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10 CFR 50.54(f)

RS-05-116
5828-05-20249

September 1, 2005

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Three Mile Island Nuclear Station, Unit 1
Facility Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Exelon/AmerGen Response to NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors"

References:

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

(2) GSI-191 SE, Revision 0, "Safety Evaluation of NEI Guidance of PWR Sump Performances," dated December 6, 2004

(3) Letter from K. R. Jury (Exelon Generation Company, LLC and AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission "Exelon/AmerGen Response to NRC Generic Letter 2004-02, 'Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,'" dated March 7, 2005

(4) Letter from P. B. Cowan (Exelon Generation Company, LLC and AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission "Response to Request for Additional Information Regarding NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" dated July 27, 2005

The U.S. Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02 (Reference 1) on September 13, 2004 to request that addressees perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions in light of the information provided in the GL and, if appropriate, take additional actions to ensure system function. Additionally, the GL requests addressees to provide the NRC with a written response in accordance with 10 CFR 50.54(f). The request was based on identified potential susceptibility of the pressurized water reactor (PWR) recirculation sump screens to debris blockage during design basis accidents requiring recirculation operation of ECCS or CSS and on the potential for additional adverse effects due to debris blockage of flowpaths necessary for ECCS and CSS recirculation and containment drainage.

The GL requested that by September 1, 2005, addressees provide information regarding 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 the Generic Letter. The GL also requested addressees discuss 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.

Attachments 1 and 2 provide the Exelon Generation Company, LLC (EGC) and AmerGen Energy Company, LLC (AmerGen) response to the requested information. This response addresses actions at the Byron, Braidwood, and Three Mile Island (TMI) stations. This information is being provided in accordance with 10 CFR 50.54(f). Attachment 3 provides a summary of the licensing commitments made in this GL response. This letter contains twelve new commitments.

If you have any questions or require additional information, please contact Mr. Doug Walker at (610) 765-5726.

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

9/1/05
Executed on

Pamela B. Cowan
Pamela B. Cowan
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC
AmerGen Energy Company, LLC

Attachments:
1. Braidwood Station, Units 1 and 2 and Byron Station, Units 1 and 2, September 2005 Response to NRC Generic Letter 2004-02
2. Three Mile Island, Unit 1, September 2005 Response to NRC Generic Letter 2004-02
3. List of Additional Commitments

cc: NRC Regional Administrator - NRC Region I
NRC Regional Administrator - NRC Region III
NRC Project Manager, NRR – Braidwood and Byron Stations
NRC Project Manager, NRR – Three Mile Island Station
NRC Senior Resident Inspector – Braidwood Station
NRC Senior Resident Inspector – Byron Station
NRC Senior Resident Inspector – Three Mile Island Station
File No. 05049

Attachment 1

Braidwood Station, Units 1 and 2
Byron Station, Units 1 and 2

September 2005 Response to NRC Generic Letter 2004-02

Addressees are requested to provide the following information no later than September 1, 2005:

NRC Requested Information 2(a)

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.

Exelon Generation Company, LLC (EGC) Response to 2(a)

The recirculation functions for the Emergency Core Cooling Systems (ECCS) and the Containment Spray Systems (CSS) for Braidwood Station, Units 1 and 2 (Braidwood), and Byron Station, Units 1 and 2 (Byron), will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of the subject generic letter under debris loading conditions by December 31, 2007. The response to NRC requested information, section 2(b) below, describes the corrective actions required to ensure this compliance.

NRC Requested Information 2(b)

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.

EGC Response to 2(b)

Based on the results from debris generation and transport analyses identified and described below, modifications to the existing debris screens will be required to meet the applicable Regulatory Requirements discussed in the generic letter. The Braidwood and Byron containments include two independent recirculation sumps. Based on the results of our analyses, the surface area of the replacement sump strainers will have a surface area of approximately 1,800 ft^2 (without thin bed) to 3,700 ft^2 (with thin bed).

These areas include in excess of 800 ft^2 of sacrificial surface area for miscellaneous debris such as tapes, labels, etc. The new strainers will occupy the space within the existing sumps as well as an area around and between the existing sumps, if required. The final layout within the sump and screen area will be determined by the sump screen manufacturer based on EGC input into the design.

The following is a schedule being used to identify the milestone steps to assure plant modification completion by December 31, 2007. The dates are for the purposes of providing a timeline of activities and are not considered commitments.

Plant modifications will be implemented per the following schedule:

- Byron Unit 1, requiring refueling outage for access – B1R14 (Fall 2006)
- Byron Unit 2, requiring refueling outage for access – B2R13 (Spring 2007)
- Braidwood Unit 1, requiring refueling outage for access – A1R13 (Fall 2007)
- Braidwood Unit 2, requiring refueling outage for access – A2R12 (Fall 2006)
- Any components not requiring a refueling outage for access will be modified by December 31, 2007.

Although the next Braidwood Unit 1 Spring Outage occurs after April 1, 2006, implementation of physical modifications will not be completed during this outage. EGC will be performing containment walkdown for latent debris sampling, confirmation of the sump space envelope, and a confirmatory walkdown for potential debris sources. Modifications will be implemented in the Fall 2007 refueling outage and all corrective actions will be completed by December 31, 2007.

EGC will install replacement sump strainers at Braidwood and Byron and are in the process of selecting a manufacturer. EGC has identified a strainer manufacturer and will finalize the selection by September 30, 2005.

The Containment Walkdowns (for Byron Unit 1 and Braidwood Unit 2), the Debris Generation, the Debris Transport (including computational fluid dynamics modeling) and the Head Loss Calculations, as well as the replacement screen Procurement Specifications are completed. Containment walkdowns for Byron Unit 2 and Braidwood Unit 1 are scheduled during upcoming outages.

The downstream effects evaluation for blockage and long-term wear is in progress, with a preliminary evaluation complete. Overall completion of the downstream effects analysis, including the fuel impact under the current WCAP guidance (i.e., WCAP-16406-P, dated June 2005, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191"), is expected to occur by January 31, 2006. Plant modifications identified in conjunction with the downstream effects evaluation will be complete by December 31, 2007.

The upstream effects evaluation for potential choke points and flow diversions were evaluated during the plant walkdowns performed to date. The walkdowns were performed in accordance with the guidance of NEI 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments". These walkdowns confirmed that there are no chokepoints that could prevent adequate water inventory from reaching the containment sump strainers.

The chemical effects evaluation is partially complete and is covered in more detail in the response to NRC requested information section, 2(d)(iii). This includes completion of the site-specific analysis as well as the sump screen vendor testing. A margin for chemical effects is included in the preliminary strainer design described in this submittal. The chemical effects evaluation (excluding vendor testing) is scheduled to complete by January 31, 2006.

This response is based on information currently available and will be supplemented if the final design deviates significantly from the information provided. The Braidwood and Byron licensing basis will be updated to reflect the results of the analysis and modifications performed to demonstrate compliance with the regulatory requirements. This update will be performed in accordance with the requirements of 10 CFR 50.71 "Maintenance of records, making of reports."

NRC Requested Information 2(c)

A description of the methodology that was used to perform the analysis of the susceptibility of the ECCS and CSS recirculation functions to the adverse effects of post-accident debris blockage and operation with debris-laden fluids. The submittal may reference a guidance document (e.g., Regulatory Guide 1.82, Rev. 3, industry guidance) or other methodology previously submitted to the NRC. (The submittal may also reference the response to Item 1 of the Requested Information described above. The documents to be submitted or referenced should include the results of any supporting containment walkdown surveillance performed to identify potential debris sources and other pertinent containment characteristics.)

EGC Response to 2(c)

Detailed analyses were completed in accordance with the methodology contained in NEI 04-07 as modified by the NRC's SER, "Pressurized Water Reactor Sump Performance Evaluation Methodology," for Debris Generation, Debris Transport and Head Loss. No exceptions to this methodology were taken.

Background Information

Braidwood and Byron are each four-loop plants with large volume dry containments. Each loop consists of the reactor coolant pump (RCP), steam generator (SG) and associated piping located within a concrete wall enclosure commonly referred to as a missile barrier. The four reactor coolant system (RCS) piping loops (loops A, B, C, and D) in each unit are nearly identical with the exception that loop D includes the pressurizer (PZR) and the associated piping. The area enclosed by the missile barrier measures an approximate 49'-0" radius from the centerline of the reactor to the missile barrier internal walls. The area inside the missile barrier (IMB) is open directly above the 377'-0" basement elevation, but at higher elevations the refueling cavity and other concrete walls separate loops A and D from loops B and C. Above elevation 426'-0" separate concrete compartments separate each SG.

