by other walls or equipment) to be 4323 ft^2. The total steel surface area, including the reactor coolant pump motor, supports, and beams, and the oil collection tank, was conservatively estimated to be 1528 ft^2. In order to account for other steel surfaces like the stairs, handrails, and miscellaneous items not included in the CAD model, the steel surface area was increased by 10% to 1681 ft^2. The thickness of inorganic zinc (IOZ) paint applied to all steel surfaces is approximately 3 mils, and the applied density is approximately 223 lb/ft^3. The thickness of the phenolic paint applied to both steel and concrete surfaces is approximately 18 mils, and the applied density is approximately 84 lb/ft^3. Using the calculated surface areas within the ZOI, this gives a total quantity of 94 lb of IOZ paint, and 757 lb of phenolic paint as shown in the following calculations:

$$Quantity_{IOZ} = (1681 ft^2) * (0.003 in) * \frac{1 ft}{12 in} * 223 \frac{lb}{ft^3} = 94 lb \quad \text{(Eq. 1)}$$

$$Quantity_{Phenolic} = (1681 ft^2 + 4323 ft^2) * (0.018 in) * \frac{1 ft}{12 in} * 84 \frac{lb}{ft^3} = 757 lb \quad \text{(Eq. 2)}$$

The size distribution for both the IOZ and phenolic paint coatings would be 100% particulate.

A five diameter ZOI for qualified coatings is also evaluated in this analysis as other plants in the industry are obtaining test data to reduce the ZOI accordingly. The total concrete surface area, including the compartment floor and walls, was conservatively estimated (crediting only a small area shielded from the break by other walls or equipment) to be 516 ft^2. The total steel surface area, including the reactor coolant pump motor, supports, and beams, and the oil collection tank, was conservatively estimated to be 470 ft^2. In order to account for other steel surfaces like the stairs, handrails, and miscellaneous items not included in the CAD model, the steel surface area was increased by 10% to 517 ft^2. As previously discussed, the thickness of IOZ paint applied to all steel surfaces is approximately 3 mils, and the applied density is approximately 223 lb/ft^3. The thickness of the phenolic paint applied to both steel and concrete surfaces used is, again, approximately 18 mils, and the applied density is approximately 84 lb/ft^3. Using the calculated surface areas within the ZOI, this gives a total quantity of 29 lb of IOZ paint, and 130 lb of phenolic paint as shown in the following calculations:

$$Quantity_{IOZ} = (517 ft^2) * (0.003in) * \frac{1ft}{12in} * 223 \frac{lb}{ft^3} = 29lb \quad \text{(Eq. 3)}$$

$$Quantity_{Phenolic} = (517 ft^2 + 516 ft^2) * (0.018in) * \frac{1ft}{12in} * 84 \frac{lb}{ft^3} = 130lb \quad \text{(Eq. 4)}$$

Once again, the size distribution for both the IOZ and phenolic paint coatings would be 100% particulate.

3.b.3 Case 2—LBLOCA in Compartment B

Figure 3.b.3.1 through Figure 3.b.3.5 show the ZOIs for each type of insulation in Compartment B for a break in the 31-inch intermediate leg at the base of the steam generator. As in Case 1, this was determined to be the worst case break location within the compartment since the intermediate leg is the largest piping, and a break right at the base of the steam generator would destroy more overall insulation (due to the ZOI reaching a larger portion of the steam generator) than a break closer to the reactor coolant pump. Compartment B is mostly enclosed by walls, which were credited as robust barriers; however, a significant quantity of debris in front of the entrance to the compartment, on the upper steam generator, and in the adjacent pressurizer compartment, was assumed to be destroyed.

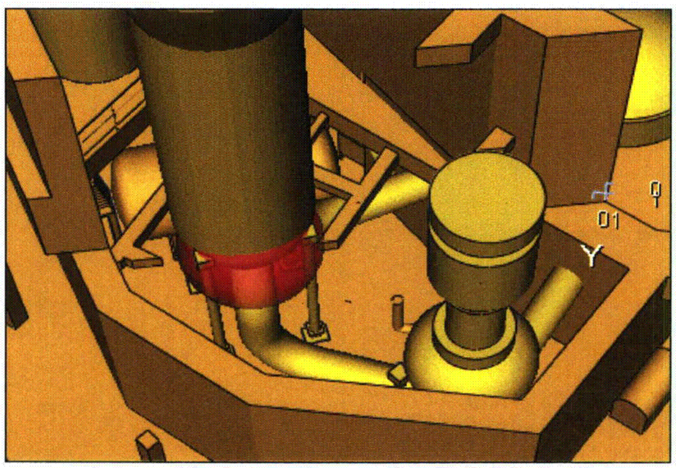


Figure 3.b.3.1 – Case 2 RMI ZOI (2.0D)

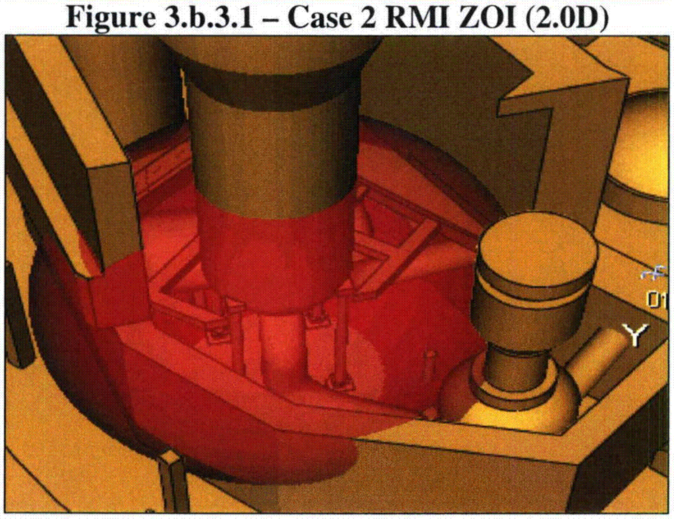


Figure 3.b.3.2 – Case 2 Cal-Sil ZOI (6.4D)

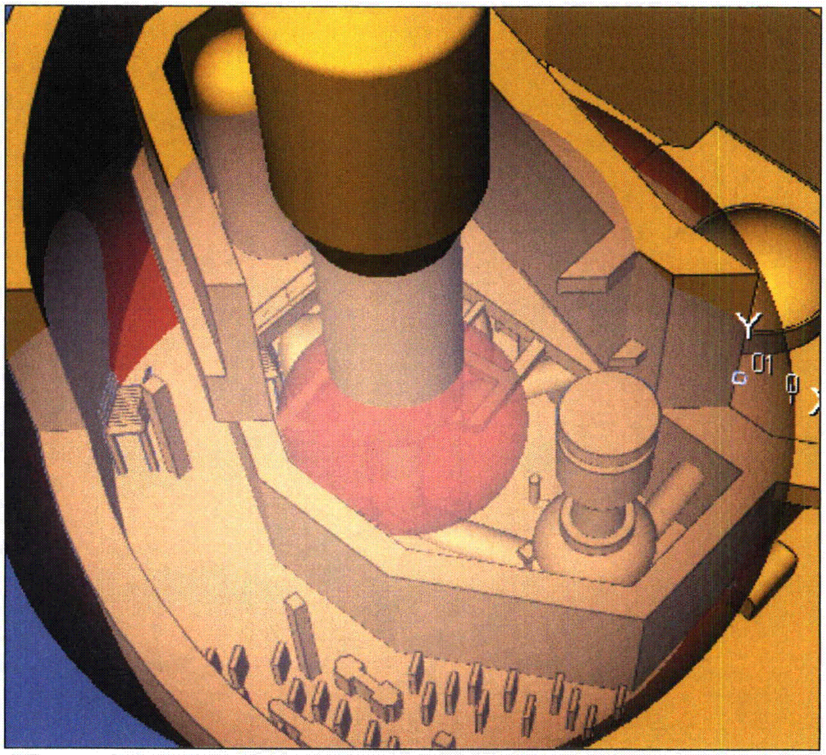


Figure 3.b.3.3 – Case 2 Temp-Mat™ ZOI (3.7D and 11.7D)

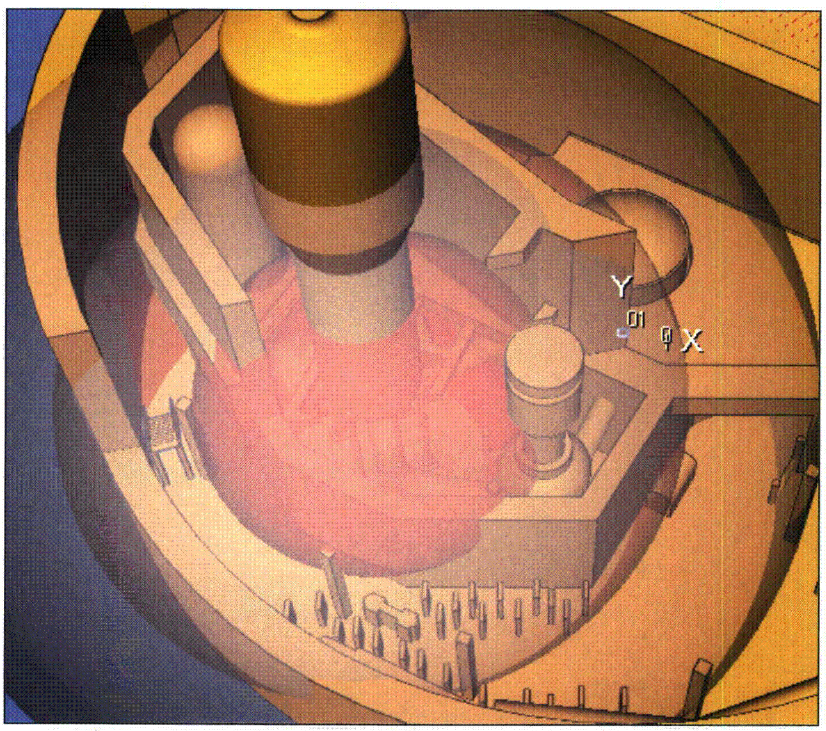


Figure 3.b.3.4 – Case 2 Thermal-Wrap™ ZOI (7.0D, 11.9D, 17.0D)

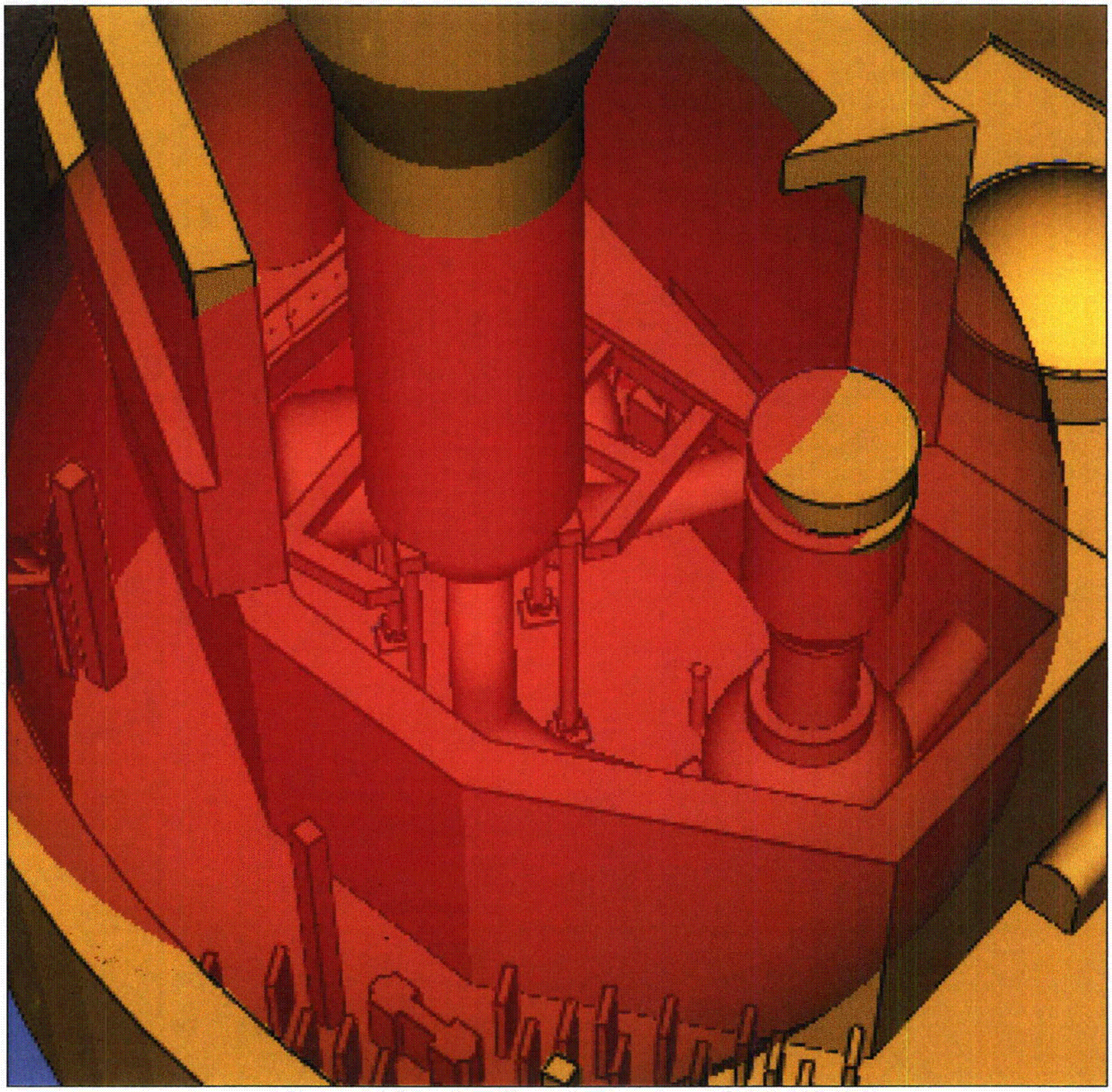


Figure 3.b.3.5 – Case 2 Coatings ZOI (10.0D)

3.b.3.1 RMI

According to the debris spreadsheet, the RMI in Compartment B is located on the bottom of the steam generator (EMS01B) and on the reactor coolant pump. There is also RMI on the pressurizer in the adjoining pressurizer compartment. As shown in Figure 3.b.3.1, the postulated break at the base of the steam generator would destroy most of the RMI on the steam generator, but would not affect the RMI on the pump or pressurizer. A break could be postulated next to the pump, which would destroy a larger quantity of RMI. However, as discussed for Case 1, the worst break location is relatively insensitive to the quantity of RMI generated.

Since the postulated break location and RMI quantities for this case are the same as Case 1, the quantity of RMI debris generated would also be the same. Therefore, the total quantity of RMI destroyed would be 2,208 ft^2, where 75% (1,656 ft^2) would be small pieces and 25% (552 ft^2) would be large pieces.

3.b.3.2 Cal-Sil/Asbestos

The Cal-Sil/Asbestos is located on a number of miscellaneous lines within Compartment B. The largest quantities (more than 5 ft^3) are on RHR piping, SI piping, a pressurizer spray line, the CVCS excess letdown line, and the primary loop piping. There is also Asbestos on the hot and cold leg support penetrations in the compartment, and Cal-Sil/Asbestos on a number of miscellaneous lines in the adjoining pressurizer compartment. The size distribution for both the Cal-Sil and Asbestos is dependant on the debris source's distance from the break location. Although the limiting break for most debris types was found to be a break in the 31-inch intermediate leg at the base of the steam generator, it was determined that this does not generate the most debris in relation to Cal-Sil. Most of the Cal-Sil insulated pipes are in close proximity to the reactor coolant pumps. As such, breaks at the intake and discharge of the RCPs were more closely analyzed. This analysis resulted in the conclusion that, for SG Compartment B, a break in the 27.5-inch cold leg at the discharge of the RCP would produce the greatest amount of Cal-Sil debris. The debris generation calculations show a total quantity of 26.2 ft^3 of Cal-Sil/Asbestos and 0.0 ft^3 of Asbestos are destroyed for this break case.

3.b.3.3 Temp-Mat™

As shown in Figure 3.b.3.3 and discussed in the methodology, two sub-zones of destruction were defined for Temp-Mat™. Small quantities of Temp-Mat™ are located on the elbows of many of the lines insulated with Cal-Sil. However, the largest quantities of Temp-Mat™ in Compartment B are located on the hot leg and intermediate leg piping, and the pressurizer surge line. The size distribution for Temp-Mat™ is dependant on the debris source's distance from the break location. The debris generation calculations show a total quantity of 65.7 ft^3 of Temp-Mat™ is destroyed for this break case.

3.b.3.4 Thermal-Wrap™

Figure 3.b.3.4, three sub-zones of destruction were defined for Thermal-Wrap™. Within Compartment B, the Thermal-Wrap™ is located on the SG blowdown lines, the primary loop piping, and the steam generator body. Since the postulated break location and Thermal-Wrap™ quantities on the steam generator for this case are the same as Case 1, the quantity destroyed in each sub-zone on the steam generator would also be the same. This was calculated to be 195 ft^3 of Thermal-Wrap™ in the first sub-zone, 161 ft^3 in the second sub-zone, and 192 ft^3 in the third sub-zone.

The size distribution for Thermal-Wrap™ is dependant on the debris source's distance from the break location. The debris generation calculations show a total quantity of 633.2 ft^3 of Thermal-Wrap™ is destroyed for this break case.

3.b.3.5 Paint Coatings

As in Case 1, the total concrete and steel surface area within the coatings ZOI in Compartment B was calculated using the Ginna CAD model. The total concrete surface area including the compartment floor and walls was conservatively estimated to be 4710 ft^2. The total steel surface area including the reactor coolant pump motor, supports and beams, and the pressurizer relief tank was conservatively estimated to be 1986 ft^2. In order to account for other steel surfaces like stairs, handrails, and miscellaneous items not included in the CAD model, the steel surface area was increased by 10% to 2185 ft^2. Using the applied paint thicknesses and densities discussed in Section3.b.2, the total coatings generated in Compartment B would be 122 lb of IOZ paint, and 869 lb of phenolic paint as shown in the following calculations:

$$Quantity_{IOZ} = (2185 ft^2)*(0.003in)*\frac{1ft}{12in}*223\frac{lb}{ft^3} = 122lb \qquad \text{(Eq. 5)}$$

$$Quantity_{Phenolic} = (2185 ft^2 + 4710 ft^2)*(0.018in)*\frac{1ft}{12in}*84\frac{lb}{ft^3} = 869lb \qquad \text{(Eq. 6)}$$

As mentioned in Section3.b.2, the size distribution for both the IOZ and phenolic paint coatings would be 100% particulate.

A five diameter ZOI for qualified coatings is also evaluated in this analysis as other plants in the industry are obtaining test data to reduce the ZOI accordingly. The total concrete surface area including the compartment floor and walls was conservatively estimated (crediting only a small area shielded from the break by other walls or equipment) to be 413 ft^2. The total steel surface area including the reactor coolant pump motor, supports and beams, and the oil collection tank was conservatively estimated to be 460 ft^2. In order to account for other steel surfaces like the stairs, handrails, and miscellaneous items not included in the CAD model, the steel surface area was increased by 10% to 506 ft^2. As discussed in Section3.b.2, the thickness of IOZ paint applied to all steel surfaces is approximately 3 mils, and the applied density is approximately 223 lb/ft^3. The thickness of the phenolic paint applied to both steel and concrete surfaces is approximately 18 mils, and the applied density is approximately 84 lb/ft^3. Using the calculated surface areas within the ZOI, this gives a total quantity of 28 lb of IOZ paint, and 116 lb of phenolic paint as shown in the following calculations:

$$Quantity_{IOZ} = (506 ft^2)*(0.003in)*\frac{1ft}{12in}*223\frac{lb}{ft^3} = 28lb \qquad \text{(Eq. 7)}$$

$$Quantity_{Phenolic} = (506 ft^2 + 413 ft^2)*(0.018in)*\frac{1ft}{12in}*84\frac{lb}{ft^3} = 116lb \qquad \text{(Eq. 8)}$$

As discussed above, the size distribution for both the IOZ and phenolic paint coatings would be 100% particulate.

