



Entergy Nuclear Operations, Inc.  
Palisades Nuclear Plant  
27780 Blue Star Memorial Highway  
Covert, MI 49043  
Tel 269 764 2000

March 20, 2009

10 CFR 50.54(f)

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

Palisades Nuclear Plant  
Docket 50-255  
License No. DPR-20

Response to Request for Additional Information Regarding Supplemental Responses to NRC Generic Letter 2004-02 (TAC No. MC4701)

Dear Sir or Madam:

On February 27, 2008, Entergy Nuclear Operations, Inc. (ENO) submitted a supplemental response to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," for Palisades Nuclear Plant (PNP). By letter dated December 24, 2008, the Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) regarding the supplemental response to GL 2004-02.

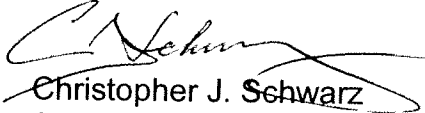
On December 3, 2008, ENO and the NRC discussed the issues that were subsequently submitted by the NRC as the RAI on December 24, 2008. That discussion led to clarification on when responses would be submitted. Responses are provided in enclosure 1 for RAI items 1, 4, 5, 6, 7, 8, 10, 11, 12, and 18. A response to RAI item 16 will be provided within 90 days of issuance of the final NRC safety evaluation on WCAP-16793, "Evaluation of Long Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The remaining responses will be submitted within 60 days following restart from the 2009 refueling outage.

Summary of Commitments

This letter contains two new commitments and no revisions to existing commitments.

Responses to RAI items 2, 3, 9, 13, 14, 15, and 17, in the NRC letter, dated December 24, 2008, will be provided in the updated supplemental response within 60 days following restart from the 2009 refueling outage.

Response to RAI item 16 in the NRC letter, dated December 24, 2008, will be provided within 90 days following issuance of the NRC staff safety evaluation for WCAP-16793.



Christopher J. Schwarz  
Site Vice President  
Palisades Nuclear Plant

Enclosure

CC Administrator, Region III, USNRC  
Project Manager, Palisades, USNRC  
Resident Inspector, Palisades, USNRC

ENCLOSURE 1  
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING  
SUPPLEMENTAL RESPONSES TO GL 2004-02

On February 27, 2008, Entergy Nuclear Operations, Inc. (ENO) submitted a supplemental response to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," for Palisades Nuclear Plant (PNP). By letter dated December 24, 2008, the Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) regarding the supplemental response to GL 2004-02.

On December 3, 2008, ENO and the NRC discussed the issues that were subsequently submitted by the NRC as the RAI on December 24, 2008. That discussion led to clarification on when responses would be submitted. Responses are provided below for RAI items 1, 4, 5, 6, 7, 8, 10, 11, 12, and 18. A response to RAI item 16 will be provided within 90 days of issuance of the final NRC safety evaluation on WCAP-16793, "Evaluation of Long Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The remaining responses will be submitted within 60 days following restart from the 2009 refueling outage.

***Nuclear Regulatory Commission (NRC) Request***

1. *If lead blankets were determined to contribute to potential sump blockage debris, please identify the zone of influence (ZOI) size used. Please provide information relative to impact of differences in jet size, target size and geometry used in developing the test report WCAP-16727-P, "Evaluation of Jet Impingement and High Temperature Soak Tests of Lead Blankets For Use Inside Containment of Westinghouse Pressurized Water Reactors," dated February 2007, with that of the jet sizes and lead blankets at Palisades.*

**ENO Response**

1. Lead blankets were included in the debris generation calculation done by Sargent & Lundy. Below is an excerpt from that calculation.

***4.6 FOREIGN MATERIALS***

*Foreign materials inside containment may become debris during a [Loss of Coolant Accident] LOCA or during Containment Spray. Examples of foreign materials are electrical tape, stickers, conduit tags, etc. See Table 5.5-1 for complete listing of foreign material compiled from information in Reference 6.1.4. Foreign materials become debris regardless of their location and the location of the*

*break as directed in Reference 6.1.3, with the exception of lead blankets (discussed below). Lead blankets are installed in containment and can become debris following a LOCA. However, the lead blankets are robust and securely held; therefore they are only considered debris when located in the same vault as the break.*

Lead blankets were reported as "Foreign Materials" in Table 5.5-1, which (according to section 4.6 above) included all of the lead blankets located in the same vault as the break.