In response to a Loss of Coolant Accident (LOCA), the residual heat removal (RHR), centrifugal charging (CV), and safety injection (SI) pumps automatically start upon receipt of a safety injection signal. These pumps inject to the RCS, taking suction from the refueling water storage tank (RWST). The CSS pumps start automatically when the containment pressure set point is reached and also take suction from the RWST. The switchover to the ECCS sumps as suction source to the RHR pumps is initiated when the RWST water level decreases to approximately 47%. The CSS pumps suction source is switched over to the ECCS sumps when the RWST water level decreases further, to approximately 12%.

Since the debris generation calculation addresses all four units at Braidwood and Byron, a review of the physical plant layout was performed to ascertain any differences between the units that might affect this calculation. The review concluded that all units have nearly identical containment layouts. Unit 1 containments at Braidwood and Byron are nearly identical, and Unit 2 containments at Braidwood and Byron are mirror images of their respective Unit 1 containment.

Baseline Break Selection (ref. calc. BRW-05-0059-M/BYR05-041)

A number of breaks in each high-pressure system that relies on recirculation are considered to ensure that the breaks that bound variations in debris generation by the size, quantity and type of debris are identified.

Based on various postulated break locations, the following break locations were evaluated per the methodology in the guidance document NEI 04-07, as modified by the NRC's Safety Evaluation Report, to maximize the postulated debris created:

1. The interim leg at the inlet to the loop D reactor coolant pump (RCP) at approximate elevation 386'-0" is the largest postulated line in containment and will affect a large amount of fiber (Transco RMI and reflective mirror insulation on the major equipment and piping inside the missile barrier). It also is the most direct path to the sump. This is the limiting break for Braidwood and Byron since it has the greatest coating debris quantity which dominates the fiber/particulate head loss.
2. The loop A cold leg between the reactor coolant loop isolation valve and the reactor shield wall at elevation 393'-0" is chosen because it is another large break that will create the greatest mix of insulation debris types. It is also located farther from the sump, which will create a different transport path for debris.
3. The loop D hot leg between the valve and the reactor shield wall at elevation 393'-0" is chosen because it generates the largest amount of fiber debris in Unit 1 of Braidwood and Byron.
4. Additionally, an alternate break is evaluated at the 14-inch pressurizer surge line (branch off of the reactor coolant system loop D line) at the connection to the pressurizer. This break would damage the reflective mirror insulation on most piping in loop D and a small amount in loop A, with the exception of piping near the top of the pressurizer. The loop D RCP and pressurizer insulation would also be damaged. For Unit 1 of Braidwood and Byron only, the fiber insulation on the loop D SG will also be damaged.

Debris Generation (ref. calc. BRW-05-0059-M/BYR05-041)

Insulation

The insulation for most lines and equipment is nearly identical in all four units. The majority of the insulation is Mirror RMI except for the SGs in Unit 1 for both Braidwood and Byron, which are insulated with Transco RMI and Transco Thermal Wrap. The associated Braidwood and Byron Unit 1 SG piping connections (Main Steam, Feedwater, Auxiliary Feedwater, Steam Generator Blowdown) also have sections of Transco Thermal Wrap.

The zones of influence (ZOI) for the RMI and fibrous Transco Thermal Wrap were applied using the criteria established in the NRC Generic Letter (GL) 2004-02 Safety Evaluation, Table 3-2.

Coating

In accordance with the NRC's Safety Evaluation Report for NEI 04-07, a ZOI of ten pipe diameters (10D) was used for the qualified coating. All unqualified coating was assumed to fail regardless of location inside the containment.

Foreign Material

The quantity and type of foreign material inside containment was based on walkdown data performed for Byron Unit 1 and Braidwood Unit 2. The foreign material included self-adhesive labels, stickers, placards, etc. The foreign material includes all identified foreign material in containment, and per the above referenced guidance, appropriate quantities were assumed to transport to the sump. In addition, 200 ft^2 of degraded qualified coating was considered in the debris mix.

Latent Debris

A latent debris walkdown was performed at Byron Unit 1 and Braidwood Unit 2 in accordance with the NRC's Safety Evaluation Report for NEI 04-07, Section 3.5. Using a masolin cloth, samples were collected from the various surfaces at different floor elevations and when practical, different locations on each floor. At minimum three samples from each of the following surfaces were taken:

- Horizontal concrete surfaces (floors)
- Vertical concrete surfaces (walls)
- Grated surfaces at support beams
- Containment liner (vertical)
- Cable trays (vertical)
- Cable trays (horizontal)
- Horizontal equipment surfaces (Heat Exchangers, Air Coolers, etc.)
- Vertical equipment surfaces (SG, Air Coolers, Pressurizer, etc.)
- Horizontal HVAC duct surfaces
- Vertical HVAC duct surfaces
- Horizontal piping surfaces
- Vertical piping surfaces (Pipes running vertically)

A total of at least 36 samples were taken. When a surface was not accessible for sampling, an alternate surface was selected and noted on the walkdown report, such as circular pipe for an inaccessible circular duct. The net weight differences between the pre-sample and post-sample weight were used to statistically extrapolate the amount of latent debris for the entire containment using a 90% confidence level.

Debris Transport (ref. calc. BRW-05-0060-M/BYR05-042)

The transport of the debris from the break location to the sump screen is evaluated using the methods outlined in section 3.6 of NEI 04-07 as amended by the NRC SER . The means of transport considered are blowdown, washdown, pool fill, and recirculation for all types of debris. The recirculation transport analysis was performed by Sargent & Lundy using computational fluid dynamics (CFD) models developed using the computer program FLUENT. The CFD models were created by RWDI, Inc. Outputs of the CFD analysis include global (entire containment) and local (near sump pit) velocity contours, turbulent kinetic energy (TKE) contours, path lines and flow distributions for various scenarios. All particulate and coating debris was modeled as fines and 100% transports to the screen.

The debris transport phenomena due to the blowdown, washdown, pool fill-up, and recirculation transport modes are summarized using debris transport logic trees consistent with the Drywell Debris Transport Study (DDTS) documented in NUREG/CR-6369, "Drywell Debris Transport Study." The debris transport logic trees consider the effect of dislocation, hold up on the floor or other structures, deposition in active or inactive pools, lift over curbs, and erosion of debris.

Miscellaneous (foreign material) debris (tape, labels, etc.) is included in the debris load, and considered in the screen design as a sacrificial area. All miscellaneous debris is assumed to be 100% transportable.

The following is a summary of the overall transport fractions for all debris types:

Debris Type	Overall Transport Fraction
RMI	1.00
Transco Thermal Wrap	0.65
Qualified Coatings	1.00
Unqualified Coatings	1.00
Latent Debris	1.00
Foreign Material	1.00

The transport fractions presented above are bounding for all break locations, including a break in the RCS piping above the sump.

Strainer Head Loss (ref. calc. BRW-05-0060-M/BYR05-042)

The debris bed head loss and net positive suction head (NPSH) margin analysis is documented in EGC calculations. The debris bed head loss depends on the composition of the debris mixture that reaches the sump screen, the debris size, and the debris characteristics.

The analysis indicates that a new larger area sump screen is needed to accommodate the debris inventory transported to the sump screen based on the head loss through the debris bed that would form during recirculation. The head loss across the debris bed is determined separately for fiber and particulate debris and for RMI debris. The head loss through a fiber/particulate debris bed is determined using the head loss correlation developed in NUREG/CR-6224 "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA-Generated Debris." The RMI debris bed head loss is determined using a bounding correlation identified in NEI PWR Sump Evaluation Methodology. The total head loss across the sump strainer is equal to the sum of the fiber/particulate debris bed head loss, the RMI debris bed head loss, and the clean strainer head loss. Information regarding the type(s) of unqualified coatings at Braidwood and Byron is not available. Therefore, in the determination of debris bed head loss, all unqualified coatings are assumed to be epoxy, as epoxy conservatively results in a greater head loss than inorganic zinc and alkyds.

Based on the results of our analyses, the replacement sump strainers will have a surface area of approximately 1,800 ft^2 (without thin bed) to 3,700 ft^2 (with thin bed). Note that these sizes include a sacrificial area in excess of 800 ft^2.

