

Attachments 1-5 Not for Public Disclosure per 10CFR2.390



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

February 29, 2008  
NOC-AE-07002240  
10CFR50.54(f)  
10CFR2.390  
File No. D43.02

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

South Texas Project  
Units 1 and 2  
Docket Nos. STN 50-498 and STN 50-499  
Supplement 3 to the Response to Generic Letter 2004-02  
(TAC Nos. MC4719 and MC4720)

- References:
1. Letter dated November 21, 2007, from William H. Ruland, NRC, to Anthony Pietrangelo, NEI, "Revised Content Guide for Generic Letter 2004-02 Supplemental Responses"(ML073110269, ML073110278)
  2. Letter dated December 13, 2007, from David W. Rencurrel, STPNOC, to NRC Document Control Desk, "Supplement to Request for Extension for Final Response to Generic Letter 2004-02 and Implementation of Revised Design Basis for ECCS Sump (TAC Nos. MC4719 and MC4720)" (ML073580125, NOC-AE-07002249)
  3. Letter dated December 19, 2007, from Mohan C. Thadani, NRC, to James J. Sheppard, STPNOC, "South Texas Project, Units 1 And 2 - Approval Of Extension Request For Corrective Actions Re: Generic Letter 2004-02, "Potential Impact Of Debris Blockage On Emergency Recirculation During Design Basis Accidents At Pressurized Water Reactors," (TAC NOS. MC4719 AND MC4720), (ML073520076)

STP Nuclear Operating Company (STPNOC) submits this supplemental response to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors." The enclosed response was prepared using the content guidance of Reference 1 with intent of allowing the NRC to close most of the sump debris blockage issues identified in GL 2004-02 for STP Units 1 and 2. Final closure is not expected until completion of testing and finalization of the design basis as described in Reference 2. As stated in Reference 2 and approved in Reference 3, STPNOC will submit a letter by June 30, 2008, verifying completion of all GL2004-02 corrective actions and confirming compliance with the regulatory requirements listed in GL2004-02.

The enclosure identifies some responses where supplemental information is to be provided. This information generally depends on the completion of the STP sump strainer testing and integration of the test results into the design. The responses will be updated with the verification letter described above. The specific items are identified in a list of committed responses in the enclosure.

STI 32229932

Attachments 1-5 Not for Public Disclosure per 10CFR2.390

*Process entire document as 10 CFR 2.390 info per Mohan Thadani (PM) request.*  
A116 NRR

STPNOC requests that Attachments 1 – 5 to the enclosure be withheld from public disclosure in accordance with 10CFR2.390.

If you have any questions concerning the content of this supplemental response, please contact Mr. A. W. Harrison at (361) 972-7298, or me at (361) 972-7867.

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

Executed on 2/29/2008.



David W. Rencurrel  
Vice President,  
Engineering & Strategic Projects

Awh/

Enclosure: Supplement 3 to the Response to Generic Letter 2004-02

cc:

(paper copy)

Regional Administrator, Region IV  
U. S. Nuclear Regulatory Commission  
611 Ryan Plaza Drive, Suite 400  
Arlington, Texas 76011-8064

Mohan C. Thadani  
Senior Project Manager  
U.S. Nuclear Regulatory Commission  
One White Flint North (MS 7 D1)  
11555 Rockville Pike  
Rockville, MD 20852

Senior Resident Inspector  
U. S. Nuclear Regulatory Commission  
P. O. Box 289, Mail Code: MN116  
Wadsworth, TX 77483

C. M. Canady  
City of Austin  
Electric Utility Department  
721 Barton Springs Road  
Austin, TX 78704

Richard A. Ratliff  
Bureau of Radiation Control  
Texas Department of State Health Services  
1100 West 49th Street  
Austin, TX 78756-3189

(electronic copy)

A. H. Gutterman, Esquire  
Morgan, Lewis & Bockius LLP

Mohan C. Thadani  
U. S. Nuclear Regulatory Commission

Thad Hill  
Eddy Daniels  
Marty Ryan  
Robert Bailey  
Steve Winn  
NRG South Texas LP

Ed Alarcon  
J. J. Nesrsta  
R. K. Temple  
Kevin Pollo  
City Public Service

Jon C. Wood  
Cox Smith Matthews

C. Kirksey  
City of Austin

**Enclosure**

**Supplement 3 to the Response to Generic Letter 2004-02**



## 1. Overall Compliance

Upon review of the requirements listed in Generic Letter (GL) 2004-02, STP Nuclear Operating Company (STPNOC) performed an evaluation of the Emergency Core Cooling System (ECCS) and Containment Spray System (CSS) recirculation functions. The evaluation demonstrated that modifications were needed to establish the new design basis. STPNOC has implemented these modifications to meet the required schedule as discussed below.

Plant hardware modifications developed in response to issues identified in GL2004-02 are installed in STP Units 1 and 2 and are supporting compliance with the current design and licensing basis regulatory requirements for long term cooling following a design basis loss of coolant accident. Similarly implementation is complete for STPNOC plant administrative procedures and processes needed to support the GL2004-02 hardware modifications and revised operating practices, as well as to support the assumptions, initial conditions and conclusions of GL2004-02 related evaluations, including evaluations of design basis accident debris generation and transport, sump strainer performance, impact of chemical effects and downstream effects of debris. Since hardware, operating procedures and administrative controls required to support actions taken in response to issues identified in GL2004-02 are already implemented at STP, STPNOC has high confidence that if an accident of the type described in GL2004-02 were to occur at STP, plant systems and plant operators would respond in a manner consistent with the intent of the GL2004-02 corrective actions, including conformance with the regulatory requirements listed in GL2004-02.

While STPNOC's confidence in expected operator and plant response to an accident is high, the plant design and licensing basis can not be changed until all regulatory requirements affecting associated change processes are complete. Consequently, STPNOC requested an extension to June 30, 2008 to allow full completion of 10CFR50, Appendix B activities to support completion of chemical effects head loss testing, preparation of the associated test report and changing the plant design and licensing bases to be in compliance with actions taken in response to issues identified in GL2004-02 (Reference 2 to the cover letter). The NRC approved the request in Reference 3 to the cover letter.

## 2. General Description of and Schedule for Corrective Actions

STPNOC will implement sump design modifications to meet the required schedule as discussed below. The design basis and licensing basis for the plant will be updated to reflect the corresponding changes due to the new regulatory requirements.

For the sump performance evaluation, STPNOC joined with other plants in the Strategic Teaming and Resource Sharing (STARS)/ Utilities Service Alliance (USA) group to engage a contractor team headed by Westinghouse Electric Co. along with Alion Science and Technology and Enercon Services, Inc. Sump evaluation activities include the following:

- Containment walkdowns
- Debris generation and transport analysis
- Calculation of required and available net positive suction head (NPSH)
- Screen requirements
- Screen structural analyses
  - Potential or planned design/operational/procedural modifications
  - Downstream effects evaluation
  - Upstream effects evaluation
  - Chemical effects evaluation

STPNOC also joined with other plants in the STARS/USA group to contract with Performance Contracting Inc. (PCI) to provide an advanced design sump strainer for each respective plant. The new sump strainer has replaced the original sump screens for STP. Laboratory testing is being performed by PCI (Alden Research Laboratory and Areva NP are the sub-contractors for this testing) to demonstrate acceptability of the new sump strainer design.

STPNOC will be in full compliance with the regulatory requirements discussed in the applicable regulatory requirements section of GL2004-02 by June 30, 2008, as discussed in Reference 2 to the cover letter.

A three-dimensional computational fluid dynamics (CFD) analysis for debris transport was performed to define the debris loading on the sump strainers and also determine the need to install any debris interceptors. It was determined that debris interceptors were not required.

A revision to the sump water level calculation was prepared to support the CFD analysis and to address the items identified in the upstream effects evaluation that was prepared by Enercon.

A latent debris walkdown inside containment was performed to validate the conservative assumptions used for latent debris in the debris generation analysis.

The design for the new sump strainers will be validated by testing. The test goals are to demonstrate that the thin-bed effect is not a concern and that the head loss due to the STP plant-specific debris loading is acceptable. The testing scheduled for February 2008 is complete and will be discussed later in the response letter due June 30, 2008.

Coatings testing was conducted by Westinghouse to demonstrate that the zone of influence (ZOI) for coatings may be defined using a radius of 5D (5 times the diameter of the break pipe). This result is used to reduce the debris loading on the sump and to demonstrate margin for the new sump strainer design.

The following plant modifications were implemented in Unit 1 during the Fall 2006 refueling outage and in Unit 2 during the Spring 2007 refueling outage:

- Remove existing sump screens from each of the three emergency sumps.
- The vortex breakers will remain in place.
- Install new emergency sump strainer modules by bolting the support frame to the floor. Modules are bolted to the frame.

### **3. Specific Information Regarding Methodology for Demonstrating Compliance**

#### ***Content Guide Item 3.a - 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.*

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

**Content Guide Item 3.a - Break Selection**

- Describe and provide the basis for the break selection criteria used in the evaluation.

**Response**

In the debris generation calculation various breaks were evaluated in the Reactor Coolant System (RCS) and connected piping.

Break selection consists of determining the size and location of the high energy line breaks (HELB) that produce debris and potentially challenge the performance of the sump screen. The break selection process evaluated a number of break locations to identify the location that is likely to present the greatest challenge to post-accident sump performance. The debris inventory and the transport path were considered when making this determination.

Regulatory guidance recommends that a sufficient number of breaks bounding variations in debris size, quantity, and type be identified. STP evaluated a number of break locations and piping systems, and considered breaks that rely on recirculation to mitigate the event. The following break locations were considered.

Break Criteria 1 - Breaks in the RCS with the largest potential for debris

Break Criteria 2 - Large breaks with two or more different types of debris

Break Criteria 3 - Breaks in the most direct path to the sump

Break Criteria 4 - Medium and large breaks with the largest potential particulate debris to fibrous insulation ratio by weight

Break Criteria 5 - Breaks that generate an amount of fibrous debris that, after transport to the sump screen, could form a uniform thin bed (i.e., usually 1/8" thick) that could subsequently filter sufficient particulate debris to create a relatively high head loss referred to as the "thin-bed effect".

This spectrum of breaks is consistent with that recommended in the NRC's Safety Evaluation Report (SER) for the Nuclear Energy Institute (NEI) Guidance Report (GR), NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology." It 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.

Locations were selected for the breaks that produce the maximum amount of debris and also the worst combination of debris mixes with the possibility of being transported to the sump screen. Section 3.3.5.2 of the SER 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) is not the exact location along the pipe, but rather the envelope of containment material targets that is affected.

A small break loss of coolant accident (SBLOCA) inside the secondary shield wall was evaluated for STP. The debris generated by the SBLOCA is less than the debris generated by the large break loss of coolant accident (LBLOCA); however the containment water level at the time of recirculation would be less than the water level caused by the LBLOCA which results in higher average fluid velocities and increases the transportation of debris to the containment sump

For SBLOCAs outside the secondary shield wall, SER Section 3.3.5.2 stipulates the need to evaluate breaks in RCS-attached piping beyond isolation points is contingent upon the determination that

recirculation would not be required should a break occur in these sections. The debris generation analysis for STP considered the failure of a single isolation valve inside the secondary shield wall and includes SBLOCAs outside the secondary shield wall in the spectrum of events evaluated to ensure these would not be limiting

### **Breaks in the RCS with the largest potential for debris (Break Criterion 1)**

The break with the largest potential for debris generation is the largest break in an area with the largest concentration of debris source material. For STP, there were seven possible break locations that have the potential to generate the largest concentration of debris:

1. 29" hot leg (LBLOCA) located inside the steam generator compartment inside the secondary shield wall.
2. A hot leg line break in the other compartment was also evaluated since the layout of the STP containment is such that the steam generator compartments each contain two RCS loops.
3. 31" ID RCS cross-over line (LBLOCA), located inside the steam generator compartment inside the secondary shield wall.
4. RCS Nozzle (LBLOCA) in the reactor vessel cavity.
5. 12" residual heat removal (RHR) pump suction line from the RCS hot leg (SBLOCA), located outside the secondary shield wall, but inside the RHR pump/heat exchanger compartment.
6. 8" SI pump discharge line to the RCS hot leg (SBLOCA), located outside the secondary shield wall.
7. 4" chemical and volume control system (CVCS) letdown line (SBLOCA) from the RCS Loop 3 cross-over pipe inside the steam generator (SG) compartment. This break was analyzed because it is the largest pipe break postulated that allows the control room operators time to isolate the safety injection (SI) accumulators before they discharge into the RCS.

### **Large breaks with two or more different types of debris (Break Criterion 2).**

The debris generated by the RCS hot leg line break and the reactor vessel cavity nozzle break discussed in Break Criterion 1 bound the break under criterion 2. The types of insulation debris within the primary shield wall are reflective metal insulation (RMI) and Marinite, and the types of insulation within the secondary shield wall are NUKON™, Thermal-Wrap and Microtherm®.

### **Breaks with the most direct path to the sump (Break Criterion 3).**

The 12" RHR pump suction lines (A, B and C) from the RCS hot legs have second isolation valves that are located outside the secondary shield wall presenting a potential for direct transport to the sump. Though these isolation valves are inside the RHR pump/heat exchanger rooms, which are separated from the area where the containment sumps are located and therefore do not provide a direct path to the sumps, a break in this line was included in the STP analyses. The "A" and "B" SI system discharge lines to the RCS hot legs also have isolation valves outside the secondary shield wall but are located on the opposite side of containment away from the sump. A break in these lines was also included in the analysis.

### **Large breaks with the largest potential particulate debris to fibrous insulation ratio by weight (Break Criterion 4).**

The types of insulation identified within the containment are RMI, NUKON™, Thermal-Wrap, Microtherm® and Marinite. Since STP has a very limited quantity of particulate type insulation with respect to the fibrous insulation, and this particulate insulation is affected by the LBLOCAs evaluated in

accordance with Break Criterion 1, large breaks with the largest potential particulate debris to fibrous insulation ratio is bounded by Break Criterion 1.

### **Breaks that generate a "thin bed" – high particulate with 1/8" fiber bed (Break Criterion 5)**

Break Criterion 5 postulates a scenario that could generate an amount of fibrous debris that, after its transport to the sump screen, could form a uniform thin bed that could subsequently filter sufficient particulate debris to create a relatively high head loss referred to as "the thin-bed effect" (TBE). The quantity of fiber needed to form a thin bed is the quantity of fiber that would form a 1/8" thick uniform debris bed on the entire surface area of the sump screen.

The STP Debris Accumulation and Head Loss Analysis does consider a thin fibrous bed on the sump screens. The STP containment contains a large quantity of fibrous insulation, which is postulated to become transportable debris due to a LBLOCA. Therefore, the analysis does consider a thin fibrous debris bed as well as the maximum fibrous debris bed.

#### ***Content Guide Item 3.a - Break Selection***

- *State whether secondary line breaks were considered in the evaluation (e.g., main steam and feedwater lines) and briefly explain why or why not.*

#### **Response**

The large main steam and feedwater line breaks were not evaluated since recirculation is not required under the plant licensing basis for STP.

#### ***Content Guide Item 3.a - Break Selection***

- *Discuss the basis for reaching the conclusion that the break size(s) and locations chosen present the greatest challenge to post-accident sump performance.*

#### **Response**

A postulated LBLOCA of the Loop "C" hot leg at the steam generator generates the maximum possible quantity of fibrous debris at STP. This break also produces some Microtherm® insulation debris. These LBLOCA debris quantities are significant due to the large zones of influence (ZOI). One other LBLOCA case analyzed is in the RCS hot leg at the reactor vessel nozzle. This break produced Marinite insulation debris and significantly less fibrous insulation debris. This break also produces RMI insulation debris and Microtherm® insulation debris. The make up of the total debris generated by these two breaks were different enough to warrant separate transport and head loss analysis to ensure that the head loss at the Containment Sump is thoroughly evaluated.

#### ***Content Guide Item 3.b Debris Generation/Zone of Influence (ZOI) (excluding coatings)***

*The objective of the debris generation/ZOI 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.*

- *Describe the methodology used to determine the ZOIs for generating debris. Identify which debris analyses used approved methodology default values. For debris with ZOIs not defined in the guidance report/SE, or if using other than default values, discuss method(s) used to determine ZOI and the basis for each.*
- *Provide destruction ZOIs and the basis for the ZOIs for each applicable debris constituent.*

- Identify if destruction testing was conducted to determine ZOIs. 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).
- 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.
- Provide total surface area of all signs, placards, tags, tape, and similar miscellaneous materials in containment.

## Response

As noted in section 3.4.2.2 of the SER, the debris generation analysis considers the ZOI to be defined based on the material with the lowest destruction pressure. Refinements in the STP analysis include debris-specific (insulation material specific) and non-spherical ZOIs. The debris-specific refinements, as endorsed in SER Section 4.2.2.1.1, provide relief as long as there are two or more distinct types of insulation within the break location. In the STP containment, there are two or more distinct types of insulation and a debris-specific refinement is beneficial in this analysis. The destruction pressures and associated ZOI radii for the insulating materials in the STP containment are listed in Table 1.

**Table 1 – Destruction Pressures and ZOI Radii for Potential Debris Sources**

Insulation Types	Destruction Pressure (psi)	ZOI Radius (Radius/Break Diameter)	Reference/Basis
Transco RMI	114	2.0	SER Table 3.2
NUKON™	6	17	SER Table 3.2
Thermal-Wrap	6	17	Assumed the same as NUKON™ based on GR 3.4.3.3.1
Marinite	114	2.0	See discussion below
Microtherm®(1)	2.4	28.6	See discussion below

### Marinite

The SER does not recommend a destruction pressure or ZOI for this material and insufficient data exists on its material properties and destruction pressure. However, since this insulation is covered with 3/16" stainless steel plate, the destruction pressure was assumed to be equivalent to that of RMI. This destruction pressure is 114 psig, which corresponds to a ZOI of 2.0D.

### Microtherm®

The material specifications for Microtherm were insufficient to determine an appropriate destruction pressure and ZOI. Therefore, the lowest destruction pressure (Min-K at 2.4 psi) and the greatest ZOI (also Min-K at L/D of 28.6) identified in Table 3-2 of the SER were utilized in the STP analysis.

Robust barriers, i.e., structures and equipment that are impervious to jet impingement, are assumed to prevent further expansion of the break jet. The volume of a spherical ZOI with a radial dimension extending beyond robust barriers such as walls or encompassing a large component such as a tank or

steam generator is truncated by the barrier. The SER stipulates that deflection/reflection need not be considered but “shadow” surfaces of components should be included in the analysis.

ZOIs were not applied within the primary shield wall due to the relatively small area between the reactor vessel and the primary shield wall. All of the insulation material within the primary shield wall was considered to be destroyed by a LBLOCA within the primary shield wall.

The debris generation analysis identified a LBLOCA break in the Loop C 29” hot leg Line break at the steam generator and the RCS hot leg line break at a nozzle in the reactor cavity as the two limiting breaks in the RCS. The debris quantities for these two breaks as well as Loop A hot leg and the 4” CVCS letdown line are presented in Table 2.

**Table 2 – Summary of Debris Generation for Breaks in the RCS**

Insulation Type	Loop “A” hot leg Line Break	Loop “C” hot leg Line Break	RCS hot leg Nozzle Line Break	4” CVCS Letdown Pipe Break (SBLOCA)
Marinite	0	0	15.2 ft <sup>3</sup>	0
RMI	0	0	24,493 ft <sup>2</sup>	0
NUKON™	838.9 ft <sup>3</sup>	908.3 ft <sup>3</sup>	424.9 ft <sup>3</sup>	212.5 ft <sup>3</sup>
Thermal-Wrap	1400.0 ft <sup>3</sup>	1400.0 ft <sup>3</sup>	85.1 ft <sup>3</sup>	42.6 ft <sup>3</sup>
Microtherm®	2.6 ft <sup>3</sup>	2.3 ft <sup>3</sup>	0.9 ft <sup>3</sup>	0

The breaks associated with the potential for direct transport to the sump (Break Criterion 3) resulted in a limiting NUKON™ debris generation of 70.5 ft<sup>3</sup> for the 12” RHR suction lines and 31.2 ft<sup>3</sup> for the 8” SI pump discharge lines.

#### Miscellaneous Solid Debris

The STP debris generation analysis does recognize the presence of miscellaneous solid object debris sources, such as equipment labels and tags, and plastic signs. As suggested by the GR, this miscellaneous solid object debris source is bounded by 100 ft<sup>2</sup>, and includes an allowance of 14 ft<sup>2</sup> for 100 equipment clearance order (ECO) tags (size of 4” x 5”) and 2 ft<sup>2</sup> for ty-wraps.

#### **Content Guide Item 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.*

- *Provide the assumed size distribution for each type of debris.*
- *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.*
- *Provide assumed specific surface areas for fibrous and particulate debris.*
- *Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.*

The debris sources for STP include insulation, coatings, and latent debris. The insulation debris types include RMI, NUKON™, Thermal-Wrap, Microtherm® and Marinite. The RMI is located on the reactor vessel inside the primary shield wall. The NUKON™ is located on various piping and equipment throughout containment. The Thermal-Wrap is installed on the steam generators. Marinite is installed on the reactor vessel nozzles. The Microtherm® is used on some piping in the secondary shield wall penetrations. The characteristics of the insulation debris materials are discussed in this section as the characteristics of the other debris types (e.g., coatings and latent) are included elsewhere

**Content Guide Item 3c. Debris Characteristics**

- Provide the assumed size distribution for each type of debris.

**Response**

As recommended by Section 4.2.4 of the SER, a four-size distribution for low density fiberglass (LDFG) insulation material inside the ZOI of a postulated break is used in the STP debris generation analysis. The distribution categorizes destroyed insulation debris as fines, small pieces, large pieces and intact blankets. Fines are defined as individual fibers, small pieces are smaller than 6" on a side, large pieces are greater than 6" on a side and intact blankets are large pieces that are still protected by the covering, thereby preventing further erosion. Table 3 summarizes the LDFG size distributions.