ENO, then, relied upon the ZOIs given in WCAP-16727-P to eliminate almost all lead blankets from further consideration as producers of Generic Safety Issue (GSI) -191 debris that can be transported to the sump screen. The ZOI values are listed below:

**ZOIs for Lead Blankets:**

- 1.25D (D = diameters) for free hanging & no backing, no damage
- 5D for attached with backing, no damage
- 0D-2.65D for attached with backing, total destruction of lead & cover
- 2.65D-5D for attached with backing, destruction of 25% cover and 10% of lead

**Conversion to spherical radius of influence in feet**

ZOI in feet (ft)	Hot Leg D=3.5 ft	Cold Leg D=2.5 ft
1.25D	4.375 ft	3.125 ft
2.65D	9.275 ft	6.625 ft
5D	17.5 ft	12.5 ft

The exception is the blankets on frame no.1 shown on drawing C-277, sheet 2, rev. 0, "Permanent Shielding Area 1 Plan of EL. 607'-0" [elevation 607 feet-zero inches] at zone C-4." Frame no.1 is a three sided wrap-around frame on the three-inch pressurizer spray line pipe installed on grating at EL 618'-7". The frame is shown on drawing C-279, sheet 1, rev 0, "Permanent Shielding & Frames Inside Containment Details," which also specifies that the blankets be covered with two layers of Alpha-Maritex Style 8459-2-SS cloth or equal. The typical six-foot long by one-foot wide blankets are laid over the frame and are bolted to the frame in four places. The frame is rated for 2880-pounds (lbs) load, which at 15-lbs per square foot (ft<sup>2</sup>), would equal 192 ft<sup>2</sup> of lead with four layers of cloth. There is no backing plate on the frame, however. This frame is less than 2.65D from the 30" cold leg, which lies right below it.

Although the frame no.1 blankets may be blown apart and enter the sump none of the constituents are transported to the screen. The lead particles

sink very rapidly and do not transport. The Alpha-Maritex cloth was included in the flume testing as small cut pieces and did not transport beyond about one pool depth.

PNP was a buy-in participant in the WCAP-16727-P effort. ENO has determined that the tested blankets were sufficiently similar to the PNP permanently installed blankets to use the test results. ENO has supported the Pressurized Water Reactor Owners Group (PWROG) effort and has accepted the conclusion in the WCAP report that it is applicable to PWROG plants for reference under GSI-191. There is an on-going PWROG effort that ENO is supporting to answer questions on the test scaling and test methodology.

With respect to geometry, ENO would be, in effect, using the results for breaks up to and including 30" cold leg breaks. This would be around 10 times the diameter of the test jets. A single ten foot long blanket wall would include around fifty blankets hung up to four deep, whereas the test targets were single blankets. Each of the single blankets in the wall would, however, scale nearly one-to-one dimensionally with the test target blankets.

### ***NRC Request***

2. *Section 3.c of the supplemental response does not provide debris characteristics for all of the debris types listed on Page 17 of the response. Therefore, please provide the following information requested by the NRC Content Guide needed by the NRC staff to complete its debris characteristics review:*
  - a. *The size distribution for calcium silicate debris (both that debris generated within a break ZOI and from containment spray impingement) and the assumed resultant particle size.*
  - b. *The size distribution for fibrous debris generated by containment spray impingement on fibrous insulation.*
  - c. *The size distribution for debris generated from Marinite board.*
  - d. *The form assumed for all types of unqualified coatings (i.e., particulate or chips) and the assumed characteristic sizes for each debris type. Page 59 of the supplemental response states the methodology for determining the form of unqualified coatings debris (it was assumed to be particulate unless supported by specific testing to prove otherwise), but the final result of applying this methodology to the specific quantities of these coatings present at Palisades was not clearly stated.*

### **ENO Response**

2. Following the submittal of the PNP GL 2004-02 supplemental response, dated February 27, 2008, revised and new basis calculations have been performed in support of PNP November 2008 strainer testing. As discussed with the NRC staff on December 3, 2008, response to this item will be provided for the new design basis debris values in the updated supplemental response due 60 days following restart from the 2009 refueling outage.

### **NRC Request**

3. *When the final supplemental response is submitted, please include a discussion of any changes that have been made to the analysis that are associated with debris characterization at a level of detail consistent with the NRC supplemental response content guide. The NRC staff will review this information when submitted, and as a result of such review, the NRC staff could request additional information in this subject area if needed.*

### **ENO Response**

3. As specified in the NRC RAI letter, dated December 24, 2008, the response to this request will be provided in the final supplemental response that is due 60 days following restart from the 2009 refueling outage.

### **NRC Request**

4. *Please provide the physical properties of the Alpha Maritex cloth material and the characteristic form and size of the debris formed from this material (e.g., fines, small pieces). In addition, please provide the technical basis for determining the transportability of debris generated from Alpha Maritex cloth.*

### **ENO Response**

4. Permanent lead blankets inside containment at PNP are controlled by the as low as reasonably achievable (ALARA) program and are described as follows.

There are two layers of covering made of Alpha Maritex per military specification MIL-Y-1140C for glass cloth. The material of the inside covering is made of 15 ounces per square yard material and the outside covering is made of heavier specification of 34 ounces per square yard.

The covering is designed for continuous temperature of +500 degrees F. and meets NRC Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel," as well as military specification MIL-I-24244, "Insulation Material."

Drawing C-279 contains note 4 that states the Alpha-Maritex is style 8459-2-SS (or equivalent).