The strainer size estimates are provided based on the case where one ECCS and one CSS pump are running following CSS switchover. The estimates are based on an allowable head loss of 5.7 feet with 0.5 feet NPSH margin allowance retained. The final strainer head loss analysis will be confirmed by the strainer manufacturer.

Containment Walkdowns

Containment walkdowns to support the analysis of debris blockage were performed for Byron Unit 1 and Braidwood Unit 2 using the guidelines provided in NEI 02-01. The results were found to be consistent for both units and are expected to be consistent with the remaining units. (Reference TODI S040-BYR-5011, April 8, 2005, GSI 191 Debris Generation Walkdown for the Byron walkdown and TODI S040-BRW-5018, May 25, 2005, GSI 191 Debris Generation Walkdown for the Braidwood walkdown)

During the Byron Unit 2 Fall 2005 and Braidwood Unit 1 Spring 2006 outages, EGC will perform the remaining containment walkdown surveillances for latent debris sampling, as well as confirmation of the sump space envelope, and a confirmatory walkdown for potential debris sources.

Downstream Effects Methodology

The methodologies of NEI 04-07 as modified by the NRC Safety Evaluation and WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," are used to evaluate the downstream effects of debris that is passed by the sump strainer. Consistent with the guidance in NEI 04-07, the evaluation considers debris that is 10% larger than the largest dimension of the sump strainer opening.

This evaluation utilizes the wear and abrasion models/methodologies developed by the Westinghouse Owner's Group (WOG) as outlined in the WCAP report to evaluate the effects of debris in the ECCS and CSS due to recirculating fluid from the containment sump. This evaluation also addresses the susceptibility of the downstream flow paths and components to obstruction by the debris carried in the fluid. Braidwood and Byron's fuel supplier is performing an additional evaluation, also using WCAP report guidance, on the core cooling impact from debris that may enter the RCS when the ECCS suction is switched to the containment sump.

Chemical Effects Methodology

Although the NRC and the Industry have jointly developed the Integrated Chemical Effects Testing (ICET) Program, this will not resolve the plant-specific chemical effects impact on the recirculation sump screen. The EGC approach for resolving the chemical effects issue and validating the assumed bump-up factor on debris bed head loss consists of the following sequence:

Step 1: Compare Braidwood and Byron conditions to ICET Test Parameters; reserve strainer head loss margin to accommodate this effect.

Step 2: Determine supplemental analysis/testing, to assess outliers identified in step 1

Step 3: Identify and Perform Chemical Effects Material Head Loss Testing

Step 4: Develop and prescribe impact to plant debris bed head loss, including the time dependence of the impact

The first 2 steps are currently underway, and the preliminary results indicate that ICET Test No. 1 most closely relates to Braidwood and Byron. Results of ICET Test No. 1 indicated that chemical precipitants increase with time and cooling of fluid over the course of the 30-day event.

The approach used to allow for chemical effects is to initially reserve a percent of the Net Positive Suction Head (NPSH) Available margin for chemical effects. Considerable margin (about 100% of the actual head loss) will be available when the CSS pumps are shutoff. CSS Pump shutoff takes place within 10 hours of the start of the event. Additional available margins are discussed in section (d)(iii) of this submittal. The combined margins given are significantly higher than the margins that were estimated to be required by industry experts. The results of sump strainer vendor head loss testing will be used to validate the final design.

The applicability of the chemical effects test results will be based on a review of the Westinghouse Owner's Group (WOG) ICET Test No. 1 and the Braidwood and Byron plant specific parameters.

Analyses Performed By Contractors

The debris generation and transport analyses were performed by Sargent & Lundy Engineers. The chemical and downstream effects analyses, with the exception of fuel related analyses, are also being performed by Sargent & Lundy Engineers. The fuel related downstream effects analyses are being performed by Westinghouse Electric Company Nuclear Services.

NRC Requested Information 2(d)(i)

The submittal should include, at a minimum, the following information: The minimum available NPSH margin for the ECCS and CSS pumps with an unblocked sump screen.

EGC Response to 2(d)(i)

The minimum available NPSH margin for the ECCS (RHR) pumps in the recirculation mode at ECCS switchover to sump recirculation, not including the clean strainer head loss, is 5.7 feet.

The minimum available NPSH margin for the ECCS (RHR) pumps in the recirculation mode at CSS switchover to sump recirculation, not including the clean strainer head loss, is 6.0 feet.

The minimum available NPSH margin for the CSS pumps in the containment spray recirculation mode at CSS switchover to sump recirculation, not including the clean strainer head loss, is 5.7 feet.

The clean strainer head loss is expected to be small (<0.1 feet based on experience). However, the exact values will be confirmed upon completion of the final design by the hardware manufacturer.

NRC Requested Information 2(d)(ii)

The submerged area of the sump screen at this time and the percent of submergence of the sump screen (i.e., partial or full) at the time of the switchover to sump recirculation.

EGC Response to 2(d)(ii)

The strainers will be fully submerged (submergence of 100%) at the time of switchover. This is based on the approximate sump screen areas of 1,800 ft^2 (without thin bed) to 3,700 ft^2 (with thin bed)

NRC Requested Information 2(d)(iii)

The maximum head loss postulated from debris accumulation on the submerged sump screen, and a description of the primary constituents of the debris bed that result in this head loss. In addition to debris generated by jet forces from the pipe rupture, debris created by the resulting containment environment (thermal and chemical) and CSS washdown should be considered in the analyses. Examples of this type of debris are disbonded coatings in the form of chips and particulates and chemical precipitants caused by chemical reactions in the pool.

EGC Response to 2(d)(iii)

The maximum postulated head loss from debris accumulation on the submerged sump strainer is specified to be 5.0 feet of water or less. The analysis considers debris generated by the resulting containment environment (thermal and chemical) and CSS washdown. The primary constituents of the debris bed are as follows:

Debris Type
Mirror RMI Foil
Transco Thermal Wrap
Qualified Coatings (epoxy)
Qualified Coatings (IOZ)
Degraded Qualified Coatings
Unqualified Coatings
Latent Debris – Fiber[1]
Latent Debris – Particulate[1]
Foreign Material[2]

1) 150 lbm of latent debris (dust and lint) is included in the debris loading. Based on Byron Unit 1 latent debris walkdown, the calculated latent debris is 67.3 lbm. Based on Braidwood Unit 2 latent debris walkdown, the calculated latent debris is 72.8 lbm.

2) Foreign material consists of tapes, labels, placards, etc

The above debris does not include debris resulting from chemical effects.

Braidwood and Byron use Sodium Hydroxide (NaOH) as the buffer. An evaluation to compare the ICET summary for Test No. 1 and the Braidwood and Byron plant specific parameters is in progress.

Sump strainer suppliers are developing plans and schedule to quantify the additional head loss associated with chemical debris. The results will be incorporated into the head loss analyses for the new strainer being procured for Braidwood and Byron as appropriate. Braidwood and Byron will validate that adequate margin exists to bound the impact of chemical effects once the tests results to quantify chemical debris effect on head loss have been published. EGC will update the Byron & Braidwood NRC Project Manager with this scheduling information when the vendors have formulated their testing schedule.

EGC believes that significant margins exist in the design of the ECCS sump screens to compensate for the chemical effect on screen head loss. The combined margins given below are significantly higher than the margins that were estimated to be required by industry experts.

The margins in Net Positive Suction Head (NPSH) Available are as follows:

	Estimated Margin (%**)	
	Initial 24 hours after Switchover	After 24 hours
Minimum Analytical Margin	> 50%	> 100%

*** Percent of strainer design head loss of 5.0 feet from the procurement specification.*

In addition, the design of the Braidwood and Byron plants does not require extended operation of the Containment Spray System (CSS) pumps. The required operating time for the CSS pumps is less than 10 hours. When the CSS pumps are shutoff, the flow rate from the ECCS sump is reduced by nearly one half. The resulting head loss through the ECCS sump screen will conservatively decrease by at least this same amount. Therefore, at 10 hours following the accident, the head loss through the screen can nearly double and remain acceptable.

For example, given a head loss of 5 ft with CSS and RHR pumps in operation from each sump, when the CSS pumps are shutoff, the resulting head loss decreases to about 2.5 ft. At this time, the head loss can increase by 100% (2.5 ft) due to the chemical effects and will remain adequate because the total head loss through the screen will be at 5 ft, which is equivalent to the original head loss.