3.b.4 Case 3—SBLOCA in Pressurizer Compartment

Figure 3.b.4.1 shows the ZOIs for Cal-Sil and Temp-Mat™ for a break in the 3-inch spray line at the top of the pressurizer. The radii of the ZOI spheres would only be 1.6 ft for Cal-Sil, and 2.9 ft for Temp-Mat™. A review of the isometric drawings showed that many of the insulated lines in the pressurizer compartment would be outside of the ZOI for a break in any given position on the spray line. However, as a conservative worst case estimate, it was assumed that each insulated line runs directly through the postulated ZOI. This gives a total destruction of 2.9 ft^3 of Cal-Sil/Asbestos, and 4.4 ft^3 of Temp-Mat™.

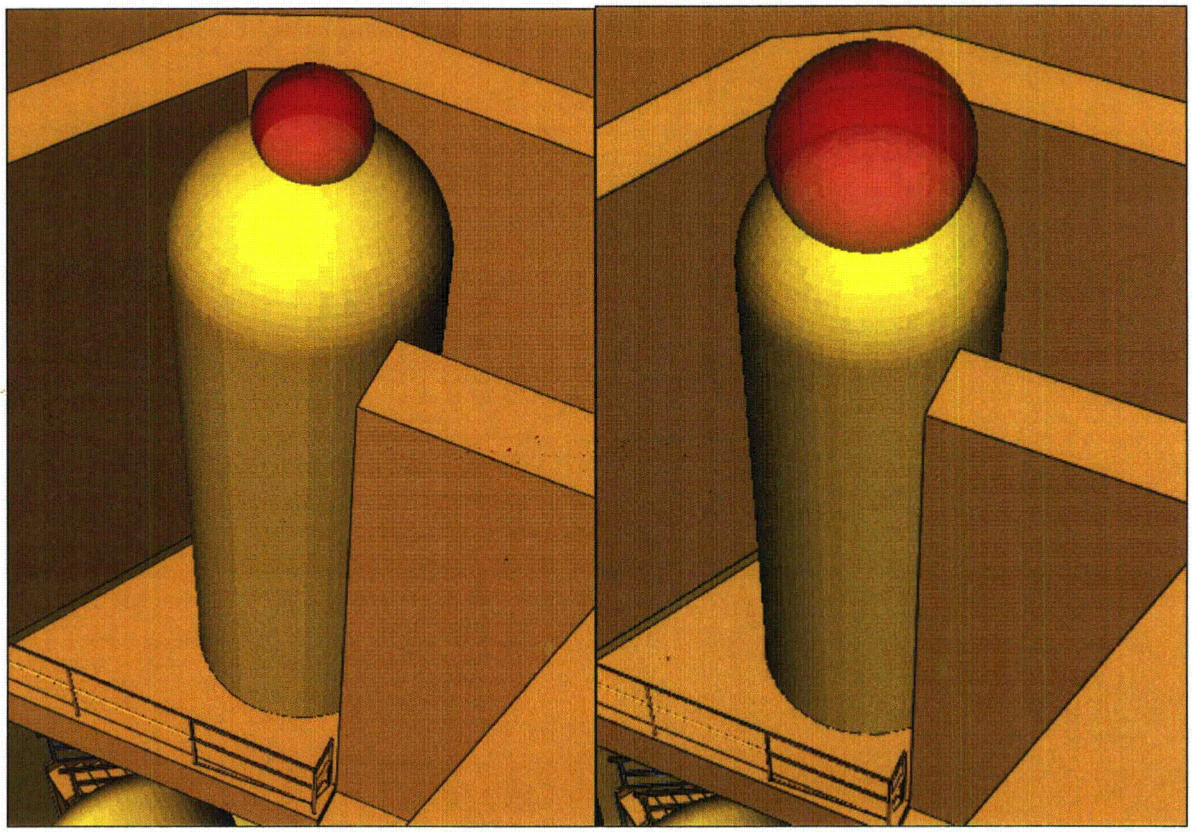


Figure 3.b.4.1 – Case 3 Cal-Sil ZOI (left) and Temp-Mat™ ZOI (right)

The pressurizer is covered with RMI insulation. However, since the RMI ZOI for a 3-inch line break would only have a 6-inch radius, the quantity of RMI debris for this case is negligible.

The ZOI for coatings would be slightly smaller than the ZOI for Temp-Mat™ shown in Figure 3.b.4.1. Due to the small size of the ZOI, and the fact that it does not impact any walls, it was assumed that the quantity of paint coatings destroyed for Case 3 can be conservatively estimated as the surface area of the coatings ZOI sphere (79 ft^2 for 10D and 19.6 ft^2 for 5D) times the density and thickness of the coatings. For a 10D ZOI, this gives a total of 4 lb of IOZ particulate, and 10 lb of phenolic paint particulate as shown in the following calculations:

$$Quantity_{IOZ} = (79 ft^2) * (0.003in) * \frac{1ft}{12in} * 223\frac{lb}{ft^3} = 4lb \quad \text{(Eq. 9)}$$

$$Quantity_{Phenolic} = (79 ft^2) * (0.018in) * \frac{1ft}{12in} * 84\frac{lb}{ft^3} = 10lb \quad \text{(Eq. 10)}$$

For a 5D ZOI, this gives a total of 1.1 lbs of IOZ particulate, and 2.5 lbs of phenolic paint particulate as shown in the following calculations:

$$Quantity_{IOZ} = (19.6 ft^2) * (0.003in) * \frac{1ft}{12in} * 223\frac{lb}{ft^3} = 1.1lb \quad \text{(Eq. 11)}$$

$$Quantity_{Phenolic} = (19.6 ft^2) * (0.018in) * \frac{1ft}{12in} * 84\frac{lb}{ft^3} = 2.5lb \quad \text{(Eq. 12)}$$

3.b.5 Degraded Qualified Coatings

Additional margin was included for the coatings due to the potential failure of degraded qualified coatings. It was assumed that 5% of the total concrete surface area below the intermediate deck and inside the inner shield wall would fail as degraded qualified coatings. This area was calculated to be 31,509 ft^2 giving 1575.5 ft^2 of degraded qualified coatings. This gives an additional quantity of 88 lbs of IOZ and 199 lbs of phenolic paint debris as shown in the following calculations:

$$Quantity_{IOZ} = (1575.5 ft^2) * (0.003in) * \frac{1ft}{12in} * 223\frac{lb}{ft^3} = 88lb \quad \text{(Eq. 13)}$$

$$Quantity_{Phenolic} = (1575.5 ft^2) * (0.018in) * \frac{1ft}{12in} * 84\frac{lb}{ft^3} = 199lb \quad \text{(Eq. 14)}$$

Since this paint was assumed to fail outside the ZOI, these quantities are applicable for each of the postulated cases.

3.b.6 Results

Tables 3.b.1 through Table 3.b.3 summarize the Ginna debris generation results for Case 1—A break in the intermediate leg piping in Compartment A, Case 2—A break in the intermediate leg piping in Compartment B, and Case 3—A break in the spray line above the pressurizer.

Table 3.b.1 – Case 1: Debris Source Term for a Break in Compartment A

Debris Generation Results		**Case 1**		
Debris Type	**Debris Size**	**Debris Quantity Generated**		**Percent of Total (%)**
Stainless Steel RMI (ft^2)	Small Pieces (<4")	1656.0	ft^2	75%
	Large Pieces (>4")	552.0	ft^2	25%
	Total	**2208.0**	ft^2	**100%**
TempMat (ft^3)	Fines	9.5	ft^3	16%
	Small Pieces (<6")	37.7	ft^3	64%
	Large Pieces (>6")	5.6	ft^3	10%
	Intact Pieces (>6")	6.0	ft^3	10%
	Total	**58.8**	ft^3	**100%**
Transco Thermal Wrap' LDFG - Fiberglass (ft^3)	Fines	90.2	ft^3	14%
	Small Pieces (<6")	316.4	ft^3	50%
	Large Pieces (>6")	107.8	ft^3	17%
	Intact Pieces (>6")	115.4	ft^3	18%
	Total	**629.8**	ft^3	**100%**
Cal-Sil (w/ Asbestos) (ft^3)	Particulate	8.7	ft^3	56%
	Pieces > 1"	6.9	ft^3	44%
	Total	**15.6**	ft^3	**100%**
Asbestos (ft^3)	Particulate	0.0	ft^3	0%
	Pieces > 1"	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Coatings	Phenolic Paint (inside 10D ZOI)	757	lb	
	IOZ Paint (inside 10D ZOI)	94	lb	
	Phenolic Paint (inside 5D ZOI)	130	lb	
	IOZ Paint (inside 5D ZOI)	29	lb	
	Phenolic Paint (outside ZOI)	199	lb	
	IOZ Paint (outside ZOI)	88	lb	
Latent Debris	Dirt/Dust*	85	lb	
	Latent Fiber*	15	lb	

* Explained in Section 3.d, Latent Debris

Table 3.b.2 – Case 2: Debris Source Term for a Break in Compartment B

Debris Generation Results		Case 2		
Debris Type	**Debris Size**	**Debris Quantity Generated**		**Percent of Total (%)**
Stainless Steel RMI (ft^2)	Small Pieces (<4")	1656.0	ft^2	75%
	Large Pieces (>4")	552.0	ft^2	25%
	Total	**2208.0**	ft^2	**100%**
TempMat (ft^3)	Fines	7.7	ft^3	12%
	Small Pieces (<6")	30.6	ft^3	47%
	Large Pieces (>6")	13.3	ft^3	20%
	Intact Pieces (>6")	14.1	ft^3	21%
	Total	**65.7**	ft^3	**100%**
Transco Thermal Wrap' LDFG - Fiberglass (ft^3)	Fines	90.7	ft^3	14%
	Small Pieces (<6")	318.6	ft^3	50%
	Large Pieces (>6")	108.1	ft^3	17%
	Intact Pieces (>6")	115.7	ft^3	18%
	Total	**633.2**	ft^3	**100%**
Cal-Sil (w/ Asbestos) (ft^3)	Particulate	14.7	ft^3	56%
	Pieces > 1"	11.5	ft^3	44%
	Total	**26.2**	ft^3	**100%**
Asbestos (ft^3)	Particulate	0.0	ft^3	0%
	Pieces > 1"	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Coatings	Phenolic Paint (inside 10D ZOI)	869	lb	
	IOZ Paint (inside 10D ZOI)	122	lb	
	Phenolic Paint (inside 5D ZOI)	116	lb	
	IOZ Paint (inside 5D ZOI)	28	lb	
	Phenolic Paint (outside ZOI)	199	lb	
	IOZ Paint (outside ZOI)	88	lb	
Latent Debris	Dirt/Dust*	85	lb	
	Latent Fiber*	15	lb	

*Explained in Section 3.d, Latent Debris

Table 3.b.3 – Case 3: Debris Source Term for a Break in the Pressurizer Compartment

Debris Generation Results		Case 3		
Debris Type	**Debris Size**	**Debris Quantity Generated**		**Percent of Total (%)**
Stainless Steel RMI (ft^2)	Small Pieces (<4")	0.0	ft^2	0%
	Large Pieces (>4")	0.0	ft^2	0%
	Total	**0.0**	ft^2	**0%**
TempMat (ft^3)	Fines	0.9	ft^3	20%
	Small Pieces (<6")	3.5	ft^3	80%
	Large Pieces (>6")	0.0	ft^3	0%
	Intact Pieces (>6")	0.0	ft^3	0%
	Total	**4.4**	ft^3	**100%**
Transco Thermal Wrap' LDFG - Fiberglass (ft^3)	Fines	0.0	ft^3	0%
	Small Pieces (<6")	0.0	ft^3	0%
	Large Pieces (>6")	0.0	ft^3	0%
	Intact Pieces (>6")	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Cal-Sil (w/ Asbestos) (ft^3)	Particulate	1.4	ft^3	50%
	Pieces > 1"	1.4	ft^3	50%
	Total	**2.9**	ft^3	**100%**
Asbestos (ft^3)	Particulate	0.0	ft^3	0%
	Pieces > 1"	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Coatings	Phenolic Paint (inside 10D ZOI)	10	lb	
	IOZ Paint (inside 10D ZOI)	4	lb	
	Phenolic Paint (inside 5D ZOI)	2.5	lb	
	IOZ Paint (inside 5D ZOI)	1.1	lb	
	Phenolic Paint (outside ZOI)	199	lb	
	IOZ Paint (outside ZOI)	88	lb	
Latent Debris	Dirt/Dust*	85	lb	
	Latent Fiber*	15	lb	

*Explained in Section 3.d, Latent Debris

Table 3.b.4 shows the material properties of the generated debris.

Table 3.b.4 – Physical Properties of Debris

Debris Type/Size	Material Bulk Density	Particulate/Individual Fiber Density	Characteristic Size
Stainless Steel RMI	-	-	1/8" to 6" pieces
Cal-Sil/Asbestos	15 lb/ft^3	144 lb/ft^3	5 μm
Temp-Mat™	9 lb/ft^3	162 lb/ft^3	9 μm*
Thermal-Wrap™	2.4 lb/ft^3	159 lb/ft^3	5.5 μm*
Phenolic Paint (Inside ZOI)	84 lb/ft^3	94 lb/ft^3	10 μm
Phenolic Paint (Outside ZOI)	84 lb/ft^3	94 lb/ft^3	18 mil thick chips
IOZ Paint	223 lb/ft^3	457 lb/ft^3	10 μm
Dirt/Dust	-	169 lb/ft^3	17.3 μm
Latent Fiber	2.4 lb/ft^3	94 lb/ft^3	7.0 μm*

Characteristic size is measured by spherical particle diameter unless indicated by an asterisk (*), in which case it is measured by characteristic fiber diameter.

References

i. NRC Safety Evaluation Report, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Nuclear Energy Institute Guidance Report 'Pressurized Water Reactor Sump Performance Evaluation Methodology," Rev. 0, December 2004.

ii. NEI PWR Sump Performance Task Force Report NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Rev. 0, December 2004.

iii. NRC Bulletin 96-03, "Utility Resolution Guidance (URG) for ECCS Suction Strainer Blockage", Volume II, BWROG, November 1996.

iv. RG&E Letter, "Response to Generic Letter 98-04, dated July 14, 1998; Subject: Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment", R.E. Ginna Nuclear Power Plant, December 1, 1998.

v. "Plant Arrangement Reactor Containment Structure Section 1-1", Drawing No. 33013-2131, Rev. 1.

vi. Ginna Equipment Insulation Drawings Used to Determine Insulation Quantities on Steam Generators

a) "Steam Generator Ins. Key Layout Elevation", Drawing No. EW-7181-G1, Rev. 4.

b) "Steam Generator 1a Layout – G1", Drawing No. EW-7181-GA7, Rev. 2.

3.c Debris Characterization

NRC Issue 3c:

Debris Characteristics

The objective of the debris characteristics determination process is to establish a conservative debris characteristics profile for use in determining the transportability of debris and its contribution to head loss.

1. *Provide the assumed size distribution for each type of debris.*
2. *Provide bulk densities (i.e., including voids between the fibers/particles) and material densities (i.e., the density of the microscopic fibers/particles themselves) for fibrous and particulate debris.*
3. *Provide assumed specific surface areas for fibrous and particulate debris.*
4. *Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.*

The debris sources at Ginna include insulation, coatings and latent debris. The insulation debris includes Transco Reflective Metal Insulation (RMI), Thermal-Wrap™ Low Density Fiberglass, Temp-Mat ™ Fiberglass and Cal-Sil/Asbestos. The characteristics of insulation debris materials are discussed in this section as the characteristics of coatings and latent debris are addressed in later sections.

3.c.1 Transco RMI

Figure 3.c.1.1 shows the debris size distribution summarizing the results of 2-phase jet tests of Mirror™ RMI. This plot shows that 71% of the RMI was destroyed in ¼-inch to 2-inch pieces, and 29% was destroyed in 4-inch to 6-inch pieces. Based on this data, the NEI 04-07 methodology (Section 3.4.3.3.2) recommends using a size distribution of 75% small fines and 25% large pieces, where small fines are defined as anything less than 4 inches. This size distribution was assumed to apply to all types of RMI, and was adopted in this analysis for the Transco RMI at Ginna.

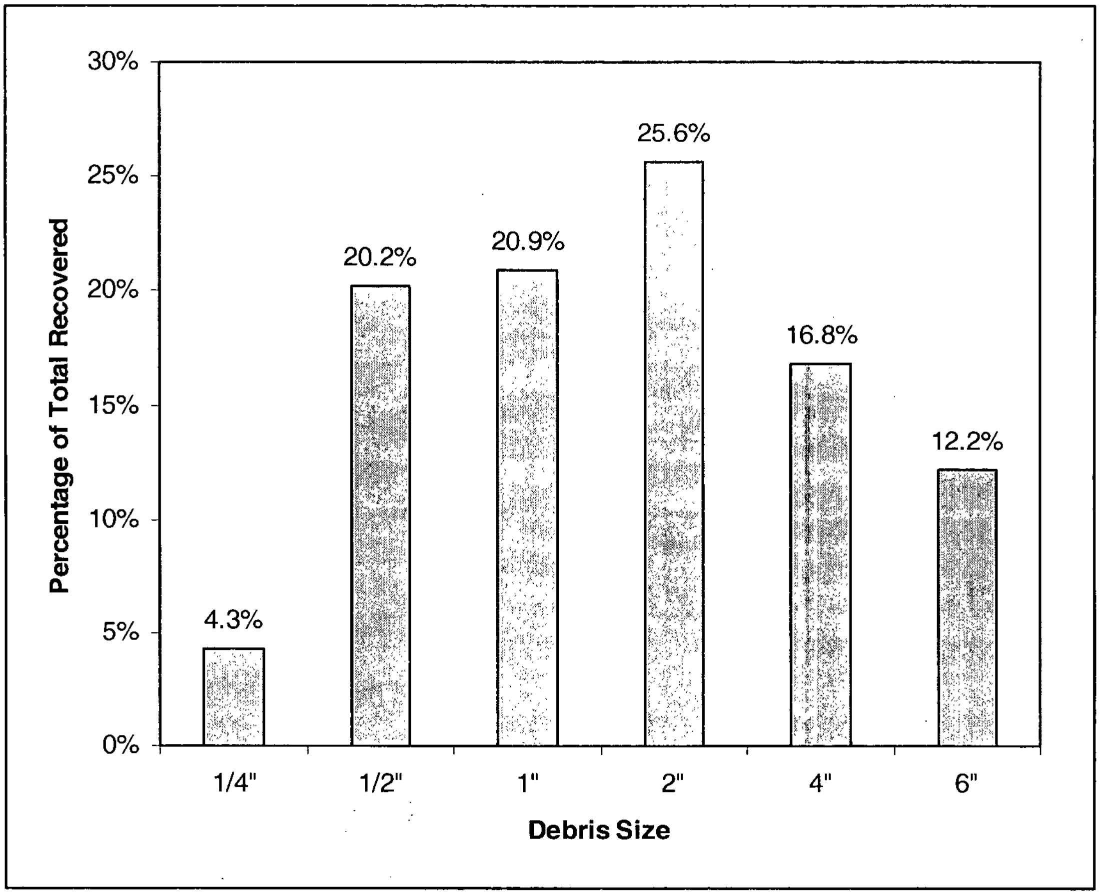


Figure 3.c.1.1 – RMI debris size distribution

3.c.2 Thermal-Wrap™ Low Density Fiberglass

Based on the Guidance Report (GR), the as-fabricated density of Thermal-Wrap™ is 2.4 lb/ft^3, and the material (individual fiber) density is 159 lb/ft^3. The characteristic diameter of the individual fibers is 5.5 μm.

For a baseline analysis of Thermal-Wrap™, the GR recommends a size distribution with two categories—60% small fines, and 40% large pieces. Alion Internal Document ALION-REP-ALION-2806-01 has taken the methodology set forth in Appendix II of the SER and developed a size distribution for Thermal-Wrap™ Low Density Fiberglass using Air Jet Impact Test (AJIT) data, with a conservatism added due to the higher level of destruction seen from two-phase testing. It was determined that within the overall ZOI, the size distribution would vary based on the distance of the insulation from the break (i.e. insulation debris generated near the break location would consist of more small pieces than insulation debris generated near the edge of the ZOI). Therefore, based on the data, three separate sub-zones were defined for Thermal-Wrap™ and the corresponding size distribution within each sub-zone was determined. These size distributions and sub-zone ZOIs are shown below in Table 3.c.2.1.