WCAP-16727 describes characteristic debris size and form as:

*Approximately 25% of the outer cover material and approximately 10% of the inner cover material is destroyed and is characterized as small pieces and strands of material (fines). Debris consisting of the lead blanket cover material has been shown to readily settle on deposition.*

Sedimentation tests of particles in the WCAP-16727 document show that the material settles quite rapidly. WCAP-16727 page 1-4 states:

*Once the debris has settled, transport is unlikely due to the low velocities expected to be present in the post LOCA sump environment. Transport experimentation performed with paint chips (Reference 5) shows that chips do not readily transport at flow velocities of 0.2 ft/sec or less. Since the cover materials (inner and outer covers) have a density and thickness similar to coatings applied in containment, it is expected that transportability of the lead blanket cover material would be similar.*

The above concept is again restated in section 8.4 of the WCAP as follows:

#### **8.4 DEBRIS CHARACTERIZATION**

*The debris characterization evaluation presented in Appendix A was designed to determine the specific gravity and settling characteristics of samples (sedimentation test), and to provide insight into how the material would perform when subjected to high temperatures. The samples for the debris characterization test were taken from the inner and outer covers of the lead blanket (#1) used in the High Temperature Soak Test. The specimens were allowed to dry after the High Temperature Soak Test and the dimensions and weights of each sample were recorded. Samples were cut from both the inner and outer 'front' cover of the lead blanket. Sample swatches ranging in size from ½ x ½ inches, up to 2 x 2 inches were used in the debris characterization. Details of the sedimentation test can be found in Table 6 of Appendix B, which*

*shows that all of the samples readily settled within 8 seconds and on average within 5.4 seconds.*

*The debris characterization evaluation indicates that any blanket cover material debris resulting from direct jet impingement would readily settle immediately on deposition following the impact. Once the debris has settled, transport is unlikely due to the low velocities expected to be present in the post LOCA sump environment. Transport experiments performed with paint chips (Reference 5) show that chips do not readily transport at flow velocities of 0.2 ft/sec [feet per second] or less, and that the incipient velocity required for initiation of transport is, on average, much greater than 0.2 ft/sec. Since the cover materials (inner and outer covers) have a density and thickness similar to coatings applied in containment, it is expected that its transportability would be similar. Reference 5 indicates that the small percentage of paint debris that was transported to the sump screen was mostly floating on the surface. As noted above, test samples of the blankets' cover materials readily sank. Results from this portion of the test program show that the cover materials will readily settle and are unlikely to transport.*

Description of the testing of the Alpha-Maritex material by ENO at Alden Research is provided below.

To determine the transportability of the Alpha-Maritex, cut squares of this material were placed in the design basis flume test at Alden Research. The material did not transport beyond the depth of the flume. The test flume was specifically set up to represent transport flow in the PNP containment.

Since they were being treated as foreign material, the material squares were not seen as needing a size distribution. Conservatively small pieces were chosen for testing. Typical of other foreign materials, no guidance was given in NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," for this material.

The above PNP flume test experience supports WCAP-16727 test results.

### ***NRC Request***

- 5. The February 27, 2008, GL 2004-02 Supplemental Response (ADAMS Accession No. ML080630253) stated that samples were taken for containment latent debris during the 2006 refueling outage. However, sufficient detail was not provided regarding the types of areas sampled, the number of samples taken for each area type, and the containment*



*elevations sampled. Please provide these details, and describe how the sample results were extrapolated in order to estimate a total latent debris amount in the containment.*

## **ENO Response**

5. The latent debris sampling and the analysis of the data were done by Sargent & Lundy using methodology utilized for other pressurized water reactor (PWR) plants.

The containment was divided into different types of surfaces. The total area of each type of surface in containment was calculated.

The surface types were:

- Floor Areas
- Containment Liner
- Horizontal Ventilation
- Vertical Ventilation
- Horizontal Cable Trays
- Vertical Cable Trays
- Walls
- Horizontal Equipment
- Vertical Equipment
- Horizontal Piping
- Vertical Piping
- Grating
- Miscellaneous Items

A sample plan was developed to sample each type of surface in various accessible areas.

Each chosen area was sampled, the sample was bagged, and the area sampled was recorded. Forty-six samples were taken from the twelve types of areas. The miscellaneous items were not sampled. The table below summarizes the sampling for each surface type.