NRC Requested Information 2(d)(iv)

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.

EGC Response to 2(d)(iv)

The sumps are located inside the missile barrier directly below some locations of postulated debris generation line breaks. Flow diversion or choke points are not predicted inside the missile barrier (vertical transport). Evaluations of potential choke points from outside the missile barrier to inside the missile barrier were evaluated during the plant walkdowns. The walkdowns were performed in accordance with the guidance of NEI 02-01. These walkdowns confirmed that there are no chokepoints that could prevent adequate water inventory from reaching the containment sump strainers.

Additionally, an inspection for non-LOCA generated material that could potentially obstruct recirculating water is conducted as part the containment cleanliness inspection program prior to plant restart following outages with containment entry. The controlling procedure specifically addresses the need to assure that the containment is free of such items that could be washed to the sump.

NRC Requested Information 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 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 sump screen's mesh spacing and state the basis for concluding that adverse gaps or breaches are not present on the screen surface.

EGC Response to 2(d)(v)

The flow paths downstream of the containment sump are being analyzed to determine the potential for blockage due to debris passing through the sump strainer. The acceptance criteria are based on WCAP-16406-P.

These evaluations address all components in the recirculation flow paths including, but not limited to: nuclear fuel and reactor vessel internals, throttle valves, flow orifii, spray nozzles, pumps, heat exchangers, and valves. The methodology employed in this evaluation is based upon input obtained from a review of the recirculation flow path shown on Piping and Instrument Diagram Drawings and plant procedures. The steps used in obtaining the flow clearance are as follows:

- Determine the maximum characteristic dimension of the debris (clearance through the sump strainer).
- Identify the recirculation flow paths.
- Identify the components in the recirculation flow paths.

- Review the vendor documents (drawings and/or manuals) for the components to obtain flow clearance dimensions.
- Determine blockage potential through a comparison of the flow clearance through the component with the flow clearance through the sump strainer.
- Identify the components that require a detailed evaluation and investigation of the effects of debris on their capability to function.

The ECCS and CSS flowpaths downstream of the sump screen were reviewed including components such as the ECCS throttle valves, pump bearings and seals, the fuel assembly inlet debris screen, and containment spray nozzles. The results of the flow clearances evaluation are summarized below for components identified with a flow clearance less than or equal to a strainer size of 1/12-inch diameter plus ten percent (or 0.092 inches). This is the anticipated maximum opening size of the new strainers. The diameter of the flow orifice in the containment spray nozzles is 0.375 inches; therefore, these nozzles are not susceptible to blockage.

<u>Components with a flow clearance less than or equal to a strainer size</u>
- SI Pumps – Wearing Ring Clearance
- Charging Pumps – Wearing Ring Clearance
- CSS Pumps – Casing Ring Clearance
- RHR Pumps – Casing Ring Clearance

The ECCS throttle valves have been identified as requiring further evaluation for blockage potential.

A number of instrumentation root valves have been identified as susceptible to blockage based on their internal dimensions. Although a formal evaluation has not been completed, EGC anticipates that these valves can be dispositioned based on the criteria from WCAP-16406-P for instrument sensing lines.

The new strainers will be designed for the effects of weight, thermal, head loss, and seismic loading. The new strainer design will ensure that gaps at mating surfaces within the strainer assembly and between the strainer and the supporting surface do not have gaps in excess of the strainer hole size of 1/12 inch. Similarly the design will ensure that drainage paths to the sump that by pass the sump strainer will also have a maximum debris size bypass of 1/12-inch (0.083 inch).

EGC is currently evaluating sump strainer debris bypass testing to be performed by the selected sump strainer supplier. The purpose of this testing will be to quantify the debris bypass fraction which passes through the sump strainer.

Core and Reactor Internals Evaluation

The downstream effects evaluation of potential flow blockage of the reactor fuel and internals is ongoing. The fuel evaluation is considering the fibrous debris sources inside containment identified in the debris generation and debris transport calculations performed to support this submittal. A conservative analysis is being performed to determine the fibrous debris that may pass through the containment sump screen and collect on the fuel components. Of special interest is whether a minimal fibrous bed thickness for the onset of the "thin-bed effect" takes place.

A preliminary analysis has been completed that evaluates the potential for blockage of essential flow paths in the reactor vessel, exclusive of fuel, by particulate and fibrous debris. The critical openings and flow paths through the reactor vessel internals assembly were reviewed to ensure that they are sufficiently large to preclude plugging during hot leg or cold leg recirculation.

Cold leg recirculation flow proceeds from the cold-leg nozzle through the downcomer between the vessel and the core support barrel, past the neutron panels, between the radial support keys and into the lower plenum. It then flows through the open area between support and instrumentation columns, up through the core support plate and the lower core plate.

Hot leg recirculation flow proceeds from the hot-leg nozzle, through the upper support columns and guide tubes and down through the upper core plate.

Limiting dimensions were evaluated in each recirculation flowpath and an analysis was completed to ensure either flow path could not be restricted by debris that has passed through the sump screen. The preliminary results indicate no modifications will be required to resolve vessel internal blockage.

These evaluations will be completed in accordance with the downstream effects scheduled dates noted previously in this submittal.

NRC Requested Information 2(d)(vi)

Verification that 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.

EGC Response to 2(d)(vi)

Verification of debris blockage of downstream components is described in 2(d)(v) above.

ECCS Components Evaluation

Verification of downstream components for long-term effects is in progress, and the final results will be submitted to the NRC as noted in Section 2(b) above.

The long-term downstream effects evaluation is in progress using the methodology and acceptance criteria presented in WCAP-16406-P. Where excessive wear is found using this methodology, a refined approach using alternative methods may be used. Examples of candidate alternative methodologies are those described in Department of Energy, Centrifugal Slurry Pump Wear and Hydraulic Studies.

For the long term wear evaluations, the quantity and type of debris is derived from the Debris Transport and Head Loss calculations and the sump screen Procurement Specification. The minimum containment flood level calculation is used for the amount of fluid in which the debris will be mixed. Preliminary calculations have been performed for heat exchangers, orifices, and valves based on Eq. 5.8-5 of WCAP-16406-P. Conservative values for C_{co} and decay coefficient were employed in the preliminary calculation. The preliminary results indicate:

- RHR Heat Exchangers, CSS nozzles, CSS restricting orifii, CSS flow element orifii and flow element orifii for recirculation paths from SI pumps to cold legs and hot legs all show acceptable wear for a period exceeding their required mission times.

- Flow element orifii for both RHR system and recirculation paths from the charging pumps to the cold legs and restricting orifii in the RHR and SI systems show unacceptable wear for their required mission times. Additional evaluations are underway for these components using alternative methodologies. It is expected each stated orifii would demonstrate capability to operate with acceptable wear for a period meeting or exceeding the required mission times. However, until this capability is formally concluded, these components are classified as potentially requiring modification.

Instrumentation required to support post-LOCA recirculation was identified and the corresponding root valves were evaluated for clearance. Evaluations for debris settling in the instrument lines are in progress but preliminary results are not available. Based upon a review of the criterion in WCAP-16406-P, it is expected that each root valve will be demonstrated to be adequate for a period meeting or exceeding the required mission times. However, until this capability is formally concluded, these items will be classified as potentially requiring modification.

Evaluations for SI, RHR, CSS, and charging pumps, ECCS throttle valves, CSS eductors, relief valves, and piston (lift) check valves are in progress. As such, these components will be classified as potentially requiring modification.

The schedule for all components requiring modification will be as follows:

- Byron Unit 1, requiring refueling outage for access – B1R14 (Fall 2006)
- Byron Unit 2 and requiring refueling outage for access – B2R13 (Spring 2007)
- Braidwood Unit 1 and requiring refueling outage for access – A1R13 (Fall 2007)
- Braidwood Unit 2 and requiring refueling outage for access – A2R12 (Fall 2006)
- Any components not requiring a refueling outage for access will be modified by December 31, 2007.

NRC Requested Information 2(d)(vii)

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 predicted flow conditions.

EGC Response to 2(d)(vii)

The sumps are located within the missile barrier and zones of influence of high-energy line breaks. Therefore, a protective structure/trash rack over the sumps will be provided for protection of the new strainers and to prevent debris from directly falling into the sumps.

The sump strainer design requirements ensure that it will be capable of withstanding the force of full debris loading, in conjunction with all design basis conditions, without collapse or structural damage. The design requirements also ensure that it will be capable of withstanding the hydrodynamic loads and inertial effects of water at full debris loading without loss of structural integrity.