Table 3.c.2.1 – Thermal-Wrap™ Debris Size Distribution Within Each Sub-zone

Size	18.6 psi (7.0 ZOI)	10.0 – 18.6 psi (11.9 – 7.0 ZOI)	6.0 – 10.0 psi (17.0 – 11.9 ZOI)
Fines (Individual Fibers)	20%	13%	8%
Small Pieces (< 6" on a Side)	80%	54%	7%
Large Pieces (> 6" on a side)	0%	17%	41%
Intact (covered) Blankets	0%	16%	44%

3.c.3 Temp-Mat™ Fiberglass

Based on a Temp-Mat™ data sheet specific to the insulation at Ginna, the as-fabricated density of the Temp-Mat™ at the plant is 9 lb/ft^3, and the material (individual fiber) density is 162 lb/ft^3. The characteristic diameter of individual Temp-Mat™ fibers is 9.0 μm.

Similar to Thermal-Wrap™, the GR recommends a size distribution with two categories: 60% small fines, and 40% large pieces. Using the same approach applied for Thermal-Wrap™, Alion Internal Document ALION-REP-ALION-2806-01 has taken the methodology set forth in Appendix II of the SER and developed a size distribution for Temp-Mat using Air Jet Impact Test (AJIT) data, with a conservatism added due to the higher destruction seen from two-phase testing. Two separate sub-zones within the overall ZOI were defined for Temp-Mat™, and the corresponding size distribution within each sub-zone was determined These size distributions and sub-zone ZOIs are shown in Table 3.c.3.1.

Table 3.c.3.1 – Temp-Mat™ Debris Size Distribution Within Each Sub-zone

Size	45.0 psi (3.7 ZOI)	10.2 – 45.0 psi (11.7 – 3.7 ZOI)
Fines (Individual Fibers)	20%	7%
Small Pieces (< 6" on a Side)	80%	27%
Large Exposed (Uncovered) Pieces	0%	32%
Intact (Covered) Blankets	0%	34%

3.c.4 Cal-Sil/Asbestos

The Cal-Sil insulation at Ginna is stainless steel jacketed Thermo-12™ Gold, an insulation manufactured by Johns Manville. Based on a technical data sheet specific to the Cal-Sil at Ginna, the Thermo-12™ Gold Cal-Sil has an as-fabricated density of 15 lb/ft^3. According to the GR Table 3-2, the material (particulate) density of Cal-Sil is 144 lb/ft^3, and the characteristic diameter of the particulate is 2-100 μm. Asbestos has an as-fabricated density of 7-10 lb/ft^3, and a material (particulate) density of 153 lb/ft^3. This analysis will assume the characteristic size of the Cal-Sil is a 5 micron mean particle per Table 3-2 of the GR. The characteristic diameter of Asbestos particulate is 1-8 μm. Since the Ginna debris spreadsheet does not distinguish between Cal-Sil and Asbestos in most cases (making it impossible to determine the individual quantities of each), and the material properties are similar, the density and representative size for Cal-Sil were used in this analysis for both Cal-Sil and Asbestos.

The size distribution recommended in the GR Section 3.4.3.3.3 for Cal-Sil is 100% fines (particulate). Alion Internal Document ALION-REP-ALION-2806-01 has taken the methodology set forth in Appendix II of the SER and developed a size distribution for Cal-Sil using Ontario Power Generation debris generation tests which used a two-phase water/steam jet. The size distribution is summarized in Table 3.c.4.1.

Table 3.c.4.1 – Cal-Sil Debris Size Distribution

Size	70.0 psi (2.7 ZOI)	20.0 – 70.0 psi (6.4 – 2.7 ZOI)
Fines (particulate)	50%	23%
Small pieces Under 1" to Over 3")	50%	15%
Remains on Target	0%	62%

3.c.5 Debris Generated

Debris characteristics summary is provide in Table 3.c.5.1

Table 3.c.5.1 – Physical Properties of Debris

Debris Type/Size	Material Bulk Density	Particulate/Individual Fiber Density	Characteristic Size
Stainless Steel RMI	-	-	1/8" to 6" pieces
Cal-Sil/Asbestos	15 lb/ft^3	144 lb/ft^3	5 μm
Temp-Mat™	9 lb/ft^3	162 lb/ft^3	9 μm
Thermal-Wrap™	2.4 lb/ft^3	159 lb/ft^3	5.5 μm
Phenolic Paint (Inside ZOI)	84 lb/ft^3	94 lb/ft^3	10 μm
Phenolic Paint (Outside ZOI)	84 lb/ft^3	94 lb/ft^3	18 mil thick chips
IOZ Paint	223 lb/ft^3	457 lb/ft^3	10 μm
Dirt/Dust	-	169 lb/ft^3	17.3 μm
Latent Fiber	2.4 lb/ft^3	94 lb/ft^3	7.0 μm

Table 3.c.5.2 – Case 1: Debris Source Term for a Break in Compartment A

Debris Generation Results		Case 1		
Debris Type	Debris Size	Debris Quantity Generated		Percent of Total (%)
Stainless Steel RMI (ft^2)	Small Pieces (<4")	1656.0	ft^2	75%
	Large Pieces (>4")	552.0	ft^2	25%
	Total	**2208.0**	ft^2	**100%**
TempMat (ft^3)	Fines	9.5	ft^3	16%
	Small Pieces (<6")	37.7	ft^3	64%
	Large Pieces (>6")	5.6	ft^3	10%
	Intact Pieces (>6")	6.0	ft^3	10%
	Total	**58.8**	ft^3	**100%**
Transco Thermal Wrap' LDFG - Fiberglass (ft^3)	Fines	90.2	ft^3	14%
	Small Pieces (<6")	316.4	ft^3	50%
	Large Pieces (>6")	107.8	ft^3	17%
	Intact Pieces (>6")	115.4	ft^3	18%
	Total	**629.8**	ft^3	**100%**
Cal-Sil (w/ Asbestos) (ft^3)	Particulate	8.7	ft^3	56%
	Pieces > 1"	6.9	ft^3	44%
	Total	**15.6**	ft^3	**100%**
Asbestos (ft^3)	Particulate	0.0	ft^3	0%
	Pieces > 1"	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Coatings	Phenolic Paint (inside 10D ZOI)	757	lb	
	IOZ Paint (inside 10D ZOI)	94	lb	
	Phenolic Paint (inside 5D ZOI)	130	lb	
	IOZ Paint (inside 5D ZOI)	29	lb	
	Phenolic Paint (outside ZOI)	199	lb	
	IOZ Paint (outside ZOI)	88	lb	
Latent Debris	Dirt/Dust*	85	lb	
	Latent Fiber*	15	lb	

*Explained in Section 3.d, Latent Debris

Table 3.c.5.3 – Case 2: Debris Source Term for a Break in Compartment B

Debris Generation Results		Case 2		
Debris Type	**Debris Size**	**Debris Quantity Generated**		**Percent of Total (%)**
Stainless Steel RMI (ft^2)	Small Pieces (<4")	1656.0	ft^2	75%
	Large Pieces (>4")	552.0	ft^2	25%
	Total	**2208.0**	ft^2	**100%**
TempMat (ft^3)	Fines	7.7	ft^3	12%
	Small Pieces (<6")	30.6	ft^3	47%
	Large Pieces (>6")	13.3	ft^3	20%
	Intact Pieces (>6")	14.1	ft^3	21%
	Total	**65.7**	ft^3	**100%**
Transco Thermal Wrap' LDFG - Fiberglass (ft^3)	Fines	90.7	ft^3	14%
	Small Pieces (<6")	318.6	ft^3	50%
	Large Pieces (>6")	108.1	ft^3	17%
	Intact Pieces (>6")	115.7	ft^3	18%
	Total	**633.2**	ft^3	**100%**
Cal-Sil (w/ Asbestos) (ft^3)	Particulate	14.7	ft^3	56%
	Pieces > 1"	11.5	ft^3	44%
	Total	**26.2**	ft^3	**100%**
Asbestos (ft^3)	Particulate	0.0	ft^3	0%
	Pieces > 1"	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Coatings	Phenolic Paint (inside 10D ZOI)	869	lb	
	IOZ Paint (inside 10D ZOI)	122	lb	
	Phenolic Paint (inside 5D ZOI)	116	lb	
	IOZ Paint (inside 5D ZOI)	28	lb	
	Phenolic Paint (outside ZOI)	199	lb	
	IOZ Paint (outside ZOI)	88	lb	
Latent Debris	Dirt/Dust*	85	lb	
	Latent Fiber*	15	lb	

*Explained in Section 3.d, Latent Debris

Table 3.5.3 – Case 3: Debris Source Term for a Break in the Pressurizer Compartment

Debris Generation Results		Case 3		
Debris Type	**Debris Size**	**Debris Quantity Generated**		**Percent of Total (%)**
Stainless Steel RMI (ft^2)	Small Pieces (<4")	0.0	ft^2	0%
	Large Pieces (>4")	0.0	ft^2	0%
	Total	**0.0**	ft^2	**0%**
TempMat (ft^3)	Fines	0.9	ft^3	20%
	Small Pieces (<6")	3.5	ft^3	80%
	Large Pieces (>6")	0.0	ft^3	0%
	Intact Pieces (>6")	0.0	ft^3	0%
	Total	**4.4**	ft^3	**100%**
Transco Thermal Wrap' LDFG - Fiberglass (ft^3)	Fines	0.0	ft^3	0%
	Small Pieces (<6")	0.0	ft^3	0%
	Large Pieces (>6")	0.0	ft^3	0%
	Intact Pieces (>6")	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Cal-Sil (w/ Asbestos) (ft^3)	Particulate	1.4	ft^3	50%
	Pieces > 1"	1.4	ft^3	50%
	Total	**2.9**	ft^3	**100%**
Asbestos (ft^3)	Particulate	0.0	ft^3	0%
	Pieces > 1"	0.0	ft^3	0%
	Total	**0.0**	ft^3	**0%**
Coatings	Phenolic Paint (inside 10D ZOI)	10	lb	
	IOZ Paint (inside 10D ZOI)	4	lb	
	Phenolic Paint (inside 5D ZOI)	2.5	lb	
	IOZ Paint (inside 5D ZOI)	1.1	lb	
	Phenolic Paint (outside ZOI)	199	lb	
	IOZ Paint (outside ZOI)	88	lb	
Latent Debris	Dirt/Dust*	85	lb	
	Latent Fiber*	15	lb	

*Explained in Section 3.d, Latent Debris

References

i. Rao, D. V., et al., "Knowledge Base for the Effects of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," NUREG/CR-6808, Los Alamos National Laboratory, February 2003.

ii. NEI PWR Sump Performance Task Force Report NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Rev. 0, December 2004.

iii. Technical datasheets for Temp-Mat™ and Thermo-12™ Gold Cal-Sil provided by Constellation Energy.

3.d Latent Debris

NRC Issue 3d:

Latent Debris

The objective of the latent debris evaluation process is to provide a reasonable approximation of the amount and types of latent debris existing within the containment and its potential impact on sump screen head loss.

1. *Provide the methodology used to estimate quantity and composition of latent debris.*
2. *Provide the basis for assumptions used in the evaluation.*
3. *Provide results of the latent debris evaluation, including amount of latent debris types and physical data for latent debris as requested for other debris under c. above.*
4. *Provide amount of sacrificial strainer surface area allotted to miscellaneous latent debris.*

Latent debris is defined as dirt, dust, paint chips, fibers, paper scraps, plastic tags, tape, adhesive, labels, fines or shards of thermal insulation, fireproof barrier, or other materials that may be present in containment prior to a postulated Loss of Coolant Accident (LOCA). Potential origins for this material include foreign particulate brought into containment during refueling outages and the normal deterioration of coatings, etc.

Based on the Guidance Report Section 3.5.2.2, the maximum quantity of latent debris inside containment is expected to be less than 200 lbs . The Safety Evaluation Report Section 3.5.2.3 suggests that 15% of the latent debris should be assumed to be fiber, and the other 85% particulate. Ginna has generated a calculation and walk down report detailing the estimated latent debris load within containment. Sampling was performed at a minimum of four representative locations for of each of twelve surface types.

The calculation estimates a latent dirt and dust load of approximately 77 lbs within containment. To provide margin for this calculation, a value of 100 lbs. will be used. Of this debris, 85 lbs were assumed to be dirt/dust and the remaining 15 lbs were assumed to be latent fiber. No sacrificial strainer area is specifically allotted for latent debris, however margin is built in to the overall surface area for the sake of conservatism. Table 3.d.1 below details the Ginna containment walk down findings with all values listed in grams/100 cm^2.

Table 3.d.1: Latent Debris Walk Down Results

	LOCATION						
SURFACE TYPE	A	B	C	D	E	$\bar{x}$	σ_s
Horizontal Concrete Surfaces (floors)	0.16	4.00	0.88	1.12		1.54	1.70
Vertical Concrete Surfaces (walls)	0.38	0.15	0.20	0.60		0.33	0.20
Grated Surfaces at Support Beams	2.48	16.20	7.90	2.10	29.60	11.66	11.53
Containment Liner (Vertical)	0.58	0.10	0.15	0.45		0.32	0.23
Cable Trays (Vertical)	9.40	1.20	5.00	1.62		4.30	3.80
Cable Trays (Horizontal)	3.56	21.20	1.05	1.80		6.90	9.58
Horizontal Equipment Surfaces	2.10	8.00	1.17	3.40		3.67	3.03
Vertical Equipment Surfaces	0.22	0.14	0.13	2.20		0.67	1.02
Horizontal HVAC Duct Surfaces	31.70	14.90	8.40	21.80		19.20	9.97
Vertical HVAC Duct Surfaces	2.07	2.87	3.97	5.00		3.48	1.28
Horizontal Piping Surfaces	7.54	2.60	3.28	2.54		3.99	2.39
Vertical Piping Surfaces	2.60	2.55	0.44	1.14		1.68	1.07

Ginna Station has a program in place for a Containment Storage and Closeout Inspection (A-3.1) and a procedure for sampling latent debris (SM-2005-0014.01).

3.e Debris Transport

***NRC Issue 3e*:**

Debris Transport

The objective of the debris transport evaluation process is to estimate the fraction of debris that would be transported from debris sources within containment to the sump suction strainers.

1. *Describe the methodology used to analyze debris transport during the blowdown, washdown, pool-fill-up, and recirculation phases of an accident.*
2. *Provide the technical basis for assumptions and methods used in the analysis that deviate from the approved guidance.*
3. *Identify any computational fluid dynamics codes used to compute debris transport fractions during recirculation and summarize the methodology, modeling assumptions, and results.*
4. *Provide a summary of, and supporting basis for, any credit taken for debris interceptors.*
5. *State whether fine debris was assumed to settle and provide basis for any settling credited.*
6. *Provide the calculated debris transport fractions and the total quantities of each type of debris transported to the strainers.*

3.e.1 Methodology

Debris transport is the estimation of the fraction of debris that is transported from debris sources (break location) to the sump strainer. The four major debris transport modes are:

- *Blowdown transport* – the vertical and horizontal transport of debris to all areas of containment by the break jet.
- *Spray Wash down transport* – the vertical (downward) transport of debris by the containment sprays and break flow.
- *Pool fill-up transport* – the transport of debris by break and containment spray flows from the Refueling Water Storage Tank (RWST) to regions that may be active or inactive during recirculation.
- *Pool Recirculation transport* – the horizontal transport of debris from the active portions of the recirculation pool to the sump strainer by the flow through the Emergency Core Cooling System (ECCS).

The methodology used in this analysis is based on the NEI 04-07 Guidance Report (GR) for refined analyses as modified by the NRC's Safety Evaluation Report (SER), as well as the refined methodologies suggested by the SER in Appendices III, IV, and VI. The specific effect of each mode of transport was analyzed for each type of debris generated, and a logic tree was developed to determine the total transport to the sump strainer. The purpose of this approach is to break a complicated transport problem down into specific smaller problems that can be more easily analyzed. A generic transport logic tree for a four-category size distribution is shown in Figure 3.e.1.1.

The logic tree approach can be used for each type of debris. The size distribution and characterization for the specific debris types comes from the debris generation calculation. The logic tree shown in Figure 3.e.1.1 is somewhat different than the baseline logic tree provided in the GR. This departure was made to add conservatisms regarding the transport of large pieces, erosion of small and large pieces, the potential for wash down debris to enter the pool after inactive areas have been filled, and the direct transport of debris to the sump strainer during pool fill-up. Also, the generic logic tree was expanded to account for a more refined debris size distribution.

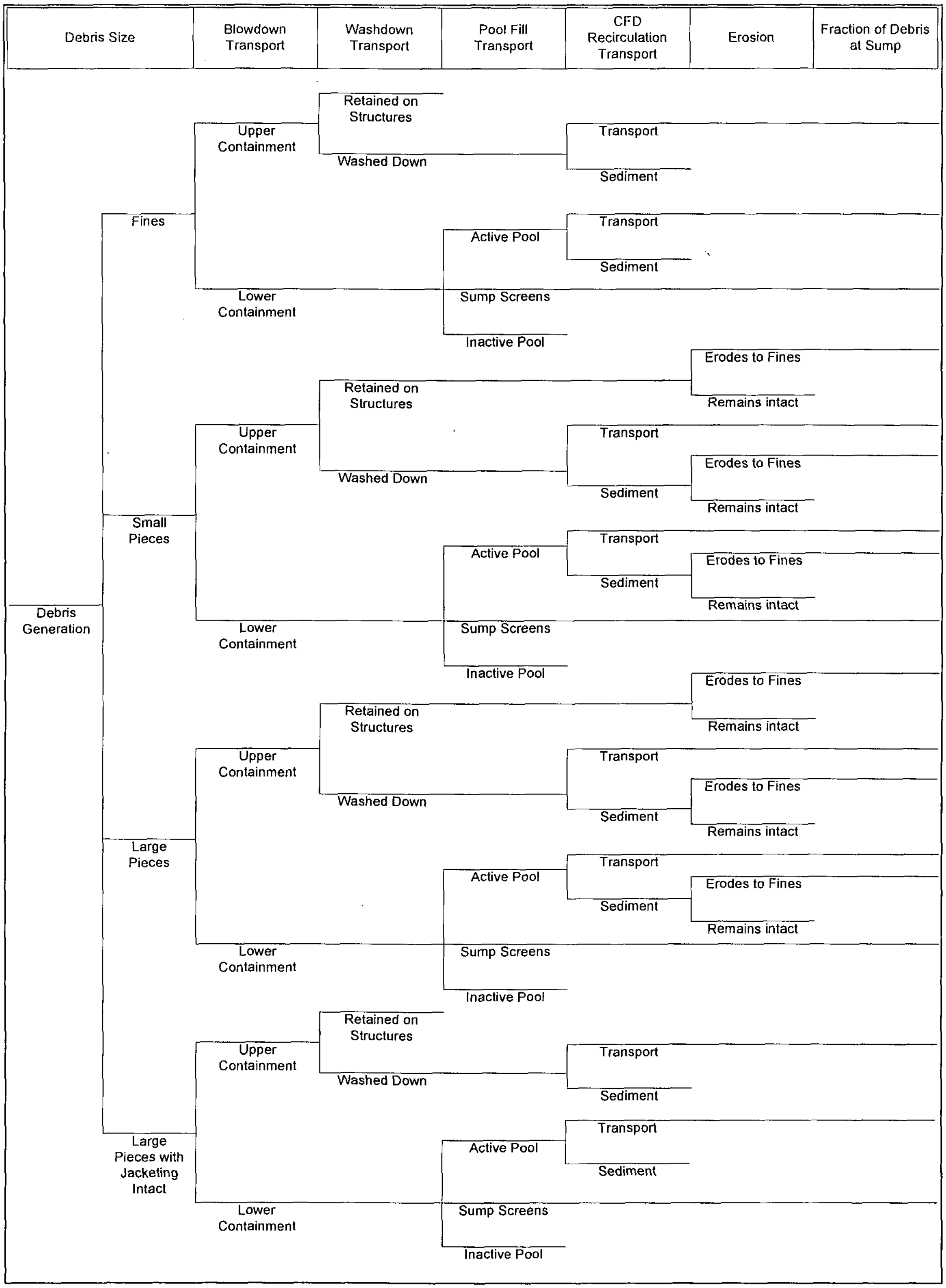


Figure 3.e.1.1 – Generic Debris Transport Logic Tree

The basic methodology used for the Ginna transport analysis is shown below:

1. Based on many of the containment building drawings, a three-dimensional model was built using Computer Aided Drafting (CAD) software.
2. Debris types and size distributions were gathered from the debris generation calculation for each postulated break location.
3. The fraction of debris blown to upper containment was determined based on the flow of steam during the blowdown.
4. The quantity of debris washed down by spray flow was conservatively determined.
5. The quantity of debris transported to inactive areas or directly to the sump strainer was calculated based on the volume of the inactive and sump cavities proportional to the water volume at the time these cavities are filled.
6. Using conservative assumptions, the location of each type/size of debris at the beginning of recirculation was determined.
7. A Computational Fluid Dynamics model was developed to simulate the flow patterns that would develop in the pool during recirculation.
   a. The mesh in the CFD model was nodalized to sufficiently resolve the features of the CAD model, but still keep the cell count low enough for the simulation to run in a reasonable amount of time.
   b. The boundary conditions for the CFD model were set based on the configuration of Ginna during the recirculation phase.
   c. At the postulated LOCA break location, a mass source was added to the model to introduce the appropriate flow rate and kinetic energy associated with the break flow.
   d. A negative mass source was added at the sump location with a total flow rate equal to the break flow.
   e. An appropriate turbulence model was selected for the CFD calculations.
   f. After running the CFD calculations, the mean kinetic energy and other relevant parameters were checked to verify that the model had been run long enough to reach steady-state conditions.
   g. Transport metrics were determined based on relevant tests and calculations for each significant debris type present in the Ginna containment building.
8. A graphical determination of the transport fraction of each type of debris was made using the velocity and Turbulent Kinetic Energy profiles from the CFD model output, along with the determined initial distribution of debris.
9. The recirculation transport fractions from the CFD analysis were gathered to input into the logic trees.
10. The quantity of debris that could experience erosion due to the break flow or spray flow was determined.
11. The overall transport fraction for each type of debris was determined by combining each of the previous steps in logic trees.