Surface Type/ Elevation	Surface Area Sampled (ft <sup>2</sup> )		Total Containment Area for Surface Type (ft <sup>2</sup> )
	Per Elevation (#Samples)	Total	
Floor Areas			
	590'	19.00 (2)	32.00
	649'	13.00 (2)	
Containment Liner			
	590'	19.78 (2)	35.03
	Below 607'-6"	6.25 (1)	
	Below 625'	9.00 (1)	
Horizontal Ventilation	None (horizontal cable tray data used)		4,860
Vertical Ventilation			
	590'	14.83 (2)	21.20
	625'	2.60 (1)	
	649'	3.67 (1)	
Horizontal Cable Trays			
	590'	12.00 (3)	22.32
	Below 625'	6.94 (1)	
	Below 649'	3.38 (1)	
Vertical Cable Trays			
	590'	15.63 (1)	23.04
	Above 590'	3.28 (1)	
	607'-6"	1.88 (1)	
	Below 649'	2.25 (1)	
Walls			
	590'	24.25 (2)	38.00
	607'-6"	6.25 (1)	
	Below 649'	7.50 (1)	
Horizontal Equipment			
	590'	11.27 (3)	12.67
	625'	1.40 (1)	
Vertical Equipment			
	590'	10.50 (1)	20.70
	607'-6"	4.42 (1)	
	625'	5.78 (2)	
Horizontal Piping			
	590'	9.75 (2)	21.57
	625'	0.93 (1)	
	Below 649'	2.36 (1)	
	649'	8.53 (1)	
Vertical Piping			
	590'	9.43 (2)	14.21
	607'-6"	1.78 (1)	
	Below 625'	3.00 (1)	
Grating			
	607'-6"	0.42 (1)	2.70
	Below 649'	0.63 (1)	
	649'	1.65 (2)	

The samples were weighed and divided by the area sampled to get a surface loading in weight per unit area. Multiple samples of like surfaces were averaged. The data was statistically analyzed and a 90% confidence upper limit was obtained.

The total area within containment was multiplied by the 90% upper limit unit surface loading to get the total latent debris on each surface type.

The total latent debris in containment was obtained by adding all of the surface type totals.

Miscellaneous items, such as various structural steel, pipe, conduit, cable tray, support steel, control rod drive mechanisms, cooling fans, heat exchangers and smaller items such as junction boxes, valve operators, air handlers, seismic restraints, hanging lamps, electrical panels and monitoring devices and others, are not addressed individually in this calculation. The conservatism adopted in the calculation in estimating total areas of major items addressed above is considered to provide enough margin to cover areas of miscellaneous items inside the containment.

The total latent debris in containment is estimated to be 156 pounds. However, the originally assumed 200 pounds was retained in the calculations of debris loading for the design basis flume test.

### ***NRC Request***

- 6. Please provide a description of the methodology used to count the number of tags, signs, tapes and stickers in containment and estimate their total surface area (e.g., walkdown of containment, photographs of containment areas, review of design drawings, etc.).*

### **ENO Response**

6. These items were hand counted by the walkdown crews and were summed in a spreadsheet when the notes were transcribed. In cases such as tie wraps, the number of items was determined by informal estimates such as counting the visible tie wraps for a known length of tray, multiplying by a depth factor to cover the hidden tie wraps in the lower levels of the tray, and by a length factor representing the length of the tray. These estimate calculations were not preserved in the recorded documentation.

### ***NRC Request***

7. *Please specify the types of materials included in the miscellaneous category in the foreign materials section of the "Summary of LOCA Generated Debris" table on page 17 of the February 27, 2008, submittal.*

### **ENO Response**

7. Below is the list of materials included in the 113.4 ft<sup>2</sup> value noted as Miscellaneous in the table on page 17 of the February 27, 2008, submittal.

- air dryer, green plastic
- Bakelite cap on shield cooling pump motors
- Bakelite knobs
- beige electrical ground fault circuit interrupter outlet on wall
- cable – neutron instrumentation (NI), braided sheath
- cable - NI, white splice tape, by containment air cooler, VHX-4
- cable - NI, wrapped with white tape, by containment air cooler VHX-3
- cable tie-wraps in cable trays
- fibrous I2 filter inlet filters
- filter on primary coolant pump motor connection box
- Gaitronics speaker rubber surround
- lucite dP gauges on iodine filter
- N2 dryer filter material
- plastic air line spacer
- plastic gauge faces
- plastic radiation detector source
- plastic telephone boxes
- plywood mount board for phone boxes
- red electrical penetration caps
- red rubber protective cap on instrument connector
- rope, nylon, on core support barrel lift rig
- rubber grommet on intake duct
- tygon tubing
- vinyl valve handle
- white conduit support "bumpers"

### ***NRC Request***

8. *Please provide the final results of the analysis of the potential for transport of fragments of the lead blankets and specify whether this material was included as miscellaneous material.*

## **ENO Response**

8. The final results of the analysis of the potential for transport of fragments of lead blankets were provided by the May 2008 PNP strainer testing performed at ALDEN Laboratory in Holden, Massachusetts. As part of the strainer testing, debris transport testing was performed for a variety of debris types. To address potential lead blanket debris, Alpha Maritex lead blanket material transportability was tested by placing sample material in the test flume under the same flow conditions used for design basis debris head loss testing. The Alpha Maritex lead blanket material settled on the floor of the flume approximately two feet from the drop zone. This result agrees well with WCAP-16727 results that tested the same fabric (reference responses to items 1 and 4 above). Since this material did not transport, it was excluded from the design basis debris testing per the testing protocol.