NRC Requested Information 2(d)(viii)

If an active approach (e.g., backflushing, powered screens) is selected in lieu of or in addition to a passive approach to mitigate the effects of the debris blockage, describe the approach and associated analyses.

EGC Response to 2(d)(viii)

The new strainer being procured employs a passive design.

NRC Requested Information 2(e)

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.

EGC Response to 2(e)

Braidwood and Byron's licensing basis will be updated to reflect the results of the analyses and the modifications performed to demonstrate compliance with the regulatory requirements by December 31, 2007. This update will be performed in accordance with the requirements of 10 CFR 50.71.

No licensing actions or exemption requests needed to support changes to the plant licensing basis have been identified. If any licensing actions are identified, this will be discussed with Braidwood and Byron's NRC Project Manager.

NRC Requested Information 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, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after 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.

EGC Response to 2(f)

Design Changes

An enhancement will be made to the Design Attributes Review (DAR) document that is part of the Configuration Change Procedure (CC-AA-102). This change will introduce a requirement for reviewing the impact of a proposed change on the documentation that forms the design basis for the response to Generic Letter 2004-02. The specific areas that will be addressed, as a minimum, are:

- Insulation inside containment
- Coatings inside containment
- Structural changes (i.e., Choke points) in containment
- Inactive volumes in containment
- Downstream Effects (piping components downstream of the ECCS sump screens)
- Labels inside containment

Inclusion in the DAR will ensure all design changes consider these attributes during the design process.

General Debris and FME

The procedures for containment closeout necessitates that a containment walkdown be performed for housekeeping deficiencies. The procedure incorporates a list of all unresolved housekeeping and equipment discrepancies and requires that resolution be included in the plant restart documentation. The procedure also provides guidance on general cleanliness and debris inspection guidelines.

Choke points/water holdup

Included in the loose debris inspection procedure is a requirement to verify both screen doors between IMB and outside missile barrier (OMB) are not blocked and debris is not present in the vicinity of the doors that represents a risk for blockage of the screen doors. This requirement is applicable to anyone traversing plant elevation 377 during Operating Modes 1-4. This ensures the flow paths for water from the OMB to IMB are unblocked.

Coatings

Braidwood and Byron have an existing coatings program that monitors and controls the quantities and types of coatings installed inside containment. As noted in our response to GL 98-04, Braidwood and Byron have implemented controls for procurement, application, and maintenance of qualified coatings used inside containment that are consistent with the licensing basis and regulatory requirements. This program conducts periodic condition assessments, typically each outage, to verify the adequacy of existing coatings and direct repair/replacement, as necessary. The quantity of unqualified coatings that are added inside containment is tracked. This program is adequate in its current form to ensure coatings are properly controlled, and that future installations of unqualified coatings are quantified. Enhancements to the existing coatings program procedure will be evaluated to further strengthen the quantification of degraded qualified coatings and qualified coatings within the ZOIfor the purposes of maintaining the design bases.

Latent Debris

Braidwood and Byron will create a predefined activity to perform latent debris measurements on a frequency of every four refueling outages (nominally, a six-year frequency). The results of this walkdown/measurement will be evaluated/incorporated in the design analysis for the ECCS sump screens.

Downstream Effects

Any hardware changes potentially affecting the downstream effects analysis will be controlled via the configuration change process.

Labels

Braidwood and Byron will upgrade the existing Labels and Tagging procedure to incorporate processes to ensure the design bases is preserved.

Attachment 2

Three Mile Island, Unit 1

September 2005 Response to NRC Generic Letter 2004-02

Addressees are requested to provide the following information no later than September 1, 2005:

NRC Requested Information 2(a)

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.

AmerGen Energy Company, LLC Response to 2(a)

The recirculation functions for the Emergency Core Cooling Systems (ECCS) and the Building Spray (BS) System for Three Mile Island, Unit 1, will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of the subject generic letter under debris loading conditions by December 31, 2007. The response to NRC requested information, section 2(b) below, describes the corrective actions required to ensure this compliance.

NRC Requested Information 2(b)

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.

AmerGen Response to 2(b)

Based on the results from debris generation and transport analyses identified and described below, modifications to the existing debris screens will be required to meet the applicable Regulatory Requirements discussed in the generic letter. TMI has a single containment sump with a strainer common to the parallel redundant ECCS trains. Based on the analysis results, the surface area of the replacement sump strainer will be increased to at least 2750 $ft^{2.}$

The new strainer will occupy the space within the existing sump and will be fully submerged prior to ECCS suction switchover to recirculation. The new strainer will be designed to prevent particles greater than 1/8 inch from passing. The final layout within the sump and screen area will be determined by the sump screen manufacturer based on AmerGen input into the design.

The following is a schedule being used to identify the milestone steps to assure modification completion by December 31, 2007. The dates are for the purposes of providing a timeline of activities and are not considered commitments.

The plant modifications will be implemented during the fall 2007 refueling outage, with all corrective actions being completed by December 31, 2007.

AmerGen will install a replacement sump strainer at TMI and is currently in the process of selecting a manufacturer. The manufacturer of choice will be selected by September 30, 2005.

A preliminary walkdown was performed during the 2003 TMI refueling outage. Existing design documentation and the preliminary walkdown results have been used to provide information for the analyses required by the GL. The formal Containment Walkdown will be performed in accordance with NEI 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments" in TMI's fall 2005 refueling outage.

Debris Generation, Debris Transport (including computational fluid dynamics modeling) and Head Loss Calculations, as well as the replacement screen Procurement Specification are completed. In addition, the "Reactor Building Minimum Level During Recirculation Following a LB LOCA" calculation was revised to support the GL response.

The downstream effects evaluation for blockage and long-term wear is in progress, with a preliminary evaluation complete. Overall completion of the downstream effects evaluation, including the fuel impact under the current WCAP guidance (i.e., WCAP-16406-P, dated June 2005, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191"), is scheduled to occur by January 31, 2006.

Based on the downstream effects evaluations discussed in this response, additional corrective actions may be needed for the LPI manual throttle valves, the ECCS pump seals, the cyclone separators, and the seal flush sub-systems. AmerGen is working with the vendors to determine whether resolution will require modifications or a revision of operating/maintenance requirements. If modification of any of these components is required, this work will be completed prior to December 31, 2007.

Additional configuration changes are being considered to address upstream flow concerns. These include:

- Removal/replacement of the doors to the entrances of the D-rings and incore chase room
- Flow diverters in the containment basement (281' floor elevation)
- Debris interceptors upstream of the containment sump
- Fuel transfer canal drain improvements

If modification of any of these components is required, this work will be completed prior to December 31, 2007.

The chemical effects evaluation is partially complete and is covered in more detail in the response to NRC requested information section, 2(d)(iii). This includes completion of the site-specific analysis as well as the sump screen vendor testing. A margin for chemical effects is included in the preliminary strainer design described in this submittal. The chemical effects evaluation (excluding vendor testing) is scheduled to complete by January 31, 2006.

This response is based on information currently available and will be supplemented if the final design deviates significantly from the information provided. TMI's licensing basis will be updated to reflect the results of the analyses and the modifications performed to demonstrate compliance with the regulatory requirements by December 31, 2007. This update will be performed in accordance with the requirements of 10 CFR 50.71 "Maintenance of records, making of reports."

NRC Requested Information 2(c)

A description of the methodology that was used to perform the analysis of the susceptibility of the ECCS and CSS recirculation functions to the adverse effects of post-accident debris blockage and operation with debris-laden fluids. The submittal may reference a guidance document (e.g., Regulatory Guide 1.82, Rev. 3, industry guidance) or other methodology previously submitted to the NRC. (The submittal may also reference the response to Item 1 of the Requested Information described above. The documents to be submitted or referenced should include the results of any supporting containment walkdown surveillance performed to identify potential debris sources and other pertinent containment characteristics.)

AmerGen Response to 2(c)

Detailed analyses were completed in accordance with the methodology contained in NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," as modified by the NRC's SER, for Debris Generation, Debris Transport and Head Loss. No exceptions to this methodology were taken.