3.e.2 Debris Types and Size Distribution

A total of three breaks were postulated in the debris generation calculation:

1. A break in the 31-inch intermediate leg at the base of the steam generator in Compartment A.
2. A break in the 31-inch intermediate leg at the base of the steam generator in Compartment B.
3. A pressurizer spray line break.

The break locations are illustrated in Figure 3.e.2.1.

Figure 3.e.2.1

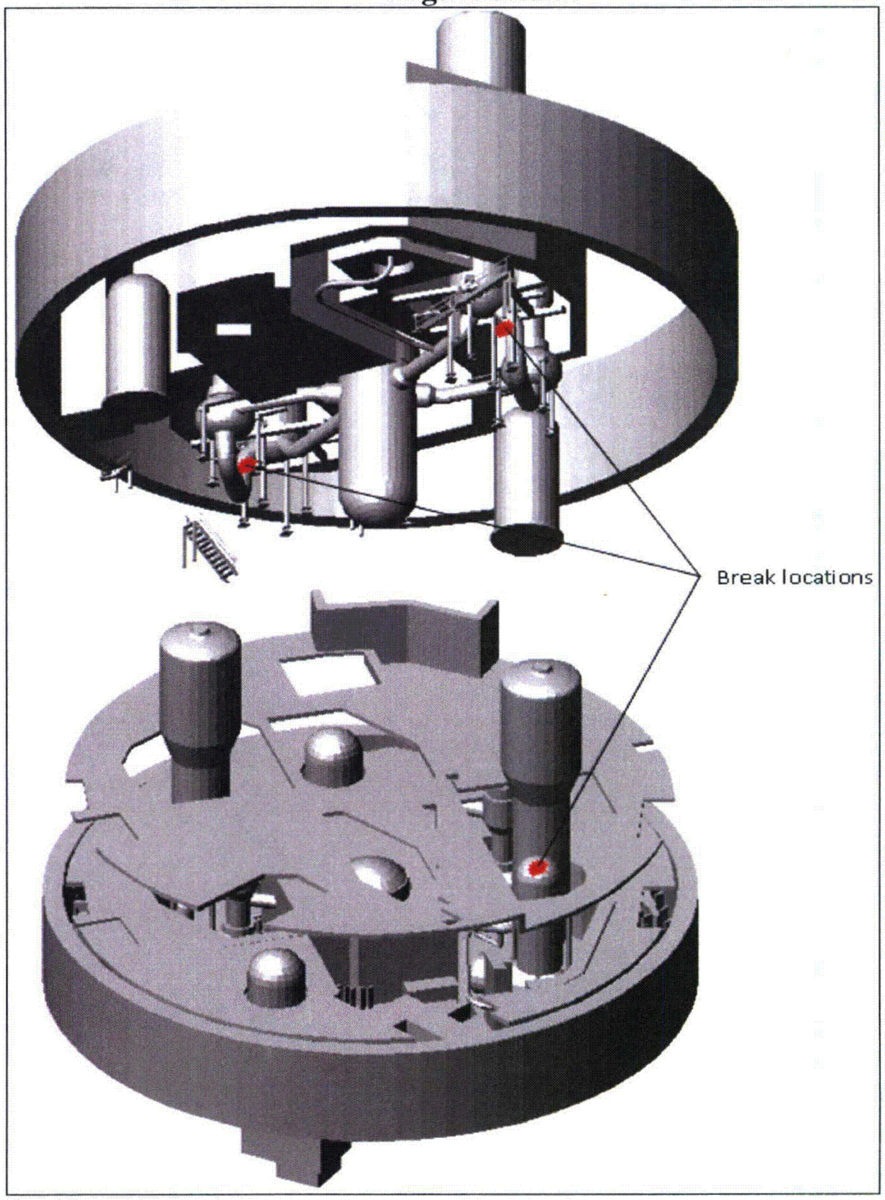


Figure 3.e.2.1 – Postulated break locations

The debris types and sizes for each break (case) were taken from the debris generation calculation and are reproduced in the tables below.

Tables 3.e.2.1, Table 3.e.2.2, and Table 3.e.2.3 represent Cases 1, 2, and 3 respectively.

Table 3.e.2.1 – Case 1 Debris Source term for LBLOCA in SG Compartment A

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Intact Blankets	Total
Stainless Steel RMI	-	1,656 ft^2 (75%)	552 ft^2 (25%)	-	2,208 ft^2
Temp-Mat™	9.5 ft^3 (16%)	37.7 ft^3 (64%)	5.6 ft^3 (10%)	6.0 ft^3 (10%)	58.8 ft^3
Thermal-Wrap™	90.2 ft^3 (14%)	316.4 ft^3 (50%)	107.8 ft^3 (17%)	115.4 ft^3 (18%)	629.8 ft^3
Cal-Sil with Asbestos	8.7 ft^3 (56%)	6.9 ft^3 (44%)	-	-	15.6 ft^3
Phenolic Paint (inside 10D ZOI)	757 lb (100%)	-	-	-	757 lb
IOZ Paint (inside 10D ZOI)	94 lb (100%)	-	-	-	94 lb
Phenolic Paint (inside 5D ZOI)	130 lb (100%)	-	-	-	130 lb
IOZ Paint (inside 5D ZOI)	29 lb (100%)	-	-	-	29 lb
Phenolic Paint (outside ZOI)	-	199 lb (100%)	-	-	199 lb
IOZ Paint (outside ZOI)	88 lb (100%)	-	-	-	88 lb
Dirt/Dust	85 lb (100%)	-	-	-	85 lb
Latent Fiber	15 lb (100%)	-	-	-	15 lb

Table 3.e.2.2 – Case 2: Debris Source Term for LBLOCA in SG Compartment B

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Intact Blankets	Total
Stainless Steel RMI	-	1,656 ft^2 (75%)	552 ft^2 (25%)	-	2,208 ft^2
Temp-Mat™	7.7 ft^3 (12%)	30.6 ft^3 (47%)	13.3 ft^3 (20%)	14.1 ft^3 (21%)	65.7 ft^3
Thermal-Wrap™	90.7 ft^3 (14%)	318.6 ft^3 (50%)	108.1 ft^3 (17%)	115.7 ft^3 (18%)	633.2 ft^3
Cal-Sil with Asbestos	14.7 ft^3 (57%)	11.5 ft^3 (43%)	-	-	26.2 ft^3
Phenolic Paint (inside 10D ZOI)	869 lb (100%)	-	-	-	869 lb
IOZ Paint (Inside 10D ZOI)	122 lb (100%)	-	-	-	122 lb
Phenolic Paint (inside 5D ZOI)	116 lb (100%)	-	-	-	116 lb
IOZ Paint (Inside 5D ZOI)	28 lb (100%)	-	-	-	28 lb
Phenolic Paint (outside ZOI)	-	199 lb (100%)	-	-	199 lb
IOZ Paint (outside ZOI)	88 lb (100%)	-	-	-	88 lb
Dirt/Dust	85 lb (100%)	-	-	-	85 lb
Latent Fiber	15 lb (100%)	-	-	-	15 lb

Table 3.e.2.3 – Case 3: Debris Source Term for a Break in the Pressurizer Compartment

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Intact Blankets	Total
Temp-Mat™	0.9 ft^3 (20%)	3.5 ft^3 (80%)	-	-	4.4 ft^3
Cal-Sil with Asbestos	1.4 ft^3 (50%)	1.4 ft^3 (50%)	-	-	2.9 ft^3
Phenolic Paint (inside 10D ZOI)	10 lb (100%)	-	-	-	10 lb
IOZ Paint (Inside 10D ZOI)	4 lb (100%)	-	-	-	4 lb
Phenolic Paint (inside 5D ZOI)	2.5 lb (100%)	-	-	-	2.5 lb
IOZ Paint (Inside 5D ZOI)	1.1 lb (100%)	-	-	-	1.1 lb
Phenolic Paint (outside ZOI)	-	199 lb (100%)	-	-	199 lb
IOZ Paint (outside ZOI)	88 lb (100%)	-	-	-	88 lb
Dirt/Dust	85 lb (100%)	-	-	-	85 lb
Latent Fiber	15 lb (100%)	-	-	-	15 lb

3.e.3 Results

Table 3.e.3.1, Table 3.e.3.2, and Table 3.e.3.3 summarize the transport results for an LBLOCA in Compartment A, an LBLOCA in Compartment B, and an SBLOCA in the pressurizer spray line respectively.

Table 3.e.3.1 – Overall Debris Transport Fractions (Case 1)

Debris Type	Debris Size	Debris Quantity Generated	Debris Transport Fraction	Debris Quantity at Sump
Stainless Steel RMI	Small Pieces (<4")	1,656 ft^2	0%	0 ft^2
	Large Pieces (>4")	552 ft^2	0%	0 ft^2
	Total	**2,208 ft^2**	**0%**	**0 ft^2**
Thermal-Wrap™	Fines	90.2 ft^3	66%	59.5 ft^3
	Small Pieces (<6")	316.4 ft^3	4%	12.7 ft^3
	Large Pieces (>6")	107.8 ft^3	4%	4.3 ft^3
	Intact Pieces (>6")	115.4 ft^3	0%	0 ft^3
	Total	**629.8 ft^3**	**12%**	**76.5 ft^3**
Temp-Mat™	Fines	9.5 ft^3	66%	6.3 ft^3
	Small Pieces (<6")	37.7 ft^3	34%	12.8 ft^3
	Large Pieces (>6")	5.6 ft^3	38%	2.1 ft^3
	Intact Pieces (>6")	6.0 ft^3	38%	2.3 ft^3
	Total	**58.8 ft^3**	**40%**	**23.5 ft^3**
Cal-Sil with Asbestos	Fines	8.7 ft^3	66%	5.7 ft^3
	Small Pieces (>1")	6.9 ft^3	50%	3.5 ft^3
	Total	**15.6 ft^3**	**59%**	**9.2 ft^3**
Qualified Phenolic (10D)	Total (fines)	757 lb	66%	500 lb
Qualified IOZ (10D)	Total (fines)	94 lb	66%	62 lb
Qualified Phenolic (5D)	Total (fines)	130 lb	66%	86 lb
Qualified IOZ (5D)	Total (fines)	29 lb	66%	19 lb
Qualified Degraded Phenolic	Total (chips)	199 lb	0%	0 lb
Qualified Degraded IOZ	Total (fines)	88 lb	100%	88 lb
Dirt/Dust	Total (fines)	85 lb	100%	85 lb
Latent Fiber	Total (fines)	15 lb	100%	15 lb

Table 3.e.3.2 – Overall Debris Transport Fractions (Case 2)

Debris Type	Debris Size	Debris Quantity Generated	Debris Transport Fraction	Debris Quantity at Sump
Stainless Steel RMI	Small Pieces (<4")	1,656 ft^2	39%	646 ft^2
	Large Pieces (>4")	552 ft^2	39%	215 ft^2
	Total	**2,208 ft^2**	**39%**	**861 ft^2**
Thermal-Wrap™	Fines	90.7 ft^3	66%	59.9 ft^3
	Small Pieces (<6")	318.6 ft^3	26%	82.8 ft^3
	Large Pieces (>6")	108.1 ft^3	15%	16.2 ft^3
	Intact Pieces (>6")	115.7 ft^3	13%	15.0 ft^3
	Total	**633.2 ft^3**	**27%**	**173.9 ft^3**
Temp-Mat™	Fines	7.7 ft^3	66%	5.1 ft^3
	Small Pieces (<6")	30.6 ft^3	34%	10.4 ft^3
	Large Pieces (>6")	13.3 ft^3	38%	5.1 ft^3
	Intact Pieces (>6")	14.1 ft^3	38%	5.4 ft^3
	Total	**65.7 ft^3**	**40%**	**26.0 ft^3**
Cal-Sil with Asbestos	Fines	14.7 ft^3	66%	9.7 ft^3
	Small Pieces (>1")	11.5 ft^3	67%	7.7 ft^3
	Total	**26.2 ft^3**	**66%**	**17.4 ft^3**
Qualified Phenolic (10D)	Total (fines)	869 lb	66%	574 lb
Qualified IOZ (10D)	Total (fines)	122 lb	66%	81 lb
Qualified Phenolic (5D)	Total (fines)	116 lb	66%	77 lb
Qualified IOZ (5D)	Total (fines)	28 lb	66%	18 lb
Qualified Degraded Phenolic	Total (chips)	199 lb	12%	24 lb
Qualified Degraded IOZ	Total (fines)	88 lb	100%	88 lb
Dirt/Dust	Total (fines)	85 lb	100%	85 lb
Latent Fiber	Total (fines)	15 lb	100%	15 lb

Table 3.e.3.3 – Overall Debris Transport Fractions (Case 3)

Debris Type	Debris Size	Debris Quantity Generated	Debris Transport Fraction	Debris Quantity at Sump
Temp-Mat™	Fines	0.9 ft^3	100%	0.9 ft^3
	Small Pieces (<6")	3.5 ft^3	100%	3.5 ft^3
	Total	**4.4 ft^3**	**100%**	**4.4 ft^3**
Cal-Sil with Asbestos	Fines	1.4 ft^3	100%	1.4 ft^3
	Small Pieces (>1")	1.4 ft^3	100%	1.4 ft^3
	Total	**2.9 ft^3**	**100%**	**2.9 ft^3**
Qualified Phenolic (10D)	Total (fines)	10 lb	100%	10 lb
Qualified IOZ (10D)	Total (fines)	4 lb	100%	4 lb
Qualified Phenolic (5D)	Total (fines)	2.5 lb	100%	2.5 lb
Qualified IOZ (5D)	Total (fines)	1.1 lb	100%	1.1 lb
Qualified Degraded Phenolic	Total (chips)	199 lb	100%	199 lb
Qualified Degraded IOZ	Total (fines)	88 lb	100%	88 lb
Dirt/Dust	Total (fines)	85 lb	100%	85 lb
Latent Fiber	Total (fines)	15 lb	100%	15 lb

3.e.4 Conclusions

Based on the results of the transport analysis, the following conclusions can be drawn for debris transport in the Ginna containment building:

- The blowdown following an LBLOCA in the loop compartment would carry a significant quantity of fines and small and large piece fiberglass debris to the upper containment.
- Given the short duration of the spray flow and the number of gratings that debris would have to pass through, a large fraction of small piece debris and all large piece debris would be held up in upper containment. Also, a significant quantity of debris would be washed down in the inactive reactor cavity.
- During recirculation, a large break in Compartment A would not transport any debris except for fines and a small amount of small piece fiberglass debris. A large break in Compartment B would transport significantly more small and large piece debris due to the proximity of this compartment to the sump.
- Overall, the transport analysis shows that a break in Compartment B is limiting and results in approximately 40% of the RMI, 30% of the low density fiberglass, 40% of the high density fiberglass, 70% of the Cal-Sil, 70% of the qualified paint particulate, 10% of the degraded qualified paint chips, and 100% of the qualified degraded paint particulate and latent debris transporting to the sump.

3.f Head Loss and Vortexing

NRC Issue 3f:

Head Loss and Vortexing

The objectives of the head loss and vortexing evaluations are to calculate head loss across the sump strainer and to evaluate the susceptibility of the strainer to vortex formation.

1. *Provide a schematic diagram of the emergency core cooling system (ECCS) and containment spray systems (CSS).*
2. *Provide the minimum submergence of the strainer under small-break loss-of-coolant accident (SBLOCA) and large-break loss-of-coolant accident (LBLOCA) conditions.*
3. *Provide a summary of the methodology, assumptions and results of the vortexing evaluation. Provide bases for key assumptions.*
4. *Provide a summary of the methodology, assumptions, and results of prototypical head loss testing for the strainer, including chemical effects. Provide bases for key assumptions.*
5. *Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.*
6. *Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.*
7. *Provide the basis for the strainer design maximum head loss.*
8. *Describe significant margins and conservatisms used in the head loss and vortexing calculations.*
9. *Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.*
10. *Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.*
11. *State whether the sump is partially submerged or vented (i.e., lacks a complete water seal over its entire surface) for any accident scenarios and describe what failure criteria in addition to loss of net positive suction head (NPSH) margin were applied to address potential inability to pass the required flow through the strainer.*
12. *State whether near-field settling was credited for the head-loss testing and, if so, provide a description of the scaling analysis used to justify near-field credit.*
13. *State whether temperature/viscosity was used to scale the results of the head loss tests to actual plant conditions. If scaling was used, provide the basis for concluding that boreholes or other differential-pressure induced effects did not affect the morphology of the test debris bed.*
14. *State whether containment accident pressure was credited in evaluating whether flashing would occur across the strainer surface, and if so, summarize the methodology used to determine the available containment pressure.*

3.f.1.0 System Description

Ginna Station utilizes a group of systems known collectively as Engineered Safety Feature (ESF) systems to mitigate the effects of design basis accidents. The systems of concern can be broken into two subgroups: Emergency Core Cooling Systems (ECCS), which provide borated injection water to the Reactor Coolant System in the event of primary system breaks, and Containment Spray (CS) System, which cools and condenses the steam released by high energy line breaks inside the containment structure. Initially, borated water from the Refueling Water Storage Tank (RWST) will be injected into the RCS and sprayed into containment to mitigate the effects of the accident. When an adequate inventory of water has been established in containment, the ESF systems will be re-aligned to take suction from the containment sump to maintain ECCS functions for the duration of the event. The CS system is not required in this latter mode except under beyond-design-basis conditions. The ECCS and CS are represented in Figure 3.f.1.0.1 and Figure 3.f.1.0.2 below.