**Table 3 – LDFG Debris Size Distribution Within Each Sub-Zone**

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

Table 4 summarizes the other potential debris sources in the STP containment and the associated debris size distributions from Table 3-3 of the SER. Materials for which debris generation is not known well enough to conservatively estimate debris size distribution will assume maximum destruction as 100% fines.

**Table 4 – Debris Size Distribution**

Material	Percentage Small Fines	Percentage Large Pieces
Within the ZOI		
RMI	75	25
Marinite	100	0
Microtherm®	100	0
Outside the ZOI		
Covered Undamaged Insulation	0	0



**Content Guide Item 3c. Debris Characteristics**

- 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.

**Response**

Table 5 and Table 6 provide a summary of the as-fabricated densities, microscopic densities, and dimensions for applicable debris types at STP. Characteristics associated with coatings will be further discussed later in this report.

**Table 5 – Fibrous Material Characteristics**

Debris Material	As-Fabricated Density (lb/ft <sup>3</sup> )	Microscopic Density (lb/ft <sup>3</sup> )	Characteristic Diameter (μm)
NUKON™	2.4	175	7 μm
Thermal-Wrap	2.4	159	5.5 μm

**Table 6 – Particulate Debris Characteristics**

Debris Material	As-Fabricated Density (lb/ft <sup>3</sup> )	Microscopic Density (lb/ft <sup>3</sup> )	Characteristic Diameter (μm)
Marinite (1)	14.5	144	5
Microtherm®	15	187	2.5 to 20

The material characteristics for Marinite are assumed to be the same as those identified for Calcium Silicate due to their similar appearances.

**Content Guide Item 3c. Debris Characteristics**

- Provide assumed specific surface areas for fibrous and particulate debris.

**Response**

The specific surface area (Sv) was only used for preliminary analytically determined head loss values across a debris laden sump screen using the correlation given in NUREG/CR-6224. Since the head loss across the installed sump screen is determined via testing, these values are not used in the design basis for STP. Therefore, these values are not provided as part of this report.

**Content Guide Item 3c. Debris Characteristics**

- *Provide the technical basis for any debris characterization assumptions that deviate from NRC-approved guidance.*

**Response**

There are no such assumptions that differ from the guidance.

**Content Guide Item 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.*

- *Provide the methodology used to estimate quantity and composition of latent debris.*
- *Provide the basis for assumptions used in the evaluation.*
- *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.*
- *Provide amount of sacrificial strainer surface area allotted to miscellaneous latent debris.*

**Response**

The latent debris at STP has been evaluated through containment condition assessments. Containment walkdowns were completed for Unit 1 and for Unit 2. The conditions were completed in accordance with the guidance of NEI 02-01, "Condition Assessment Guidelines, Debris Sources Inside Containment," Revision 1. The quantity and composition of the latent debris was evaluated by extensive sampling for latent debris (dirt/dust and latent fiber) considering the guidance in NEI 04-07, Volume 2.

Samples were taken to determine the latent debris mass distribution per unit area, referred to as latent debris density (e.g. lbm/1000 ft<sup>2</sup>) of representative surfaces throughout containment including vertical surfaces such as the liner and walls. These debris densities were then applied to all of the surface areas inside containment to calculate the total amount of latent debris inside containment.

The latent debris density was estimated by weighing sample bags before and after sampling, dividing the net weight increase by the sampled surface area, and converting the result to a density (e.g. lbm/1000 ft<sup>2</sup>).

Samples were taken for Unit 1. The visual assessments and walkdowns supported that there were no significant differences between the Units that would affect the quantity or types of latent debris. Therefore, the samples taken are representative of both Units.

The results of the latent debris calculation conservatively determined the debris loading to be less than 160 lbm in each containment. Therefore, it was elected to use a conservative bounding value of 200 lbm for the latent debris source term in containment.

Visual examination of the debris showed very low fiber content. In lieu of analysis of samples, conservative values for debris composition properties were assumed as recommended by NEI 04-07 Volume 2. This results in a very conservative estimate of fiber content. The particulate / fiber mix of the latent debris will be assumed to be 15% fiber. The latent debris source term value incorporated into the STP analysis is presented in Table 7.

**Table 7 – Latent Debris Source Term**

Latent Debris Type	Mass (lbm)	Density (lbm/ft <sup>3</sup> )	Characteristic Size (ft)
Dirt and Dust	170	169	5.67E-05
Latent Fiber	30	175	2.3 E-05

The containment condition assessments also included the identification of miscellaneous solid objects such as labels and tags. Qualified tags attached with stainless steel wires were found for much of the equipment. Unqualified items were identified and removed. The total surface area for any remaining debris of this type was determined to be much less than 100 ft<sup>2</sup>. Therefore, as suggested by NEI 04-07, this miscellaneous solid object debris source is bounded by the 100 ft<sup>2</sup> that was implemented in the STP debris generation and transport analyses.

A sacrificial area of 200 ft<sup>2</sup> of strainer surface per strainer was designated as a penalty for miscellaneous latent debris including labels and tags. STP has identified tags and labels which are qualified and which have been shown to not transport to the emergency sump strainers (acceptable labels).

**Content Guide Item 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.*

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

**Content Guide Item 3e. Debris Transport**

- *Describe the methodology used to analyze debris transport during the blowdown, washdown, pool-fill-up, and recirculation phases of an accident.*

**Response**

The methodology used in the transport 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 of the four modes of transport was analyzed for each type of debris generated. These modes of transport are:

- *Blowdown transport* – the vertical and horizontal transport of debris to all areas of containment by the break jet.
- *Washdown 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.
- *Recirculation transport* – the horizontal transport of debris from the active portions of the recirculation pool to the sump screens by the flow through the emergency core coolant system (ECCS).

The logic tree approach was then applied for each type of debris determined from the debris generation calculation. The logic tree shown in Figure 1 is somewhat different than the baseline logic tree provided in the GR. This departure was made to account for certain non-conservative assumptions identified by the SER including the transport of large pieces, erosion of small and large pieces, the potential for washdown debris to enter the pool after inactive areas have been filled, and the direct transport of debris to the sump screens during pool fill-up. Also, the generic logic tree was expanded to account for a more refined debris size distribution. (Note that some branches of the logic tree may not be required for certain debris types).

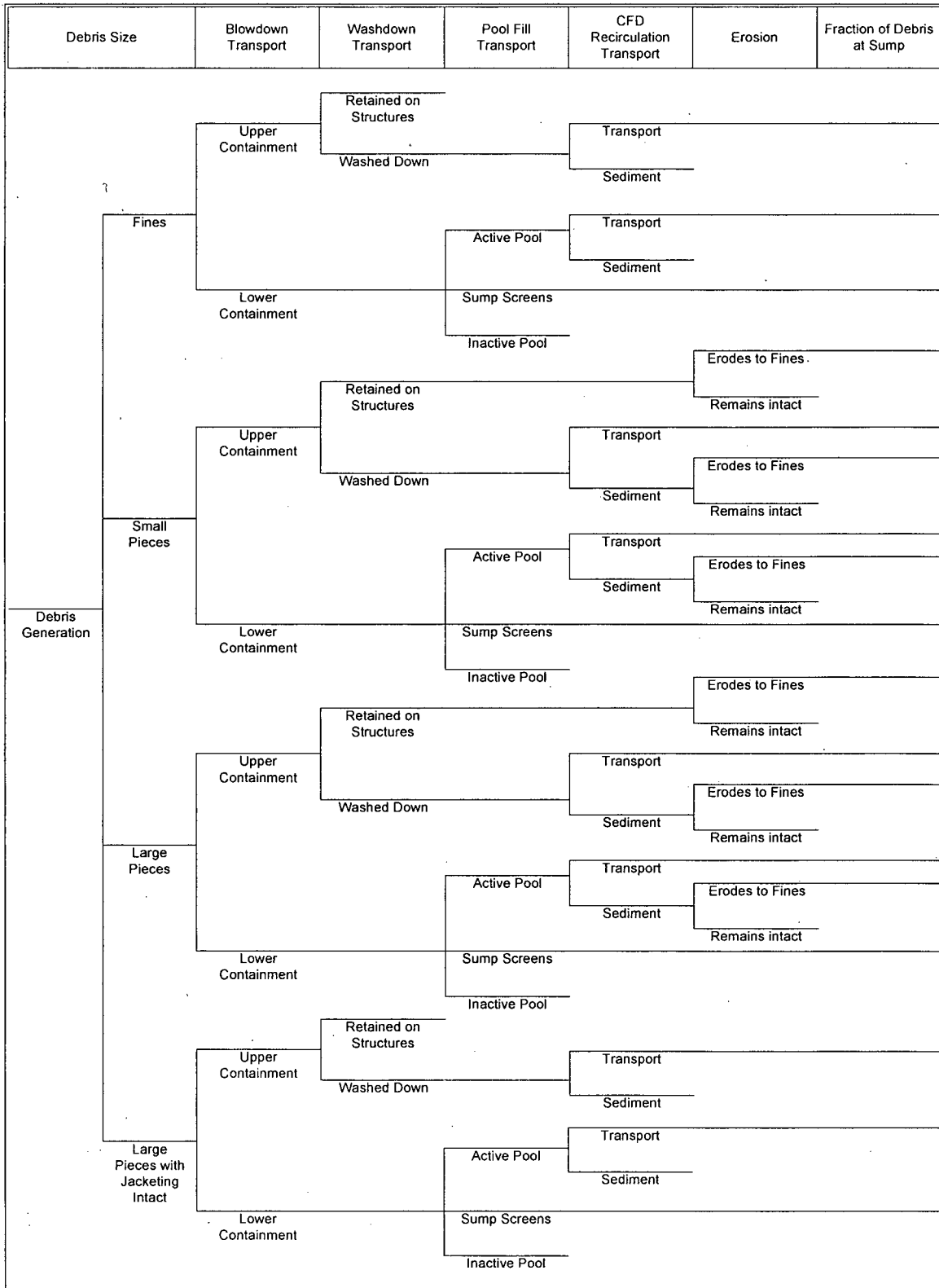


Figure 1 – Generic debris transport logic tree

The basic methodology used for the South Texas Project transport analysis is shown below:

1. Based on many of the containment building drawings, a three-dimensional model was built using computer aided design and drafting (CADD) software.
2. A review was made of the drawings and CADD model to determine transport flow paths. Potential upstream blockage points including screens, fences, grating, drains, etc. that could lead to water holdup were addressed.
3. Debris types and size distributions were gathered from the debris generation calculation for each postulated break location.
4. The fraction of debris blown into upper containment was determined based on the relative volumes of upper and lower containment.
5. The quantity of debris washed down by spray flow was conservatively determined.
6. The quantity of debris transported to inactive areas or directly to the sump screens was calculated based on the volume of the inactive and sump cavities proportional to the water volume at the time these cavities are filled.
7. Using conservative assumptions, the locations of each type/size of debris at the beginning of recirculation was determined.
8. A computerized flow dynamics (CFD) model was developed to simulate the flow patterns that would occur during recirculation.
9. A graphical determination of the transport fraction of each type of debris was made using the velocity and turbulent kinetic energy (TKE) profiles from the CFD model output, along with the determined initial distribution of debris.
10. The recirculation transport fractions from the CFD analysis were gathered to input into the logic trees.
11. The effects of erosion on the LOCA generated debris were evaluated to determine the potential significance.
12. The overall transport fraction for each type of debris was determined by combining each of the previous steps in logic trees.

## BLOWDOWN TRANSPORT

The fraction of blowdown flow to various regions was estimated using the relative volumes of containment. Fine debris would be suspended and carried by the blowdown flow. Small and large piece debris would also be carried by the high velocity blowdown flow in the vicinity of the break. However, in areas farther away from the break that are not directly affected by the blowdown, this debris would likely fall to the floor.

The volumes for the upper containment (including the refueling canal and areas above the operating deck) and for lower containment (including the open area inside the steam generator and pump enclosures, the area inside the secondary shield wall, and the annulus area below the operating deck) were determined from the CADD model. Because the debris was assumed to be carried with the blowdown flow, the flow split is then proportional to the containment volumes. This resulted in a transport fraction for the fine debris to upper containment of 69%.

The drywell debris transport study (DDTS)<sup>1</sup> testing provides debris holdup values for blowdown occurring in a wetted and highly congested area. Values associated with grating being present in the

---

<sup>1</sup> D.V. Rao, et al., "Drywell Debris Transport Study: Experimental Work", NUREG/CR-6369, Volume 2, September 1999.

blowdown flowpath were utilized in the STP blowdown analysis. The DDTs also presents values for holdup when blowdown travels a flow path with 90° turn(s). Although 90° turns might not have to be negotiated by debris blown to upper containment at STP, significant bends would have to be made. Therefore, it was estimated that 5% (versus the 17% value in the study) of the small fiberglass debris blown upward would be trapped due to changes in flow direction.

Additional guidance was incorporated into the analysis through use of the Boiling Water Reactor (BWR) Utility Resolution Guide (URG). The guidance from this document indicates that grating would trap approximately 65% of the small RMI debris blown toward it.

Table 8 and Table 9 show the transport fractions for each type/size of debris to upper containment and to the containment pool due to the blowdown forces for breaks inside the steam generator compartments. Table 10 through Table 13 show the blowdown transport fractions for the break inside the reactor cavity and the small breaks outside the secondary shield wall. Note that debris outside the ZOI is not affected by the blowdown, and therefore the transport fraction for this debris would be 0%.

**Table 8 – Blowdown transport fraction of debris to upper containment (Cases 1 and 5)**

<b>Debris Type</b>	<b>Fines</b>	<b>Small Pieces</b>	<b>Unjacketed Large Pieces</b>	<b>Jacketed Large Pieces</b>
LDFG	69%	46%	0%	0%
Microtherm™ (Case 1)	69%	NA	NA	NA
Qualified Coatings (inside ZOI)	69%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	0%	NA	NA	NA
Latent Fiber	0%	NA	NA	NA

**Table 9 – Blowdown transport fractions of debris to containment pool (Cases 1 and 5)**

<b>Debris Type</b>	<b>Fines</b>	<b>Small Pieces</b>	<b>Unjacketed Large Pieces</b>	<b>Jacketed Large Pieces</b>
LDFG	31%	20%	0%	0%
Microtherm™ (Case 1)	31%	NA	NA	NA
Qualified Coatings (inside ZOI)	31%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	0%	NA	NA	NA
Latent Fiber	0%	NA	NA	NA

**Table 10 – Blowdown transport fractions of debris to upper containment (Case 2)**

<b>Debris Type</b>	<b>Fines</b>	<b>Small Pieces</b>	<b>Unjacketed Large Pieces</b>	<b>Jacketed Large Pieces</b>
Stainless Steel RMI	NA	0%	0%	NA
LDFG	69%	46%	0%	0%
Marinite™	0%	NA	NA	NA
Qualified Coatings (inside ZOI)	0%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	0%	NA	NA	NA
Latent Fiber	0%	NA	NA	NA

**Table 11 – Blowdown transport fractions of debris to containment pool (Case 2)**

<b>Debris Type</b>	<b>Fines</b>	<b>Small Pieces</b>	<b>Unjacketed Large Pieces</b>	<b>Jacketed Large Pieces</b>
Stainless Steel RMI	NA	100%	100%	NA
LDFG	31%	20%	0%	0%
Marinite™	100%	NA	NA	NA
Qualified Coatings (inside ZOI)	100%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	0%	NA	NA	NA
Latent Fiber	0%	NA	NA	NA

**Table 12 – Blowdown transport fractions of debris to upper containment (Cases 3 and 4)**

<b>Debris Type</b>	<b>Fines</b>	<b>Small Pieces</b>	<b>Unjacketed Large Pieces</b>	<b>Jacketed Large Pieces</b>
LDFG	0%	0%	0%	0%
Qualified Coatings (inside ZOI)	0%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	0%	NA	NA	NA
Latent Fiber	0%	NA	NA	NA



Table 13 – Blowdown transport fractions of debris to containment pool (Cases 3 and 4)

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
LDFG	100%	100%	100%	100%
Qualified Coatings (inside ZOI)	100%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	0%	NA	NA	NA
Latent Fiber	0%	NA	NA	NA

### WASHDOWN TRANSPORT

During the washdown phase, debris in upper containment could be washed down by the containment sprays. For STP, some small piece debris as well as all large pieces would be held up by grating.

The debris blown to upper containment was assumed to be scattered around and a reasonable approximation of the washdown locations was made based on the spray flow split in upper containment. This resulted in the following washdown split of 26% of the containment sprays were estimated to flow directly into the steam generator compartments, 31% were estimated to flow into the steam generator compartments via the refueling canal (28.5%) and cable tray chase (2.7%), and the remaining 43% of the sprays were estimated to flow into the annulus.

Multiple levels of grating are present in the STP Containment. The results of the DDTs testing showed that approximately 40-50% of small fiberglass debris landing on grating would be washed through the grating due to spray flows. (Note that the spray flow at the plant is on the lower end of the 1 to 12 gpm/ft<sup>2</sup> spray flow used in the testing). Holdup of small pieces of fiberglass debris was credited at each level of grating that washdown flow passed through. Credit was also taken for holdup of small pieces of RMI on grating based on the BWR URG, which indicates that the retention of small RMI debris on grating is approximately 29%.

The following tables show the fraction of debris in upper containment and the steam generator compartments that would be expected to transport to the pool floor inside and outside the secondary shield wall.

Table 14 – Washdown transport fractions of debris from upper containment to the annulus

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
LDFG	43%	3%	0%	0%
Microtherm™ (Case 1)	43%	NA	NA	NA
Qualified Coatings (inside ZOI)	43%	NA	NA	NA
Unqualified Coatings (outside ZOI)	NA	NA	NA	NA
Dirt/Dust	NA	NA	NA	NA
Latent Fiber	NA	NA	NA	NA

**Table 15** – Washdown transport fractions of debris from upper containment directly to the steam generator compartments

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
LDFG	26%	7%	0%	0%
Microtherm™ (Case 1)	26%	NA	NA	NA
Qualified Coatings (inside ZOI)	26%	NA	NA	NA
Unqualified Coatings (outside ZOI)	NA	NA	NA	NA
Dirt/Dust	NA	NA	NA	NA
Latent Fiber	NA	NA	NA	NA

**Table 16** – Washdown transport fractions of debris from upper containment to the steam generator compartments via the canal drains and cable tray chase

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
LDFG	31%	16%	0%	0%
Microtherm™ (Case 1)	31%	NA	NA	NA
Qualified Coatings (inside ZOI)	31%	NA	NA	NA
Unqualified Coatings (outside ZOI)	NA	NA	NA	NA
Dirt/Dust	NA	NA	NA	NA
Latent Fiber	NA	NA	NA	NA

**Table 17** – Washdown transport fractions of debris in the steam generator compartments at the end of the blowdown phase

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
LDFG	100%	50%	0%	0%
Microtherm™ (Case 1)	100%	NA	NA	NA
Qualified Coatings (inside ZOI)	100%	NA	NA	NA
Unqualified Coatings (outside ZOI)	NA	NA	NA	NA
Dirt/Dust	NA	NA	NA	NA
Latent Fiber	NA	NA	NA	NA

## POOL FILLUP TRANSPORT

During pool fill-up, the flow of water transports insulation debris from the break location to all areas of the recirculation pool. Some of the debris was assumed to transport to inactive areas of the pool and some was assumed to transport directly to the sump screens as the emergency sump cavities are filled. The cavities considered for pool fill up transport include the containment sump, the elevator pit, and the three ECCS sumps. Other potentially inactive areas where debris could be held up including the secondary normal sump were conservatively assumed to be negligible and were not credited.

Assuming that fine debris is uniformly distributed in the pool, and the water entering the pool from the break and sprays is clean (i.e. washdown of debris in upper containment occurs after inactive cavities have been filled), the transport to each of the inactive cavities was calculated for STP. (Note that the assumption that debris washdown occurs after inactive cavities have been filled is consistent with the requirements of the SER Section 3.8.