Lead blanket material was not included as part of the "miscellaneous" category given in the table on page 17 of the February 27, 2008, supplemental response. The lead blanket Alpha Maritex material was itemized separately in the table on page 17 of the supplemental response. See response to item 7 above for what was included in the miscellaneous category.

## ***NRC Request***

9. *The supplemental response states that a computational fluid dynamics analysis is being performed and that the containment debris transport analysis is being revised. When the final supplemental response is submitted, please include a discussion of the computational fluid dynamics analysis and the changes that have been made to the transport calculation at a level of detail consistent with the NRC supplemental response content guide. The NRC staff will review this information when the licensee submits it and, as a result of such review, the NRC staff could request additional information in this subject area if needed.*

## **ENO Response**

9. As specified in the NRC RAI letter, dated December 24, 2008, the response to this request will to be provided in the final supplemental response that is due 60 days following restart from the 2009 refueling outage.

## **NRC Request**

10. *The supplemental response discusses the applicability of Westinghouse letter LTR-SEE-05-172 to the settling of coating chips within the containment pool. In the NRC staff's audit of Waterford 3 (ADAMS Accession No. ML080140318), this letter was reviewed by the NRC staff and was considered to have significant technical deficiencies as a basis for justifying the settling of coating chips in a containment pool. Section 3.5.5.2 of the Waterford 3 audit report states three main NRC staff concerns: (1) the size distribution assumed for the failed chips, (2) the failure to distinguish between chip diameter and chip thickness, and (3) the consideration of vertical flow conditions that are typically inapplicable to containment pools. Please state whether this letter will be credited as a basis for assumptions concerning unqualified coating chip transport in the revised transport analysis, and, if credit is taken, please address the three deficiencies summarized above.*

## **ENO Response**

10. The ENO February 27, 2008, supplemental response referred to the Westinghouse letter LTR-SEE-05-172 as potential conservatism to the approach taken for PNP up to that point, which was documented as assuming all coatings fail as small fines. ENO has not credited the subject Westinghouse letter for any coating transport assumptions. The final supplemental response will remove any reference to Westinghouse letter LTR-SEE-05-172.

Following the submittal of the PNP GL 2004-02 supplemental response on February 27, 2008, revised and new basis calculations have been performed in support of the PNP November 2008 strainer testing. As part of that effort, the treatment of some coating material has been revised. The final supplemental response will provide further detailed information. However, the overview of the changes as it pertains to RAI number 10 is discussed in this response. All qualified and unqualified coatings are assumed to transport to the strainers in the debris transport calculation that is unchanged from the February 27, 2008, supplemental response. For determining the appropriate surrogate material to use in strainer testing for the various coating materials, most of the coatings (26.75 ft<sup>3</sup>) are assumed to fail as fine particulate and the appropriate surrogate is added in the form of powder to the test flume. For a relatively small portion of the coating material (2.42 ft<sup>3</sup>), the coating was evaluated to fail since chips as this portion is epoxy outside the qualified coating zone of influence. The appropriate surrogate for this material was added in the form of 1/32" chips to the test flume. A small chip size was used and no attempt was made to credit a size distribution.

## **NRC Request**

11. *Page 25 of the supplemental responses states that no curbs or debris interceptors were credited with inhibiting debris transport. However, Figures 3.e.2 and 3.e.5 in the supplemental response (which are debris transport logic trees) clearly indicate that debris curbs were credited with inhibiting debris transport. Please describe the debris curbs for which credit was taken and clarify whether similar credit will be taken in the revised debris transport analysis.*

## **ENO Response**

11. This issue is a matter of semantics. Per assumption 5 (stated below) of Appendix C, "Debris Allocation," of the transport analysis, the debris landing on elevation 608 ft. 6 in. will not transport to elevation 590 ft.
  5. *Large debris generated on the 608 ft. 6 in. level will not transport to the basement. This is a reasonable assumption since large debris will either settle during pool fill, be unable to overtop the curbing or be held from further transport by stairwell grating. This calculation treats this as 0% transport of large debris.*

Further explanation is available in section C.3.3, "Large Debris" subsection C.3.3.2, "608 ft. 6in. elevation level" as given below:

### **C.3.3.2 608 ft. 6 in. elevation level**

*It is expected that large debris generated will not transport off SG Room A or B floor. Based on Assumption 5, any large debris that does transport to the basement during the initial LOCA blast will settle and not transport to the strainers. The large debris that remains on the 608 ft. 6 in. elevation will be subject to erosion due to break flow and containment spray. The large debris will be eroded to fine debris and distributed to the applicable proximity zones utilizing the ratio of the flow exiting each flow path to the total flow draining off of the 608 ft. 6 in. elevation. These flow ratios are presented in Table C.5.3-1 (Break S5) and Table C.5.5-1 (Break S6) as "% Total Flow From SG Room Floor To Basement."*

In effect, it makes almost no difference if the debris stays on elevation 608' or drops to elevation 590' because, in either case, the large debris does not transport and in both cases it is assumed to erode. The assumption 5 wording does include curbing as a part of the reason for the assumption. The curbs on elevation 608' are assumed to be uniform and 6-inches high except for a 9-inch curb cut that is treated separately. The

flow rate over the curbs would vary with the break location being analyzed and in some cases there would be no water flow over the curbs.