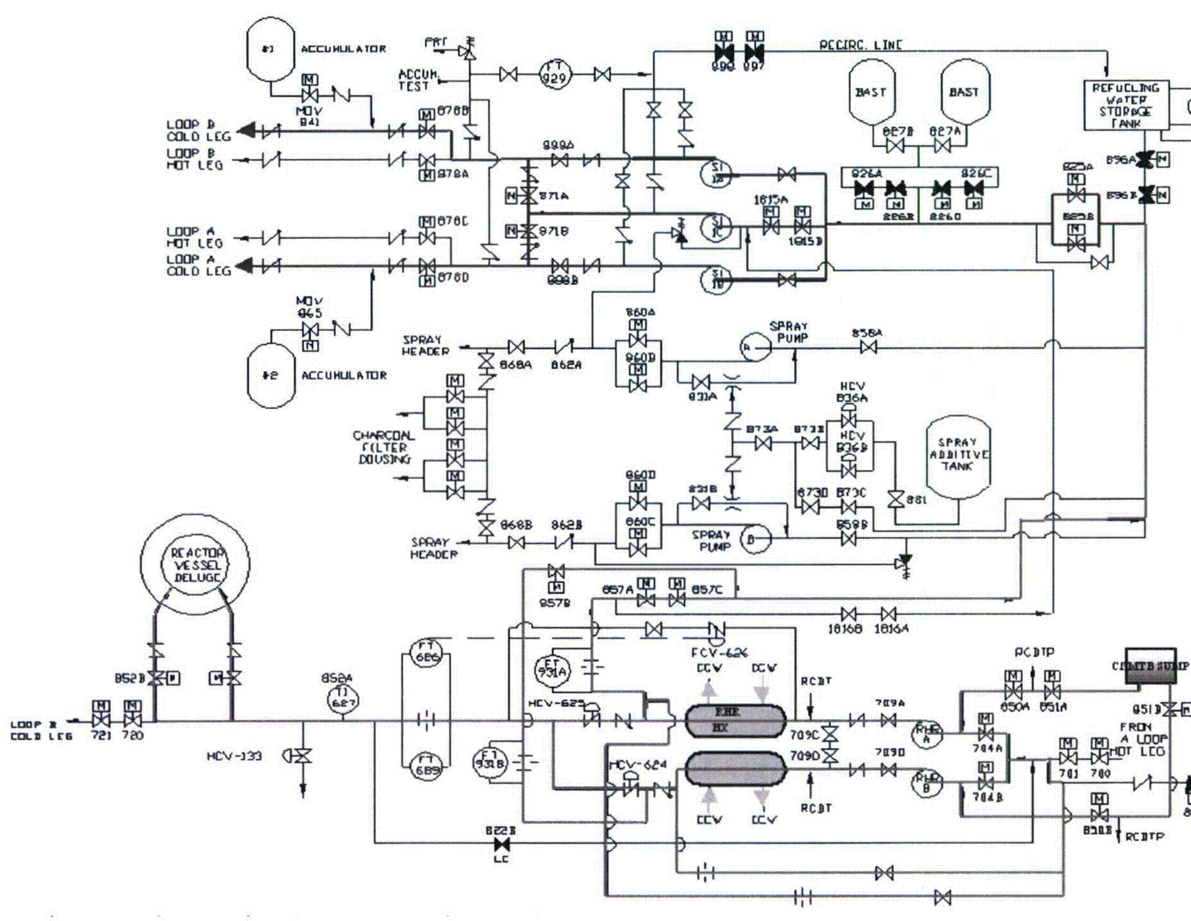


Figure 3.f.1.0.1 ECCS Composite

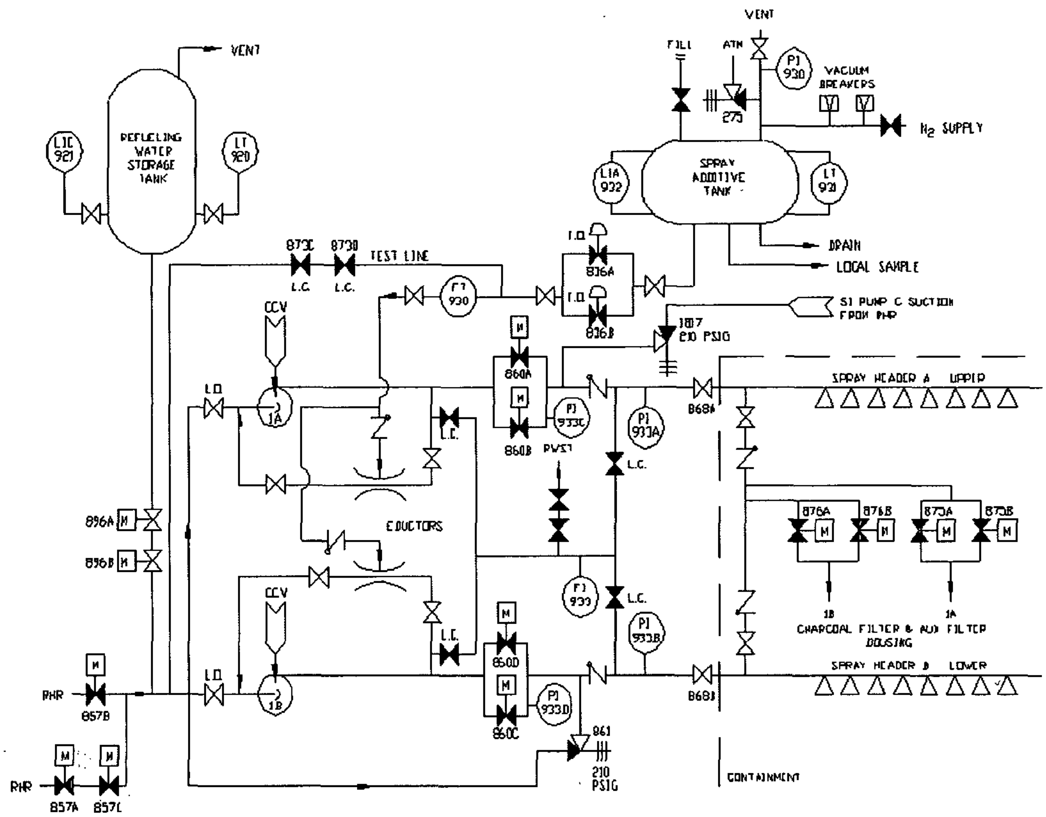


Figure 3.f.1.0.2 Containment Spray

3.f.1.1 Emergency Core Cooling System

The ECCS function is performed by the Safety Injection (SI) system, which is comprised of three subsystems:

- High Pressure Safety Injection (HPSI), which contains three Safety Injection (SI) pumps to provide high head, low volume injection. Each SI pump has a shutoff head of 3,400 ft. (1,470 psig) and maximum flow rate is 625 gpm [i].

- Low Pressure Safety Injection (LPSI), which contains two Residual Heat Removal (RHR) pumps to provide low head, high volume injection. Each RHR pump has a shutoff head of approximately 340 ft. (147 psig) and a maximum flow rate of 2,500 gpm. Flow through the RHR pumps is limited by operating and calibration procedures [v, iii] when the plant is online.

- Passive (Accumulator) Injection, which contains two accumulator tanks. Each accumulator tank contains a minimum volume of approximately 1,090 ft^3 of borated water and is pressurized to a minimum of 700 psig (715 psia) [i].

3.f.1.2 Recirculation Mode

Following a large break loss-of-coolant accident, the RHR flowrate to the reactor vessel deluge lines is limited by the RHR discharge control valves, which are maintained in a throttled position. During the injection phase post-LOCA, once the RWST inventory is depleted to below 28%, the RHR pumps are stopped. Core cooling continues to be provided by two SI pumps and containment temperature and pressure control are provided by at least one CS pump. During this time operators transfer the suction of the RHR pumps from the RWST to Sump "B". One of the RHR pumps is then re-started. Once the RWST is depleted to 15%, all running SI pumps and CS pumps are stopped. It should be noted that Reference vi provides criteria for whether SI and/or CS pumps should be re-started following transfer of the RHR pump suction from the RWST to Sump "B". CS pumps are not required and not re-started except for beyond-design-basis conditions to control high containment pressure.

The SI and CS pumps do not take suction directly from the sump on recirculation. However, they can be aligned in series with the RHR pump discharge when required to be in service. Because of NPSH concerns associated with various ESF system configurations during recirculation, limitations are placed on the operation of CS and SI pumps. If core cooling from the RHR pumps is adequate, SI pumps are not restarted. If criteria are met indicating RHR flow is inadequate for core cooling, the "C" SI pump is preferentially started, since it delivers flow to both RCS loops. Criteria are based on RCS pressure known to be in excess of the RHR pump shutoff pressure (225 psig with uncertainties) or if the Core Exit Thermocouple (CET) temperature exceeds limits.

A CS pump is not re-started in series with an RHR pump following transfer to the recirculation phase unless containment pressure exceeds an established pressure setpoint such that operation of a single RHR pump in conjunction with one CS pump can deliver adequate core cooling to the reactor vessel core deluge lines as well as supporting adequate NPSH margin for the RHR pump. For the design basis LOCA, no credit is taken for containment spray in the recirculation mode. The containment pressure predicted to occur is well below the pressure setpoint established to restart a CS pump.

If indications of inadequate core cooling persist, a second SI pump will be started [ii], but only after the CS pump has been stopped, if it had been restarted based on the high containment pressure setpoint discussed above.

Operational restrictions exist in the EOPs, such that only a single RHR pump will be operated during the initial period of the sump recirculation phase. Based upon the possible system configurations and the pump maximum rated capacity limitation, the maximum flowrate expected to be drawn from Sump "B" will not exceed 2300 gpm with a single operating RHR pump. The Sump "B" flowrate would be maximized when one SI pump and one CS pump are operated in series with a single RHR pump. However, this configuration would be a beyond-design-basis condition. As previously stated, the need to operate an SI pump early in the sump recirculation phase would be accompanied by a higher RCS pressure, such that the flow to the reactor core deluge lines would be limited. Utilizing the criteria in

Reference ii, the Sump "B" flowrate would be less than the 2300 gpm value, and the RHR pump flow would be within runout conditions.

Long term, to sump recirculation, requirements dictate operation of at least one SI pump in order to promote flushing of the reactor core to prevent boron precipitation. The RCS pressure is assumed to be near atmospheric pressure at this point. Under these conditions, where two SI pumps are operated in series with a single RHR pump, and the RCS pressure is near atmospheric, the Sump "B" flowrate would be approximately 2200 gpm, which is less than the goal of 2300 gpm. Operation of a CS pump in the long term in conjunction with either one or two SI pumps with low RCS pressure is not permitted as the RHR pump would exceed runout flow.

3.f.1.3 Sump Configuration

The ESF Recirculation Sump (known as Sump "B") is a pit-style sump located outside of the primary shield wall in relatively close proximity to the "B" RCS loop enclosure. The two RHR trains take suction within Sump "B". The sump is currently planned to be outfitted with new strainer modules in the Spring 2008 refuel outage. Once installed, all water entering the sump will pass through approximately 4000 ft^2 of sump strainer surface area, located above the sump cover plate, in close proximity to Sump "B". The strainer modules are constructed of perforated stainless steel plate with 1/16" openings.

3.f.1.4 Containment Water Level

The minimum water level in containment is based on conservative values for water sources on the containment floor and for water holdup mechanisms and associated volumes. The inputs to the water level calculation are biased toward minimizing the containment water level. The calculation uses the RWST and the Accumulators as water sources. The Spray Additive Tank and RCS volume was not included as a water source for conservatism. The volume of these water sources was decreased by the volumes of Sump "A", Sump "B", and the water holdup.

The water holdups included: the volume of containment spray held up in the refuel cavity; the volume of the containment spray ring header and risers, since they were assumed to be voided; the volume of condensation on containment surfaces; the volume of moisture in the containment atmosphere; and the volume of the RHR suction lines, since they are assumed to be voided.

The volume of containment spray that may be held up in the containment refuel cavity was determined by the ratio of the cavity area to the containment basement floor area. The total volume of containment spray held up in the refuel cavity was conservatively maximized by assuming both containment spray pumps are operating in conjunction with just one train of RHR and the SI pumps [iii].

Calculation of the containment basement floor area, into which the above water sources would empty, was conservatively determined. The floor area calculation was reduced by the interior concrete walls only. It does not include an area reduction due to installed equipment or other structural features. This is conservative since any reduction in containment basement surface area would result in a higher calculated containment water level, which increases the NPSH available and the strainer submergence.

As a result of these considerations, the minimum water level in containment upon completion of the switchover to recirculation was calculated to be 3.39' (239' 3/4" el.) [iii].

3.f.2.0 Sump B Strainer Head loss

Approximately 4000 ft^2 of strainer surface area is currently planned to be added during the 2008 refueling outage. The large surface area was selected to minimize head loss and its impact on the RHR pump NPSH available. As strainer surface area increases, the flow rate through the strainer decreases, thereby reducing the head loss caused by the strainer and preserving more of the NPSH available to the RHR pumps.

3.f.2.1 Strainer Design

The strainers to be installed adjacent to the Ginna Sump "B" are manufactured by CCI, AG. The strainers consist of 16 total strainer modules, connected through a center channel and duct that directs flow into the sump. Each strainer module is constructed of stainless steel plate with 1/16" perforations. All liquid in the containment basement recirculation pool must pass through these perforations or similarly sized equipment gaps prior to entering the RHR pump suction lines within the sump. The strainers prevent all debris greater than 1/16" diameter from the recirculation pool from entering the sump. Much of the remaining debris generated collects on the strainer surface. That portion that transports to the strainers was determined through analysis (see Section 3.f.3.1).

3.f.2.2 Strainer Head loss Testing

The strainers were initially sized to limit the head loss through the strainers to less than 1.5 ft. WC at 1750 gpm and less than 2 ft. WC at 2300 gpm, when subjected to the anticipated debris loading resulting from a LOCA. These head loss values were deemed to be an acceptable encroachment on calculated NPSH available margins. Initial head loss testing of Ginna's strainer design was performed at CCI's facility in Winterthur, Switzerland. The goal of the head loss testing was to provide information about the impact on flow through the strainer as a result of being subjected to the different types of debris.

The CCI multi-functional test loop is a closed recirculation loop with test channel piping, pump, and instrumentation. Flow recirculates from the discharge of the pump, to the test volume, through the strainer, and back to the pump suction. The strainer module used mimics the Ginna design in submerged height, elevation off the floor, pocket depth, and perforation hole size. The flowrate and debris quantity for each test was scaled down in proportion to the test strainer surface area and that being installed at Ginna. The flowrate used for the tests were equivalent to 2300 gpm.

Initially, testing was performed with the scaled down insulation, coatings and latent debris loading calculated in the Debris Generation and Debris Transport Calculations [xiii, viii]. It did not include the added strainer loading due to chemical precipitant formation. The debris loading used for the full debris head loss test was a combination of the largest quantities of each debris type and size from two different break scenarios: steam generator "A" crossover pipe and steam generator "B" crossover pipe [vii]. In so doing, the debris loading bounds all debris generated for each break location.

Three head loss tests were run: clean strainer head loss test; full debris load head loss test; and thin bed debris head loss test [viii]. The tests were run for approximately 20 hours each. The test results are as follows:

Table 3.f.2.2.1

Head loss Test (Debris Only)		
Test #	Test Type	Head loss Normalized to 20 °C (ft. WC)
0	Clean	0.004
1	Full Debris	0.211
2	Thin Bed	0.061

These test results were normalized to 20 °C (68 °F), which adds considerable conservatism to the test results, as the expected temperature range of the containment recirculation pool is between 120 °F and 272 °F for the first 24 hours post-LOCA.

Subsequent to the initial head loss testing, additional testing was performed in November 2007 that included the additional debris load from the chemical precipitate formation in the recirculation pool. As calculated using the WCAP-16530-NP methodology, a total of 81 kg of chemical precipitant will form in the Ginna recirculation pool[ix]. All of the precipitate formed was determined to be sodium aluminum silicate ($Na\ Al\ Si_3\ O_8$). The entire calculated chemical precipitant was assumed to transport to the sump strainer. No credit was taken for any Silica inhibition to the formation of the chemical precipitant quantities, as detailed in WCAP-16530-NP.

The chemical effects testing was conducted in the CCI multi-functional test loop in Winterthur, Switzerland. A surrogate of the precipitant was prepared within the multi-functional test loop, along with an increased quantity of insulation and coatings debris, above that used in the initial head loss testing, described above. The insulation debris calculated to be generated and transported to the sump was increased by 20% in order to add conservatism. Similarly, the quantities of qualified coatings were increased to be equivalent to a 10D ZOI; and the quantity of degraded/unqualified coatings was increased four-fold.

The chemical effects testing conducted in November 2007 resulted in very high head losses across the strainer. An analysis of the precipitant generation methodology used, concluded that approximately four times the precipitant that was expected per WCAP-16530-NP formed in the test loop. The testing methodology used required the addition of boric acid and sodium hydroxide to simulate the post-LOCA containment recirculation pool conditions. As part of the chemical solution addition in the test loop, large quantities of calcium and silicon were also added. It is suspected that these constituents combined with the sodium hydroxide to form various calcium precipitants in addition to the sodium aluminum silicate predicted by WCAP-16530-NP. As a result, this test was considered flawed and not representative of the precipitant formation in the containment environment.

Because of these test results, a new series of chemical effects tests is scheduled for February 2008. These tests will strictly comply with the methodology developed in WCAP-16530-NP and the associated NRC SER recommendations. The precipitant generation will be performed outside the test loop in the quantities predicted by the WCAP. The debris loading for the first of two tests will be similar to that used in the initial head loss testing in June 2007. Some of the conservatisms of the debris loading will be reduced for the second test. Details of the test results and its impact on head loss will be made available when complete.

In conjunction with the head loss test data of the strainer cartridges, head loss calculations of the strainer channels, between the strainer cartridges, and the connecting ducts were performed [xi]. The calculated head loss of the strainer internals for the flow rate equivalent to 2300 gpm was determined to be 0.117 ft. WC.

3.f.2.3 Conclusion

Final sump strainer head loss is not yet available; however, it is expected that the head loss determined from the chemical effects testing will be such that the total strainer head loss will be less than the calculated head loss margin of 2.99 ft WC for the LBLOCA case.

3.f.3.0 Vortexing

The design of the Ginna sump strainers is such that the strainers will be fully submerged during all post-LOCA events, requiring recirculation. The strainers were designed to be fully submerged below the worst case containment recirculation pool depth by at least 7 inches (~40 5/8" – 33 5/8") [iii, x].

The strainer opening with the highest elevation, through which pump suction is drawn, is within the top row of cartridge pockets. The top surface of the Ginna strainer modules do not have perforations and are covered with solid diamond plate. Through experimental testing at CCI, no vortex formation has ever been observed, over a wide range of strainer submergences and strainer head losses, for strainers with non-perforated plate covering the strainers [xi]. The Ginna specific strainer submergence and strainer head loss falls well within this range of experimental data.

The testing completed to date has also shown a linear relationship between the Froude number and the submergence limit at which vortex formation would occur. Calculation of the Ginna Froude number for a submergence of 7" (minimum strainer submergence based on the minimum recirculation pool depth) and a head loss of 2.99 feet WC (minimum NPSH margin) was found to be well below the vortex formation limit, concluding that there is no possible danger of vortexing in the Ginna strainers. Furthermore, during strainer head loss testing, in which strainer flow, head loss and submergence mimicked that expected at Ginna, no instances of vortexing were observed. These conclusions will require additional verification following the completion of the chemical effects testing.

Flashing

Based on the CCI head loss calculation document, the minimum water submergence is larger than the head loss through the debris bed. Even conservatively assuming the water surface is exactly at saturation, flashing can therefore be excluded.