**Table 18 – Pool fill-up transport fractions of debris to the two active sumps**

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
Stainless Steel RMI (Case 2)	NA	0%	0%	NA
LDFG	8%	0%	0%	0%
Marinite™ (Case 2)	8%	NA	NA	NA
Microtherm™ (Case 1)	8%	NA	NA	NA
Qualified Coatings (inside ZOI)	8%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	8%	NA	NA	NA
Latent Fiber	8%	NA	NA	NA

**Table 19 – Pool fill-up transport fractions of debris to the inactive sump**

Debris Type	Fines	Small Pieces	Unjacketed Large Pieces	Jacketed Large Pieces
Stainless Steel RMI (Case 2)	NA	0%	0%	NA
LDFG	4%	0%	0%	0%
Marinite™ (Case 2)	4%	NA	NA	NA
Microtherm™ (Case 1)	4%	NA	NA	NA
Qualified Coatings (inside ZOI)	4%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	4%	NA	NA	NA
Latent Fiber	4%	NA	NA	NA

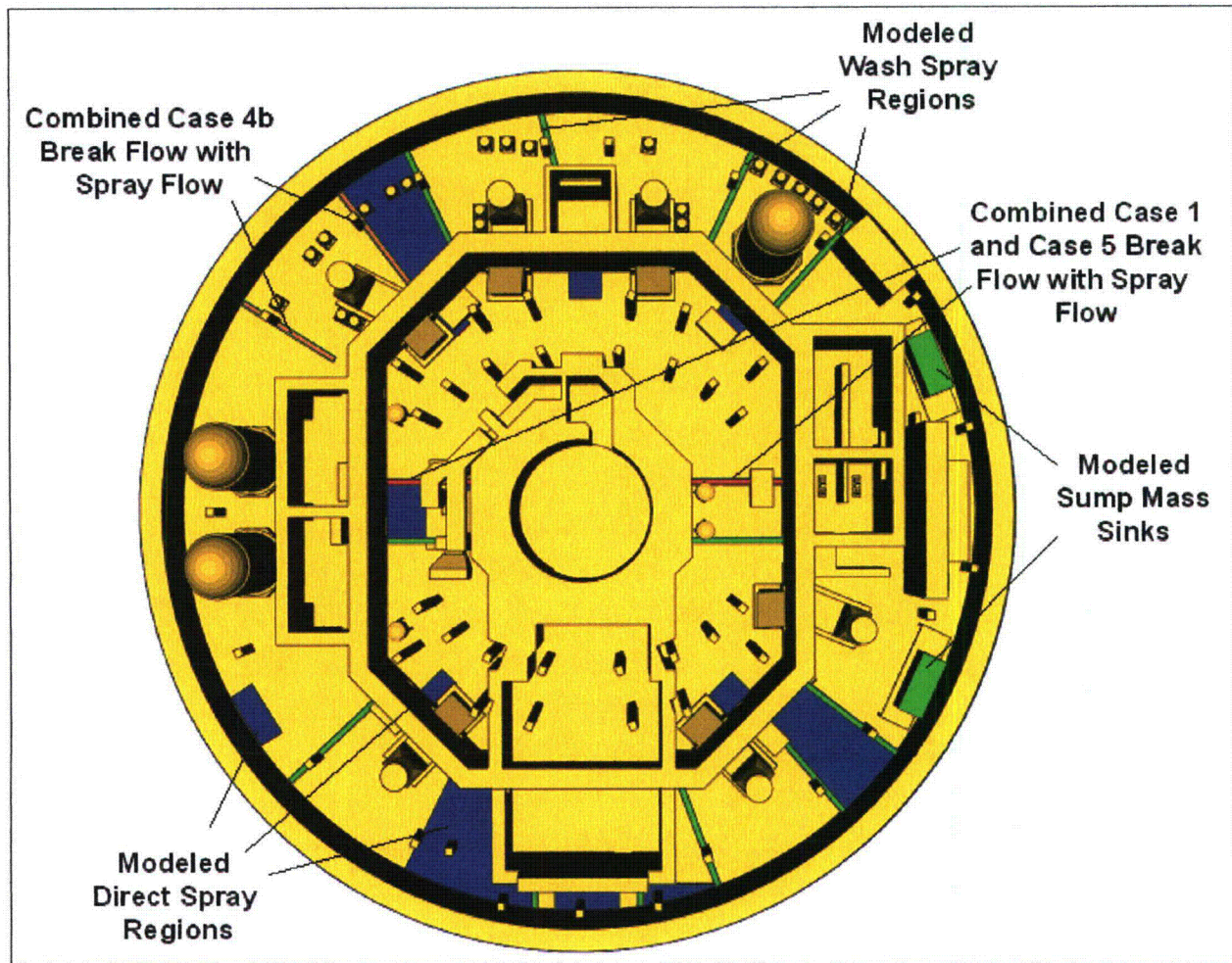
**Table 20 – Pool fill-up transport fractions of debris to the inactive cavities**

<b>Debris Type</b>	<b>Fines</b>	<b>Small Pieces</b>	<b>Unjacketed Large Pieces</b>	<b>Jacketed Large Pieces</b>
Stainless Steel RMI (Case 2)	NA	0%	0%	NA
LDFG	13%	0%	0%	0%
Marinite™ (Case 2)	13%	NA	NA	NA
Microtherm™ (Case 1)	13%	NA	NA	NA
Qualified Coatings (inside ZOI)	13%	NA	NA	NA
Unqualified Coatings (outside ZOI)	0%	NA	NA	NA
Dirt/Dust	13%	NA	NA	NA
Latent Fiber	13%	NA	NA	NA

### RECIRCULATION TRANSPORT

The recirculation pool debris transport fractions were determined through CFD modeling. To accomplish this, a three-dimensional CADD model was imported into the CFD model, flows into and out of the pool were defined, and the CFD simulation was run until steady-state conditions were reached. The result of the CFD analysis is a three-dimensional model showing the turbulence and fluid velocities within the pool. By comparing the direction of pool flow, the magnitude of the turbulence and velocity, the initial location of debris, and the specific debris transport metrics (i.e. the minimum velocity or turbulence required to transport a particular type/size of debris), the recirculation transport of each type/size of debris to the sump screens was determined.

A diagram showing the significant parts of the CFD model is shown below. The sump mass sink, the various direct and wash spray regions, and the combined break and spray wash regions are highlighted.



**Figure 2 – Diagram of significant features modeled**

Flow-3D® Version 9.0 developed by Flow Science Incorporated was used for the CFD modeling. The key CFD modeling attributes/considerations included the following:

*Computational Mesh:*

A rectangular mesh was defined in the CFD model that was fine enough to resolve important features, but not so fine that the simulation would take prohibitively long to run. A 6-inch cell length was chosen as the largest cell size that could reasonably resolve the concrete structures that compose the containment floor. For the cells right above the containment floor, the mesh was set to 3 inches tall in order to closely resolve the vicinity of settled debris. To further define specific objects, node planes were placed at the edges of key structures including the top of the sump curb, and the edges of the break and spray mass source obstacles.

*Modeling of Containment Spray Flows:*

From consideration of various plan and section drawings, as well as the containment building CADD model, it was judged that spray water would drain to the pool through numerous pathways. Some of these pathways included: the steam generator compartments through the open area above the steam

generators, into the refueling canal and through the refueling canal drains, and into the annulus through the various open sections of grating. The sprays were introduced near the surface of the pool.

#### *Modeling of Break Flow:*

STP breaks were modeled at the break location which was not directly above the recirculation pool and consideration of the additional free fall energy was not necessary. The break flow falls onto the floor at the associated elevation and then drains through various paths to the recirculation pool. This break flow was combined with the spray flow and introduced to each region where flow occurs near the surface of the pool.

#### *Modeling of the Emergency Sump:*

The emergency sumps at STP consist of three sumps. To bound the transport analysis, the worst case scenario (two sumps operating) was modeled. The two outer sumps were chosen as the active sumps since debris would be more likely to transport to the outer sumps. The mass sink used to pull flow from the CFD model was defined within the two sump cavities. A negative flow rate was set for the sump mass sink, which tells the CFD model to draw the specified amount of water from the pool over the entire exposed surface area of the mass sink obstacle.

#### *Turbulence Modeling:*

Several different turbulence modeling approaches can be selected for a Flow-3D® calculation. The approaches are (ranging from least to most sophisticated):

- Prandtl mixing length
- Turbulent energy model
- Two-equation k-ε model
- Renormalized group theory (RNG) model
- Large eddy simulation model

The RNG turbulence model was judged to be the most appropriate for this CFD analysis due to the large spectrum of length scales that would likely exist in a containment pool during emergency recirculation. The RNG approach applies statistical methods in a derivation of the averaged equations for turbulence quantities (such as turbulent kinetic energy and its dissipation rate). RNG-based turbulence schemes rely less on empirical constants while setting a framework for the derivation of a range of models at different scales.

#### *Steady-State Metrics:*

The CFD models were started from a stagnant state at a defined pool depth and run long enough for steady-state conditions to develop. A plot of mean kinetic energy was used to determine when steady-state conditions were reached. Checks were also made of the velocity and turbulent energy patterns in the pool to verify that steady-state conditions were reached.

#### *Debris Transport Metrics:*

Metrics for predicting debris transport have been adopted or derived from data. The specific metrics are the turbulent kinetic energy (TKE) necessary to keep debris suspended, and the flow velocity necessary to tumble sunken debris along a floor. The metrics utilized in the STP transport analysis originate from the sources below:

- 1) NUREG/CR-6772 Tables 3.1, 3.2 & 3.5,
- 2) NUREG/CR-6808 Table 3.2 and Figure 5-2, or
- 3) Calculated using Stokes' Law using water properties at 120° F.

## Graphical Determination of Debris Transport Fractions

The following steps were taken to determine what percentage of a particular type of debris could be expected to transport through the containment pool to the emergency sump screens.

- Colored contour velocity and TKE maps indicating regions of the pool through which a particular type of debris could be expected to transport were generated from the Flow-3D® results in the form of bitmap files.
- The bitmap files were overlaid on the initial debris distribution plots and imported into AutoCAD® with the appropriate scaling factor to convert the length scale of the color maps to feet.
- For the uniformly distributed debris, closed polylines were drawn around the contiguous areas where velocity or TKE was high enough that debris could be carried in suspension or tumbled along the floor to the sump screens.
- The areas within the closed polylines were determined utilizing an AutoCAD® querying feature.
- The combined area within the polylines was compared to the debris distribution area.
- The percentage of a particular debris type that would transport to the sump screens was estimated based on the above comparison.

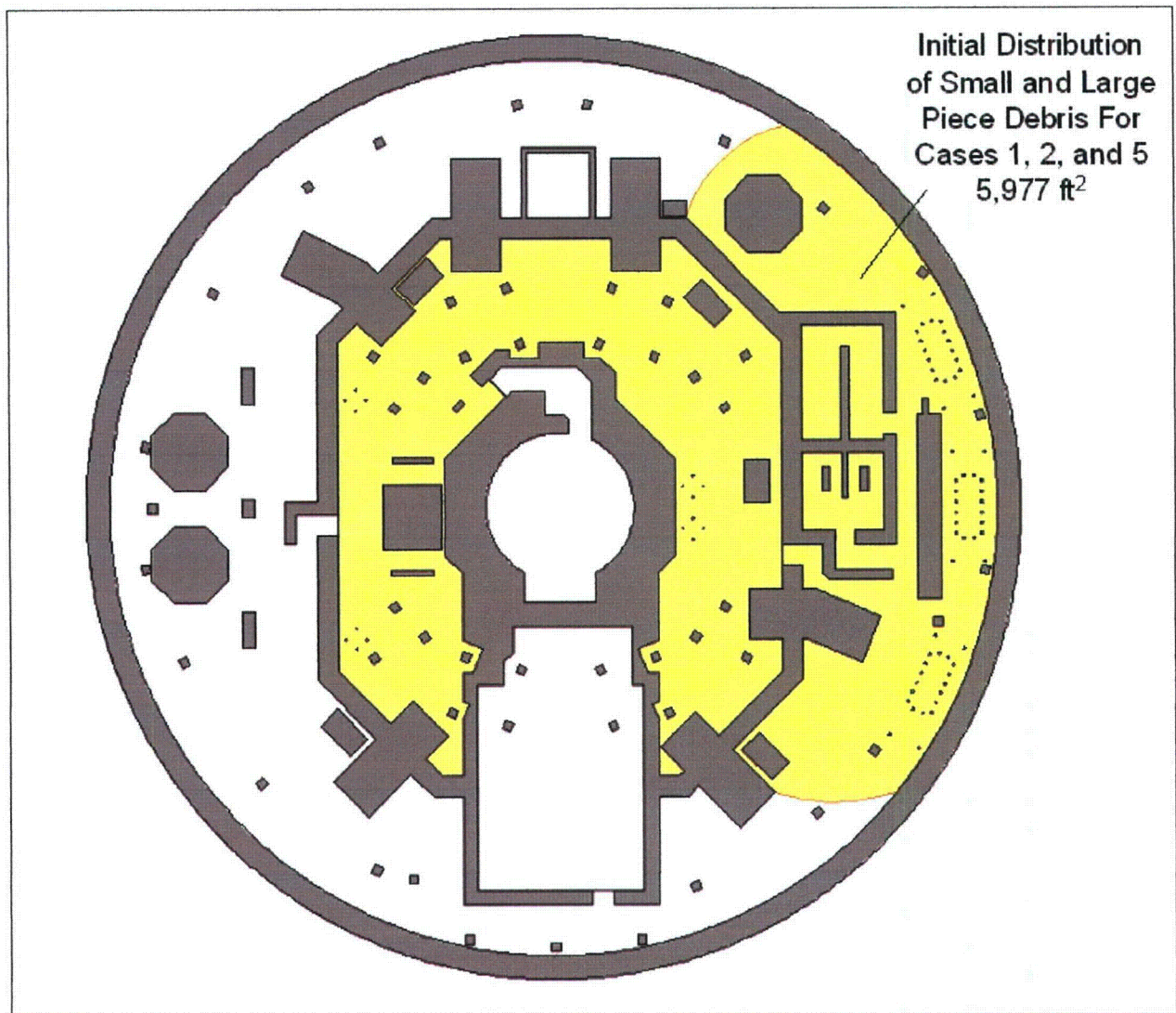
Plots showing the TKE and the velocity magnitude in the pool were generated for each case to determine areas where specific types of debris would be transported. The limits on the plots were set according to the minimum TKE or velocity metrics necessary to move each type of debris. The overlying yellow areas represent regions where the debris would be suspended, and the red areas represent regions where the debris would be tumbled along the floor. The yellow TKE portion of the plots is a three-dimensional representation of the TKE. The velocity portion of the plots represents the velocity magnitude just above the floor level (1.5 inches), where tumbling of sunken debris could occur. Directional flow vectors were also included in the plots to determine whether debris in certain areas would be transported to the sump screens or transported to quieter regions of the pool where it could settle to the floor.

The following figures and discussion are presented as an example of how the transport analysis was performed for a single debris type – Small Piece Stainless Steel RMI. This same approach was utilized for other debris types analyzed at STP.

Figure 4 and Figure 5 show that the turbulence in the pool is only high enough to suspend small RMI debris in the vicinity of the location where break and spray flow from the steam generator compartments enters the pool.

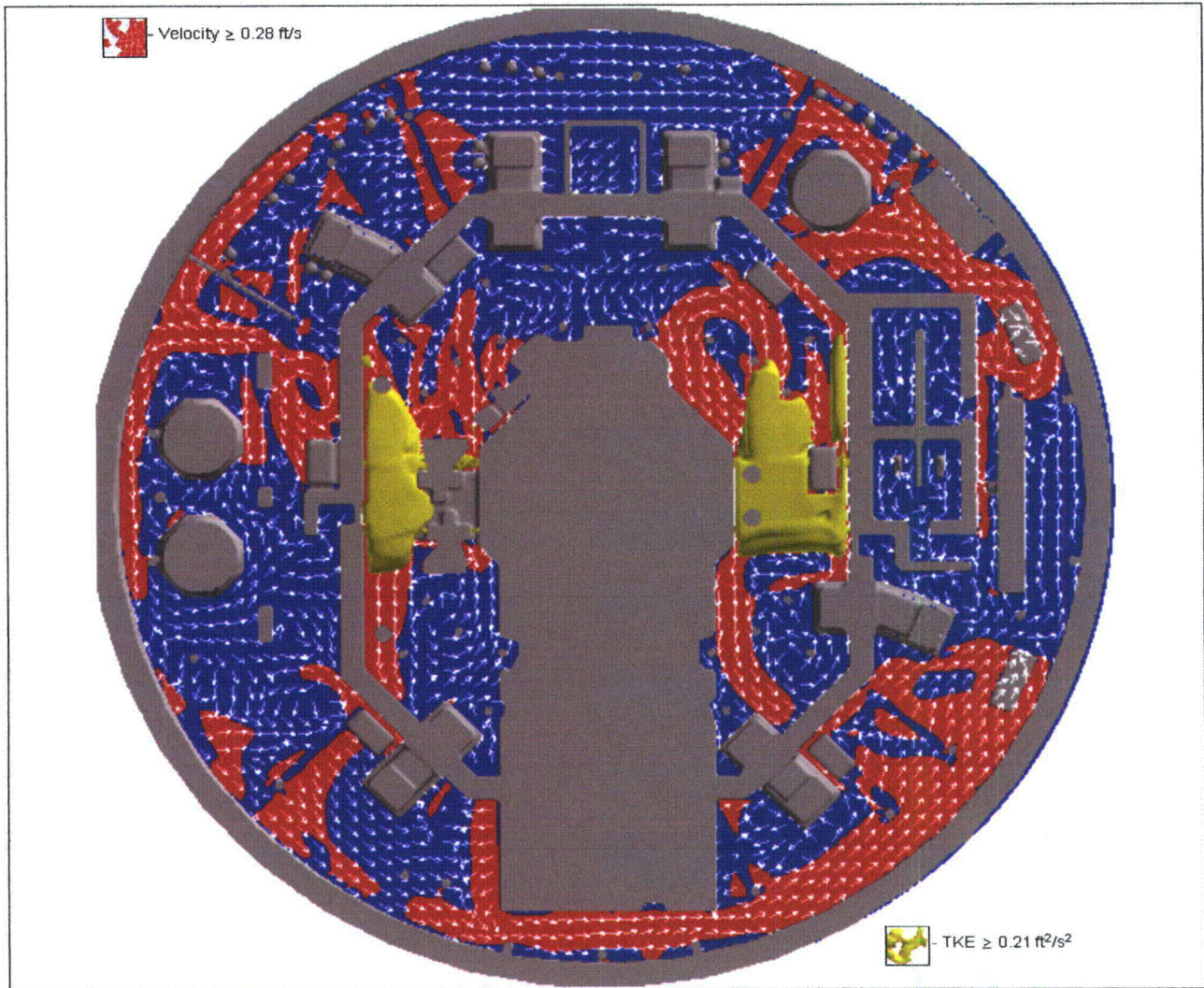
As shown in Figure 3, the small RMI debris was assumed initially to be uniformly distributed inside the secondary shield wall and in the vicinity of the sump screens. This area was overlaid on top of the plot showing tumbling velocity and flow vectors to determine the recirculation transport fraction. The area where small pieces of RMI would transport within the initial distribution area is 1,872 ft<sup>2</sup>, as shown in Figure 6. Since the initial distribution area was determined to be 5,977 ft<sup>2</sup> the recirculation transport fraction for small pieces of RMI is 31%.





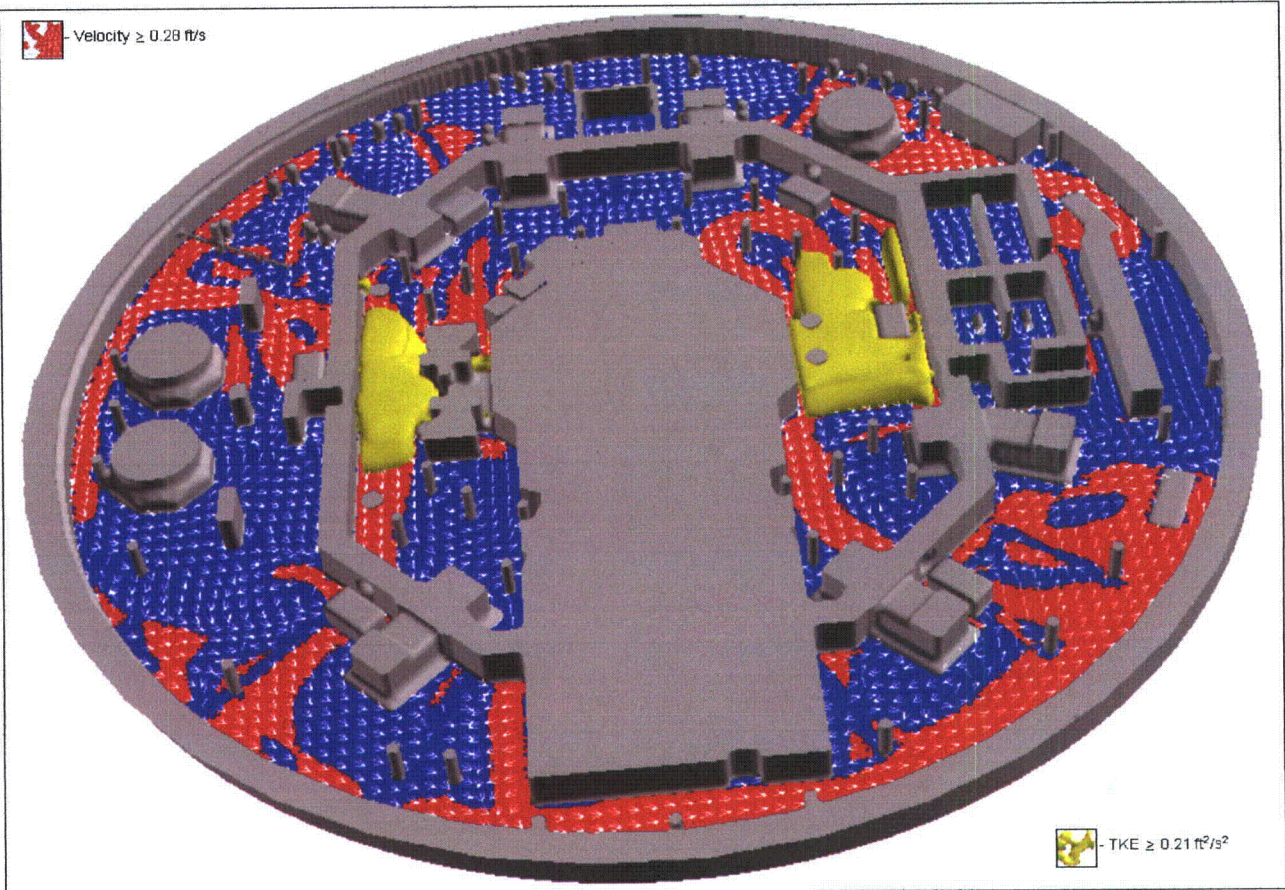
**Figure 3** – Distribution of small & large piece debris in lower containment