### ***NRC Request***

- 12. Please describe how the flume velocity was determined for the final strainer head loss testing to be conducted for Palisades based upon the plant computational fluid dynamics calculation, specifically addressing the potential for non-uniform velocities on the approach to the actual strainer installed in the plant.*

### **ENO Response**

12. The flume setup calculation is Appendix F in the debris transport computational fluid dynamics (CFD) analysis.

In the test flume, the approach velocity is modeled by changing the width of the flume as the flow progresses down the flume toward the strainer. The goal is to model in the flume the average approach velocity to a strainer module as installed in the PNP sump. There is one full size module in the test and there are 23 modules in the plant. There are four banks of strainers in the plant. A bank is defined as group of modules, that are plumbed so that the core tubes of each module pass flow in series, so that the output from the first module's core tube must pass through the core tube of the second and all the rest in that bank to reach the pump suction.

Each bank of strainers passes flow in parallel to the pump suction. The plant has four banks labeled A, B, C, and D. Banks A and B have four modules, bank C has nine modules, and bank D has six modules.

The calculation of the flume configuration utilizes the results of the CFD debris transport study to define the average approach velocities to each strainer array. In doing so, the flow to each module group was identified by using the CFD results to track the trajectory of the fluid passing through each strainer module group throughout the containment. With the water path to each module bank identified, vertical planes at one foot increments back from the bank, along the calculated trajectories were defined. Each plane was analyzed to ensure that the velocities within that plane were sufficient to convey water to the module. At each of these incremental planes, the cross section average of the velocity was recorded. If the paths diverged around objects in the flow, each bifurcated path was analyzed individually.

This methodology was used for each individual bank. For modules with more than one approach flow direction, the flow paths were averaged.



Once the averaging was complete, the module weighted average of the flow streams, approaching the four banks, at each vertical plane was conducted. Plots of the calculated module weighted average velocity versus incremental distance back from the module bank was used to calculate the width of the test flume at each one foot increment using the relation  $Q = (H)(W)(V)$ . In this expression, Q = flow rate, H = water depth, W = flume width, and V = cross section velocity.

The transition of the flume near the test strainer module was defined by the trajectory of the water as it approaches the modules in the prototype installation. These flow patterns were calculated in the CFD debris transport analysis. Engineering judgment was used to interpret these flow patterns and define the shape of the flume at the test module.

The full (proprietary) calculation with graphics is available at the plant for NRC inspection.

### ***NRC Request***

13. *The single failure of a low-pressure safety injection (LPSI) pump to trip at the time of switchover to recirculation was not fully addressed in the supplemental response. The supplemental response also noted that a LPSI pump could be restarted later in the event if necessary. Therefore, please address how the following items related to the potential operation (including failure to trip) of a LPSI pump during recirculation are addressed in the strainer performance analysis:*
  - a. *Increased flow from an operating LPSI pump could lead to increased debris transport that was not considered in the debris transport calculation or flume testing.*
  - b. *Increased flow from an operating LPSI pump could lead to a larger clean strainer head loss value than was calculated in the existing analysis.*
  - c. *Increased flow from an operating LPSI pump could result in higher than analyzed flow through the strainer. Events that would result in higher than analyzed flow through the strainer should be evaluated and shown to result in acceptable NPSH [net positive suction head] margin.*

### ***ENO Response***

13. The ability to restart a LPSI pump later in the event if necessary was a carry over from a step that once existed in PNP Emergency Operating Procedure EOP-9.0, "Functional Recovery Procedure." The step had

been removed from EOP-9.0 in late 2001. Procedures that govern actions following a LOCA are EOP-4.0, "Loss of Coolant Accident Recovery," and EOP-9.0. These procedures contain no steps for restarting a LPSI pump post-RAS. The final supplemental response will remove reference to restarting a LPSI pump.

Higher clean strainer head loss and higher head loss due to increased flow through the debris bed on the strainer were evaluated for a LPSI pump failure to trip. Adequate NPSH margin was shown to exist for the required containment spray and high pressure safety injection pumps. The operating LPSI pump was shown to not have adequate NPSH margin and will likely cavitate.

The NPSH calculation is currently being revised to address updated containment water level calculations. The LPSI pump failure to trip is being re-evaluated within the calculation revision. The NPSH results for the LPSI pump failure to trip will be provided in the final supplemental update including specifics associated with items a, b, and c in the above request.