Background Information

TMI is a Babcock and Wilcox two loop plant with a large volume dry containment. Each loop contains two reactor coolant pumps (RCP), a once-through steam generator (OTSG), and associated piping located within a concrete wall enclosure commonly referred to as a D-ring. The two reactor coolant system (RCS) piping loops (A and B) are nearly identical with the exception that loop A includes the pressurizer (PZR) and it's associated piping. The area inside each D-ring is open directly above the 281'-0" basement elevation. The two D-rings are connected by walkways in the basement, but at higher elevations the refueling cavity and other concrete walls separate the two loops.

Baseline Break Selection (ref. calc. ALION-CAL-EXEL2737-001)

A number of breaks in each high-pressure system that relies on recirculation are considered to ensure that the breaks that bound variations in debris generation by the size, quantity and type of debris are identified. As a minimum, the following break locations are considered:

- Break No. 1: Breaks in the RCS with the largest potential for debris.
- Break No. 2: Large breaks with two or more different types of debris.
- Break No. 3: Breaks in the most direct path to the sump.

- Break No. 4: Large breaks with the largest potential particulate debris to insulation ratio by weight.
- Break No. 5: Breaks that generate a "thin bed" – high particulate with 1/8 inch fiber bed.

The controlling breaks are as follows:

- East D-Ring RCS Hot leg break (LB LOCA)
- West D-Ring RCS Hot leg break (LB LOCA)
- Nozzle Break at the Reactor Vessel Cavity (LB LOCA)
- 2½-inch letdown line in the vicinity of the containment sump (SBLOCA)

All breaks are assumed to be double-ended guillotine (DEG) and fully offset.

Debris Generation (ref. calc. ALION-CAL-EXEL2737-001)

Insulation

The majority of the insulation on the components within containment is Transco Reflective Metal Insulation (RMI) except for the pressurizer and portions of the Steam Generators (SG), which are insulated with Nukon fiberglass, most of which is fully jacketed in stainless steel.

The zones of influence (ZOI) for the Transco RMI and Nukon were applied using the criteria established in the NRC Generic Letter (GL) 2004-02 Safety Evaluation, Table 3-2.

Coating

In accordance with the NRC's Safety Evaluation Report for NEI 04-07, a ZOI of ten pipe diameters (10D) was used for the qualified coating. All unqualified coating was assumed to fail regardless of location inside the containment. TMI has an unqualified coating report that provides information on these coating types and areas. In addition, 50 ft^2 of degraded qualified coatings was considered in the debris mix.

Foreign Material

The surface area of the sump screen blocked by foreign material (tags/labels/placards) is assumed to be 400 ft^2. The quantity and type of foreign material inside containment will be assessed and validated in a detailed walkdown scheduled for November 2005.

Latent Debris

TMI has assumed a latent debris loading of 200 lb. The latent debris assumptions will be validated following the containment walkdown scheduled for November 2005.

The size distribution of the latent debris is taken from the NRC's SER for NEI 04-07 as 15% fibrous and 85% particulates. The latent debris sampling will be performed in accordance with NEI 02-01 and supplemented by plant specific procedures. Multiple samples will be collected. The net weights will then be used to statistically extrapolate the amount of latent debris for the entire containment.

Debris Transport (ref. calc. ALION-CAL-EXEL2737-002)

The transport of the debris from the break location to the sump screen is evaluated using the methods outlined in NEI 04-07 as amended by the NRC SER. The means of transport considered are blowdown, washdown, pool fill, and recirculation for all types of debris. A computational fluid dynamics (CFD) model was developed using the computer program Flow-3D for the recirculation transport analysis. Outputs of the CFD analysis include velocity contours, turbulent kinetic energy (TKE) contours, path lines and flow distributions for various scenarios.

The debris transport phenomena due to blowdown, washdown, pool fill-up, and recirculation transport modes are summarized using debris transport logic trees. This methodology 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 set forth in the SER in its 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 screen. The debris transport logic trees consider the effect of dislocation, hold up on the floor or other structures, deposition in active or inactive pools, lift over curbs, and erosion of debris.

Miscellaneous (foreign material) debris (tape, labels, etc.) is included in the debris load and considered in the screen design as sacrificial area. All miscellaneous debris is assumed to be 100% transportable.

Debris transport logic trees were developed for each of the four controlling break cases listed in the previous section on break selection. Overall, the transport analysis showed that most fine debris (individual fibers, dirt/dust, and paint particulate) would reach the sump, but in the hot leg break cases, less than half of the small and large piece insulation debris would be transported to the sump.

Strainer Head Loss (ref. calc. ALION-CAL-EXEL2737-003)

AmerGen has confirmed that a new larger area sump screen is needed to accommodate the debris inventory transported to the sump screen based on the head loss through the debris bed that would form during recirculation. The head loss across the debris bed is determined separately for fiber and particulate debris and for RMI debris. The head loss through a fiber/particulate debris bed is determined using the head loss correlation developed in NUREG/CR-6224 "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA-Generated Debris." The RMI debris bed head loss is determined using a bounding correlation identified in NEI PWR Sump Evaluation Methodology. The total head loss across the sump strainer is equal to the sum of the fiber/particulate debris bed head loss, the RMI debris bed head loss, 0.5 ft of head loss assumed for chemical effects (see chemical effects discussion below), and the clean strainer head loss. These debris bed head losses are based on a strainer area of 2750 ft^2 (including a sacrificial area of 400 ft^2).

The strainer size is provided based on full recirculation flow for LPI and BS switchover. The NPSH margin upon installation of the new screen will be 0.6 ft. The final strainer head loss will be confirmed by the strainer manufacturer as required by the procurement specification.

Containment Walkdowns

Containment walkdowns to verify the analyses that were generated will be performed in November 2005 using the guidelines provided in NEI 02-01. This will include latent debris sampling, confirmation of the sump space envelope, and a confirmatory walkdown for potential debris sources.

Downstream Effects Methodology

The methodologies of NEI 04-07 as modified by the NRC Safety Evaluation and WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," are being used to evaluate the downstream effects of debris that is passed by the sump strainer.

This evaluation utilizes the wear and abrasion models/methodologies developed by the Westinghouse Owner's Group (WOG) as outlined in the WCAP report to evaluate the effects of debris in the ECCS and BS systems due to recirculating fluid from the containment sump. This evaluation also addresses the susceptibility of the downstream flow paths and components to obstruction by the debris carried in the fluid. TMI's fuel supplier is performing an evaluation, also using WCAP report guidance, on the core cooling impact from debris that may enter the RCS when the ECCS suction is switched to the containment sump.

Chemical Effects Methodology

Although the NRC and the Industry have jointly developed the Integrated Chemical Effects Testing (ICET) Program, this will not resolve the plant-specific chemical effects impact on the recirculation sump screen. The TMI approach for resolving the chemical effects issue and validating the assumed bump-up factor on debris bed head loss consists of the following sequence:

Step 1: Compare TMI conditions to ICET Test Parameters; reserve strainer head loss margin to accommodate this effect.

Step 2: Determine supplemental testing, primarily vendor testing to assess outliers identified in step 1

Step 3: Identify and Perform Chemical Effects Material Head Loss Testing

Step 4: Develop and prescribe impact to plant debris bed head loss, including the time dependence of the impact

TMI is currently working with Alion Science and Technology Corporation (Alion) to address the chemical effects issue using the above approach. The first 2 steps are currently underway, and the preliminary results indicate that ICET test #1 most closely relates to TMI, and there are no material outliers. Results of ICET No. 1 indicated that chemical precipitants increase with time and cooling of fluid over the course of the 30-day event.

In the interim, additional debris head loss amounting to 0.5 ft. (250% of the design head loss for the replacement strainer) is being reserved for chemical effects. This debris head loss is considered bounding because it assumes over a factor of 2 increase in head loss at the onset of recirculation when temperatures and flow rates are the highest (NPSH margin lowest) which corresponds to little or no chemical effects. The impact of chemical effects is pronounced when flows and temperatures have been reduced and additional NPSH margin is available.

Analyses Performed By Contractors

The debris generation, debris transport, head loss, downstream effects, and the chemical effects analyses are being performed by Alion Science and Technology in partnership with Enercon Services, Inc. The downstream effects analyses of the fuel are being performed by Framatome ANP, Inc., who is the supplier of TMI's fuel.

NRC Requested Information 2(d)(i)

The submittal should include, at a minimum, the following information: The minimum available NPSH margin for the ECCS and CSS pumps with an unblocked sump screen.

AmerGen Response to 2(d)(i) (ref. calc. ALION-CAL-EXEL2737-003)

The minimum available NPSH margin for the LPI pumps in the recirculation mode at ECCS and BS switchover to sump recirculation, not including the clean strainer head loss, is 1.3 feet.