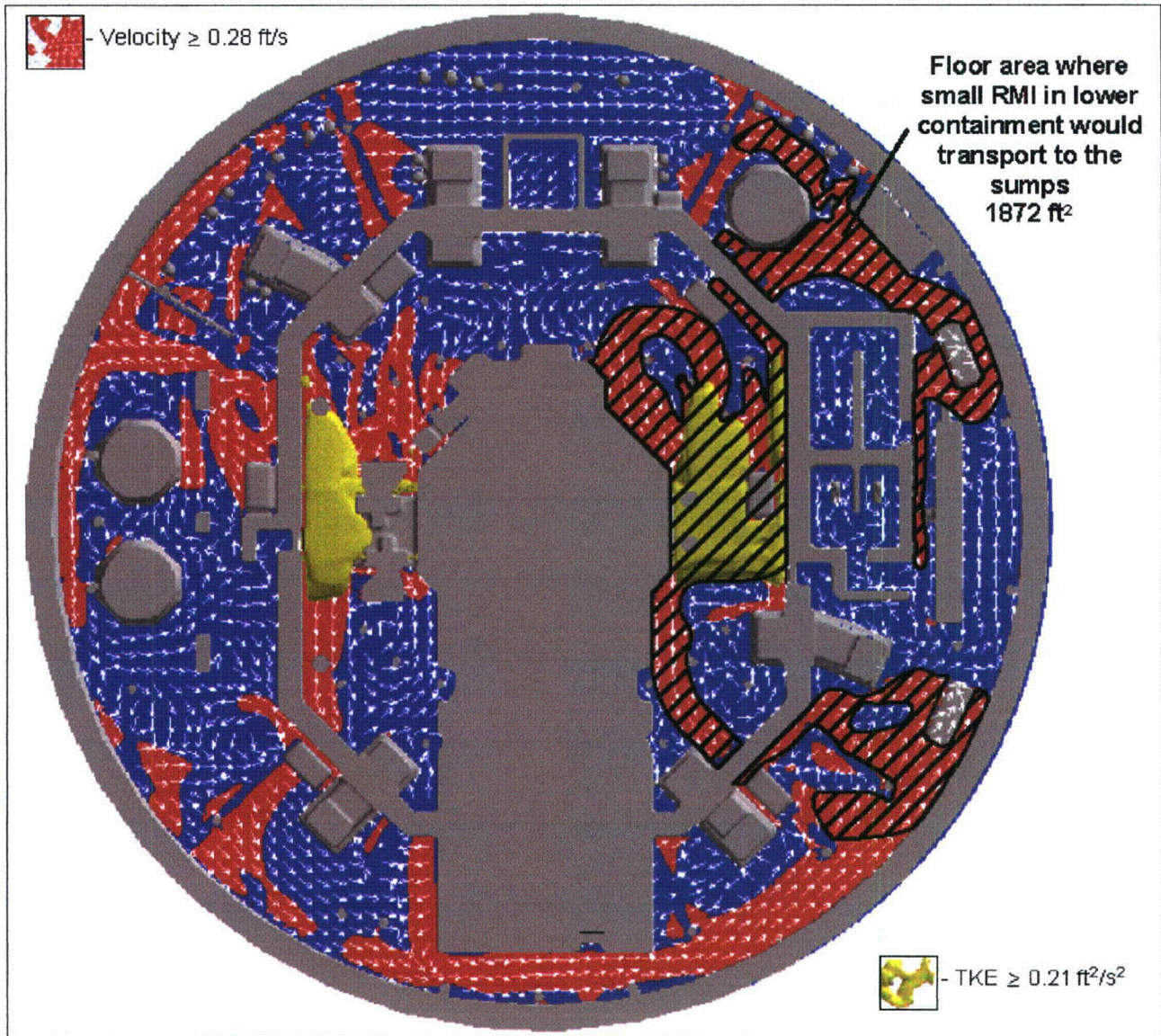
**Figure 4** – TKE and velocity with limits set at suspension/tumbling of small pieces of stainless steel RMI





**Figure 5** – 3D view of TKE and velocity with limits set at suspension/tumbling of small pieces of stainless steel RMI





**Figure 6** – Floor area where small RMI would transport to the sumps

This same analysis was applied for each debris type (grouping was performed as applicable) evaluated at STP. Recirculation pool transport fractions were identified for each debris type associated with the location of its original distribution. This includes a transport fraction for debris: 1) not originally blown into upper containment, 2) washed down inside the secondary shield wall, and 3) washed down into the annulus.

**Content Guide Item 3e. Debris Transport**

- Provide the technical basis for assumptions and methods used in the analysis that deviate from the approved guidance.

**Response**

Debris erosion is the only area where the debris transport analysis deviates from the regulatory guidance. The guidance specifies that an erosion fraction of 90% should be used for fiberglass debris. However, as described in the justification below, an erosion fraction of 10% was used for fiberglass debris in the recirculation pool.

The only insulation debris with the potential for erosion at STP is the unjacketed small and large pieces of Nukon™ and Thermal-Wrap™ fiberglass.

Tests performed as a part of the drywell debris transport study (DDTS) have indicated that the erosion of fibrous debris is significantly different for debris directly impacted by containment sprays versus debris directly impacted by break flow. The erosion of large pieces of fibrous debris by containment sprays was found to be less than 1%, whereas the erosion due to the break flow was much higher. Due to differences in the design of PWR nuclear plants compared to the boiling water reactor (BWR) nuclear plants, the results of the erosion testing in the DDTS are only partially applicable. In a BWR plant, a LOCA accident would generate debris that would be held up below the break location on grating above the suppression pool. In STP, however, the break would generate debris that would either be blown to upper containment or blown out away from the break. Most of the debris would not be hung up directly below the break flow where it would undergo the high erosion rates suggested by the DDTS. Any debris blown to upper containment that is not washed back down, however, would be subject to erosion by the sprays. Based on the results of the DDTS testing, a 1% erosion factor was applied for small and large piece fibrous debris held up in upper containment. This is consistent with the approach taken for the pilot plant in the SER (Appendix VI). The erosion mechanism for debris in the pool is somewhat different than what was tested in the DDTS. The SER (Appendix III) describes erosion tests that indicated that the erosion rate of fibrous debris could be on the order of 0.3 percent of the current debris per hour for a pool with a 16-inch depth (compared to 2 percent per hour for a pool with a 9-inch depth). Using the following equation, this gives a total erosion of 7% after 24 hours, and 89% after 30 days.

$$f_{eroded} = 1 - (1 - rate)^{Number\ of\ Hours}$$

where:

$f_{eroded}$  = total fraction of debris eroded

$rate$  = erosion rate of current debris per hour

$Number\ of\ Hours$  = Number of hours debris is subject to erosion

The SER points out substantial uncertainties associated with the erosion testing including the following:

- The integral debris transport tests lasted 3 to 5 hours. Therefore, the question remains whether the erosion rate tapers off with time. In addition, it is not certain that all of the end-of-test debris accumulation was the result of erosion products.

- The test results include the usual variances in test data, such as flow and depth control and debris collection.
- Although the test series was designed to approximate the flow and turbulence characteristics of the volunteer-plant sump pool, the tank characteristics may have been significantly different than those at the plant. The difference in the erosion rates between the 9-inch and 16-inch pool depths in the integrated tests clearly illustrates the effect of pool turbulence on fibrous debris erosion.
- The geometry of the volunteer-plant sump pool is larger and more complex than that of the test tank used in the integrated tests.
- The long-term tests did not study large-piece debris.

Since the test data showed in general that the erosion consisted primarily of small, loosely attached pieces of fiber breaking off from larger pieces, it is considered reasonable to assume that erosion would taper off after 24 hours. To be conservative, however, the 24 hour erosion was rounded up to 10%. This erosion fraction was applied for both small and unjacketed large fiberglass pieces in the containment pool.

***Content Guide Item 3e. Debris Transport***

- *Identify any computational fluid dynamics codes used to compute debris transport fractions during recirculation and summarize the methodology, modeling assumptions, and results.*

**Response**

See response in subsection above for first bullet.

***Content Guide Item 3e. Debris Transport***

- *Provide a summary of, and supporting basis for, any credit taken for debris interceptors.*

**Response**

Debris interceptors are not integrated into the STP debris transport analysis

***Content Guide Item 3e. Debris Transport***

- *State whether fine debris was assumed to settle and provide basis for any settling credited.*

**Response**

Debris settling is not credited for the STP debris transport analyses. The analysis is a model of transport to the sump.

***Content Guide Item 3e. Debris Transport***

- *Provide the calculated debris transport fractions and the total quantities of each type of debris transported to the strainers.*

**Response**

Transport logic trees were developed for each size and type of debris generated. These trees were used to determine the total fraction of debris that would reach the sump screen in each of the postulated cases. The postulated cases include; a break in the Loop C hot leg, a break in reactor cavity, breaks in the RHR and SI pump suction and discharge lines of Loops A and B, a break in the RHR pump suction line of Loop C, and a break in the CVCS letdown line.

**Table 21 – Case 1 (Loop C hot leg) debris transport fractions and debris amounts**

Debris Type	Debris Size	Debris Transport Fraction	Debris Generated	Debris At Sump
LDFG	Fines	95%	329.2 ft <sup>3</sup>	312.7 ft <sup>3</sup>
	Small Pieces (<6")	36%	1238.2 ft <sup>3</sup>	445.8 ft <sup>3</sup>
	Large Pieces (>6")	1%	358.6 ft <sup>3</sup>	3.6 ft <sup>3</sup>
	Intact Pieces (>6")	0%	382.5 ft <sup>3</sup>	0 ft <sup>3</sup>
Microtherm™	Total (Fines)	95%	2.3 ft <sup>3</sup>	2.2 ft <sup>3</sup>
Qualified Coatings (inside ZOI)	Total (Fines)	95%	586 lb	556.7 lb
Unqualified Coatings (outside ZOI)	Total (Fines)	100%	3278 lb	3278 lb
Dirt/Dust	Total (Fines)	83%	170 lb	141.1 lb
Latent Fiber	Total (Fines)	83%	30 lb	24.9 lb

**Table 22 – Case 2 (Reactor cavity) debris transport fractions**

Debris Type	Debris Size	Debris Transport Fraction	Debris Generated	Debris At Sump
RMI	Small Pieces (<4")	31%	18,370 ft <sup>2</sup>	5694.7 ft <sup>2</sup>
	Large Pieces (>4")	31%	6,123 ft <sup>2</sup>	1898 ft <sup>2</sup>
LDFG	Fines	95%	305.9 ft <sup>3</sup>	290.6 ft <sup>3</sup>
	Small Pieces (<6")	36%	NA	NA
	Large Pieces (>6")	1%	204.1 ft <sup>3</sup>	2.0 ft <sup>3</sup>
	Intact Pieces (>6")	0%	NA	NA
Marinite	Total (Fines)	83%	15.2 ft <sup>3</sup>	12.6 ft <sup>3</sup>
Microtherm™	Total (Fines)	95%	0.9 ft <sup>3</sup>	0.86 ft <sup>3</sup>
Qualified Coatings (inside ZOI)	Total (Fines)	83%	586 lb	486.4 lb
Unqualified Coatings	Total (Fines)	100%	3278 lb	3278 lb
Dirt/Dust	Total (Fines)	83%	170 lb	141.1 lb
Latent Fiber	Total (Fines)	83%	30 lb	24.9 lb

**Table 23 –RHR suction line of Loops A (bounding for suction lines) debris transport amounts**

Debris Type	Debris Size	Debris Transport Fraction	Debris Generated	Debris At Sump
LDFG (Nukon™)	Fines	100%	42.3 ft <sup>3</sup>	42.3 ft <sup>3</sup>
	Small Pieces (<6")	76%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
	Large Pieces (>6")	22%	28.2 ft <sup>3</sup>	6.20 ft <sup>3</sup>
	Intact Pieces (>6")	13%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
Qualified Coatings (inside ZOI)	Total (Fines)	100%	586 lb	586 lb
Unqualified Coatings (outside ZOI)	Total (Fines)	100%	3278 lb	3278 lb
Dirt/Dust	Total (Fines)	100%	170 lb	170 lb
Latent Fiber	Total (Fines)	100%	30 lb	30 lb

**Table 24** –SI Discharge line of Loops B (bounding for discharge lines) debris transport amounts

Debris Type	Debris Size	Debris Transport Fraction	Debris Generated	Debris At Sump
LDFG (Nukon™)	Fines	100%	18.7 ft <sup>3</sup>	18.7 ft <sup>3</sup>
	Small Pieces (<6")	76%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
	Large Pieces (>6")	22%	12.5 ft <sup>3</sup>	2.75 ft <sup>3</sup>
	Intact Pieces (>6")	13%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
Qualified Coatings (inside ZOI)	Total (Fines)	100%	586 lb	586 lb
Unqualified Coatings (outside ZOI)	Total (Fines)	100%	3278 lb	3278 lb
Dirt/Dust	Total (Fines)	100%	170 lb	170 lb
Latent Fiber	Total (Fines)	100%	30 lb	30 lb

**Table 25** – RHR pump suction line of Loop C debris transport fractions

Debris Type	Debris Size	Debris Transport Fraction	Debris Generated	Debris At Sump
LDFG	Fines	100%	41 ft <sup>3</sup>	41 ft <sup>3</sup>
	Small Pieces (<6")	100%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
	Large Pieces (>6")	100%	27.3 ft <sup>3</sup>	27.3 ft <sup>3</sup>
	Intact Pieces (>6")	100%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
Qualified Coatings (inside ZOI)	Total (Fines)	100%	586 lb	586 lb
Unqualified Coatings (outside ZOI)	Total (Fines)	100%	3278 lb	3278 lb
Dirt/Dust	Total (Fines)	100%	170 lb	170 lb
Latent Fiber	Total (Fines)	100%	30 lb	30 lb



**Table 26 – CVCS letdown line debris transport fractions**

Debris Type	Debris Size	Debris Transport Fraction	Debris Generated	Debris At Sump
LDFG (Nukon™)	Fines	95%	153.1 ft <sup>3</sup>	145.4 ft <sup>3</sup>
	Small Pieces (<6")	17%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
	Large Pieces (>6")	1%	102.0 ft <sup>3</sup>	1.02 ft <sup>3</sup>
	Intact Pieces (>6")	0%	0 ft <sup>3</sup>	0 ft <sup>3</sup>
Qualified Coatings (inside ZOI)	Total (Fines)	95%	586 lb	556.7 lb
Unqualified Coatings (outside ZOI)	Total (Fines)	100%	3278 lb	3278 lb
Dirt/Dust	Total (Fines)	83%	170 lb	141.1 lb
Latent Fiber	Total (Fines)	83%	30 lb	24.9 lb

**Content Guide Item 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.**

- Provide a schematic diagram of the emergency core cooling system (ECCS) and containment spray systems (CSS).
- Provide the minimum submergence of the strainer under small-break loss-of-coolant accident (SBLOCA) and large-break loss-of-coolant accident (LBLOCA) conditions.
- Provide a summary of the methodology, assumptions and results of the vortexing evaluation. Provide bases for key assumptions.
- 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.
- Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.
- Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.
- Provide the basis for the strainer design maximum head loss.
- Describe significant margins and conservatisms used in the head loss and vortexing calculations.
- Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.
- Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.
- 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.
- 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.
- 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.

- 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.

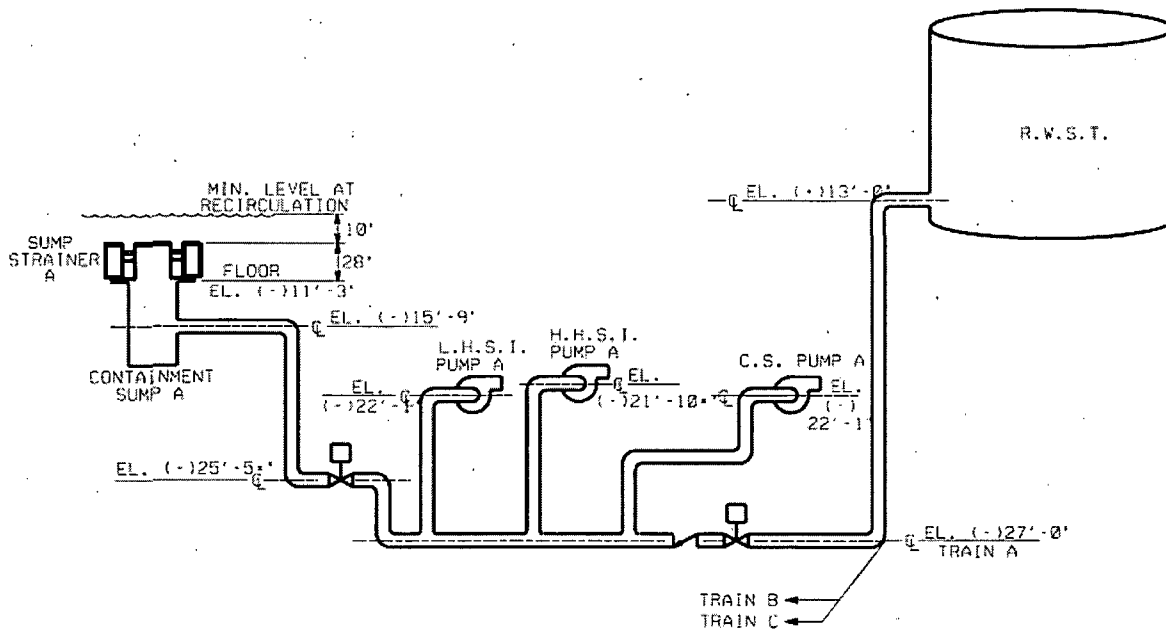
**Content Guide Item 3f. Head Loss and Vortexing**

- Provide a schematic diagram of the emergency core cooling system (ECCS) and containment spray systems (CSS).

**Response**

See Figure 7 below for schematic with elevation layout.

STP SAFETY, INJECTION AND  
CONTAINMENT SPRAY  
TRAIN A LAYOUT



**Figure 7 – ECCS Schematic**

**Content Guide Item 3f. Head Loss and Vortexing**

- Provide the minimum submergence of the strainer under small-break loss-of-coolant accident (SBLOCA) and large-break loss-of-coolant accident (LBLOCA) conditions.

**Response**

For the SBLOCA low water condition, the strainer has 1/2 in. submergence. For the LBLOCA at the start of recirculation, the minimum water level provides the strainer with 10 in. submergence.

**Content Guide Item 3f. Head Loss and Vortexing**

- *Provide a summary of the methodology, assumptions and results of the vortexing evaluation. Provide bases for key assumptions.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3f. Head Loss and Vortexing**

- *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.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3f. Head Loss and Vortexing**

- *Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3f. Head Loss and Vortexing**

- *Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3f. Head Loss and Vortexing**

- *Provide the basis for the strainer design maximum head loss.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3f. Head Loss and Vortexing**

- *Describe significant margins and conservatisms used in the head loss and vortexing calculations.*

**Response**

This information will be provided in a later supplemental response.

***Content Guide Item 3f. Head Loss and Vortexing***

- *Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.*

**Response**

This information will be provided in a later supplemental response.

***Content Guide Item 3f. Head Loss and Vortexing***

- *Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.*

**Response**

This information will be provided in a later supplemental response.

***Content Guide Item 3f. Head Loss and Vortexing***

- *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.*

**Response**

The strainers are fully submerged for SBLOCA and LBLOCA conditions.

***Content Guide Item 3f. Head Loss and Vortexing***

- *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.*

**Response**

This information will be provided in a later supplemental response.

***Content Guide Item 3f. Head Loss and Vortexing***

- *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.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3f. Head Loss and Vortexing**

- *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.*

**Response**

Containment accident pressure is not credited.

**Content Guide Item 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.*

- *Provide applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level.*
- *Describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.*
- *Provide the basis for the required NPSH values, e.g., three percent head drop or other criterion.*
- *Describe how friction and other flow losses are accounted for.*
- *Describe the system response scenarios for LBLOCA and SBLOCA's.*
- *Describe the operational status for each ECCS and CSS pump before and after the initiation of recirculation.*
- *Describe the single failure assumptions relevant to pump operation and sump performance.*
- *Describe how the containment sump water level is determined.*
- *Provide assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.*
- *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.*
- *Provide assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.*
- *Provide assumptions (and their bases) as to what water sources provide pool volume and how much volume is from each source.*
- *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.*
- *Provide assumptions made which minimize the containment accident pressure and maximize the sump water temperature.*
- *Specify whether the containment accident pressure is set at the vapor pressure corresponding to the sump liquid temperature.*
- *Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.*

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- *Provide applicable pump flow rates, the total recirculation sump flow rate, sump temperature(s), and minimum containment water level.*

**Response**

The design flow per sump for LBLOCA is 7,020 gpm. Two of the three sumps are assumed to be operating due to single failure of the diesel for the third train. The flows for the pumps in each operating train are:

LHSI 2,800 gpm      HHSI 1,620 gpm      CS 2,600 gpm

The sump temperature at start of recirculation is 267 degrees F.

The minimum containment water level at start of recirculation is 38 in. off the floor.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Describe the assumptions used in the calculations for the above parameters and the sources/bases of the assumptions.

**Response**

The SI pump flow rates are the maximum values given in the Technical Specifications. The CS pump flow rate is based on calculated maximum flows when two trains are operating. The sump temperature is from the containment LOCA pressure-temperature analysis which maximizes the sump temperature by using the maximum temperatures for cooling water to the heat exchangers and for the water of the ultimate heat sink. The containment water level was determined using conservative input values for the pool contributions and conservatively accounting for items such as holdup in locations in the containment, filling of empty pipe, water in transit, steam holdup, etc.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Provide the basis for the required NPSH values, e.g., three percent head drop or other criterion.

**Response**

Westinghouse supplied the LHSI, HHSI, and CS pumps to STP from Pacific Pumps. The required NPSH values are based on input from Westinghouse and are as follows:

LHSI 16.5 ft.      HHSI 16.1 ft.      CS 16.4 ft.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Describe how friction and other flow losses are accounted for.

**Response**

The strainer modification did not change the piping friction losses used in the NPSH calculation. The friction losses are based on the maximum flows of the SI and CS pumps.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Describe the system response scenarios for LBLOCA and SBLOCA's.

**Response**

For LBLOCA the Safety Injection Pumps and the Containment Spray Pumps start automatically and take suction from the Refueling Water Storage Tank. When the tank is drawn down, the pumps' suction is automatically switched over to the containment sumps for the recirculation mode. The HHSI and CS Pumps may be turned off later in the post-accident mitigation per the emergency operating procedures.

For SBLOCA the HHSI Pump is used for the core cooling function during the injection and the recirculation phases. The CS pump is also assumed to be in operation due to automatic actuation by reaching the containment pressure set point.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Describe the operational status for each ECCS and CSS pump before and after the initiation of recirculation.