#### ***NRC Request***

14. *The NRC's June 27, 2008, Generic Letter 2004-02 extension approval letter addressed the following program plan for Palisades:*
  - a. *Complete chemical effects strainer testing by September 30, 2008.*
  - b. *Complete strainer debris and chemical effects test report including supporting analyses for testing and inputs by December 31, 2008.*
  - c. *Complete any necessary modifications prior to restart from the 2009 refueling outage.*
  - d. *Complete design and license bases updates, and provide final update to GL 2004-02 supplemental response by February 27, 2009, if no modification is required, or 60 days following completion of the 2009 refueling outage if modification is required.*

*Because the final head loss and vortexing evaluation has not yet been transmitted to the NRC, no actual RAIs could be developed in this area. However, the head loss and vortexing testing subject areas and/or issues listed below should be addressed in the final supplemental response:*

(Sub-items 14.a. through 14.q. of the December 24, 2008, NRC letter are not repeated here.)

## **ENO Response**

14. As specified in the 12/24/08 RAI letter, the response to this request will be provided in the final supplemental response that is due 60 days following restart from the 2009 refueling outage.

## **NRC Request**

15. *The supplemental response to item (m) "Downstream Effects-Components and Systems" includes a detailed description of the downstream effects evaluations performed by the licensee. However, these evaluations were performed prior to the issuance of the approved WCAP-16406-P, Rev 1, ["Evaluation of Downstream Sump Debris Effects in Support of GSI-191"] and the NRC safety evaluation (SE) of that document. The Entergy Nuclear Operations Inc. (ENO) supplemental response states that the current evaluations will be revised, applying the guidance provided in the approved WCAP-16406-P, Rev. 1 and data obtained through additional testing. ENO stated that a revised final response will be submitted once the evaluations are completed. The NRC staff requests that ENO provide the final description of the downstream effects evaluations in accordance with the request under item (m) in the Revised Content Guide for Generic Letter 2004-02 Supplemental Response dated November 2007.*

## **ENO Response**

15. Following the submittal of the February 27, 2008, PNP GL 2004-02 supplemental response, a revision to the downstream effect components evaluation was completed. It had been referenced as an open item in the February 27, 2008, response. Following the November 2008 strainer testing, ENO is again revising the downstream effects components evaluation. As discussed with the staff on December 3, 2008, the response to this RAI will be provided using the new downstream components evaluation in the updated supplemental response due 60 days following restart from the 2009 refueling outage.

## **NRC Request**

16. *The NRC staff considers in-vessel downstream effects to not be fully addressed at Palisades Nuclear Plant (Palisades), as well as at other PWRs. The ENO supplemental response for Palisades refers to draft WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The NRC staff has not issued a final SE for WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for Palisades by showing that the licensee's plant conditions are bounded*

*by the final WCAP-16793-NP and the corresponding final NRC staff SE, and by addressing the conditions and limitations in the final SE. The licensee may also resolve this item by demonstrating without reference to WCAP-16793-NP or the NRC staff SE that in-vessel downstream effects have been addressed at Palisades. In any event, the licensee should report how it has addressed the in-vessel downstream effects issue within 90 days of issuance of the final NRC staff SE on WCAP-16793-NP. The NRC staff is developing a Regulatory Issue Summary to inform the industry of the NRC staffs expectations and plans regarding resolution of this remaining aspect of GSI-191.*

### **ENO Response**

16. As specified in the NRC RAI letter, dated December 24, 2008, the response to this request will be provided within 90 days following issuance of the final NRC staff SE on WCAP-16793-NP.

### **NRC Request**

*Regarding the last two RAIs below, the licensee indicated in its February 27, 2008 supplemental response that additional chemical effects testing will be performed for PNP and, as a result, the NRC staff has not been able to develop a comprehensive list of chemical effects RAIs. The NRC staff expects that chemical effects information as called for in the NRC Content Guide will be forthcoming in a follow-on Generic Letter 2004-02 supplemental response. The NRC staff will review this information when the licensee submits it, and as a result of such review, the NRC staff could request additional information in this subject area if needed. Nevertheless, at this time the NRC staff has the two chemical effects questions that follow:*

17. *The February 27, 2008, supplemental response states that the "choice of worst breaks is applicable to the new passive strainers and the new STB [sodium tetraborate] buffer" in part because the impact of trisodium phosphate and calcium silicate was not widely understood at the time the break selection analysis was performed. Please clarify this statement and confirm that the break location determined to be the "worst case" results in the projected maximum quantity of aluminum containing precipitates being generated.*

### **ENO Response**

17. Following the submittal of PNP GL 2004-02 supplemental response, on February 27, 2008, revised and new basis calculations have been performed in support of the PNP November 2008 strainer testing. As discussed with the staff on December 3, 2008, response to this RAI will be provided using the updated design basis debris values in the updated

supplemental response due 60 days following restart from the 2009 refueling outage.