The minimum available NPSH margin for the BS pumps in the recirculation mode at ECCS and BS switchover to sump recirculation, not including the clean strainer head loss, is 2.94 feet.

The clean strainer head loss is expected to be small (<0.1 feet based on vendor proposals for replacement ECCS sump screens). However, the exact values will be confirmed upon completion of the final design by the hardware manufacturer.

NRC Requested Information 2(d)(ii)

The submerged area of the sump screen at this time and the percent of submergence of the sump screen (i.e., partial or full) at the time of the switchover to sump recirculation.

AmerGen Response to 2(d)(ii)

TMI's new strainer will be 100% submerged at the time of switchover, and the new strainer submergence area will be at least 2750 square feet.

NRC Requested Information 2(d)(iii)

The maximum head loss postulated from debris accumulation on the submerged sump screen, and a description of the primary constituents of the debris bed that result in this head loss. In addition to debris generated by jet forces from the pipe rupture, debris created by the resulting containment environment (thermal and chemical) and CSS washdown should be considered in the analyses. Examples of this type of debris are disbonded coatings in the form of chips and particulates and chemical precipitants caused by chemical reactions in the pool.

AmerGen Response to 2(d)(iii)

In the specification for its replacement strainer, TMI has specified a maximum postulated head loss from debris accumulation on the submerged sump strainer to be 0.5 feet of water. The analysis considers debris generated by the resulting containment environment (thermal and chemical) and BS washdown. The primary constituents of the debris bed are as follows:

Debris Type

- Insulation
  - Transco RMI (Stainless steel)
  - NUKON (fiber)
- Qualified Coatings
  - K & L 4129
  - K & L 4000
  - K & L D-series
  - K & L 6548/7107
  - K & L E-I 1860
- Unqualified Coatings
  - Unqualified coatings
- Latent Debris
  - Latent Fiber (based on a density of 175 lbm/ft^3)
  - Latent Particulate (based on a density of 169 lbm/ft^3)
- Foreign Materials
  - Sacrificial strainer area for labels, placards, etc

The above listing does not include debris resulting from chemical effects.

TMI uses sodium hydroxide (NaOH) as the pH buffer, and has fibrous debris. A comparison of the EPRI/NRC chemical test plan and these TMI plant specific parameters has been performed. This comparison shows that ICET Test #1 applies to TMI and there are no material outliers.

Sump strainer suppliers are developing plans and schedules to quantify the additional head loss associated with chemical debris. The results will be incorporated into the head loss analyses for the new strainer being procured for TMI as appropriate. TMI will validate that adequate margin exists to bound the impact of chemical effects once the tests results to quantify chemical debris effect on head loss have been published. AmerGen will update the TMI NRC Project Manager with this scheduling information when the vendors have formulated their testing schedule.

AmerGen has considered a 0.5 ft increase in the debris head loss to account for the impact of chemical effects. This debris head loss is considered bounding because it assumes over a factor of 2 increase in head loss at the onset of recirculation when temperatures and flow rates are the highest (NPSH margin lowest) which corresponds to little or no chemical effects. The impact of chemical effects is pronounced when flows and temperatures have been reduced and additional NPSH margin is available.

NRC Requested Information 2(d)(iv)

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.

AmerGen Response to 2(d)(iv)

TMI has re-evaluated their RB minimum water level inventory calc to ensure all holdup concerns have been identified (ref. calc. C-1101-210-E610-010). TMI's sump is located outside the D-rings (secondary shield). The transport analysis performed by the vendor included a detailed CAD model of the internal containment structures. This was used to assess washdown and break flows. The significant choke points are the doorways to the D-ring and the incore chase areas. These are normal doors with screen mesh in the bottom portion to allow fluid flow outside the secondary shield. These doors have been identified as needing to be replaced with more open gates to eliminate holdup concerns. Additionally, there is choke potential at the drain for the fuel transfer canal. This has also been identified as needing to be modified to eliminate the holdup concern. These corrective actions are being planned for implementation in the fall 2007 refueling outage.

Additionally, an inspection for non-LOCA generated material that could potentially obstruct recirculating water is conducted as part of the containment cleanliness inspection program prior to plant restart following outages.

NRC Requested Information 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 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 sump screen's mesh spacing and state the basis for concluding that adverse gaps or breaches are not present on the screen surface.

AmerGen Response to 2(d)(v)

The flow paths downstream of the containment sump are being analyzed to determine the potential for blockage due to debris passing through the sump strainer. The acceptance criteria were based on WCAP-16406-P.

These evaluations were done for all components in the recirculation flow paths including, but not limited to, nuclear fuel and reactor vessel internals, throttle valves, flow orifices, spray nozzles, pumps, heat exchangers, and valves. The methodology employed in this evaluation is based upon input obtained from a review of the recirculation flow path shown on Piping and Instrument Diagram Drawings and plant procedures. The steps used in obtaining the flow clearance are as follows:

- Determine the maximum characteristic dimension of the debris (clearance through the sump strainer).
- Identify the recirculation flow paths.
- Identify the components in the recirculation flow paths.
- Review the vendor documents (drawings and/or manuals) for the components to obtain flow clearance dimensions.
- Determine blockage potential through a comparison of the flow clearance through the component with the flow clearance through the sump strainer.
- Identify the components that require a detailed evaluation and investigation of the effects of debris on their capability to function.

The ECCS and BS flowpaths downstream of the sump screen were reviewed including components such as the HPI and LPI throttle valves, pump bearings and seals, the fuel assembly inlet debris screen, and containment spray nozzles. The flow clearances were compared against a maximize debris size 10% larger than the strainer openings which are 1/8-inch diameter. This is the maximum opening size that has been specified for new strainer proposals. This yields a maximum debris size of 0.138 inches.

The impact on the fuel is in progress. The analysis will conservatively assume that all debris that reaches the RCS is transported to the reactor vessel. Following the fall 2007 refueling outage, the MK-B12 fuel design will be in use almost exclusively at TMI. This fuel assembly design incorporates the $TRAPPER_{TM}$ fine mesh debris filter. Future fuel designs may include the $FUELGUARD_{TM}$ lower tie plate (LTP). The fuel inlet debris filters are designed to trap debris before it enters the core region. For fuel designs without a fuel filter, the inlet spacer grid located just above the lower fuel assembly end fitting will tend to capture debris. Therefore, it is expected that debris that enters the RCS will be trapped at the core inlet. Based on the amount and type of debris that penetrates the sump screen ($<9\ ft^3$), it is not expected that an unacceptable head loss at the core inlet will occur. Less than $0.2\ ft^3$ of fiber penetrates the sump screen, which does not provide enough of a fiber bed at the core inlet to form a thin bed. Again, this should not produce an unacceptable head loss at the core inlet. Moreover, the TMI baffle region has numerous "LOCA" holes in the baffle plates that allow flow from the baffle region into the core at the periphery. These flow holes are large compared to the debris size that penetrates the screen and of sufficient size to provide adequate flow to remove core decay heat in the unlikely event that the core inlet is blocked. The lack of a significant fiber bed at the core inlet and the flow paths through the baffle region are expected to assure adequate core flow to remove core decay heat.

It is recognized that smaller debris may pass through the fuel end fittings and lodge in smaller clearances in the fuel grids, particularly towards the lower portion of the core. Because the volume of debris that reaches the RCS is less than $9\ ft^3$ and consists of mostly small particulates, it is not expected that a significant local buildup of debris will occur at any one location in the core. Although it is improbable that a buildup may occur that completely blocks a fluid sub-channel at the spacer grid around a single rod, an evaluation will be performed to demonstrate that, even for this situation, the requirements of 10CFR50.46 can be met. An assessment of this blockage will be completed by considering a two-inch solid plug around the limiting fuel pin at the peak power location with conduction through the cladding as the only cooling mechanism. This calculation should demonstrate that the cladding temperature would remain well below 2200ºF. For grid locations away from the peak power location, the cladding temperature would be even lower.

This analysis is currently being completed. The calculation will provide the basis for demonstrating that adequate core cooling is available to maintain the cladding temperature well below 2200ºF, thus supporting TMI's ability to meet the criteria of 10 CFR 50.46 when the plant is on sump recirculation.