**Response**

Both before and after the initiation of recirculation, two Trains are operating. Each Train consists of one HHSI, one LHSI, and one CS pump. Each Train has its own containment sump with strainer.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Describe the single failure assumptions relevant to pump operation and sump performance.

**Response**

The STP design has three safety Trains each with its own containment sump. The sump performance analysis is based on a single failure that results in two Trains operating to handle the debris generated.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- Describe how the containment sump water level is determined.

**Response**

The Containment Water Level Calculation analyzed multiple high-energy line break cases including large break and small break LOCA's chosen to encompass a wide range of potential break sizes and locations. The breaks were analyzed at various times throughout the event including at the start of recirculation, at suspension of containment sprays and at the end of the event. The following methodology was used to develop the Containment Water Level Calculation:

1. A correlation was developed for the relationship between containment water level and the containment volume as a function of elevation using information from existing STP calculations. The correlation between containment volume and water level developed in the Water Level Calculation assumes equalization of water level between all areas of containment at the (-)11'-3" elevation including internal compartments (e.g., incore instrument room, reactor cavity and elevator shaft). The volume inside the accumulator skirts is only credited as a displacement volume for the small break LOCA case in which the water level does not reach the service way openings preventing this volume from filling. The correlation also includes all volumes below the (-)11'-3" elevation (e.g., elevator shaft, normal sump, secondary normal sump, emergency sumps, incore instrument room sump and drain lines).

2. The quantity of water added to containment from the Refueling Water Storage Tank, SI Accumulators, and the Reactor Coolant System was determined for each of the breaks considered.

3. The quantity of water diverted from the containment sump was determined. The following effects were considered:

- Steam holdup in the containment atmosphere
- Additional mass of water that must be added to the RCS due to the increase in the water density at the lower sump water temperature versus the RCS temperature prior to the LOCA
- Water volume required to fill the RCS steam space as condensation occurs
- Condensation on containment surfaces
- Water volume required to fill the Safety Injection and Containment Spray Piping that is empty prior to the LOCA
- Water in transit from the Containment Spray nozzles and the break location to the Containment Sump
- ECCS leakage outside of containment
- Miscellaneous hold-up volumes throughout containment

4. Given the net mass of water added to the containment floor based on items 2 and 3 listed above, the post-LOCA containment water level was then calculated using the correlation developed in item 1.

***Content Guide Item 3g. Net Positive Suction Head (NPSH)***

- *Provide assumptions that are included in the analysis to ensure a minimum (conservative) water level is used in determining NPSH margin.*

**Response**

See subsection immediately above.

***Content Guide Item 3g. Net Positive Suction Head (NPSH)***

- *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.*

**Response**

See subsection immediately above.

***Content Guide Item 3g. Net Positive Suction Head (NPSH)***

- *Provide assumptions (and their bases) as to what equipment will displace water resulting in higher pool level.*

**Response**

See subsection immediately above.



**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- *Provide assumptions (and their bases) as to what water sources provide pool volume and how much volume is from each source.*

**Response**

See subsection immediately above.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- *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.*

**Response**

Containment accident pressure is not credited for available NPSH.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- *Provide assumptions made which minimize the containment accident pressure and maximize the sump water temperature.*

**Response**

Containment accident pressure is not credited for available NPSH.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- *Specify whether the containment accident pressure is set at the vapor pressure corresponding to the sump liquid temperature.*

**Response**

Containment accident pressure is not credited for available NPSH.

**Content Guide Item 3g. Net Positive Suction Head (NPSH)**

- *Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.*

**Response**

This information will be provided in a later supplemental response.

**Content Guide Item 3.h - Coatings Evaluation**

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

- *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.*
- *Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.*
- *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.*
- *Provide bases for the choice of surrogates.*
- *Describe and provide bases for coatings debris generation assumptions. For example, describe how the quantity of paint debris was determined based on ZOI size for qualified and unqualified coatings.*
- *Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.*
- *Describe any ongoing containment coating condition assessment program.*

#### **Content Guide Item 3.h - Coatings Evaluation**

- *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.*

#### **Response**

The qualified coatings inside the Unit 1 and Unit 2 Reactor Containments are detailed in STP calculations. There are various types of qualified coatings used in the containment including Ethyl Silicate Inorganic Zinc (IOZ), Epoxy System, Phenolic Epoxy, Clear Sealer, Alkyd, Baked Enamel and Epoxy Intumescent.

The unqualified coatings inside the Unit 1 and Unit 2 Reactor Containments are detailed in STP calculations. There are various types of unqualified coatings used in the containment including IOZ, Epoxy System, Phenolic Epoxy, Alkyd and Baked Enamel.

The following is a brief summary of specific equipment and their coatings; the concrete walls are coated with an Epoxy System, the equipment (valves) are coated with IOZ, whip restraints are coated with Epoxy, the equipment supports are coated with IOZ, the pipe supports are coated with both Polyamide Primer (an epoxy coating) and IOZ.

#### **Content Guide Item 3.h - Coatings Evaluation**

- *Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.*

#### **Response**

The methodology utilized for the STP debris transport analysis is described above in another section. The transport of containment coatings was included in the analyses. In addition to the methodology described above, the following key attributes apply and are intended to describe and provide the bases for assumptions made in post-LOCA paint debris transport analysis.

1. It was assumed that the settling velocity of fine debris (insulation, dirt/dust, and paint particulate) can be calculated using Stokes' Law. This is a reasonable assumption since the particulate debris is generally spherical and would settle slowly (within the applicability of Stokes' Law).

2. It was assumed that the unqualified coatings would be uniformly distributed in the recirculation pool. This is a reasonable assumption since the unqualified coatings are scattered around containment in small quantities.
3. Both the qualified coatings (inside the ZOI) and the unqualified coatings were conservatively assumed to fail as 10 micron particulate in the debris generation analysis.

The results of debris transport are included in the section above and include the associated values for the transport of coatings debris both within and outside the ZOI. A review of Table 21 through Table 26 identify that for the bounding LOCA analyses, coating debris transports as fines and 83% - 100% are transported to the screen, depending on the case.

***Content Guide Item 3.h - Coatings Evaluation***

- *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.*

**Response**

This information will be provided in a later supplemental response.

***Content Guide Item 3.h - Coatings Evaluation***

- *Provide bases for the choice of surrogates.*

**Response**

This information will be provided in a later supplemental response.

***Content Guide Item 3.h - Coatings Evaluation***

- *Describe and provide bases for coatings debris generation assumptions. For example, describe how the quantity of paint debris was determined based on ZOI size for qualified and unqualified coatings.*

**Response**

The methodology utilized for the STPEGS debris generation analyses is described in sections above. The generation of containment coating debris was included in the analyses. In addition to the methodology described in these sections, the following key attributes apply and are intended to describe and provide the bases for coatings debris generation assumptions for STPEGS, and describe how the quantity of paint debris was determined based on ZOI size for qualified and unqualified coatings.

All coatings, qualified and unqualified, within the ZOI are assumed to fail and generate debris in the form of 10 $\mu$ m spherical particles, which is equivalent in size to the average zinc particle in inorganic zinc (IOZ) coatings or the pigment used in epoxy coatings.

Qualified Coatings

The assumption made for coatings in the zone of influence (ZOI) of the LOCA is based on testing performed on representative coating systems. A spherical ZOI of 5D for qualified coatings was selected based on refined analysis in WCAP-16568-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA Qualified/Acceptable Coatings", Revision 0. This was developed and

performed in order to identify an appropriate ZOI for DBA-Qualified / Acceptable coating systems less than the 10D ZOI mandated by the NRC SER on NEI 04-07. The results of this program demonstrate that a ZOI radius of 5D should be used for epoxy and untopcoated inorganic zinc coatings.

Per NEI 04-07, qualified coatings within the ZOI are assumed to fail as a result of impingement and post-accident environmental conditions. Qualified coatings outside the ZOI are assumed to remain intact. In order to determine the amount of qualified coatings that fail, a 3 dimensional model of the containment to calculate the areas of specific surfaces (i.e. floors, walls, equipment, etc.) within the ZOI. Plant documentation identifying coating types and applications were then used to determine the associated volume, weight and density of coatings. The density and weight of each of the various qualified coatings is listed in Table 27.

#### Unqualified Coatings

Per NEI 04-07, all unqualified coatings inside and outside the ZOI are assumed to fail as a result of impingement and post-accident environmental conditions. The amount of unqualified coatings that will fail was determined in a similar manner. However, the weight of the applied coatings are determined based on a theoretical coating spread rates (sq. ft. per gallon @ 1 mil thickness) instead of specific vendor coating spread rates. The density and weight of each of the various unqualified coatings is listed in Table 28.

STP request for additional information (RAI) #26 is addressed by WCAP-16568-P.

**Table 27 – Failed Qualified Coating Debris Source Term**

<b>Type of Coating</b>	<b>Density (lb/ft<sup>3</sup>)</b>	<b>Weight (lb)</b>
Epoxy	94	23
IOZ	457	553
Polyamide Primer	94	10

**Table 28 – Failed Unqualified Coating Debris Source Term**

Type of Coating	Density (lb/ft <sup>3</sup> )	Weight (lb)
Epoxy	94	1,815
Alkyd	98	310
IOZ	457	884
Baked Enamel	98	269

**Table 29 – Total Failed Qualified and Unqualified Coating Debris Source Term**

Type of Coating	Density (lb/ft <sup>3</sup> )	Weight (lb)
Epoxy	94	1,838
IOZ	457	1,437
Alkyd	98	310
Baked Enamel	98	269
Polyamide Primer	94	10

**Content Guide Item 3.h - Coatings Evaluation**

- Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.

**Response**

See section above.

**Content Guide Item 3.h - Coatings Evaluation**

- Describe any ongoing containment coating condition assessment program.

## Response

STPNOC periodically conducts condition assessments of coatings inside containment. Coating condition assessments are conducted as part of the structures monitoring program. Visual inspection of coatings in containment is intended to characterize the condition of the coating systems. If localized areas of degraded coatings are identified, those areas are evaluated and scheduled for repair/replacement as necessary.

### **Content Guide Item 3.i 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.*

- *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, "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:*

- *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.*
- *A summary of the foreign material exclusion programmatic controls in place to control the introduction of foreign material into the containment.*
- *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.*
- *A description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.*

*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*

- *Actions taken to modify or improve the containment coatings program*

**Content Guide Item 3.i Debris Source Term**

- *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.*

**Response**

During outages, STPNOC maintains containment cleanliness by adherence to the housekeeping procedure. Containment cleanliness is emphasized by the reactor containment building coordinators and the work supervisors. Prior to containment closeout at the end of the outage, the building coordinators oversee the cleanup of the containment work areas to achieve the goal of no loose debris.

**Content Guide Item 3.i Debris Source Term**

- *A summary of the foreign material exclusion programmatic controls in place to control the introduction of foreign material into the containment.*

**Response**

STPNOC uses a procedure to maintain containment integrity with respect to potential sump debris sources. This procedure provides guidance for a visual inspection of the affected areas inside containment at the completion of each containment entry when containment integrity has been established to verify that no loose debris is present that could be transported to the emergency sump and cause restriction of pump suction during LOCA conditions.

STPNOC has a procedure that governs signs and labels that contains the requirements for labeling inside containment. These requirements are used to minimize potential sump debris items.

**Content Guide Item 3.i Debris Source Term**

- *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*

**Response**

Insulation replacement inside containment is either a like-for-like replacement as a maintenance activity ("rework") or is a modification with a design change that has been approved by STPNOC Engineering. The STPNOC design change process ensures that new insulation material that differs from the initial design is evaluated.

The STPNOC design change process also calls for evaluations of added metals such as aluminum that could contribute to post-LOCA chemical effects in the sump water. The process looks at coatings that are to be used inside containment. Impacts to post-LOCA recirculation flow paths and recirculation sump debris impact on internals of fluid containing components are part of the design change evaluation process described in the procedure.

**Content Guide Item 3.i Debris Source Term**

- *A description of how maintenance activities including associated temporary changes are assessed and managed in accordance with the Maintenance Rule, 10 CFR 50.65.*

**Response**

Maintenance activities inside containment are subject to the cleanliness requirements that are given in the containment integrity surveillance procedure. The temporary change process also calls for an evaluation of items installed inside containment.

**Content Guide Item 3.i Debris Source Term**

- *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*

**Response**

STPNOC did not perform (and does not plan to perform) any insulation change outs or modifications to insulation banding or jacketing to reduce the potential insulation debris source term. No modifications to components or to systems were made to reduce the debris burden at the sump strainers.

**Content Guide Item 3.i Debris Source Term**

- *Actions taken to modify or improve the containment coatings program*

**Response**

The sump performance evaluation did not result in any changes to the containment coatings program.

**Content Guide Item 3.j Screen Modification Package**

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

- *Provide a description of the major features of the sump screen design modification.*
- *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.*

**Content Guide Item 3.j Screen Modification Package**

- *Provide a description of the major features of the sump screen design modification*

**Response**

There is no change to the three independent sump pits. The sump screen above the pit has been removed; and now each sump has its own new strainer. There are no shared components between trains.

The new strainer assemblies for each of the 3 emergency sumps consist of two 5-module assemblies, one 4-module assembly, and one 6-module assembly. Each module is made up of eleven strainer disks. The strainer consists of stainless steel perforated plate with 0.095 in. diameter openings. Flow leaving the



strainer assembly enters a four inlet plenum box (one inlet for each strainer assembly). The plenum box collects the flow from the strainer assemblies and directs it downward directly into the sump pit. An access cover is provided on the plenum box for internal inspection of the sump structures, vortex suppressor, and the strainer assemblies. The sump pit is now covered with a sump cover plate that prevents material from falling directly into the pit without passing through the strainer assemblies.

The new strainers have a surface area of 1,818.5 sq ft per sump. The old screens had a surface area of 155.4 sq ft per sump. For the design flow of 7,020 gpm per sump, the new strainers have a flow velocity of 0.009 ft/sec.

See the attached figures for the old screen design and the new strainer design.

***Content Guide Item 3.j Screen Modification Package***

- *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.*

**Response**

There are no high energy lines in the area of the emergency sumps except for the High Head Safety Injection lines which are used for accident mitigation and are not assumed to be the accident initiator. No piping reroutes were needed for installation of the new sump strainers. No component relocations or additions were necessitated by the new strainer installation.

***Content Guide Item k. 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).*

- *GL 2004-02 Requested Information Item 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 flow conditions*
- *Summarize the design inputs, design codes, loads, and load combinations utilized for the sump strainer structural analysis.*
- *Summarize the structural qualification results and design margins for the various components of the sump strainer structural assembly.*
- *Summarize the evaluations performed for dynamic effects such as pipe whip, jet impingement, and missile impacts associated with high-energy line breaks (as applicable).*
- *If a backflushing strategy is credited, provide a summary statement regarding the sump strainer structural analysis considering reverse flow.*

***Content Guide Item k. Sump Structural Analysis***

- *Summarize the design inputs, design codes, loads, and load combinations utilized for the sump strainer structural analysis.*

**Response**

The strainer components are designed in accordance with the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, 7th Edition" with Supplement Numbers 1, 2 and 3; and SEI/ASCE 8-02, "Specification for the Design of Cold-Formed Stainless Steel Structural Members". The acceptance criteria are primarily in accordance with these codes. In circumstances where these specifications do not provide adequate guidance for a particular component, other codes, specifications or standards are used for guidance. For instance, the strainers are made from stainless steel materials. The AISC Specification does not specifically cover stainless steel materials. Therefore, ANSE/AISC N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety Related Structures for Nuclear Facilities", is used to supplement the AISC Specification in any areas related specifically to the structural qualification of stainless steel. Note that only the allowable stresses are used from this Specification and load combinations and allowable stress factors for higher service levels are not used.

For the perforated plates, the equations from Appendix A, Article A-8000 of the ASME B&PV Code, Section III, 1998 Edition are used instead of the AISC code. A-8000 is deemed more appropriate because it is written specifically for perforated plates.

The strainer also has several components made from thin gage sheet steel, and cold formed stainless sheet steel. SEI/ASCE 8-02, "Specification of the Design of Cold-Formed Stainless Steel Structural Members", is used for certain components where rules specific to thin gage and cold form stainless steel are applicable. The rules for Allowable Stress Design (ASD) as specified in Appendix D of this specification are used. This is further supplemented by the AISC Specification where the ASCE Specification is lacking specific guidance. Finally, guidance is also taken from AWS D1.6, "Structural Welding Code – Stainless Steel", as it relates to the qualification of stainless steel welds.

The new strainers are designed for loads due to weight, pressure, and dynamic loads. The dynamic loads come from seismic and from hydrodynamic drag loads due to sloshing. The strainers are loaded due to the inertia effect due to the motion of the containment floor during an earthquake. Hydrodynamic loads on the strainers are due to the motion of the water surrounding the strainer during a seismic event. Two weight loads are applicable. This includes the weight of the strainer components themselves and the weight of the debris that accumulates on the strainer. The design weight of the debris per strainer module is taken as 150 lbs. which bounds the calculated weight.

Thermal expansion loads are taken as zero because the strainers are essentially free standing structures that are basically free to expand without restraint due to sufficient gaps built-in to the pin connections that secure the modules to the floor tracks. Thermal expansion loads on the sump pit cover plate and the floor angles are considered negligible because these components have slotted holes or edge clips to allow for substantially unrestrained thermal growth.

The pressure load acting on the strainer is the differential pressure across the strainer perforated plates in the operating condition. This is defined as 5.71 ft. of head.

The load combinations and allowable stresses are based on the requirements of STP design criteria and are provided below.

Load Condition	Combination	Allowable
Normal Operating	DW + DP + WD	1.0 S
Normal Operating (Outage/Lift Load)	DW + LL	1.0 S
Operating Basis Earthquake	DW + DP + WD + OBE	1.0 S
Safe Shutdown Earthquake	DW + DP + WD + SSE	1.6 S

- DW = Dead Weight Load  
 LL = Live Load (additional live loads acting on strainer assembly during outages only)  
 WD = Weight of Debris  
 DP = Differential Pressure  
 OBE = Operating Basis Earthquake  
 SSE = Safe Shutdown Earthquake  
 S = Required section strength based on elastic design methods and the allowable stress defined in the 7th edition AISC Specification, or other applicable specifications (ASCE 8-00, N-690, etc.)

**Content Guide Item k. Sump Structural Analysis**

- Summarize the structural qualification results and design margins for the various components of the sump strainer structural assembly

**Response**

The calculation for seismic design margins for the strainers and their components shows that the stress Interaction Ratios (calculated stress/allowable stress) are less than one for both Operating Basis Earthquake and Safe Shutdown Earthquake loads.

**Content Guide Item 3.k Sump Structural Analysis**

- Summarize the evaluations performed for dynamic effects such as pipe whip, jet impingement, and missile impacts associated with high-energy line breaks (as applicable).

**Response**

There are no high energy lines in the area of the emergency sumps except for the High Head Safety Injection lines which are used for accident mitigation and are not assumed to be the accident initiator. Thus no evaluations were needed for high energy line breaks.

**Content Guide Item 3.k Sump Structural Analysis**

- If a backflushing strategy is credited, provide a summary statement regarding the sump strainer structural analysis considering reverse flow.

**Response**

The new strainer design does not involve any backflushing.

**Content Guide Item 3.1 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.

Provide a summary of the upstream effects evaluation including the information requested in GL 2004-02 Requested Information Item 2(d)(iv).

GL 2004-02 Requested Information Item 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.*

*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.*

- *Summarize measures taken to mitigate potential choke points.*
- *Summarize the evaluation of water holdup at installed curbs and/or debris interceptors.*
- *Describe how potential blockage of reactor cavity and refueling cavity drains has been evaluated, including likelihood of blockage and amount of expected holdup.*

**Content Guide Item 3.1 Upstream Effects**

- *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.*

**Response**

The Upstream Effects Evaluation provides a general description of the containment and sub-compartments as well as an examination of each elevation to identify physical and structural features that affect the flow of debris and water to lower containment. The Upstream Effects Evaluation preceded the Containment Water Level Calculation and served to identify potential flow path choke points and areas of containment where water volumes could potentially be held up from reaching the containment sumps due to the actual design layout or due to the added effects of debris resulting from high-energy line break accidents. The evaluation was based on a review of STP design documents including the UFSAR, calculations and containment drawings. No containment walkdowns were performed in support of the evaluation; however, containment photographs were reviewed. Plant personnel also provided additional information as needed.

Spray/break inventory and debris originating at upper elevations will eventually flow down to the 19'-0" elevation. The primary flow paths are through significant grated floor areas at upper elevations. See STP Response to Item 3.1 (4th bullet) below for additional information regarding the drainage flow path from the refueling cavity. Once at the 19'-0" elevation, significant concrete flooring routes the flow of water and debris to grated areas inside and outside the secondary shield wall. The primary sources of insulation debris are located above the 19'-0" elevation (e.g., the primary RCS piping and components). Therefore, the majority of insulation debris will be trapped at this elevation unless it can fit through standard floor grating. It is judged that this elevation will not become a choke point for flow because should large debris hold up at area of floor grating, the water has multiple other potential grated flow paths to the lower elevations. In addition, there is open communication between the areas inside and outside the secondary shield wall increasing the grated floor area available to pass flow.

The recirculation pool forms at the (-)11'-3" elevation. The ECCS emergency sumps are located in the southern quadrants of containment outside the secondary shield wall. The flow path around the outside of the secondary shield wall is generally open providing large flow passages to the ECCS emergency sumps. See STP Response to Item 3.1 (3rd bullet) for description of flow communication between areas inside and outside the secondary shield wall at the (-)11'-3" elevation.

**Content Guide Item 3.1 Upstream Effects**

- *Summarize measures taken to mitigate potential choke points.*

**Response**

No measures are necessary to mitigate potential choke points.