References

i. R.E. Ginna UFSAR, Revision 20.

ii. Ginna Design Analysis, DA-ME-2006-016, Containment Spray Restart Criteria During Sump Recirculation, May 20, 2006

iii. Ginna Design Analysis, DA-ME-2005-085, Rev.2, "NPSH of ECCS Pumps During Injection and Recirculation".

iv. NEI 04-07, Rev 0, "Pressurized Water Reactor Sump Performance Evaluation Methodology", December, 2004.

v. Ginna Operating Procedure O-1.1, Rev 160, Plant Heatup From Cold Shutdown to Hot Shutdown

vi. Ginna Emergency Operating Procedure ES-1.3, R42, "Transfer to Cold Leg Recirculation".

vii. Alion Design Calculation, CAL-GINNA-4376-03, Rev. 0, "Ginna GSI-191 Debris Transport Calculation".

viii. CCI Head Loss Test Report, 680/41392, Rev. 1, "Bypass and Head Loss Tests"

ix. Westinghouse Report, CN-SEE-I-07-20, Rev. 0, "R. E. Ginna pH Versus Time Evaluation".

x. CCI Drawing, 103.134.547.500, Rev. a, "Ginna Layout".

xi. CCI Calculation, 3SA-096.064, Rev. 0, "Head Loss Calculation".

xii. Alion Design Calculation, CAL-CONS-3237-02, Rev. 1, "Ginna Reactor Building GSI-191 Debris Generation Calculation".

3.g **RHR Pump NPSH Margin**

NRC Issue 3g:

Net Positive Suction Head (NPSH)

The objective of the NPSH section is to calculate the NPSH margin for the ECCS and CSS pumps that would exist during a loss-of-coolant accident (LOCA) considering a spectrum of break sizes.

1. *Provide applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level.*
2. *Describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.*
3. *Provide the basis for the required NPSH values, e.g., three percent head drop or other criterion.*
4. *Describe how friction and other flow losses are accounted for.*
5. *Describe the system response scenarios for LBLOCA and SBLOCAs.*
6. *Describe the operational status for each ECCS and CSS pump before and after the initiation of recirculation.*
7. *Describe the single failure assumptions relevant to pump operation and sump performance.*
8. *Describe how the containment sump water level is determined.*
9. *Provide assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.*
10. *Describe whether and how the following volumes have been accounted for in pool level calculations: empty spray pipe, water droplets, condensation and holdup on horizontal and vertical surfaces. If any are not accounted for, explain why.*
11. *Provide assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.*
12. *Provide assumptions (and their bases) as to what water sources provide pool volume and how much volume is from each source.*
13. *If credit is taken for containment accident pressure in determining available NPSH, provide description of the calculation of containment accident pressure used in determining the available NPSH.*
14. *Provide assumptions made which minimize the containment accident pressure and maximize the sump water temperature.*
15. *Specify whether the containment accident pressure is set at the vapor pressure corresponding to the sump liquid temperature.*
16. *Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.*

NPSH calculations [i] were prepared based on hydraulic models of the systems aligned for ECCS sump recirculation per plant procedures. Different configurations were modeled and the system configuration resulting in the highest sump flow rate was used for sizing of the ECCS sump strainers. The configuration resulting in the smallest NPSH margin was used to determine acceptable screen head loss. NPSH available ($NPSH_A$) calculations utilized conservative containment recirculation water levels.

3.g.1 NPSH Margin During Recirculation

Because plant configuration is crucial in determining available NPSH for the RHR pumps, NPSH margins for several configurations were calculated in Reference i. These configurations vary depending on the single failures assumed, pumps operating, and flow paths utilized from sump to injection point. The configurations investigated represent the limiting failures with respect to NPSH margin. Configurations not included in the analysis are less limiting. In all cases, the RHR discharge throttle valves are throttled to 30° open. The most limiting case with respect to NPSH margin is shown to provide 2.99 ft. WC of margin for the LBLOCA case.

Table 3.g.1

Case Description	Pumps Operating	Sump Flow (gpm)	Sump Lines Open	Deluge Lines Open	NPSHA (ft.)	NPSHR (ft.)	Margin
RHR Pumps in Recirculation (Large Breaks)							
Base Case No Failures	"A" RHR "B" RHR	**2702**	2	2	**15.72**	**6.88**	**8.84**
Suction Line Fails to Open	"B" RHR	**1671**	1	2	**12.07**	**9.08**	**2.99**
Train B Failure	"A" RHR	**1406**	1	1	**14.67**	**7.19**	**7.48**
Train A Failure	"B" RHR	**1343**	1	1	**15.24**	**6.84**	**8.57**
Train B Deluge Line Failure	"A" RHR	**1414**	2	1	**18.24**	**7.23**	**11.01**
Train A Deluge Line Failure	"B" RHR	**1350**	2	1	**18.72**	**6.88**	**11.84**
B RHR Pump Fails to Start	"A" RHR	**1681**	2	2	**16.42**	**9.17**	**7.26**
RHR and SI Pumps in Recirculation (Small Breaks)							
Suction Line Fails to Open	"A" RHR "C" SI	**1689**	1	2	**11.86**	**9.22**	**2.64**
"C" SI Pump Fails to Start	"A" RHR "A" SI "B" SI	**1975**	2	2	**15.92**	**10.74**	**5.19**

The $NPSH_A$ calculations were performed using assumptions consistent with guidance in NEI 04-07 [ii] and its associated SER for minimizing the effect of containment overpressure on the NPSH calculation results. For the minimum NPSH margin case, no containment overpressure was credited (i.e., containment pressure was assumed to equal the saturation pressure corresponding to the sump water temperature). In examining the potential for release of gas from the fluid as it passes through the ECCS strainer, it was assumed that the containment dry air pressure remained constant. No credit was taken for an elevated containment pressure resulting from post-LOCA heating of the air. This approach is consistent with the guidance of NEI 04-07.

$NPSH_A$ calculations were performed for saturated sump water at a temperature of 212°F. This temperature was determined to be the most limiting based on the significant decrease in vapor pressure with corresponding increase in NPSH available at temperatures below 212°F. However, the pump curves depicting the RHR pump flow versus NPSH do not include the benefit of pump recirculation flow returning to the pump suction. Since the RHR pump recirculation flow will have been cooled by the RHR heat exchanger prior to returning to the pump suction, the mixing of the cooler recirculation flow with the flow from Sump "B" will lower the water temperature entering the RHR pump. The vapor pressure at the pump suction, therefore, is less than the vapor pressure associated with the sump water temperature, which is assumed to be 212° F.

$NPSH_A$ calculations were based on the minimum recirculation pool level of 3.39 ft. This value was derived considering minimum RWST, RCS, and accumulator volumes, less the volume of sump "A", sump "B", and various water holdups.

3.g.2 Containment Water Level

The minimum water level in containment is based on conservative values for water sources on the containment floor and for water holdup mechanisms and associated volumes. The inputs to the water level calculation are biased toward minimizing the containment water level. The calculation uses the RWST and the Accumulators as water sources. The Spray Additive Tank and RCS volume were not included as a water source for conservatism. The volume of these water sources used was decreased by the volumes of Sump "A", Sump "B", and the water holdup.

The water holdups included: the volume of containment spray held up in the refuel cavity; the volume of the containment spray ring header and risers, since they were assumed to be voided; the volume of condensation on containment surfaces; the volume of moisture in the containment atmosphere; and the volume of the RHR suction lines, since they are assumed to be voided.

The volume of containment spray that may be held up in the containment refuel cavity was determined by the ratio of the cavity area to the containment basement floor area. The total volume of containment spray held up in the refuel cavity was conservatively maximized by assuming both containment spray pumps are operating in conjunction with just one train of RHR and the SI pumps [i].

Calculation of the containment basement floor area, into which the above water sources would empty, was conservatively determined [iii]. The floor area calculation was reduced by the interior concrete walls only. It does not include an area reduction due to installed equipment or other structural features. This is conservative since any reduction in containment basement surface area would result in a higher calculated containment water level, which increases the NPSH available and the strainer submergence.

As a result of these considerations, the minimum water level in containment upon completion of the switchover to recirculation was calculated to be 3.39' (239' 3/4" el.) [i].

References

i. Ginna Design Analysis DA-ME-2005-085 Rev.2, "NPSH of ECCS Pumps During Injection and Recirculation".

ii. NEI 04-07, Revision 0, "Pressurized Water Reactor Sump Performance Evaluation Methodology" December, 2004.

iii. Ginna Design Analysis, DA-NS-97-065, Rev.0, "Post-LOCA Sump B Level"

3.h Coatings Evaluation

NRC Issue 3h:

Coatings Evaluation

The objective of the coatings evaluation section is to determine the plant-specific zone of influence and debris characteristics for coatings for use in determining the eventual contribution of coatings to overall head loss at the sump screen.

1. *Provide a summary of type(s) of coating systems used in containment, e.g., Carboline CZ 11 Inorganic Zinc primer, Ameron 90 epoxy finish coat.*
2. *Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.*
3. *Discuss suction strainer head loss testing performed as it relates to both qualified and unqualified coatings and what surrogate material was used to simulate coatings debris.*
4. *Provide bases for the choice of surrogates.*
5. *Describe and provide bases for coatings debris generation assumptions. For example, describe how the quantity of paint debris was determined based on zone of influence size for qualified and unqualified coatings.*
6. *Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.*
7. *Describe any ongoing containment coating condition assessment program.*

The primary field-applied DBA-qualified coatings systems in containment for R.E. Ginna are Carbozinc-11 and Phenoline 305 for steel. Phenoline 305 was applied to all concrete not covered by insulation. These remain the majority of the coatings systems in containment.

Carboline CZ-11 was also applied to various pieces of equipment including: Fans and Motors, Containment Auxiliary Charcoal Filter Plenums, Coils, Valves, Charcoal Filter Plenums, and Plenum Support Beams and Angles. The Neutron Detector Windows used either Carboline CZ-11 with either Phenoline 305 or Amercoat-66.

DBA-qualified coating system Amercoat 66 has also been used on steel, concrete, and other miscellaneous surfaces in containment.

More recently the following DBA-qualified coatings systems for steel and concrete have been used during maintenance activities: Carboline 801 and Carboline 890.

According to the response to Generic Letter 98-04 [i] for Ginna, virtually all coatings in containment are DBA-qualified.

3.h.1 Bases for assumptions made in post-LOCA paint debris generation and transport analysis

The post-DBA debris evaluations of all coatings were all based on NEI-04-07 (ii) and/or testing as discussed below.

The debris generation assumption made for DBA-qualified coatings in the Zone of Influence (ZOI) of the LOCA was selected based on the SER recommendation of using a spherical ZOI equal to ten diameters (10D). Also, a five diameter (5D) spherical ZOI was evaluated as part of the debris generation and transport analyses based on WCAP-16568-P (iii). This testing concluded that a spherical ZOI of 4D is conservative for the DBA-qualified epoxy coatings used by R.E. Ginna.

For all coatings within the ZOI, 10 micron particles were assumed for the transport analysis. Qualified coatings outside of the 5D/10D ZOI were not assumed to fail.

For the degraded qualified coatings outside of the 5D/10D ZOI the total concrete surface area below the annulus deck and the total concrete surface area inside the steam generator compartments were calculated, and 5% of that total area was estimated as the total quantity of the degraded-qualified coatings load in the debris generation and transport calculations. However, for testing a 20% total area estimate was also used for coatings volumes (four-fold increase).

For the degraded qualified coatings outside of the 5D/10D ZOI, the size of the particles was based on testing.

Testing performed for Comanche Peak Steam Electric Station by Keeler & Long (iv) has been reviewed by Alion and found applicable to the degraded DBA-qualified epoxy and inorganic zinc coatings applied at R.E. Ginna. In the test, epoxy topcoat/inorganic zinc primer coating system chips, taken from the Comanche Peak Unit 1 containment after 15 years of nuclear service, were subjected to DBA testing in accordance with ASTM D 3911-03. In addition to the standard test protocol contained in ASTM D 3911-03, 10 μm filters were installed in the autoclave recirculation piping to capture small, transportable particulate coating debris generated during the test.

The data in this report shows that Inorganic Zinc (IOZ) predominantly fails in a size range from 9 to 89 microns with the majority being between 14 and 40 microns. Therefore, a conservative size of 10 microns was assumed for transport and head loss analysis of inorganic zinc. The data in this report also showed that DBA-qualified epoxy that has failed as chips by delamination tend to remain chips in a LOCA environment. The data showed that almost all of the chips remained larger than 1/32 inch diameter. Therefore, a chip diameter of 1/32 inch may be used for transport for Phenoline 305 epoxy coatings shown to fail as chips by delamination. Carboline Phenoline 305, according to manufacturer's published data sheets and MSDSs, is conservatively representative of the other DBA-qualified/Acceptable epoxy coatings found in US NPP, including Mobil 78, Mobil 89, Amercoat 66, Keeler & Long 6548/7107 and Keeler & Long D-1 and E-1 (v).

A Ginna specific analysis (vi) was performed, and determined that 31% of the coatings that fail will do so as fines (IOZ particulate), while 69% will fail as chips (phenolics).

For Original Equipment Manufacturer (OEM) coatings, EPRI report 1011753 (vii), was used to determine that 10 microns is a very conservative assumption for particle sizes. This report also showed that, on average, much less than half of OEM coatings detached and failed during testing. Based on the EPRI test results and the conservative assumption of 10 micron particle size, the 100% failure of the OEM coatings is considered to be enveloped by the 5%/20% degraded-qualified/unqualified coatings assumption in the Alion Debris Generation Analysis.

No debris was included in transport and head loss analysis for degraded/OEM unqualified coatings outside the ZOI that are a) within an inactive sump, b) covered by intact insulation, or c) otherwise isolated from spray and transport to the sump.

3.h.2 Head Loss Testing

For head loss testing, representative surrogates with similar density, size, and shape characteristics to the debris generation assumptions above were selected.

For epoxy and phenolic coating debris specified as chips, the surrogate was formed from the dry film of Carboline® Carboguard® 890.

For coating debris from inorganic zinc, the surrogate used was silicon carbide with a particle size range of ~10 to 44 microns. Silicon carbide has similar density, size, and shape characteristics as inorganic zinc. The particle size selected was based on the Keeler & Long Report No. 06- 0413 as discussed above.

3.h.3 Ongoing Containment Coating Condition Assessment Program

The acceptability of visual inspection as the first step in monitoring of Containment Building coatings is validated by EPRI Report No. 1014883 (viii). Monitoring of Containment Building coatings is conducted once per fuel cycle at a minimum. Monitoring involves conducting a general visual examination of all assessable coated surfaces within the Containment Building, and degraded-qualified coatings are identified by this visual examination. When such conditions are noted, the area is remediated to remove the damaged or failed area to sound coatings; when determined necessary, the coatings are replaced with qualified systems. This removes that quantity of degraded or damaged coating from the containment.

References

i. RG&E Letter, "Response to Generic Letter 98-04, dated July 14, 1998; Subject: Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment", R.E. Ginna Nuclear Power Plant, December 1, 1998.

ii. NEI PWR Sump Performance Task Force Report NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology", Rev. 0, December 2004.

iii. WCAP-16568-P, "Jet Impingement Testing to Determine the ZOI for DBA Qualified/Acceptable Coatings", Revision 0 dated June 2006.

iv. Keeler and Long Report No. 06-0413, "Design Basis Accident Testing of Coating Samples from Unit 1 Containment, TXU Comanche Peak SES"

v. Letter from Jon Cavallo, Vice President, Corrosion Control Consultants and Labs Inc., September 20, 2007.

vi. Ginna Calculation CAL-CONS-3237-02, "Ginna Reactor Building GSI-191 Debris Generation Calculation", May 2007.

vii. EPRI Report No. 1011753, "Design Basis Accident Testing of Pressurized Water Reactor Unqualified Original Equipment Manufacturer Coatings", September 2005.

viii. EPRI Report No. 1014883, "Plant Support Engineering: Adhesion Testing of Nuclear Coating Service Level 1 Coatings," August 2007.

3.i Debris Source Term Refinements

NRC Issue 3i:

Debris Source Term

The objective of the debris source term section is to identify any significant design and operational measures taken to control or reduce the plant debris source term to prevent potential adverse effects on the ECCS and CSS recirculation functions.

1. *Provide the information requested in GL 04-02 Requested Information Item 2.(f) regarding programmatic controls taken to limit debris sources in containment.*

GL 2004-02 Requested Information Item 2(f)

A description of the existing or planned programmatic controls that will ensure that potential sources of debris introduced into containment (e.g., insulations, signs, coatings, and foreign materials) will be assessed for potential adverse effects on the ECCS and CSS recirculation functions. Addressees may reference their responses to GL 98-04, "A Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of- Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," to the extent that their responses address these specific foreign material control issues. In responding to GL 2004 Requested Information Item 2(f), provide the following:

2. *A summary of the containment housekeeping programmatic controls in place to control or reduce the latent debris burden. Specifically for RMI/low-fiber plants, provide a description of programmatic controls to maintain the latent debris fiber source term into the future to ensure assumptions and conclusions regarding inability to form a thin bed of fibrous debris remain valid.*
3. *A summary of the foreign material exclusion programmatic controls in place to control the introduction of foreign material into the containment.*
4. *A description of how permanent plant changes inside containment are programmatically controlled so as to not change the analytical assumptions and numerical inputs of the licensee analyses supporting the conclusion that the reactor plant remains in compliance with 10 CFR 50.46 and related regulatory requirements.*
5. *A description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.*
6. *If any of the following suggested design and operational refinements given in the guidance report (guidance report, Section 5) and SE (SE, Section 5.1) were used, summarize the application of the refinements.*
    - *Recent or planned insulation change-outs in the containment which will reduce the debris burden at the sump strainers*
    - *Any actions taken to modify existing insulation (e.g., jacketing or banding) to reduce the debris burden at the sump strainers*
    - *Modifications to equipment or systems conducted to reduce the debris burden at the sump strainers*

7. *Actions taken to modify or improve the containment coatings program*

R. E. Ginna Nuclear Power Plant is installing a strainer with adequate surface area and sufficient NPSH margin. Ginna does not plan to make any physical modifications in order to alter the quantities of debris.

Ginna programmatic and process controls are in place as described below to prevent the entry of foreign materials into the containment area. A review of plant procedures, programs, and design requirements was performed in an attempt to diagnose potential vulnerabilities that could impact analyzed containment or recirculation function criteria.

- The addition of materials to containment is controlled through an administrative process in which change impacts are evaluated for each design change. The "Change Impact Evaluation" requires the cognizant engineer to evaluate the impact on ECCS recirculation function of materials that are added, removed, or changed in containment. Every material added, removed, or changed is evaluated as a potential source of debris that could be generated during a LOCA. This provides the assurance that GSI-191 related analysis assumptions remain bounding. Similarly, quantities of aluminum in containment that are added, removed or changed are evaluated for impact.

- Procedure IP-PSH-2, Integrated Work Schedule Risk Management, establishes the administrative controls, responsibilities, and oversight of risk associated with the removal of structures, systems, and components (SSCs) from service and managing risk significant activities in accordance with the maintenance Rule, 10CFR50.65. The scope of this procedure applies to all plant activities during Modes: 1, 2, 3, 4, 5, 6, and Defueled.

- UFSAR Chapter 6, especially Section 6.1, lists the materials of construction in the Ginna containment. This specification is considered the master document for determining the acceptability of materials for use in containment for preventing changes to the debris source term.

- Technical Specification SR 3.5.2.7 states the minimum periodicity for visual inspection of the containment sump area and makes it a licensing basis-level requirement. Whether or not work is done in the vicinity of the containment sump, an entry must be made and the sump inspected every 24 months for foreign material and debris.

- CNG-MN-1.01-1001, the Constellation Fleet Foreign Material Exclusion Program, contains guidance specifically addressing FME concerns in areas like the containment sump and the Spent Fuel Pool. It classifies the containment sump as a Zone 1 Special Foreign Materials Exclusion Area, and requires an FME Project Plan for any entry into the sump. FME Project Plans are prepared, reviewed, and approved per CNG-MN-1.01-1001 Attachment 3, which also details content requirements and provides a Quality Checklist for workers to selfcheck the adequacy of their plan. The requirements of this instruction are stringent with regard to standards but allow flexibility for adapting an FME Project Plan for any kind of maintenance evolution.

- Procedure A-3.1, Containment Storage and Closeout Inspection, is executed prior to closing out the containment sump prior to the end of the outage. It provides specific guidance on what must be done at each mode change as the plant transitions from Mode 5 to Mode 1, and incorporates all the requirements of SR 3.5.2.7, providing direction for verification that equipment storage and cleanliness requirements are maintained inside containment.