As discussed in section 2(d)(vi), the long-term downstream evaluations are in progress. The preliminary analysis has determined that for all the ECCS and BS pumps, that the pump seal flush sub-system and the cyclone separator design be considered for improvements to prevent blockage by fibrous debris. In addition, for the LPI manual throttle valves, the stacked disc assembly must be considered for replacement with a design less susceptible to blockage by fibrous debris.

These specific concerns regarding these components will be addressed as corrective actions. AmerGen will obtain design input and recommendations from the component manufacturers and implement the modifications needed prior to or during the fall 2007 refueling outage.

The new strainer will be designed for the effects of weight, thermal, head loss, and seismic loading. The new strainer design will ensure that gaps at mating surfaces within the strainer assembly and between the strainer and the supporting surface do not have gaps in excess of the strainer hole size of 1/8 inch. In addition to the hole/gap size, compliance with the FSAR structural requirements has been included in the specification for the replacement strainer.

NRC Requested Information 2(d)(vi)

Verification that 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.

AmerGen Response to 2(d)(vi)

Verification of debris blockage of downstream components is described in 2(d)(v) above. A preliminary evaluation of downstream components for long-term wear has been completed. The final evaluation is scheduled to be completed by January 31, 2006. Using the guidance of WCAP-16406-P, the evaluation performs wear analyses on the ECCS and BS system components for operation up to 30 days. Over this interval all wear rates were found acceptable. Note that the WCAP guidance recognizes that there will be gradual depletion of the debris in the fluid, thereby reducing wear rates beyond this time period. Those components presenting plugging concerns were identified in section 2(d)(v) above.

NRC Requested Information 2(d)(vii)

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 predicted flow conditions

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AmerGen Response to 2(d)(vii)

The sump is located within the zone of influence of a high-energy line break (i.e., the 2.5 inch letdown line). Therefore, a protective structure/trash rack over the top of the sump will be provided for protection of the new strainer and to prevent debris from directly falling into the sump.

The sump strainer design requirements ensure that it will be capable of withstanding the force of full debris loading, in conjunction with all design basis conditions, without collapse or structural damage. The design requirements also ensure that it will be capable of withstanding the hydrodynamic loads and inertial effects of water at full debris loading without loss of structural integrity.

NRC Requested Information 2(d)(viii)

If an active approach (e.g., backflushing, powered screens) is selected in lieu of or in addition to a passive approach to mitigate the effects of the debris blockage, describe the approach and associated analyses.

AmerGen Response to 2(d)(viii)

The new strainer being procured employs a passive design.

NRC Requested Information 2(e)

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.

AmerGen Response to 2(e)

TMI's licensing basis will be updated to reflect the results of the analyses and the modifications performed to demonstrate compliance with the regulatory requirements by December 31, 2007. This update will be performed in accordance with the requirements of 10 CFR 50.71.

No licensing actions or exemption requests needed to support changes to the plant licensing basis have been identified. If any licensing actions are identified, this will be discussed with TMI's NRC Project Manager.

NRC Requested Information 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, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after 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.

AmerGen Response to 2(f)

Design Changes

An enhancement will be made to the Design Attributes Review (DAR) document that is part of the Configuration Change Procedure (CC-AA-102). This change will introduce a requirement for reviewing the impact of a proposed change on the documentation that forms the design basis for the response to Generic Letter 2004-02. The specific areas that will be addressed, as a minimum, are:

- Insulation inside containment
- Coatings inside containment
- Structural changes (i.e., Choke points) in containment
- Inactive volumes in containment
- Downstream Effects (piping components downstream of the ECCS sump screens)
- Labels inside containment

Inclusion in the DAR will ensure all design changes consider these attributes during the design process.

General Debris and FME

The procedures for containment closeout necessitates a containment walkdown be performed for housekeeping deficiencies. The procedure incorporates a list of all unresolved housekeeping and equipment discrepancies and requires that resolution be included in the plant restart documentation. The procedure also provides guidance on general cleanliness and debris inspection guidelines.

Choke points/water holdup

TMI's outage procedure for containment closeout includes verifying that the sump grating is free of debris/material. AmerGen will add provisions for verifying that the recirculation upstream flow paths and choke points are free of debris and equipment that obstruct or adversely divert the flow. The choke points will be specifically listed, and these currently include the secondary shield doorway, the incore chase doorway, and the fuel transfer canal drain. This will be completed prior to the fall 2007 outage.

Coatings

TMI has an existing coatings program that monitors and controls the quantities and types of coatings installed inside containment. As noted in our response to GL 98-04, TMI has implemented controls for procurement, application, and maintenance of qualified coatings used inside containment that are consistent with the licensing basis and regulatory requirements. This program conducts periodic condition assessments, typically each outage, to verify the adequacy of existing coatings and direct repair/replacement, as necessary. A log is maintained that includes the quantity of unqualified coatings that are installed inside containment. This program is adequate in its current form to ensure coatings are properly controlled, and that future installations of unqualified coatings are quantified. Enhancements to the existing coatings program procedure will be evaluated to further strengthen the quantification of degraded qualified coatings and qualified coatings within the ZOI for the purposes of maintaining the design bases.

Latent Debris

TMI will create a predefined activity to perform latent debris measurements on a frequency of every three refueling outages (nominally, a six-year frequency). The results of this walkdown/measurement will be evaluated/incorporated in the design analysis for the ECCS sump screens.

Downstream Effects

Any hardware changes potentially affecting the downstream effects analysis will be controlled via the configuration change process.

Labels and Tags
TMI will upgrade the existing Labels and Tagging procedure to incorporate processes to ensure the design bases is preserved.

Attachment 3

Braidwood Station, Units 1 and 2
Byron Station, Units 1 and 2
Three Mile Island, Unit 1

List of Additional Commitments

The following table identifies those actions to which EGC and AmerGen have committed in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	Scheduled Completion Date
The recirculation functions for the Emergency Core Cooling Systems (ECCS) and the Containment Spray Systems (CSS) for Braidwood Station, Units 1 and 2 (Braidwood), will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of the subject generic letter under debris loading conditions by December 31, 2007.	December 31, 2007
Overall completion of the downstream effects analysis, including the fuel impact under the current WCAP guidance, will occur by January 31, 2006	January 31, 2006
The chemical effects evaluation (excluding vendor testing) will complete by January 31, 2006 for Braidwood.	January 31, 2006
Braidwood will validate that adequate margin exists to bound the impact of chemical effects once the vendors' tests results to quantify chemical debris effect on head loss have been published. EGC will update the Braidwood NRC Project Manager with this scheduling information when the vendors have formulated their testing schedule.	Within 3 months after vendor test results are published.

Attachment 3
Byron Station, Units 1 and 2
Commitments

The following table identifies those actions to which EGC and AmerGen have committed in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	Scheduled Completion Date
The recirculation functions for the Emergency Core Cooling Systems (ECCS) and the Containment Spray Systems (CSS) for Byron Station, Units 1 and 2 (Byron), will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of the subject generic letter under debris loading conditions by December 31, 2007.	December 31, 2007
Overall completion of the downstream effects analysis, including the fuel impact under the current WCAP guidance, will occur by January 31, 2006	January 31, 2006
The chemical effects evaluation (excluding vendor testing) will complete by January 31, 2006 for Byron.	January 31, 2006
Byron will validate that adequate margin exists to bound the impact of chemical effects once the vendors' tests results to quantify chemical debris effect on head loss have been published. EGC will update the Byron NRC Project Manager with this scheduling information when the vendors have formulated their testing schedule.	Within 3 months after vendor test results are published.

Attachment 3
Three Mile Island, Unit 1
Commitments

The following table identifies those actions to which EGC and AmerGen have committed in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

COMMITMENT	Scheduled Completion Date
The recirculation functions for the Emergency Core Cooling Systems (ECCS) and the Building Spray (BS) System for Three Mile Island, Unit 1, will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of the subject generic letter under debris loading conditions by December 31, 2007.	December 31, 2007
Overall completion of the downstream effects evaluation, including the fuel impact under the current WCAP guidance, will occur by January 31, 2006	January 31, 2006
The chemical effects evaluation (excluding vendor testing) will complete by January 31, 2006 for TMI.	January 31, 2006
TMI will validate that adequate margin exists to bound the impact of chemical effects once the vendors' tests results to quantify chemical debris effect on head loss have been published. AmerGen will update the TMI NRC Project Manager with this scheduling information when the vendors have formulated their testing schedule.	Within 3 months after vendor test results are published.