**Content Guide Item 3.1 Upstream Effects**

- *Summarize the evaluation of water holdup at installed curbs and/or debris interceptors.*

**Response**

There are only four (4) significant openings through which recirculation water and debris may pass from inside the secondary shield wall to the annular region outside the secondary shield wall at the (-)11'-3" elevation. These openings are four 30" circular vent holes located at a centerline elevation of (-)8'-6". Since these vent holes are above the floor, the secondary shield wall acts as a curb, or debris barrier, in the flow path to the containment sumps. As discussed in the response to Item 3.1 (2nd bullet), only small debris (small enough to fit through standard floor grating) is expected to reach the base floor elevation. Significant mounding of small debris is not expected to create a dam that would prevent flow through the vent openings. The volume of water below the vent holes is considered lost to the ECCS emergency sump.

No new curbs and/or debris interceptors have been installed.

**Content Guide Item 3.1 Upstream Effects**

- *Describe how potential blockage of reactor cavity and refueling cavity drains has been evaluated, including likelihood of blockage and amount of expected holdup.*

**Response**

The refueling cavity drains via two (2) horizontal 6" drains with center line elevation located 10.75 inches above the bottom of the lower internals storage area. The two horizontal refueling cavity drains have an inside diameter of 6.065" and are straight pipe segments approximately 7 feet long. ALION Calculation ALION-CAL-STPEGS-2916-006, Rev. 0, "GSI 191 Containment Recirculation Sump Evaluation: Determination of Fibrous Debris Transport to the Refuel Cavity" and Westinghouse letter LTR-CSA-06-45 "Refueling Cavity Drain Lines" are the basis for concluding that the refueling cavity drain will not become plugged with debris. Based on debris generation and transport analyses, it was conservatively determined that 71 ft<sup>3</sup> of fines (individual fibers) and 177 ft<sup>3</sup> of small pieces (< 6") of fibrous insulation are transported to the Refueling Cavity. The STP analyses assume that the drains do not become blocked by debris, thus restricting flow from the cavity. No additional water hold-up are assumed for the refueling cavity except that volume required to induce flow through the cavity drains above the cavity floor.

Debris blown out of the steam generator compartments is expected to be distributed evenly around the operating floor (elevation 68'-0"). The refueling cavity drain lines are located on opposite walls of the lower internals storage area and large concentrations of debris would not be expected to land near both drain lines. There are no drain covers or trash racks for the drains that would allow fibers to build up and block flow. The largest debris transported to the refueling cavity (<6") is smaller than the drain line diameter (6.065"). In addition, fibrous debris is not rigid and will deform to fit through the drain if needed. The flow velocity through the drains has been determined to be greater than the incipient tumbling velocity for 6" pieces of Nukon; however, should debris accumulate in the drain line, the

buildup of water behind the debris will provide sufficient driving force to push the debris through the straight pipes.

STP RAI #39 is addressed by this evaluation.

***Content Guide Item 3.m 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.*

*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 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.*

*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.*

- *If NRC-approved methods were used (e.g., WCAP-16406-P with accompanying NRC SE)<sup>1</sup>, 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.*
- *Provide a summary and conclusions of downstream evaluations.*
- *Provide a summary of design or operational changes made as a result of downstream evaluations.*

<sup>1</sup> *The draft NRC SE for this document was issued to the applicant in November 2007.*

***Content Guide Item 3.m Downstream effects - Components and Systems***

- *If NRC-approved methods were used (e.g., WCAP-16406-P with accompanying NRC SE)<sup>1</sup>, 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.*

**Response**

Methods are discussed below under summary and conclusions. See next response.

***Content Guide Item 3.m Downstream effects - Components and Systems***

- *Provide a summary and conclusions of downstream evaluations.*

## Response

The evaluations listed below were developed to address effects of debris carried downstream of the containment sump screen on the function of the ECCS and containment spray system (CSS) in terms of potential wear of components and blockage of flow streams. Close-tolerance subcomponents in pumps, valves and other ECCS and CSS components were evaluated for potential plugging or excessive wear due to extended post-accident operation with debris-laden fluids. The evaluations were developed in accordance with WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191" prior to issuance of Revision 1 and the accompanying NRC SER. No exceptions were taken to the WCAP-16406-P methodology. A revised evaluation will be performed using Rev. 1 and the SER and will be described in a later Supplemental response to the GL.

STP RAI #31 is addressed by these evaluations.

The quantity of debris in the recirculating fluid that passes through the sump is characterized in terms of volume concentration. For downstream effects, this debris concentration is defined as the ratio of the solid volume of the debris in the pumped fluid to the total volume of water that is being recirculated by the ECC and CS systems. The resulting volume concentration from the initial debris concentration and total water volume is 0.001021.

The mass of debris in the recirculating fluid that passes through the sump is characterized in terms of parts per million (ppm). For downstream effects, the total initial debris concentration comprised of the individual debris concentrations is defined as the ratio of the solid mass of the debris in the pumped fluid to the total mass of water that is being recirculated by the ECC and CS systems.

Debris Type	Concentration
Fibrous	14 ppm
Particulate	99 ppm
Coatings	1388 ppm
Total	1501 ppm

It was determined that all of the following ECCS and CSS components evaluated for STP can accommodate sump bypass particles without blockage: throttle valves; pipes, valves, and instrumentation; orifices and eductors; heat exchangers; and nozzles. A review of drawings and documents indicated that none of the ECCS and CS valves are throttled. There are no blockage/plugging issues: for existing piping, valves, and instrumentation lines; for the ECCS and CS flow element orifices, flow restricting orifices or in educator passages; for RHR heat exchangers; and for the CS spray nozzles.

According to the criteria established in WCAP-16406-P, the wear impact on the valves identified in the STP evaluation was determined not critical and needs no further erosion evaluation.

### Pump Wear Evaluation:

For pumps, the effect of debris ingestion through the sump screen were evaluated based on three aspects of operability, including hydraulic performance, mechanical shaft seal assembly performance, and mechanical performance (vibration) of the pumps. The pumps identified for evaluation were the High Head Safety Injection (HHSI), Low Head Safety Injection (LHSI), and Containment Spray (CS) pumps. According to the methodology established in WCAP-16406-P, because the increased clearance for the pumps is within two times the design clearance, no effect on their hydraulic performance is expected.

Pump	Normal Wear (mils)	Erosive Wear (mils)	Abrasive Wear (mils)	Total Wear (mils)	Design Wear (mils)	Increased Clearance (mils)	2X Design Clearance (mils)
HHSI	0.0	1.0E-3	19.6766	19.6766	17	36.6776	34
LHSI	0.0	1.0E-3	19.6766	19.6766	23	42.6776	46
CS	0.0	1.0E-3	19.6766	19.6766	23	42.6776	46

For South Texas, the HHSI, LHSI, and CS pumps are multi-stage and must be evaluated for mechanical (vibration) performance. As evaluated in WCAP-16406-P, the other models of SI pumps will meet operability requirements for wear ring clearances up to 2 times the design clearance. Although the resulting wear ring gap for the HHSI pumps is greater than the 34 mils criteria, the 25% margin in the abrasive wear model (Appendix F.4.4 of WCAP-16406-P) allows for a margin of 34 mils \* 0.25 or 8.5 mils, so there is no expected pump vibration concern due to the containment sump debris for any of the pumps.

The initial results of the pump wear are acceptable; however the STP evaluation will be revised to incorporate the Archard pump wear model from WCAP-16406-P, Revision 1 and the accompanying NRC SER. The results of this evaluation are expected to be completed in 2008 and will be included in the final submittal of the GL 2004-02 Supplemental Responses.

The mechanical shaft seal assembly performance evaluation resulted with the suggested replacement of the Low Head Safety Injection (LHSI), High Head Safety Injection (HHSI) and Containment Spray (CS) pumps' carbon/graphite packing assemblies with a more wear resistant material. However because South Texas Project has an Engineered Safety Feature (ESF) atmospheric filtration system for the building where the pumps are located, replacement of the carbon/graphite seal bushing is not required.

#### Heat Exchanger Wear Evaluation:

Tube failure for heat exchangers will occur when the resultant wall thickness after erosion is less than the required wall thickness to retain internal and external pressures. According to methodology established in WCAP-16406-P, the minimum wall thickness required to retain both internal and external pressures is less than the resultant wall thickness after erosion. Therefore, the heat exchangers are not expected to fail.

Heat Exchangers	D <sub>0</sub> (in)	Required (in)	t <sub>m</sub>	t <sub>actual</sub> (in)	t <sub>eroded</sub> (in)	Failure (yes/no)
RHR	0.75	0.0173		0.049	3.78E-4	no

#### Orifice Wear Evaluation:

If the orifice inside diameter due to erosive wear is changed by less than 3%, the system performance may be considered negligible. This criterion was established in WCAP-16406-P which states that an insignificant amount of wear occurs when they system flow through the orifice is changed by less than 3%. The STP evaluation considers the initial ratio of the diameters before erosive wear and the ratio of the diameters after erosive wear for single plate and multiple plate multiple hole orifices. It was found that the inside diameters of all the orifices change by less than 3% and therefore are not expected to fail.

#### Spray Nozzle Wear Evaluation:

Failure due to erosive wear for spray nozzles is expected to occur when the flow from the nozzle is increased by 10% due to the increase in the nozzle inner diameter. The STP evaluation considers the



inner diameter before and after erosive wear begins. This acceptance criterion and methodology was established in WCAP-16406-P. It was found that the flow is changed by less than 4% which is less than the 10% limit; therefore the nozzles do not fail.

	Nozzle Velocity (ft/sec)	Accelerated Rate (in/hr)	Wear	D <sub>1</sub> (in)	Flow Increase (%)
CSS Spray Headers	44.16	4.538E-6		0.3816	3.6

#### Instrumentation Blockage Evaluation:

The potential for blockage of the reactor vessel Level Instrumentation System (RVLIS) is not evaluated since South Texas Project has a Westinghouse design RVLIS, for which WCAP-16406-P states there is no blockage concern due to the debris ingested through the sump screen during recirculation.

#### **Content Guide Item 3.m Downstream effects - Components and Systems**

- Provide a summary of design or operational changes made as a result of downstream evaluations.

#### **Response**

No design or operational changes were made as a result of the current downstream evaluations.

#### **Content Guide Item 3.n 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.*

- Show that the in-vessel effects evaluation is consistent with, or bounded by, the industry generic guidance (WCAP-16793)<sup>2</sup>, 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.

<sup>2</sup> Because this document is still under NRC review, licensees should be aware of any NRC RAIs on it. The draft NRC SE for WCAP-16793 is expected to be issued in December 2007. After resolution of any open items from the staff's evaluation of this document, the staff will determine whether additional information is needed from licensees. Licensees should not delay their GL responses pending this information.

#### **Content Guide Item 3.n Downstream Effects - Fuel and Vessel**

- Show that the in-vessel effects evaluation is consistent with, or bounded by, the industry generic guidance (WCAP-16793)<sup>2</sup>, 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.

#### **Response**

The following evaluations consider the effects that debris carried downstream of the containment sump screen and into the reactor vessel has on core cooling, including fuel and vessel blockage. These evaluations were performed in accordance with WCAP-16406-P and WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate and Chemical Debris in the Recirculating Fluid" with no exceptions taken. The NRC SER is still pending on WCAP-16793-NP.

STP RAI #31 and 36 are addressed by these evaluations.

It was found that all evaluated dimensions of essential flow paths through the reactor internals are adequate to preclude plugging by sump debris. There is sufficient clearance for debris that may pass the containment sump screen since the limiting dimensions of the essential flow paths in the upper and lower internals are all greater than the maximum particle dimension. The maximum particle dimension is defined as twice the sump screen hole diameter. The sump screen hole diameter evaluated is 0.125 inches. The smallest clearance found in South Texas Project is 1.19 inches. Therefore, any screen size smaller than 0.59 inches will prevent plugging by sump debris in the vessel at South Texas Project. The new strainers have a hole size of 0.095 in. dia.

STPNOC evaluated the potential for fuel blockage from debris carried downstream of the containment sump screen. In the cold-leg break evaluation, the high rate of bypass flow around the core and increased filtering by the containment emergency recirculating sump (CERS) screen is insufficient to preclude the formation of a fiber bed of 0.125 inches from forming on the underside of the bottom nozzles within approximately 10 minutes after initiation of the CERS recirculation flow. At the time of hot-leg injection, 5.5 hours after accident initiation, an insignificant fraction of the initial fiber concentration remains available in the CERS for deposition on the top of the core. In the hot-leg break evaluation, the thickness of the fibrous bed forming on the underside of the fuel bottom nozzle reaches approximately 0.125 inches immediately after initiation of the CERS recirculation flow. At the time of hot-leg injection, 5.5 hours after accident initiation, an insignificant fraction of the initial fiber concentration remains available in the CERS for deposition on the top of the core.

The conclusion of this evaluation indicated that the amount of fibrous debris generated by a large break LOCA in STPEGS would produce a fibrous concentration in the CERS volume that would allow fibrous debris on the underside of the fuel bottom nozzle to exceed the acceptance criterion of less than 0.125 inches. STPNOC determined that additional evaluation of fuel blockage potential would be required.

Subsequently, a preliminary refined fuel blockage assessment was performed for STP to demonstrate that blockage from fiber build-up will not compromise fuel cooling. The results of PCI prototype strainer performance testing based on water flow and debris mix conditions expected in South Texas containments following a postulated LOCA was used to determine the potential for STP fuel blockage. The evaluation used fibrous debris bypass test data to determine the fuel blockage potential and was performed in accordance with guidance from WCAP-16406-P, Revision 1 and WCAP-16793-NP (as modified by initial NRC staff comments on that document). The results of this evaluation indicate that the amount of fibrous debris generated by a large break LOCA will not produce a fibrous debris build-up on the underside of the fuel bottom nozzle that exceeds the acceptance criterion of less than 0.125 inches. Fibrous debris bypass test data from strainer testing in February 2008 will be used in the revised evaluation that will be included in STP's final GL response submittal.

The in-vessel effects evaluation for STP will be performed in accordance with guidance from WCAP-16793-NP as modified by NRC staff comments on that document. The results of this evaluation are expected to be completed in 2008 and will be included in STP's final submittal of GL 2004-02 Supplemental Responses. No design or operational changes have been made as a result of the current fuel blockage evaluation.

### **Content Guide Item 3.0 Chemical Effects**

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

- *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.*
- *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. ML0726007425).*

<sup>3</sup> *The NRC staff expects to issue a draft SE on WCAP-16530, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," in November 2007.*

## **Response**

The purpose of this analysis is to determine the type and quantity of chemical precipitates which may form post-LOCA. This input is intended to be used for screen performance testing and may be used in the evaluation of chemical effects on downstream equipment. Though the quantities of precipitates expected to form have been calculated, the sump strainer blockage headloss effects will not be known until after testing has been completed in 2008. A later Supplemental response to the GL will describe the chemical effects testing method and results.

STPNOC evaluated the type and expected quantity of chemical products that would be expected to form in the recirculation fluid specifically for STP. Revision 0 of this evaluation used the chemical model/methodology developed in WCAP-16530-NP, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," prior to release of the accompanying NRC SER. No deviations were taken to the WCAP-16530-NP methods.

STP RAI numbers 6, 14 and 20 are addressed by the application of WCAP-16530-NP and the results from this evaluation. STP RAI numbers 2, 3, 4, 5 and 7 are addressed as material and condition inputs to the evaluation.

Input assumptions (and their basis) used to determine chemical effects loading: pH range, temperature profile, duration of containment spray, and materials expected to contribute to chemical effects are described in the chemistry effects evaluation. The spray values from the time of recirculation were assumed to equal the sump pH values. This is conservative because the higher pH of the sump will produce more precipitates. The spray pH curve consists of the initial pH of 4.5 and the calculated values for the sump pH from the time of recirculation. Because the sump temperature data was only provided for 2 days, the final temperature was extended for the 30 day period. Extending the final temperature of 165 °F from 2 days to 30 days will provide more conservative values for precipitate formation since this temperature is higher than the actual temperatures expected due to cooling by the RHR heat exchangers.

Because of the uncertainty of the operator actions which may be taken post-LOCA, the evaluation was performed with spray continuing for both 24 hour and 30 day durations for both maximum and minimum recirculation volumes. This resulted in four sensitivity cases. The materials expected to contribute to the formation of chemical precipitates are: CalSil (Marinite) insulation, fiberglass insulation, microtherm, concrete, trisodium phosphate, submerged aluminum, and non-submerged aluminum. The resulting expected chemical precipitates are sodium aluminum silicate (NaAlSi<sub>3</sub>O<sub>8</sub>), aluminum oxyhydroxide (AlOOH), and calcium phosphate (Ca<sub>3</sub>(P<sub>04</sub>)<sub>2</sub>).

The case with the maximum recirculation water volume and 30-day spray duration yields the maximum total amount of precipitates.

Spray Duration	Maximum Recirculation Volume				Minimum Recirculation Volume			
	24 hours		30 days		24 hours		30 days	
	kg	ppm	kg	ppm	kg	ppm	kg	ppm
NaAlSi3O8	318.4	128.9	649.5	262.9	295.1	219.6	497.8	370.5
AlOOH	0.0	0.0	35.7	14.5	0.0	0.0	64.9	48.3
Ca3(PO4)2	162.7	65.9	162.7	65.9	132.0	98.2	132.0	98.2

Revision 1 of the STP chemistry effects evaluation used the refined methodology developed in WCAP-16785-NP, "Evaluation of Additional Inputs to the WCAP-16530-NP Chemical Model," to perform additional sensitivity cases. STP will use the base case chemical effects quantities from Revision 0 during the performance of strainer headloss testing with chemical effects surrogates.

### ***Content Guide Item 3.p 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. 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.*

*GL 2004-02 Requested Information Item 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 GL. Any licensing actions or exemption requests needed to support changes to the plant licensing basis should be included.*

### **Response**

A license amendment request was submitted that proposed revising the Technical Specification (TS) Surveillance Requirement (SR) 4.5.2.d for the inspection of the Emergency Core Cooling System (ECCS) sumps for consistency with the new STP sump design.

**Commitments from the Supplemental Response to GL2004-02**

Commitment	Tracking Action	Due Date
<p><i>Content Guide Item 3f. Head Loss and Vortexing</i></p> <ul style="list-style-type: none"> <li>• Provide a summary of the methodology, assumptions and results of the vortexing evaluation. Provide bases for key assumptions.</li> <li>• Address the ability of the design to accommodate the maximum volume of debris that is predicted to arrive at the screen.</li> <li>• Address the ability of the screen to resist the formation of a "thin bed" or to accommodate partial thin bed formation.</li> <li>• Provide the basis for the strainer design maximum head loss.</li> <li>• Describe significant margins and conservatisms used in the head loss and vortexing calculations.</li> <li>• Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the clean strainer head loss calculation.</li> <li>• Provide a summary of the methodology, assumptions, bases for the assumptions, and results for the debris head loss analysis.</li> <li>• 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.</li> <li>• 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.</li> </ul>	CR04-12498-15-1	6/30/2008
<p><i>Content Guide Item 3g. Net Positive Suction Head (NPSH)</i></p> <ul style="list-style-type: none"> <li>• Provide the NPSH margin results for pumps taking suction from the sump in recirculation mode.</li> </ul>	CR04-12498-15-2	6/30/2008
<p><i>Content Guide Item 3.h - Coatings Evaluation</i></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Provide bases for the choice of surrogates.</li> </ul>	CR04-12498-15-3	6/30/2008
<p><i>Content Guide Item 3.m Downstream effects - Components and Systems</i></p> <ul style="list-style-type: none"> <li>• Provide a summary and conclusions of downstream evaluations.</li> </ul> <p>A revised evaluation will be performed using Rev. 1 and the SER and will be described in a later Supplemental response to the GL.</p>	CR04-12498-15-4	6/30/2008
<p>The initial results of the pump wear are acceptable; however the STP evaluation will be revised to incorporate the Archard pump wear model from WCAP-16406-P, Revision 1 and the accompanying NRC SER. The results of this evaluation are expected to be completed in 2008 and will be included in the final submittal of the GL 2004-02 Supplemental Responses.</p>	CR04-12498-15-5	6/30/2008
<p>The in-vessel effects evaluation for STP will be performed in accordance with guidance from WCAP-16793-NP as modified by NRC staff comments on that document. The results of this evaluation are expected to be completed in 2008 and will be included in STP's final submittal of GL 2004-02 Supplemental Responses. No design or operational changes have been made as a result of the current fuel blockage evaluation.</p>	CR04-12498-15-6	6/30/2008

Commitment	Tracking Action	Due Date
<p><b>Content Guide Item 3.o Chemical Effects<sup>3</sup></b>  <i>The objective of the chemical effects section is to evaluate the effect that chemical precipitates have on head loss and core cooling.</i></p> <ul style="list-style-type: none"> <li>• <i>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.</i></li> <li>• <i>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. ML0726007425).</i></li> </ul> <p><sup>3</sup><i>The NRC staff expects to issue a draft SE on WCAP-16530, "Evaluation of Post-Accident Chemical Effects in Containment Sump Fluids to Support GSI-191," in November 2007.</i></p> <p><b>Response</b></p> <p>The purpose of this analysis is to determine the type and quantity of chemical precipitates which may form post-LOCA. This input is intended to be used for screen performance testing and may be used in the evaluation of chemical effects on downstream equipment. Though the quantities of precipitates expected to form have been calculated, the sump strainer blockage headloss effects will not be known until after testing has been completed in 2008. A later Supplemental response to the GL will describe the chemical effects testing method and results.</p>	<p>CR04-12498-15-7</p>	<p>6/30/2008</p>