- A database exists which, as of September 2004, listed all the insulation in the containment loop area, including associated components, amounts, insulation type, and associated reference drawings.

Potential vulnerabilities:

- R.E. Ginna did not have a robust coatings program. An enhanced coatings program is in the process of being developed to ensure the effects of degraded qualified coatings are measured and considered in calculations for NPSH calculations for design basis casualty scenarios.

3.j Screen Modification Package

NRC Issue 3j:

Screen Modification Package

The objective of the screen modification package section is to provide a basic description of the sump screen modification.

1. *Provide a description of the major features of the sump screen design modification.*
2. *Provide a list of any modifications, such as reroute of piping and other components, relocation of supports, addition of whip restraints and missile shields, etc., necessitated by the sump strainer modifications.*

3.j.1 Sump Strainer Description

The intent of the Ginna Sump "B" strainer modification is to perform the hardware change required to resolve issues presented in GL 2004-02 and GSI-191. This modification will be installed during the Ginna 2008 Spring refueling outage. The new design will replace an interim compensatory strainer design, installed during the Fall 2006 refueling outage, as part of the GL 2004-02 corrective action extension request approved by the NRC[i]. The interim strainer design added 600 ft^2 of passive sump strainer surface area. It also included a diverter wall installed in the containment basement in order to reduce the direct transport path of debris into the recirculation sump from a postulated break in the "B" reactor coolant system compartment. The interim strainer, diverter wall, existing sump screens and grating is planned to be replaced by a CCI designed and fabricated passive sump strainer with 4000 ft^2 of surface area.

The proposed strainer installation consists of 16 total strainer modules, connected through a center channel that will direct flow from each strainer to Sump "B" [ii]. The modules are comprised of multiple cartridges arranged on both sides of a center channel, within the module structure. Each cartridge is constructed of stainless steel plate with 1/16" perforations, which is bent to form pockets, generally 3" x 3½" x 15" deep. Each module, although varying in length to conform to the containment basement physical layout, measures approximately 44" wide and 33" high.

The strainer design will include debris interceptors that will take advantage of the unique strainer installation location. Perforated plate will be affixed to the bottom of the strainer modules and from the corner of each strainer module train to the wall on the backside of the modules. This arrangement will limit the amount of debris that enters the backside of the strainer, thereby reducing the quantity of debris that impacts that portion of the strainer.

Five of the 16 strainer modules will sit directly on the sump cover. Since the sump cover is approximately 6" above containment basement floor elevation, the height of these modules is adjusted to maintain the same overall height as the modules that are fixed to the basement floor. These 5 modules will direct the flow into the sump. To accommodate the increased weight of the modules on the sump cover, structural modifications are required [ii]. The existing 4" x 8" steel beams will be replaced to accommodate cross-bracing and ensure proper fit-up of the sump cover plate. A post will be added at the mid-point of each new beam. Additionally, the existing grating on the sump cover will be replaced by diamond plate, preventing material from entering directly into the sump without passing through the strainer modules.

Sump "B" operability can be affected whenever the personnel hatchway to the interior of the sump is opened. To limit the instances when the personnel hatchway must be opened while at power, two modification to the sump components will be made. The Reactor Coolant Drain Tank (RCDT) vent line, with its manual isolation valve, will be routed up through the sump cover to allow operators to vent the tank without entering the sump. Similarly, the reactor cavity drain line isolation valve to the RCDT may require manipulation when the sump is required to be operable. Therefore, a reach rod will be used to penetrate the sump cover, allowing valve operation without entering the sump. Each penetration of the sump cover, including existing level instrumentation conduit, is designed to ensure the maximum clearance directly communicating with the sump is no more than 1/16".

The existing Johnson screen, which runs the entire width of the "B" sump, will be removed to allow for structural modifications to the sump in support of adding modules to the sump cover. If left in place, the Johnson screen would operate in series with the new strainer modules; however, it is a much coarser mesh than the 1/16" perforated holes in the strainer modules and would therefore offer no additional removal of debris from the water passing through the strainer.

With the addition of 16 strainer modules to the containment basement, some minor piping interferences result. A 3" waste disposal sump "A" pump discharge line on the north side of the refueling canal wall will be re-routed. Also, a 45 ft section of the 44" Containment Recirculation Fan Cooler air duct will be removed and capped. These modifications are to allow for improved access to the area in which strainer modules will be installed. Each modification has been designed in adherence to the design requirements for that system.

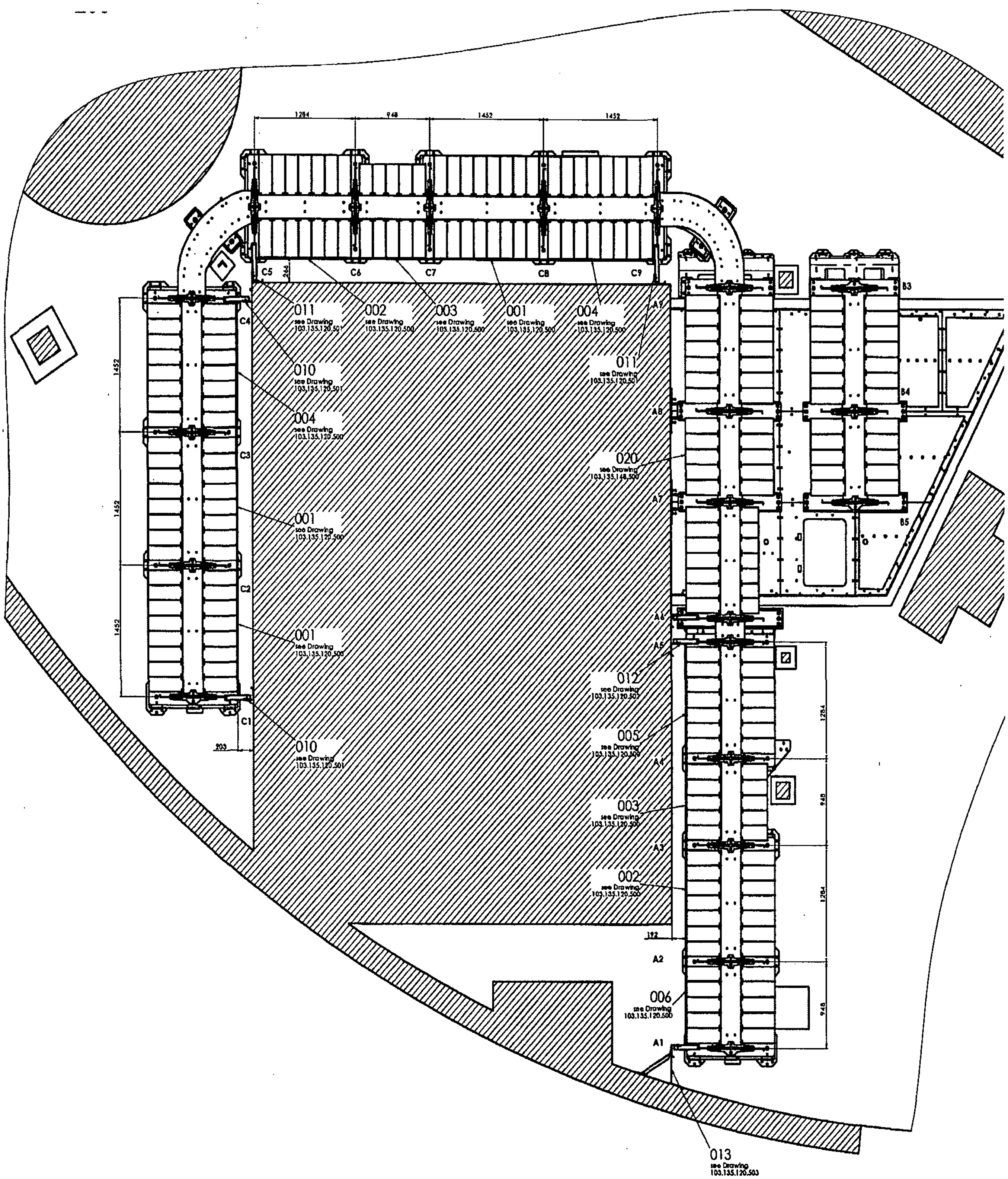
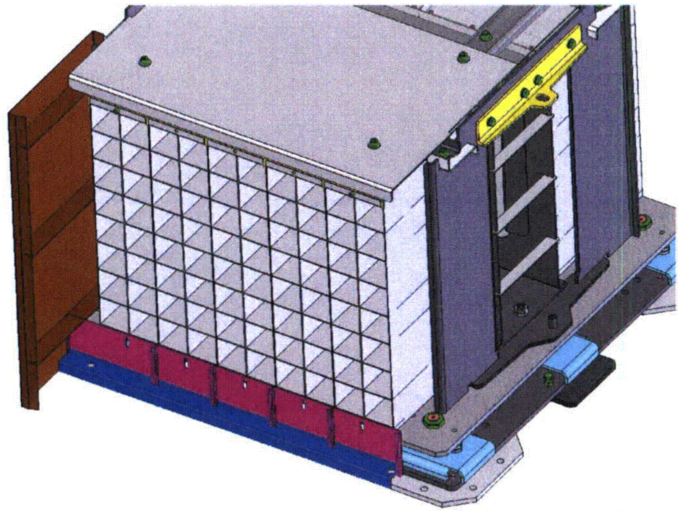
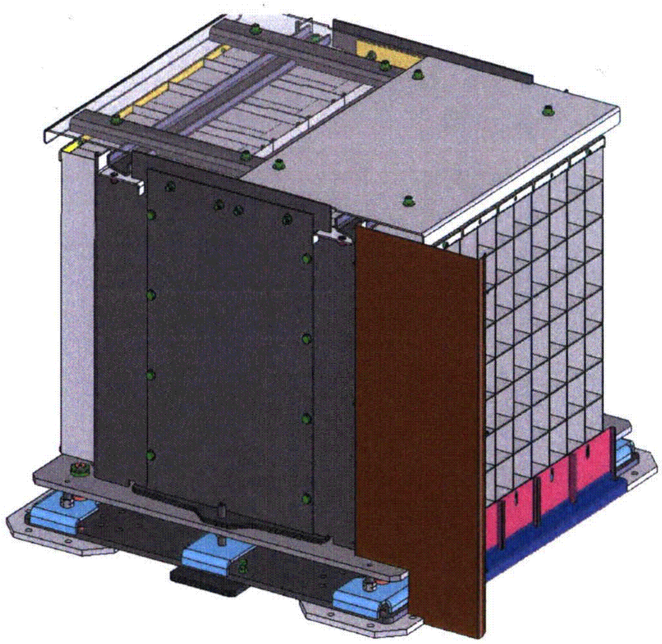


Figure 3.j.1.1: Planned Strainer Module Arrangement

Figure 3.j.1.2: Strainer Modules





References

i. Letter from Patrick D. Milano (NRC) to Mary G. Korsnick (Ginna LLC), dated October 4, 2006, R.E. Ginna Nuclear Power Plant – Approval of Extension Request for Completions of Corrective Actions in Response to Generic Letter 2004-02.

ii. CCI Drawing, 103.134.547.500, Rev. a, "Ginna Layout".

3.k Sump Structural Analysis

NRC Issue 3k:

Sump Structural Analysis

The objective of the sump structural analysis section is to verify the structural adequacy of the sump strainer including seismic loads and loads due to differential pressure, missiles, and jet forces. Provide the information requested in GL 2004-02, "Requested Information," Item 2(d)(vii), that is, provide verification that the strength of the trash racks is adequate to protect the debris screens from missiles and other large debris. The submittal should also provide verification that the trash racks and sump screens are capable of withstanding the loads imposed by expanding jets, missiles, the accumulation of debris, and pressure differentials caused by post-LOCA blockage under flow conditions.

1. *Summarize the design inputs, design codes, loads, and load combinations utilized for the sump strainer structural analysis.*
2. *Summarize the structural qualification results and design margins for the various components of the sump strainer structural assembly.*
3. *Summarize the evaluations performed for dynamic effects such as pipe whip, jet impingement, and missile impacts associated with high-energy line breaks (as applicable).*
4. *If a backflushing strategy is credited, provide a summary statement regarding the sump strainer structural analysis considering reverse flow.*

3k.1 Sump Structural Analysis Description

The Sump "B" strainer modification for Ginna, including the new strainer assembly and sump re-design, was structurally analyzed and found to meet all design requirements given in the UFSAR. The load combinations used in this analysis are the same as already defined for structures in safety related applications at Ginna. The strainer modules and sump cover structural elements were designed and qualified to operate during and after a design basis earthquake. Consistent with Regulatory Guide 1.29, the passive strainer assembly is designated as "Seismic Category I". Response Spectra applicable to the containment basement were applied to the design. Damping values for the seismic design of the strainer assembly are per Regulatory Guide 1.61. Equivalent static analysis or Seismic Response (Dynamic) analyses were performed to seismically analyze the strainer assembly. Regulatory Guide 1.92 was used for modal combinations when dynamic analysis is performed. Seismic loads (SSE and OBE) in conjunction with applicable deadweight, liveload, thermal, pressure, hydrodynamic, and LOCA loads shall be considered. ASME Section III, subsection NF, was used as a guideline to evaluate the structural adequacy of strainer assembly supports. The strainer assembly, where applicable, was verified to be within AISC allowable design limits. Anchorages of the strainer module will be provided by Hilti Kwik-Bolt III anchor bolts or equivalent. The allowable load on the anchor bolts is ¼ the ultimate load. The concrete strength is taken as 3000 psi. Anchor bolt locations on the strainer structural steel allows for 2 inches of tolerance to avoid contact with rebar. All concrete work shall be in accordance with ACI 318-63.

The asymmetric blowdown loads resulting from double-ended pipe breaks in the primary system piping need not be considered (References ii through v) as a design basis for Ginna, therefore, Leak-Before-Break (LBB) methodology has been applied for the primary system piping for which LBB methodology has been approved. This LBB provision has been invoked under the containment sump modification so that the replacement sump strainers do not need protection from the dynamic effects of a break in this piping.

Missiles that are generated internal to the reactor containment may cause damage to structures, systems, and components that are necessary for the safe shutdown of the reactor or for accident mitigation. They could also cause damage to the structures, systems, and components whose failure could result in a significant release of radioactivity. The potential sources of such missiles are valve bonnets and associated hardware, relief valve parts, instrument wells, high speed rotating machinery, and rotating segments.

A review of all high pressure or high temperature lines (>275 psig or > 200 F) in direct line of sight to the proposed Sump "B" strainer installation was conducted to identify the potential for missile generation that may impact the functionality of the sump strainers. A detailed review of the orientation of potential missile sources associated with these components resulted in the conclusion that there are no relief valves, instrument wells or rotating machinery in direct line of sight and all bonnets, valve stems, and bonnet hardware are directed away from the sump strainers.

Further confirmation of this conclusion is supported by evaluations performed in support of UFSAR Section 3.5, which concluded that no missile generation sources are oriented toward any safety related equipment. Since the majority of the strainer installation location is in the area where the safety related CRFC duct will be removed, and the entire strainer is in close proximity to safety injection and containment spray lines, no missiles would threaten the functionality of the strainers.

To maintain the structural integrity of the strainer modules, each module is covered with ¼" stainless steel diamond plate bolted to the module frame. Additionally, signage will be affixed to each train to ensure that personnel do not step on or store equipment on the strainer modules. Plant procedures were revised to require that the Sump "B" strainer assemblies be inspected prior to containment closeout at the end of a refuel outage. This inspection is to be done as part of the containment housekeeping inspection. This inspection is to ensure that debris is not impacting the strainer surface area and that any damage is present. If any damage is found, the inspectors are instructed to contact Design Engineering to evaluate the damage.

References

i. CCI Calculation, 3SA-096.061, Rev. 0, "Structural Analysis of Strainer and Support Structure"

ii. Letter from D. M. Crutchfield, NRC, to J. E. Maier, RG&E, dated June 28, 1983, IPSAR Section 4.13, Effects of Pipe Break on Structures, Systems, and Components Inside Containment for the R. E. Ginna Nuclear Power Plant.

iii. Letter from Dominic C. DiIanni, NRC, to R. W. Kober, RG&E, September 9, 1986, Generic Letter 84-04.

iv. Letter from G. Vissing, NRC, to R. Mecredy, RG&E, February 25, 1999, Staff Review of the Submittal By RG&E to Apply Leak - Before - Break Status to Portions of the RHR System Piping.

v. Letter from J. Widay (Ginna LLC) to R. Clark (NRC), dated September 30, 2004, Fracture Mechanics Analysis per GDC-4.

3.l Upstream Effects

NRC Issue 3l:

Upstream Effects

The objective of the upstream effects assessment is to evaluate the flowpaths upstream of the containment sump for holdup of inventory which could reduce flow to and possibly starve the sump. Therefore, provide a summary of the upstream effects evaluation including the information requested in GL 2004-02, "Requested Information," Item 2(d)(iv) including the basis for concluding that the water inventory required to ensure adequate ECCS or CSS recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths.

1. *Summarize the evaluation of the flow paths from the postulated break locations and containment spray washdown to identify potential choke points in the flow field upstream of the sump.*
2. *Summarize measures taken to mitigate potential choke points.*
3. *Summarize the evaluation of water holdup at installed curbs and/or debris interceptors.*
4. *Describe how potential blockage of reactor cavity and refueling cavity drains has been evaluated, including likelihood of blockage and amount of expected holdup.*

An evaluation of the flow paths necessary to return water to the recirculation sump strainers was performed in accordance with the recommendations contained in NEI 04-07. The Debris Generation Analysis, Debris Transport Analysis, and containment basement recirculation pool level calculation were instrumental in the identification of the flow paths that could result in the holdup of water. These analyses provide the break locations, debris characteristics, flow paths, and flow velocities to the sump. These flow paths included all areas from which Containment Spray and RCS break flow would enter. This evaluation determined that, with the exception of containment spray holdup in the reactor cavity, all water return flow paths have sufficiently large openings to prevent the holdup of significant quantities of water that could challenge the containment sump minimum water level analysis.

As part of the recirculation pool water level calculation, holdup volumes were calculated for all containment spray return pathways that due to physical design features, such as curbs and recessed areas would cause a reduction in the volume of water returning to the sump. This calculation assumed that the volume of containment spray flow credited in the recirculation pool water level would be reduced by an amount proportionate to the area of the reactor cavity.

The required containment basement flow paths for return of water to the sump, as identified in the Debris Transport Analysis, were evaluated for their ability to pass debris laden water. No flow path is obstructed by any physical barrier, such as a gate, curb, or wall. There is a six inch curb around the sump; however, that is not a choke point. Only five of the sixteen modules sit on the sump cover, and the curb is not a barrier that will impede flow to these modules. The other modules are unaffected by the curb. The width of each flow path, created by the physical features of the containment basement walls, stairways, and components, was evaluated based on its ability to pass the volume of large or intact insulation debris, as determined by the Debris Generation and Debris Transport Analyses. The most restrictive flow path provides a minimum of 3 ft. of clearance, as determined by walk downs and system drawings. As a result, no single choke point exists. Additionally, for each break location, there are two primary flow paths in opposite directions to the containment sump location. Each primary flow path has multiple secondary flow paths providing additional assurance that water will reach the sump.

As a result of the evaluation performed, Ginna has determined that the upstream effects analysis provides the necessary level of assurance that the required volume of water will be available to the recirculation sump to meet the applicable requirements in NEI 04-07 and GL 2004-02.

References

[i] Alion Design Calculation, CAL-CONS-3237-02, Rev. 1, "Ginna Reactor Building GSI-191 Debris Generation Calculation".

[ii] Alion Design Calculation, CAL-GINNA-4376-03, Rev. 0, "Ginna GSI-191 Debris Transport Calculation".

[iii] Ginna Design Analysis, DA-ME-2005-085, Rev.2, "NPSH of ECCS Pumps During Injection and Recirculation".