### **NRC Request**

18. *Page 66 of the February 27, 2008, supplemental response indicates that Palisades Technical Specification Surveillance Procedure RT-92 addresses the biological cleanliness of the sump, and specifies that algae and/or slime in the sump that could impede ECCS operation be removed. Please discuss the typical amounts of algae and/or slime that are removed from the sump and justify why this amount of biological material does not need to be considered as an additional debris source after a postulated LOCA.*

### **ENO Response**

18. The sump area is a confined space and typically has been a high radiation area and a very high contamination area. Radiological doses up to two rads per hour at contact and contamination levels to 1,000,000 dpm/100 cm<sup>2</sup> have been reported during some refueling outages. There is no lighting in the area and the entrance is via a 10-foot long, 24-inch diameter tube with a severe downward slope. The sump is circular, 22 feet in diameter and 3.5-feet high. The floor of the sump is uneven due to the way concrete was placed. The center of the floor is on the order of ¾-inch higher than the outer edges. The old screens are at the periphery, as are most of the floor drain inputs. This complicates reporting of residual water level in the sump during inspections and also prevents complete gravity draining of the sump.

The combination of personnel protection gear and poor available lighting makes measurements, data taking, and color fidelity problematical. Due to a significant safety focus, most attention in the past was placed on the old sump screens. The old sump screens were removed from the sump.

The historic data that exists was mostly casually taken by radiation protection technicians and written on the radiation work permits (RWPs). Going back to 1990, the reports of residual water level on the floor, after gravity draining the sump to the dirty radioactive waste system, range in the ½ to 1 ½ inch area. These levels are thought to have been maximum levels, to control the protective clothing choice, taken on the edge of the sump either at the location of the 24" entrance or in front of the of screens. Both are known to be sump low points. Most of these reports also include a smear taken at the center of the sump that was frequently reported as a dry smear.

The sump was typically cleaned by vacuuming the material into a 55 gallon drum and transporting it out of containment by crane, as opposed to flushing it out to radioactive waste. The material did all fit in the drum and the drum was usually around  $\frac{3}{4}$  full (for example in 2001). It was reported that less than half of the drum was "sludge" and the rest was water. There were at least two methods of judging the fraction of the sludge component. One method was by dip-sticking the drum and another by variation of contact dose rate as the meter was moved up the outside diameter of the drum. The drum represents a significant radiation source during cleaning and must be monitored to ensure a high radiation area is not created. Thus, the radiation meter method is readily available for judging how much sludge is present.

If it is assumed the drum was full and half of the contents were sludge, then the sludge volume would be 27.5 gallons. It is noted that a full uniform depth of one inch in the sump would equal 237 gallons. The difference from 55 gallons relates to the non-uniform floor elevation and the tendency to estimate and report the maximum sludge depth rather than actually measure it. If volume had been reported, average depth readings would be needed to yield a good volume estimate. Taking the time to do that, without a good reason, would not, at the time, have been considered to be ALARA.

The 27.5 gallon conservative estimate was for material removed from the sump floor. The volume of material removed from the screens while they were cleaned would have been very small. Cleaning was rendered difficult due to the low ceiling and the fact that only one side of the screen was accessible to brush. Also, the high viscosity of the material made a bubble form in the small screen squares and it resisted removal by a stiff wire brush that rode over the high points on the screens. Adding soapy cleaning solution did nothing to help this phenomenon. This kind of bubble does not support any differential pressure so is not a plugging concern. More recent efforts successfully used high pressure spray with hot water. This is quicker, easier for the decontamination technicians to apply, and is more effective from an ALARA standpoint.

The use of "algae" is not found in the documents written by those who handle the material. The words used to describe the material include: sludge, sediment, oil and water mixture, muddy water, and slimy/oily water. Algae may be used as a "conservative" assumption. Since the containment air cooler condensate leaves containment via the sump, and since leakage of lake water from the cooling coils had been known to occur in the past, it is possible that algae and other biological material are present. The possibility that a significant fraction of it is emulsified oil from the primary coolant pumps is quite high since their RMI insulation has a tendency to hold oil and significant quantities of oil went unaccounted for in past spill cleanups. Hot boric acid containing leakage from pump seals

could easily complex with the oil and transfer it to the sump that also caught the pump leakage.

The new screens are all above the sump on the 590' elevation of containment and are not exposed to the material in the sump until after it has gone through a containment spray pump, a high pressure safety injection pump, the recirculation heat exchanger, and either through the core and line break or through the containment spray valves and spray nozzles, and then on to the 590' elevation containment sump pool containing sodium tetraborate.

The post LOCA containment sump pool contains approximately 250,000 gallons of hot borated water containing a significant amount (8,000 lbs) of sodium tetraborate. The sodium tetraborate is the same material sold as borax for use in laundry as a surfactant. There is little doubt that 250,000 gallons of hot soapy sump water can easily dissolve 27.5 gallons of either oily emulsion or algae created biological material. Similar surfactants are also sold as algacides. Extreme agitation as it transits through the above described path will ensure good mixing takes place and will enhance the process of dissolution of solubles or suspension of small particles.