Attachments 1-5  
Sump Design Drawings  
~~(NOT FOR PUBLIC DISCLOSURE)~~

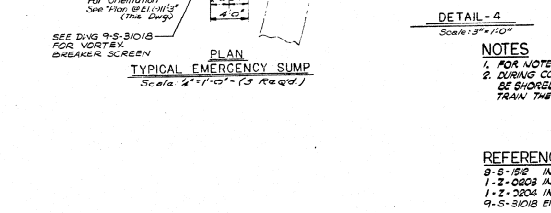
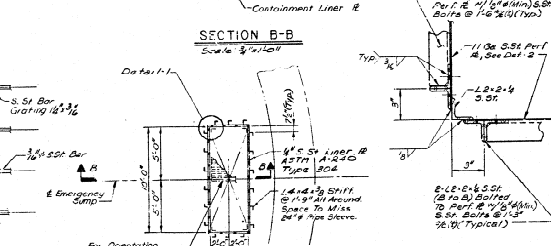
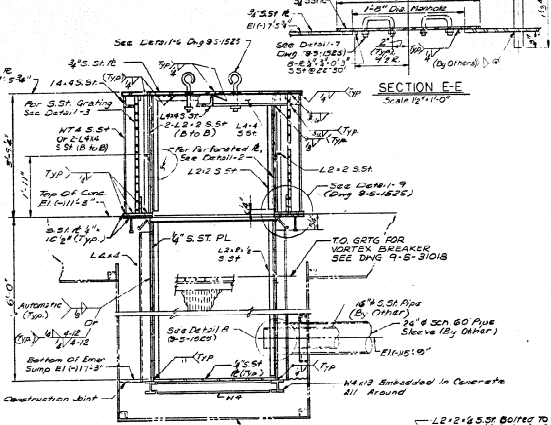
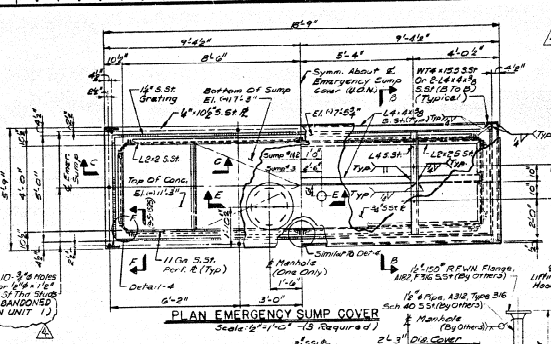
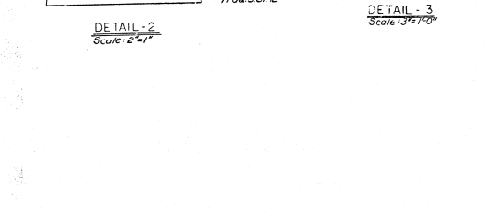
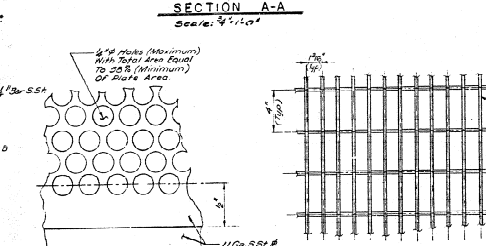
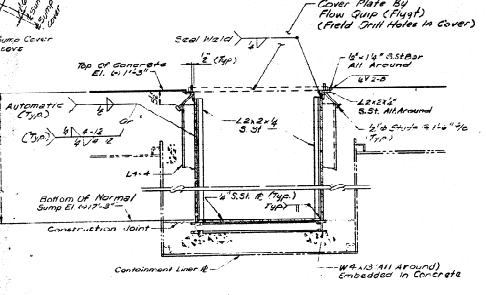
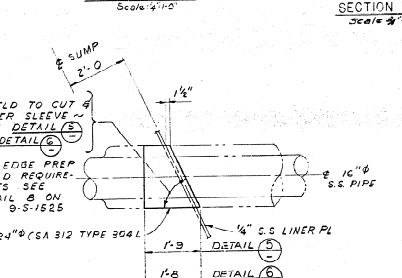
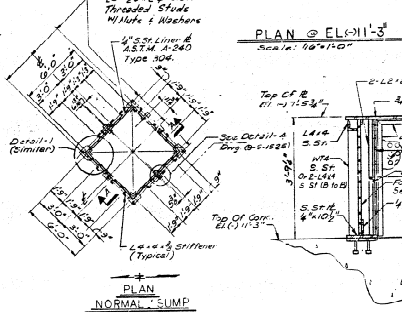
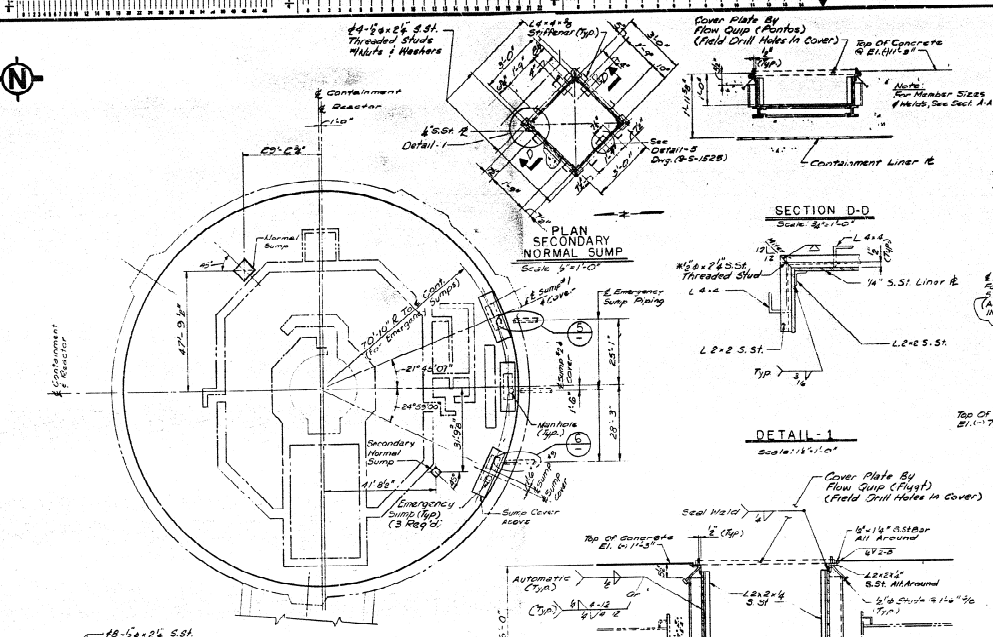
1. 3C269S1516 Rev. 4 Original Sump Design
2. SFS-STP-DD-00 General Arrangement
3. SFS-STP-DD-02 Sump A
4. SFS-STP-DD-03 Sump B
5. SFS-STP-DD-04 Sump C

# 9-S-1516

# 9-S-1516

SIZE E

SCALE: 1/8" = 1'-0"



REV. TO BE INCORPORATED INTO SHEET		
NO.	DESCRIPTION	DATE
1	FOR 3D MODELING	11/18/02
2	FOR 3D MODELING	11/18/02
3	FOR 3D MODELING	11/18/02
4	FOR 3D MODELING	11/18/02
5	FOR 3D MODELING	11/18/02
6	FOR 3D MODELING	11/18/02
7	FOR 3D MODELING	11/18/02
8	FOR 3D MODELING	11/18/02
9	FOR 3D MODELING	11/18/02
10	FOR 3D MODELING	11/18/02
11	FOR 3D MODELING	11/18/02
12	FOR 3D MODELING	11/18/02
13	FOR 3D MODELING	11/18/02
14	FOR 3D MODELING	11/18/02
15	FOR 3D MODELING	11/18/02
16	FOR 3D MODELING	11/18/02
17	FOR 3D MODELING	11/18/02
18	FOR 3D MODELING	11/18/02
19	FOR 3D MODELING	11/18/02
20	FOR 3D MODELING	11/18/02
21	FOR 3D MODELING	11/18/02
22	FOR 3D MODELING	11/18/02
23	FOR 3D MODELING	11/18/02
24	FOR 3D MODELING	11/18/02
25	FOR 3D MODELING	11/18/02
26	FOR 3D MODELING	11/18/02
27	FOR 3D MODELING	11/18/02
28	FOR 3D MODELING	11/18/02
29	FOR 3D MODELING	11/18/02
30	FOR 3D MODELING	11/18/02
31	FOR 3D MODELING	11/18/02
32	FOR 3D MODELING	11/18/02
33	FOR 3D MODELING	11/18/02
34	FOR 3D MODELING	11/18/02
35	FOR 3D MODELING	11/18/02
36	FOR 3D MODELING	11/18/02
37	FOR 3D MODELING	11/18/02
38	FOR 3D MODELING	11/18/02
39	FOR 3D MODELING	11/18/02
40	FOR 3D MODELING	11/18/02

NOTES  
 1. FOR NOTES SEE DWG 9-S-1512.  
 2. DURING CONCRETE POUR, THE LINER & SHALL BE SHORED TEMPORARILY AT THE TOP TO RESIST THE INWARD LINER MOVEMENT.

REFERENCE DRAWINGS  
 9-S-1512 INVERTAL-S.S. LINER @ EL. 111-6 1/2"  
 1-2-0203 INSTRUMENT PIPING EL. (111)-8"  
 1-2-0204 INSTRUMENT PIPING EL. (111)-5"  
 9-S-3108 EMERGENCY SUMP VORTEX BREAKER

THIS DWG SUPERSEDES BROWN & ROOT DWGS. 3C26-1-S-1516, REV. 8  
 3C26-2-S-1516, REV. 4

Sta. 24046  
**BECHTEL ENERGY CORPORATION**  
 HOUSTON, TEXAS  
**HOUSTON LIGHTING & POWER CO.**  
 SOUTH TEXAS PROJECT

STRUCTURAL CONTAINMENT BUILDING S. ST. LINER & NORMAL & EMERGENCY SUMPS UNIT NO. 1 & 2  
 SCALE AS NOTED  
 JOB NO. 14926  
 DRAWING NO. 3C26-9-S-1516  
 REV. 4

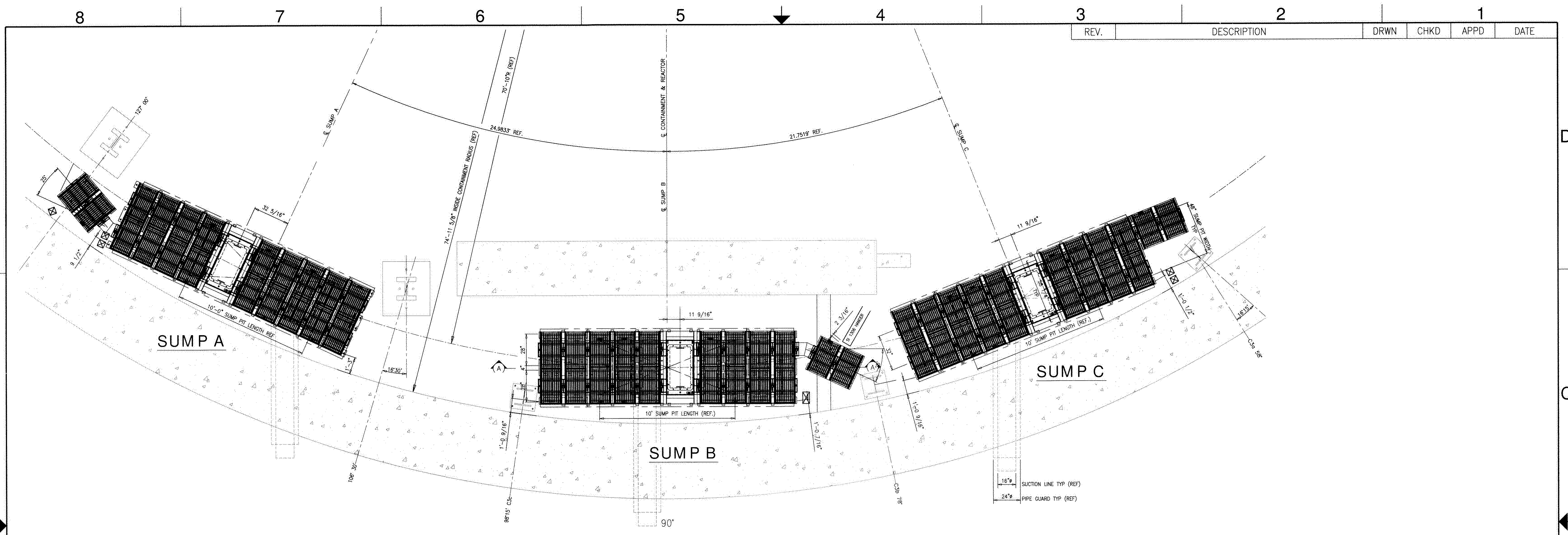
This drawing and the design it covers are the property of BECHTEL. They are made loaned and on the borrower's return; agreement that they will not be reproduced, loaned, issued, exhibited or used except on the limited way and areas set forth in the letter to the borrower.

NO.	DESCRIPTION	DATE	DW.	CHK.	GL.	EGS.	FCM.	DAI.	NC.	REVISION	OFF.	CHK.	GL.	EGS.	FCM.	DATE
1	INC. FOR 3D MODELING	11/18/02														
2	INC. FOR 3D MODELING	11/18/02														
3	INC. FOR 3D MODELING	11/18/02														
4	INC. FOR 3D MODELING	11/18/02														
5	INC. FOR 3D MODELING	11/18/02														
6	INC. FOR 3D MODELING	11/18/02														
7	INC. FOR 3D MODELING	11/18/02														
8	INC. FOR 3D MODELING	11/18/02														
9	INC. FOR 3D MODELING	11/18/02														
10	INC. FOR 3D MODELING	11/18/02														
11	INC. FOR 3D MODELING	11/18/02														
12	INC. FOR 3D MODELING	11/18/02														
13	INC. FOR 3D MODELING	11/18/02														
14	INC. FOR 3D MODELING	11/18/02														
15	INC. FOR 3D MODELING	11/18/02														
16	INC. FOR 3D MODELING	11/18/02														
17	INC. FOR 3D MODELING	11/18/02														
18	INC. FOR 3D MODELING	11/18/02														
19	INC. FOR 3D MODELING	11/18/02														
20	INC. FOR 3D MODELING	11/18/02														
21	INC. FOR 3D MODELING	11/18/02														
22	INC. FOR 3D MODELING	11/18/02														
23	INC. FOR 3D MODELING	11/18/02														
24	INC. FOR 3D MODELING	11/18/02														
25	INC. FOR 3D MODELING	11/18/02														
26	INC. FOR 3D MODELING	11/18/02														
27	INC. FOR 3D MODELING	11/18/02														
28	INC. FOR 3D MODELING	11/18/02														
29	INC. FOR 3D MODELING	11/18/02														
30	INC. FOR 3D MODELING	11/18/02														
31	INC. FOR 3D MODELING	11/18/02														
32	INC. FOR 3D MODELING	11/18/02														
33	INC. FOR 3D MODELING	11/18/02														
34	INC. FOR 3D MODELING	11/18/02														
35	INC. FOR 3D MODELING	11/18/02														
36	INC. FOR 3D MODELING	11/18/02														
37	INC. FOR 3D MODELING	11/18/02														
38	INC. FOR 3D MODELING	11/18/02														
39	INC. FOR 3D MODELING	11/18/02														
40	INC. FOR 3D MODELING	11/18/02														

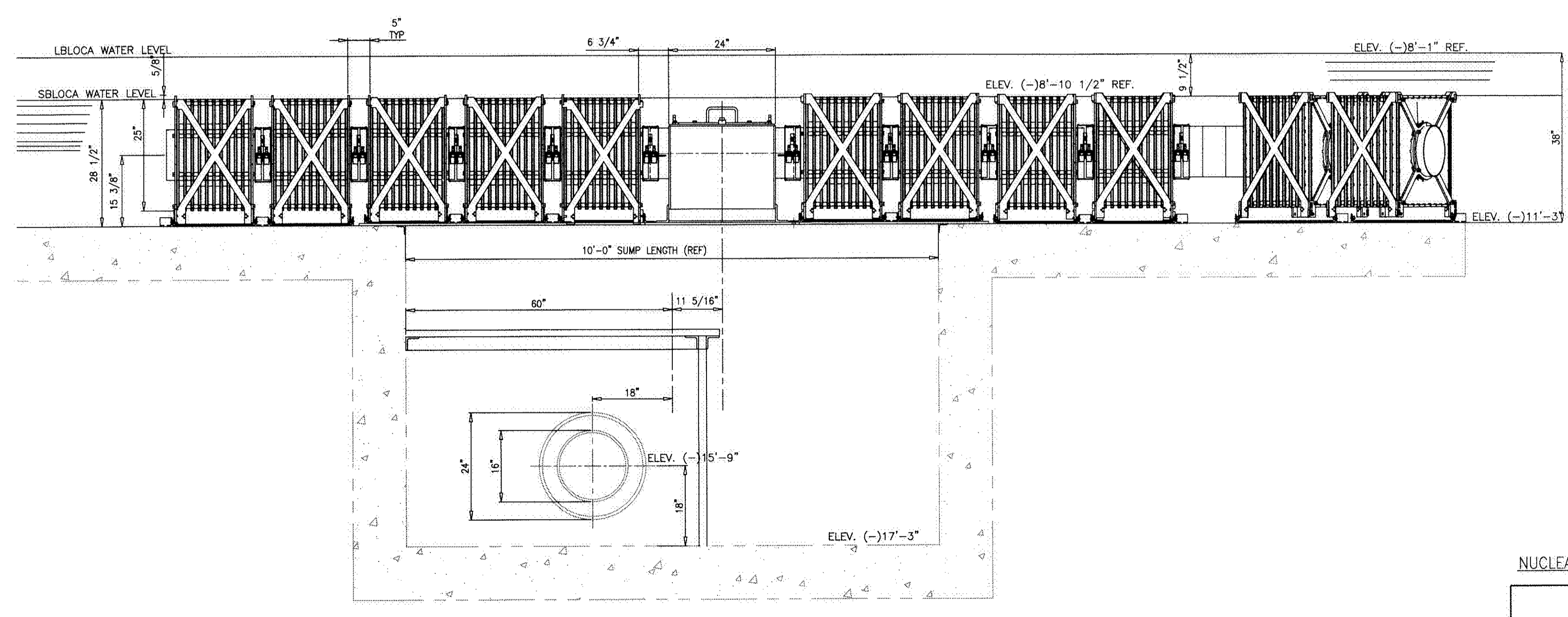
23 20 18 16 14 5 12 30X 19 14.5 16 18 20 22 24 26



REV.	DESCRIPTION	DRWN	CHKD	APPD	DATE



PARTIAL PLAN VIEW



SECT. VIEW "A-A"

NUCLEAR SAFETY RELATED

**PC**  
PERFORMANCE  
CONTRACTING INC  
ENGINEERED SYSTEMS

ENGINEERED SYSTEMS GROUP  
18047 West 110th Street  
Lenexa, Kansas 66219  
Phone: (913) 928-2800  
Fax: (913) 307-0453

SOUTH TEXAS PROJECT UNITS 1 & 2  
SURE-FLOW® STRAINER  
GENERAL ARRANGEMENT

Scale: 1:40	Job No.: 01-02-90-6005	Size: D	Drawing Number: SFS-STP-DD-00	Rev:
Date: 6/27/06	Chkd: DEF	Appd: KDK		
Drwn: RAW	Customer's Purchase Order: B03247			

Unless otherwise noted tolerances are:  
± 3mm for metric  
± 1/8" for fractions  
± 0.0625" for decimals  
± 2' for angles