3.m Downstream Effects – Components and Systems

NRC Issue 3m:

Downstream effects - Components and Systems

The objective of the downstream effects, components and systems section is to evaluate the effects of debris carried downstream of the containment sump screen on the function of the ECCS and CSS in terms of potential wear of components and blockage of flow streams. Provide the information requested in GL 04-02, "Requested Information," Item 2.(d)(v) and 2.(d)(vi) regarding blockage, plugging, and wear at restrictions and close tolerance locations in the ECCS and CSS downstream of the sump. If approved methods were used (e.g., WCAP-16406-P), briefly summarize the application of the methods. The objective of the downstream effects, components and systems section is to evaluate the effects of debris carried downstream of the ECCS Sump screen on the function of the ECCS and CSS in terms of potential wear of components and blockage of flow streams. Provide the information requested in GL 04-02 Requested Information Item 2(d)(v) and 2(d)(vi) regarding blockage, plugging, and wear at restrictions and close tolerance locations in the ECCS and CSS downstream of the ECCS Sump.

GL 2004-02 Requested Information Item 2(d)(v)

The basis for concluding that inadequate core or containment cooling would not result due to debris blockage at flow restrictions in the ECCS and CSS flowpaths downstream of the ECCS Sump screen, (e.g., a HPSI throttle valve, pump bearings and seals, fuel assembly inlet debris screen, or containment spray nozzles). The discussion should consider the adequacy of the ECCS Sump screen's mesh spacing and state the basis for concluding that adverse gaps or breaches are not present on the screen surface.

GL 2004-02 Requested Information Item 2(d)(vi)

Verification that the close-tolerance subcomponents in pumps, valves and other ECCS and CSS components are not susceptible to plugging or excessive wear due to extended post-accident operation with debris-laden fluids.

1. *If NRC-approved methods were used (e.g., WCAP-16406-P with accompanying NRC SE) briefly summarize the application of the methods. Indicate where the approved methods were not used or exceptions were taken, and summarize the evaluation of those areas.*
2. *Provide a summary and conclusions of downstream evaluations.*
3. *Provide a summary of design or operational changes made as a result of downstream evaluations.*

REGNPP, member of the Pressurized Water Reactor Owner's Group (PWROG), sponsored the development of a methodology and data collection effort to evaluate the effects of debris ingested into the Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) during post-accident operation when these systems are realigned for recirculation of inventory from the containment sump. The resulting topical report, WCAP-16406-P, has been used as the basis for the methodologies employed for the analyses addressed herein.

3.m.1 Valves

The valves utilized in post-LOCA recirculation mode were evaluated using the criteria in WCAP-16406 to determine whether or not detailed plugging and wear evaluations need to take place.

The valves were identified from the REGNPP process and instrumentation diagrams (P&IDs) and from valve drawings.

Based upon the acceptance criteria, it is concluded that none of the REGNPP ECCS and CSS valves utilized in post-LOCA recirculation must be evaluated for plugging.

Only two valves – specifically, RHR butterfly valves HCV-624 and HCV-625 – required further evaluation for erosive wear. Evaluation of valves HCV-624 and HCV-625 shows that the actual $\Delta A/A$ (change in flow area through the valve divided by flow area) through the valve is nearly zero (.0015) for both of these valves. Thus, these valves wear insufficiently to change the flow area of the valve and consequently pass the acceptance criteria.

Therefore, all ECCS and CSS valves utilized in post-LOCA recirculation are acceptable for use with respect to GSI-191.

3.m.2 ECCS Pumps

The effects of debris ingestion through the sump screen on three aspects of operability, including hydraulic performance, mechanical shaft seal assembly performance, and mechanical performance (vibration) of the pump, were evaluated. Conclusions are summarized below:

1. ECCS and CSS pump blockage is determined not to be a concern for REGNPP.

2. The hydraulic and mechanical performances of the pumps were determined to not be affected by the recirculating sump debris.

3.m.3 ECCS Heat Exchangers

The smallest clearance found for Ginna's heat exchangers, orifices, and spray nozzles in the recirculation flow path is 0.152 in for the containment spray pump cooler. Therefore, no blockage of the ECCS flow paths is expected with the sump screen hole size of 0.063 in.

The instrumentation tubing is also evaluated for potential blockage of the sensing lines. The minimum transverse velocity past this tubing, except for instrument FE626, is determined be sufficient to prevent debris settlement into these lines, so no blockage will occur. The minimum transverse velocity past FE626 is insufficient to prevent debris settlement; however, blockage of the sensing lines will not occur because the sensing lines are water solid and are also located at either the top (12 o'clock position) or sides (3 o'clock or 9 o'clock positions) of the pipe.

The Reactor Vessel Level Instrumentation System (RVLIS) was also evaluated. Since the RVLIS installed at Ginna is a Westinghouse design, no effect on its performance by the debris is expected per WCAP-16406-P.

The heat exchangers, orifices, and spray nozzles were evaluated for the effects of erosive wear for a constant debris concentration of 497.8 ppm over the mission time of 30 days. The erosive wear on these components is determined to be insufficient to affect the system performance.

3.n Downstream Effects – Fuel and Vessel

NRC Issue 3n:

Downstream Effects - Fuel and Vessel

The objective of the downstream effects, fuel and vessel section is to evaluate the effects that debris carried downstream of the containment sump screen and into the reactor vessel has on core cooling.

1. *Show that the in-vessel effects evaluation is consistent with, or bounded by, the industry generic guidance (WCAP-16793), as modified by NRC staff comments on that document. Briefly summarize the application of the methods. Indicate where the WCAP methods were not used or exceptions were taken, and summarize the evaluation of those areas.*

3.n.1 Reactor Vessel Blockage Analysis

Evaluation of the potential for blockage of the reactor vessel internals is summarized in Table 3.n.1. If the maximum debris size is smaller than the calculated clearance, that flow path is considered "Not Blocked". It was found that all dimensions of the essential flow paths through the reactor internals are sufficiently large as to preclude plugging by sump debris. The maximum particle dimension is 0.125 inches, which is two times the sump screen hole diameter being evaluated. The smallest clearance listed in Table 3.n.2 is 0.99 inches, which is greater than seven times the maximum particle dimension.

Table 3.n.1 Summary of Vessel Blockage Evaluation

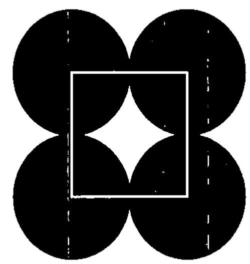
POI No.	Location	Value	Blockage Evaluation
1	Clearance of Annulus Between Vessel and Thermal Shield	4.80 in.	Not Blocked
2	Clearance of Annulus Between Core Barrel and Thermal Shield	1.38 in.	Not Blocked
3	Clearance of Core Barrel Annulus Below Thermal Shield	9.75 in.	Not Blocked
4	Limiting Clearance Between Bottom Mounted Instrumentation and Supports	3.78 in.	Not Blocked
5	Clearance Through-Holes in Core Support Plate	3.35 in.	Not Blocked
6	Dimension of Holes in Diffuser Plate	6.48 in.	Not Blocked
7	Dimension of Holes in Lower Core Plate	2.31 in.	Not Blocked
8	Clearance Through-Holes in Upper Core Plate – Square	2.03 in.	Not Blocked
9	Clearance Through-Holes in Upper Core Plate – Round	5.96 in.	Not Blocked

10	Limiting Dimension Between Upper Support Columns and Guide Tubes	1.31 in.	Not Blocked
11	Clearance Through-Holes in Guide Tubes	0.99 in.	Not Blocked

3.n.2 Acceptance Criteria – Fuel Grid Calculation

The acceptance criterion developed for this calculation is based on a realistically conservative debris capture evaluation by the fuel grids deployed at the R. E. Ginna Nuclear Plant. The criterion takes advantage of and uses fibrous debris characteristics from screen bypass or pass-through testing that was performed by the replacement sump screen vendor for other high-fiber nuclear plants.

This acceptance criterion considers the length of the fibrous debris that passes through the replacement sump screen and the wrapping of fibers about the fuel grids in the flow as opposed to the matting of long fibers to build a fiber bed across the top of a grid. The fibers are assumed to wrap on a fuel grid similar to the manner in which hair would collect on a sink drain. The fibers are conservatively evaluated to collect or pack as shown in the figure to the right. This configuration provides for a maximum blockage of the open area of the grid as the fiber collects on the grid itself.



3.n.3 Results

For Upper Plenum Injection (UPI) plants, the cold-leg break scenario is limiting with respect to fiber build-up on the top support grid of the core. With a cold-leg break, the flow path is from the upper plenum, through the core, up the downcomer, and out the cold-leg break. All of the debris-laden UPI flow must pass through the top support grids of the core before spilling out of the cold-leg break; this provides for the maximum deposition of fibrous debris on the top support grid of the core. The results of the fuel evaluation have shown that at approximately 6 hours, the fibrous debris available in the emergency sump fluid has been totally depleted.

The cumulative total amount of fibrous debris captured by the top fuel grid in the core for this scenario is 6.12 lb_m. This value is approximately 39% of the limit at which total core blockage is expected to occur.

For a hot-leg break, once the core is flooded, a large amount of the UPI flow would bypass the top of the core and flow out the hot-leg break. This bypass flow initially contains the same fibrous debris concentration as found in the cold-leg break scenario. However, since much of the UPI flow spills before being introduced to the upper core components, it is recycled through the sump screen where it is subject to the 99.1% capture efficiency of the sump screen, providing additional depletion of the fibrous source. Thus, a hot-leg break would be much less limiting than the cold-leg break scenario described above, and thus was not explicitly evaluated.

The results of the analysis show that, for a worst-case post-LOCA scenario, a maximum of 39% of the flow area at the top of the core would be blocked. It is thus concluded that fibrous debris sources inside R. E. Ginna reactor containment building are of an insufficient quantity to compromise long-term core cooling.

3.o Chemical Effects

NRC Issue 3o:

Chemical Effects

The objective of the chemical effects section is to evaluate the effect that chemical precipitates have on head loss and core cooling.

1. *Provide a summary of evaluation results that show that chemical precipitates formed in the post-LOCA containment environment, either by themselves or combined with debris, do not deposit at the sump screen to the extent that an unacceptable head loss results, or deposit downstream of the sump screen to the extent that long-term core cooling is unacceptably impeded.*
2. *Content guidance for chemical effects is provided in Enclosure 3 to a letter from the NRC to NEI dated September 27, 2007 (ADAMS Accession No. ML072600372).*

Determination of the quantities of chemical precipitate formation in the post-LOCA containment recirculation pool and its impact on strainer head loss was addressed in two phases. First, Ginna specific chemical precipitate formation was determined using the WCAP-16530-NP methodology. Once the quantities and types of chemical precipitates were determined, surrogates of the precipitates were developed and used in a multifunctional test loop where the impact of the precipitates on head loss, in combination with other debris transported to the sump strainer, was determined.

3.o.1 Chemical Effects Analysis

The WCAP-16530-NP chemical effects model was used to determine the expected chemical precipitate formation and subsequent loading on the Ginna sump strainers. The various inputs to the WCAP model were selected to ensure that a bounding conservative result was obtained. The sensitivity of the model to various inputs was determined to identify the materials and containment conditions that were most influential in precipitate formation. It was evident from the chemical effects model that the containment recirculation pool pH was very influential. As a result, Ginna enlisted the assistance of Westinghouse to determine the post-LOCA recirculation pool pH as a function of time [i].

Under LOCA conditions, buffering agents are added to the containment sump fluid to keep the fluid at a pH greater than 7.0. Buffering agent addition is mainly required to reduce release of iodine fission products from the coolant to the containment atmosphere as iodine. Thus, pH control is primarily an offsite dose control measure. Increasing the coolant pH also reduces the corrosion rates of most materials in the containment sump, most notably stainless steel metal structural members and components. Sodium hydroxide (NaOH) is used as the buffering agent at REGNPP. The NaOH is introduced into the containment sump fluid via the Containment Spray (CS) system.

To bound the range of post-LOCA pH conditions, maximum and minimum pH profiles were calculated. Minimum sump pH is determined by considering the maximum amount of boric acid from various sources, combined with a minimum amount of sodium hydroxide buffer.

Conversely, maximum sump pH is determined by considering the minimum amount of boric acid combined with the maximum amount of sodium hydroxide.

The following is a brief description of the calculation scheme used to calculate the post-accident sump pH timeline.

1. At time zero, the entire RCS and accumulator volume has been discharged to the sump. This establishes the initial sump boric acid and NaOH concentrations.

2. At one-minute increments, the cumulative additions of borated water (from the RWST via ECCS) and sodium hydroxide solution (via the CS system) were considered and updated sump boric acid and NaOH concentrations were determined.

3. At each time step, a pH value was determined using titration data and the discrete values of boric acid and NaOH concentrations determined in step 2 above.

4. Steps 2 and 3 were repeated from time 0 through 60 minutes for both the maximum and minimum pH conditions.

After 60 minutes, there are no further additions of either NaOH or boric acid; and as no acid generation effects were assumed, the pH remains constant for the remainder of the 30-day mission time.

The Westinghouse pH analysis concluded that the containment basement recirculation pool pH increased from an initial value of 4.76 to a maximum ph of 8.58, which was reached at 56 minutes. Similarly, the minimum containment basement recirculation pool pH increased from an initial value of 4.72 to a maximum pH of 7.60, which was reached at 57 minutes. Since it was recognized from the WCAP chemical effects model that a higher pH results in more precipitate generation, the terminal pH of 8.58 from the "maximum pH" case was assumed constant starting at time zero of the chemical effects evaluation. While it is known that the actual maximum pH values are transient (i.e., increasing to 8.58) during the first 60 minutes of the post-LOCA event, use of a constant value of 8.58 provides a degree of conservatism when evaluating the amounts of chemical precipitates over the total 30-day mission time

Similarly, the recirculation pool temperature as a function of time was determined. This information was obtained from the long term LBLOCA mass and energy release and containment response analysis for Ginna in support of EPU [ii]. The sump temperature varied from an initial temperature of 120 °F to a peak of 272 °F at 1330 seconds, and decreased to 136 °F at 100,000 seconds. The sump temperature was assumed to remain constant at 136 °F through the end of the recirculation phase.

The materials available for reaction within the recirculation pool chemistry were taken from the Ginna debris generation calculation. The various quantities of insulation debris including, calcium silicate, Temp-Mat, and Thermal Wrap were included in the WCAP chemical model. Additionally, quantities of material that reside in containment and have shown to be contributors to precipitate formation were quantified. This includes the quantities of metallic aluminum, both submerged and non-submerged. The aluminum quantities were conservatively estimated through pre-existing controlled lists, which controlled and maintained quantities of aluminum in containment. These quantities were re-confirmed and quantities below the maximum containment basement recirculation pool level were conservatively assumed to be submerged. A total of 164.4 ft^2 of aluminum surface area was assumed to be submerged, and 1730.3 ft^2 of aluminum surface area was assumed to be unsubmerged.

The results of the WCAP-16530-NP chemical model with the Ginna specific inputs showed that the Ginna expected precipitant formation quantity would be sodium aluminum silicate ($NaAlSi_3O_8$) [iv]. No aluminum oxyhydroxide precipitate would be formed, due to the relatively high quantities of silicon which preferentially form sodium aluminum silicate. The following table summarizes the results of the chemical precipitant formation calculation.

Table 3.o.1: Predicted Chemical Precipitate Formation

	Baseline Methodology (Break Case 1)	**Baseline Methodology (Break Case 2)**	**[Si] > 75 ppm refinement (Break Case 1)**	**[Si] > 75 ppm refinement (Break Case 2)**	**50 ≤ [Si] ≤ 75 ppm & [Si] > 75 ppm refinement (Break Case 1)**	**50 ≤ [Si] ≤ 75 ppm & [Si] > 75 ppm refinement (Break Case 2)**
Aluminum Release (kg)	8.34	8.34	8.34	6.63	7.34	6.46
Precipitate	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**
$NaAlSi_3O_8$	81.0	81.0	81.0	64.4	71.3	62.8
AlOOH	0.0	0.0	0.0	0.0	0.0	0.0
$Ca_3(PO_4)_2$	0.0	0.0	0.0	0.0	0.0	0.0

3.o.2 Chemical Effects Testing

Chemical Effects Testing was conducted at CCI in November 2007. A conservative quantity of precipitant (81 kg), as calculated following WCAP-16530-NP guidance, was generated in the CCI multifunctional test loop. The quantity used did not credit the silicon inhibition of aluminum. The entire quantity of precipitant calculated through the WCAP methodology is assumed to transport to the sump strainer. Therefore, a scaled quantity of a surrogate, representative of the entire amount of precipitant was used in the multifunctional test loop at CCI, along with an increased quantity of insulation and coatings debris. The insulation debris calculated to be generated and transported to the sump was increased by 20% in order to add conservatism. Similarly, the quantities of qualified coatings were increased to be equivalent to a 10D ZOI; and the quantity of degraded/unqualified coatings was increased four-fold.

Prior to the chemical effects testing, in which strainer head loss was determined, laboratory bench top testing was conducted. This was done to assure the chemicals to be used as surrogates in the head loss testing would produce the precipitates identified in WCAP-16530-NP. The chemical laboratory bench top tests were conducted by NIUTEC, a subcontractor to CCI, in accordance with test specifications[iii] .

The chemical effects testing conducted in November 2007 resulted in very high head losses across the strainer. An analysis of the precipitant generation methodology used, concluded that approximately four times the precipitant that was expected per WCAP-16530-NP formed in the test loop. The testing methodology used required the addition of boric acid and sodium hydroxide to simulate the post-LOCA containment recirculation pool conditions. As part of the chemical solution addition in the test loop, large quantities of calcium and silicon were also added. It is suspected that these constituents combined with the sodium hydroxide to form various calcium precipitants in addition to the sodium aluminum silicate predicted by the WCAP. As a result, this test was considered flawed and not representative of the precipitant formation in the containment environment.

Because of these test results, a new series of chemical effects tests is scheduled for February 2008. These tests will strictly comply with the methodology developed in WCAP-16530-NP and the associated NRC SER recommendations. The precipitant generation will be performed outside the test loop in the quantities predicted by the WCAP. The debris loading for the first of two tests will be similar to that used in the initial head loss testing in June 2007. Some of the conservatisms of the debris loading will be reduced for the second test. Details of the test results and its impact on head loss will be made available when complete

3.o.3 Conclusions:

Final sump strainer head loss is not yet available; however, it is expected that the head loss determined from the chemical effects testing will be such that the total strainer head loss will be less than the calculated head loss margin of 2.99 ft WC.

References

i. Westinghouse Report, CN-SEE-I-07-20, Rev. 0, "R. E. Ginna Sump pH Versus Time Evaluation for R. E. Ginna Nuclear Power Station"

ii. Westinghouse Calculation, CN-CRA-06-70, Rev. 0, "R. E. Ginna Unit 1 (RGE) EPU Program: Long-Term LOCA M&E Release and Containment Integrity Analyses – Sump Flow Rate Sensitivity"

iii. CCI Specification, Q.003.84 803, Rev. 0, "Chemical Laboratory Bench Top Test"

vi. Westinghouse Calculation, CN-SEE-I-07-16, Rev 0, "R. E. Ginna GSI-191 Chemical Effects Evaluation"

3.p License Amendments

NRC Issue 3p:

Licensing Basis

The objective of the licensing basis section is to provide information regarding any changes to the plant licensing basis due to the sump evaluation or plant modifications. Provide the information requested in GL 04-02, "Requested Information," Item 2.(e) regarding changes to the plant licensing basis. That is, provide a general description of and planned schedule for any changes to the plant licensing bases resulting from any analysis or plant modifications made to ensure compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this generic letter. Any licensing actions or exemption requests needed to support changes to the plant licensing basis should be included. The effective date for changes to the licensing basis should be specified. This date should correspond to that specified in the 10 CFR 50.59 evaluation for the change to the licensing basis.

R.E. Ginna Nuclear Power Plant does not intend to pursue an amendment to their licensing basis for this modification. In accordance with Technical Specifications Surveillance Requirement (SR) 3.5.2.7, Ginna must "Verify, by visual inspection, each RHR containment sump suction inlet is not restricted by debris and the containment sump screen shows no evidence of structural distress or abnormal corrosion." This wording does not conflict with the planned sump modification.