8

7

6

5

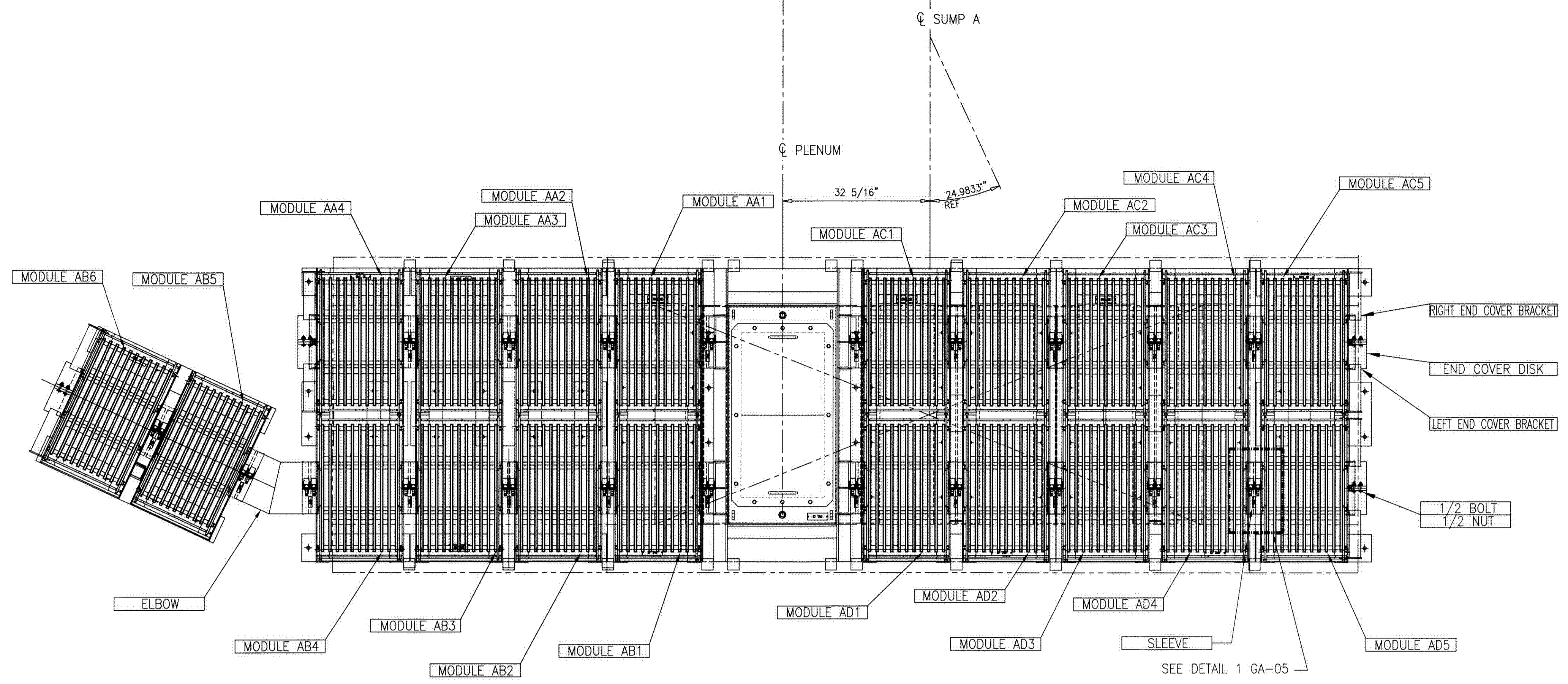
4

3

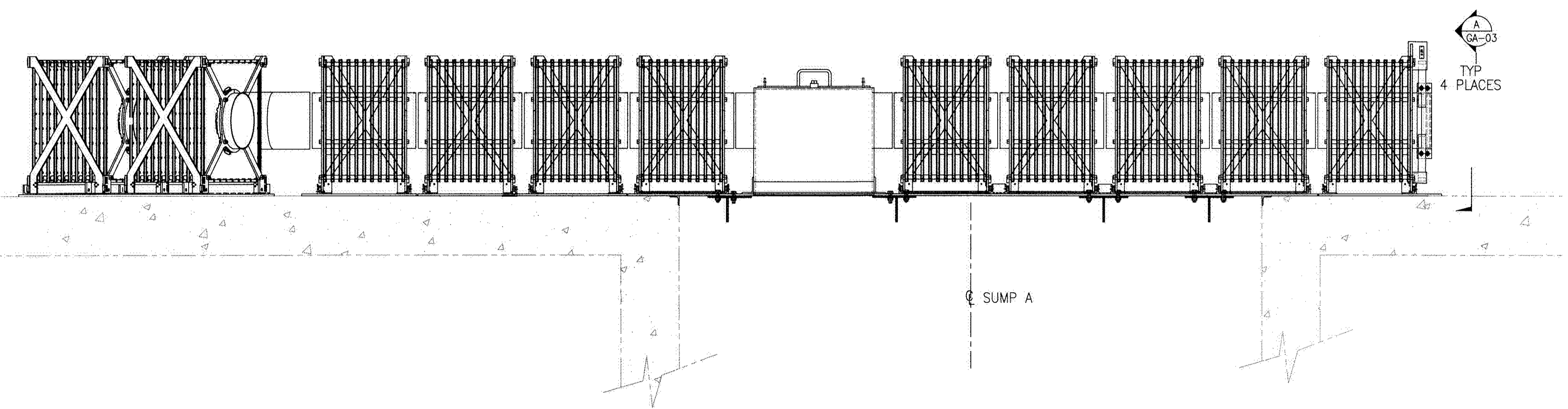
2

1

REV.	DESCRIPTION	DRWN	CHKD	APPD	DATE



**SUMP A PLAN**



**ELEVATION**

NUCLEAR SAFETY RELATED

**PC**  
**PERFORMANCE CONTRACTING INC.**  
 ENGINEERED SYSTEMS GROUP  
 16047 West 110th Street  
 Lenexa, Kansas 66219  
 Phone: (913) 928-2800  
 Fax: (913) 307-0453

SOUTH TEXAS PROJECT UNITS 1 & 2  
 SURE-FLOW® STRAINER  
 GENERAL ARRANGEMENT - SUMP "A"

Unless otherwise noted tolerances are:  
 ± 3mm for metric  
 ± 1/8" for fractions  
 ± 0.0025" for decimals  
 ± 2° for angles

Customer's Purchase Order:  
 B03247

Scale: 1:16	Job No.: 01-02-90-6005	Size: <b>D</b>	Rev:
Date: 8/2/06	Chkd: HW	Drawing Number: SFS-STP-DD-02	
Drwn: RAW	Appd: KDK		

8

7

6

5

4

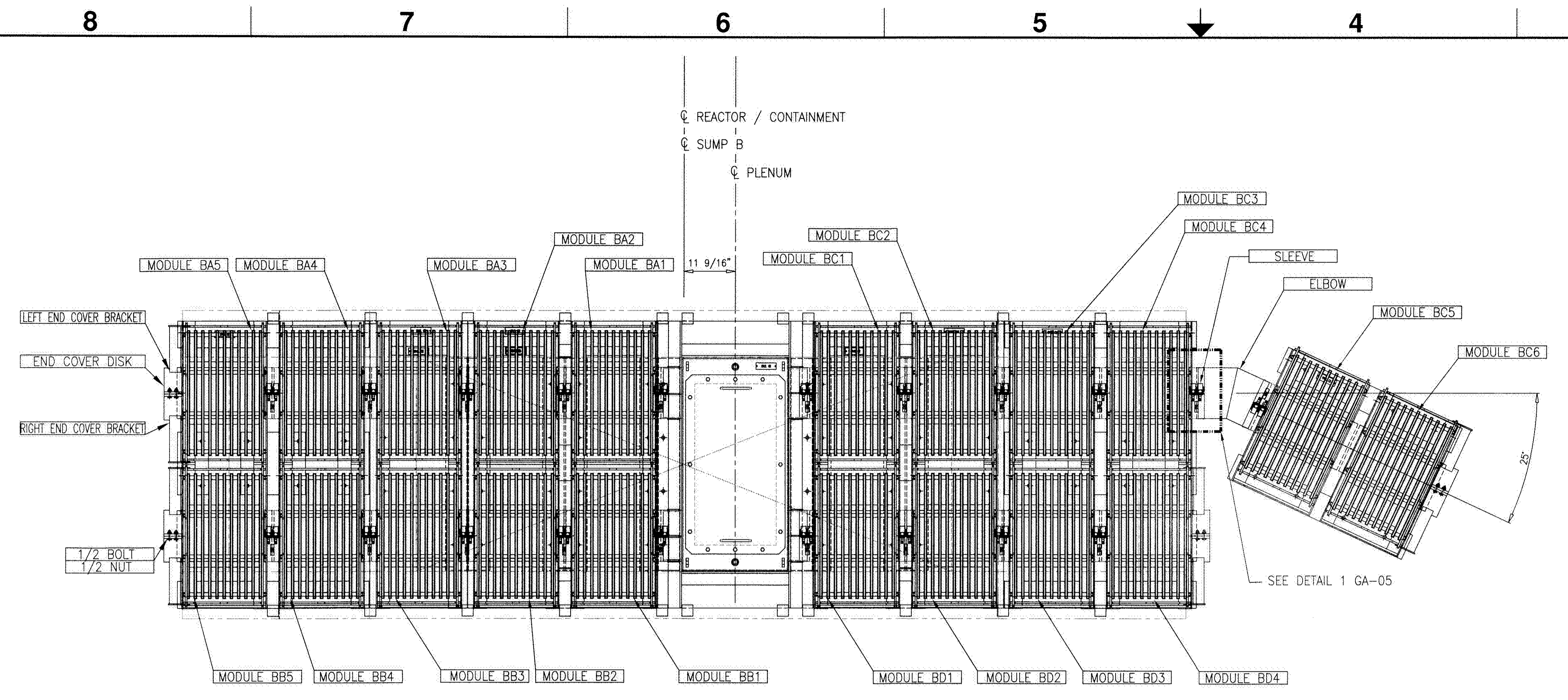
3

2

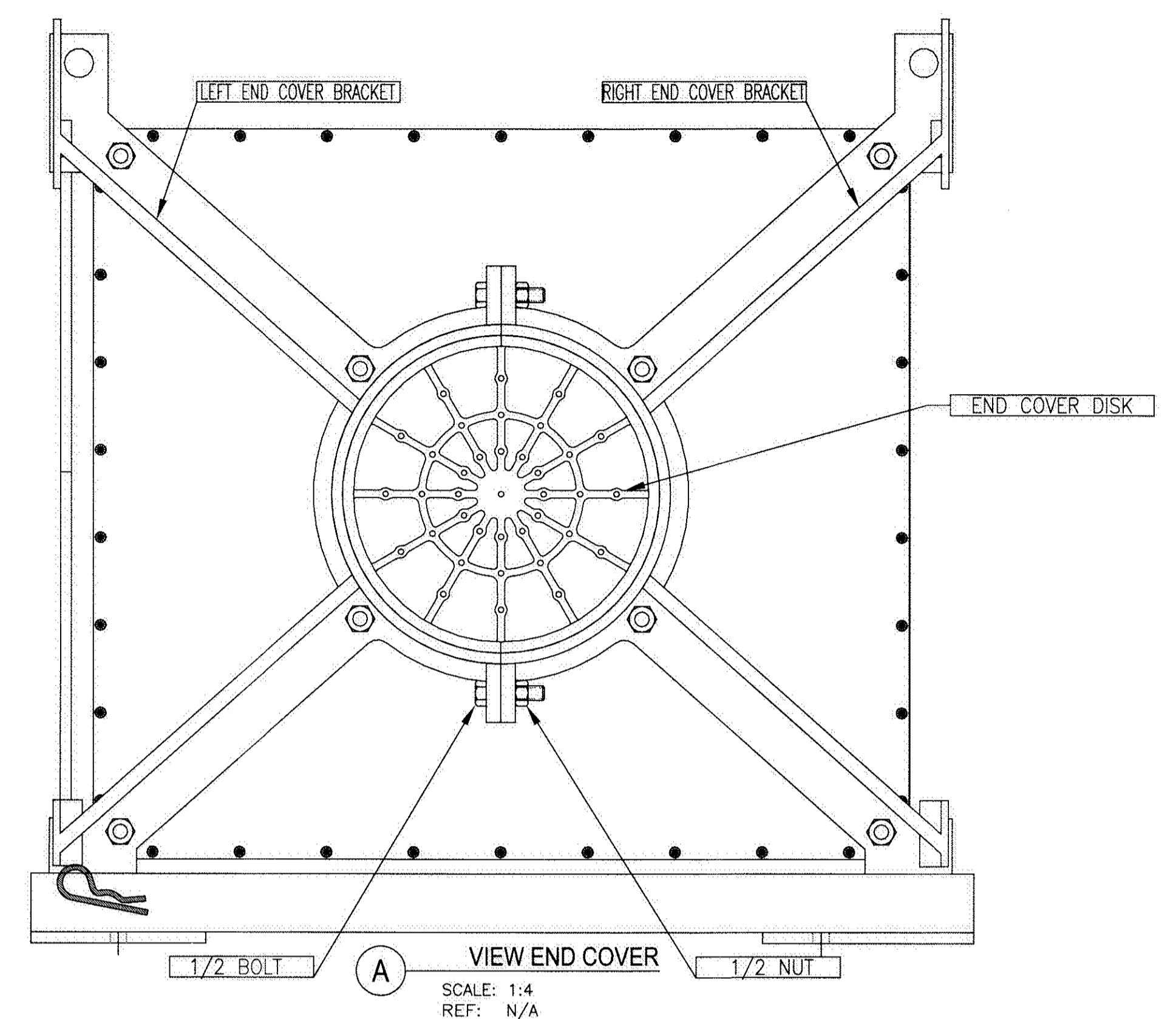
1



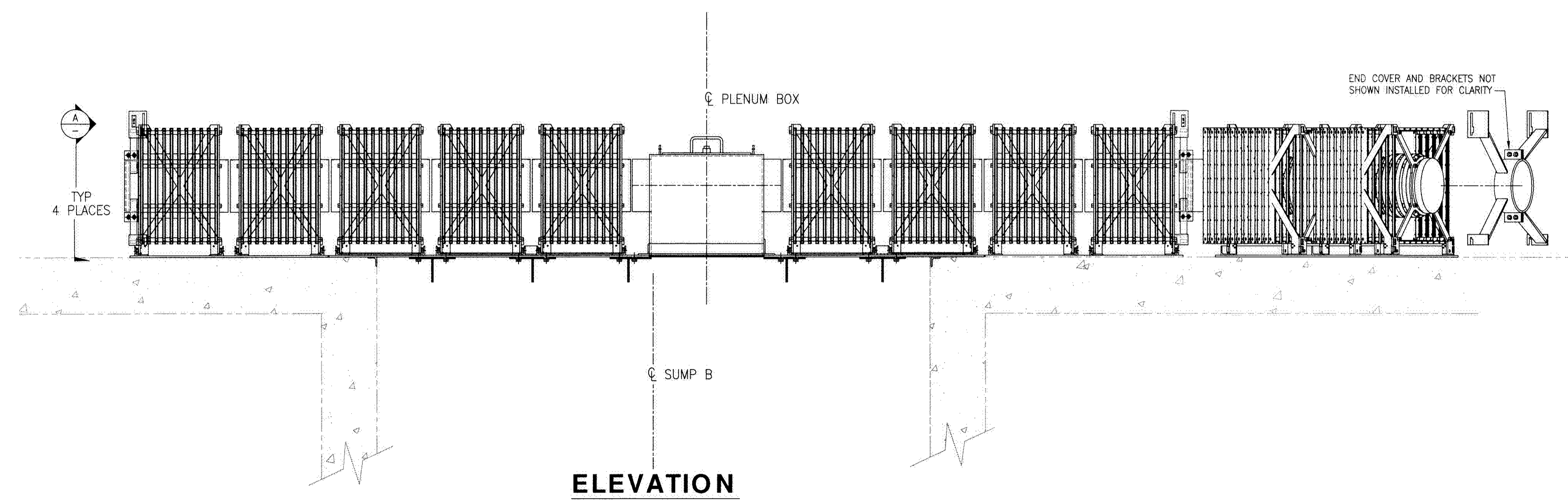
REV.	DESCRIPTION	DRWN	CHKD	APPD	DATE



**SUMP B PLAN**



**VIEW END COVER**  
SCALE: 1:4  
REF: N/A



**ELEVATION**

NUCLEAR SAFETY RELATED

**PC**  
PERFORMANCE CONTRACTING INC.  
ENGINEERED SYSTEMS GROUP  
16047 West 110th Street  
Lennox, Kansas 66219  
Phone: (913) 928-2800  
Fax: (913) 307-0453

Unless otherwise noted tolerances are:  
± 3mm for metric  
± 1/8" for fractions  
± 0.0625" for decimals  
± 2° for angles

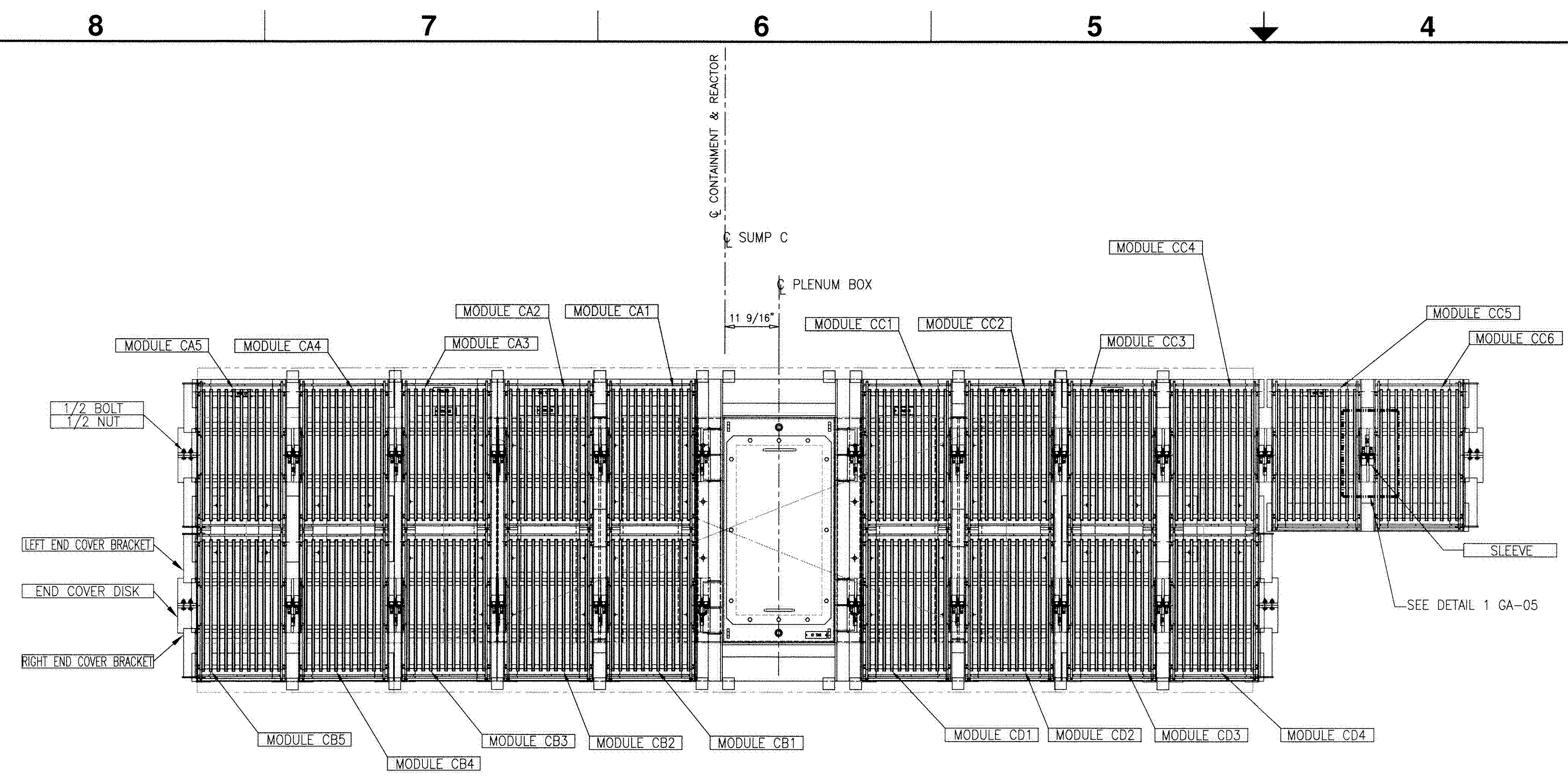
Customer's Purchase Order:  
**B03247**

**SOUTH TEXAS PROJECT UNITS 1 & 2**  
**SURE-FLOW® STRAINER**  
**GENERAL ARRANGEMENT - SUMP B**

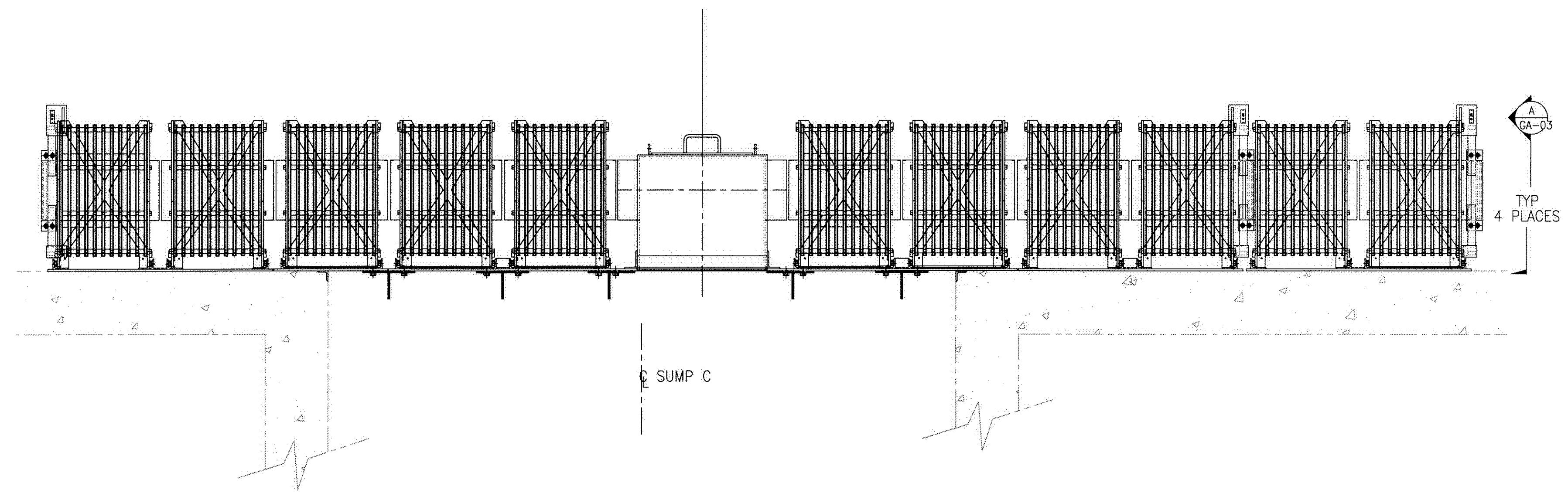
Scale: 1:16	Job No.: 01-02-90-6005	Size: <b>D</b>	Drawing Number: <b>SFS-STP-DD-03</b>	Rev: <b>1</b>
Date: 8/1/06	Chkd: HW	Appd: KDK		
Drwn: RAW				



REV.	DESCRIPTION	DRWN	CHKD	APPD	DATE



**SUMP C PLAN**



**ELEVATION**

NUCLEAR SAFETY RELATED

**PC**  
**PERFORMANCE CONTRACTING INC.**  
 ENGINEERED SYSTEMS  
 ENGINEERED SYSTEMS GROUP  
 16047 West 110th Street  
 Lenexa, Kansas 66219  
 Phone: (913) 928-2800  
 Fax: (913) 307-0453

SOUTH TEXAS PROJECT UNITS 1 & 2  
 SURE-FLOW® STRAINER  
 GENERAL ARRANGEMENT - SUMP "C"

Unless otherwise noted tolerances are:  
 ± 3mm for metric  
 ± 1/8" for fractions  
 ± 0.0625" for decimals  
 ± 2° for angles

Customer's Purchase Order:  
 B03247

Scale: 1:16	Job No.: 01-02-90-6005	<b>D</b>
Date: 8/1/06	Chkd: HW	
Drwn: RAW	Appd: KDK	

Drawing Number:  
**SFS-STP-DD-04**

