VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

June 23, 1980

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attention: Mr. B. Joe Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Serial No. 547
NO/MDK:smv
Docket No. 5 [illegible]
License No. NPF-7

Dear Mr. Denton:

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
FOR THE REVIEW OF THE NORTH ANNA POWER STATION
UNIT 2 FINAL SAFETY ANALYSIS REPORT (FSAR)
DATED MAY 31, 1980

Our response to the enclosure of the subject request is attached herein. This information is complete and fulfills our response requirement.

If you require further clarification to the specific items addressed, please do not hesitate to contact us.

Sincerely,

BRSylvia
B. R. Sylvia
Manager - Nuclear
Operations and Maintenance

MDK/smv:SA1

Attachment

cc: Mr. James P. O'Reilly, Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Region II
Atlanta, Georgia 30303

8006250 289

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

Question:

1. In addition to insulation debris resulting from LOCA effects, debris can be generated within the containment from other sources, such as (1) degraded materials (paint chips), and (2) items which are taken into and left in the containment following maintenance and inspection activities.

Describe how the housekeeping program for the North Anna Unit 2 will control and limit debris accumulation from these sources. The objective is to assure that debris capable of defeating the post-LOCA core cooling function are identified and removed from the containment.

The response should include references to specific procedures or other means to assure that "as licensed" cleanliness will be attained prior to initial operation and prior to each resumption of operation.

Response:

1. All maintenance personnel and supervisors are thoroughly instructed in cleanliness requirements to insure that their work areas are properly cleaned following the completion of work. Prior to establishing containment integrity, following an outage, the entire containment is inspected in accordance with procedure OP-1B "Containment Checklist" to insure cleanliness. Procedure OP-1B details the sequential inspection of the entire containment and requires the removal of any material "that could possibly be transported to the containment sump during LOCA conditions."

Question:

2. Address the degree of compliance of North Anna Unit 2 with the following recommendation which is also set forth as item C.14 of Regulatory Guide 1.82:

"Inservice inspection requirements for coolant pump components (trash racks, screens, and pump suction inlets) should include the following:

a. coolant sump components should be inspected during every refueling period downtime, and

b. the inspection should be a visual examination of the components for evidence of structural distress of corrosion."

Response:

2. North Anna Unit 2 Technical Specification 4.5.2.d-1 specifically states that at least once per 18 months, each ECCS subsystem shall be demonstrated OPERABLE by a visual inspection of the containment sump and verifying that the subsystem suction inlets are not restricted by debris and that the sump components (trash racks, screens, etc.) show no evidence of structural distress or corrosion.

Question:

3. As stated in Supplement No. 8, a scale model test of the North Anna sump design has been successfully conducted to show that adverse hydraulic phenomena which would impede long-term cooling of the core following a LOCA will not occur. This testing was performed with up to fifty percent of the sump screens blocked. The responses to the following concerns are required to support this assumption.

   a. FSAR page 6.2-63 Amendment 65 states that seven types of insulation are used in the containment. For each type provide the following information:

      (1) The manufacturer, brand name, volume and area covered.

      (2) A brief description of the material and an estimate of the tendency of this material either to form particles small enough to pass through the fine screen in the sump or to block the sump trash racks or sump screens.

      (3) Location of the material (metal mirrored, foam glass, foam rubber, foam concrete, fiberglass, etc.) with respect to whether a mechanism exists for the material to be transported to the sump.

   b. We will require the following additional information concerning the design of the containment sump.

      (1) Provide an estimate of the amount of debris that the sump inlet screens may be subjected to during a loss-of-coolant accident. Describe the origin of the debris and design features of the containment sump and equipment which would preclude the screens becoming blocked or the sump plugged by debris. Your discussion should include consideration of at least the following sources of possible debris: equipment insulation, sand plug materials, reactor cavity annulus sand tanks or sand bags for biological shielding, containment loose insulation, and debris which could be generated by failure of non-safety related equipment within the containment. Entry of sand plug materials into the containment sump and the possibility of sand covering the recirculation flow from the containment should be specifically addressed.

      (2) We have reviewed the letter of S. C. Brown, VEPCO, to Mr. E. G. Case, NRC, dated March 23, 1978 relative to this issue. It is not apparent from a reading of the letter's attachment what percentage of the containment was included in the pump tests relative to the volumes and surface areas which would be effective in a post-LOCA ECCS recirculation mode. It is also not apparent what the total weight of the debris was in each particle size class on table C.

Please provide this information along with your conclusion regarding the percentage of the screens which would be expected to be blocked by particles of all sizes, including those greater than 250 mils.

c. With respect to the conclusion that debris with a specific gravity greater than unity will settle before reaching the sump cover, consider the potential for flow paths which may direct significant quantities of debris laden coolant into the lower containment in the vicinity of the sump and the availability or lack of sufficient horizontal surface areas or obstructions to promote settlings or holdup of debris prior to reaching the sump.

d. Does metal mirror insulation house other materials, fibrous or otherwise, which could become debris if the insulation were blown off as a result of a LOCA?

e. If the North Anna containment contains loose insulation, include examples of how the insulation will be precluded from reaching the sump.

Response:

3.a All exposed insulation within the containment is jacketed with stainless steel or silicone rubber impregnated fiberglass cloth encased in stainless steel mesh for protection and is designed to withstand the post-LOCA containment environment. Therefore, the post-LOCA environment and chemical spray will not cause the insulation to be dislodged from its piping or equipment and possibly migrate to the containment sump.

The only plausible mechanism that could dislodge piping and equipment insulation during a LOCA would be the impact from the high energy jet from the break and/or a whipping pipe. The insulation removal would occur in the very localized area of the high energy jet and/or whipping pipe.

All pipe, with one exception, whose failure could result in a LOCA is located within the steam generator cubicles, the pressurizer cubicle or the reactor cavity inside the primary shield wall. The greatest quantity of insulation in proximity to a postulated LOCA is located in the steam generator cubicles. The only pipe whose failure could result in a LOCA which is not located entirely within the steam generator cubicles, pressurizer cubicle, or reactor cavity is a portion of the pressurizer spray piping which is routed under the cubicle between elevations 236' and 241'. The spray piping outside the cubicles has a nominal internal diameter of 3.4 inches, and therefore, the high energy jet would have a relatively small area of influence and insulation removal potential. The spray piping is not routed in a pipe rack or chase containing a large quantity of insulated piping. The only insulated pipe in the reactor cavity are short sections of reactor coolant loop piping. The amount of insulation in the pressurizer cubicle is a small percentage of that in one of the steam generator cubicles.

Since the largest quantity of insulation coupled with the potential for the largest high energy jets due to a LOCA exists in the steam generator cubicles, the response to questions 3.a (1), (2), and (3) will only consider insulation in the steam generator cubicles. This will represent a worse case analysis.

3.a (1) The steam generator cubicles contain the following types of insulation:

	Manufacturer	Brand Name	Estimated Area (ft^2)	Estimated Volume (ft^3)
1.	Transco	Metallic Reflective	1700-2200	560-730
2.	Eastern Refractories Co.	Erco Mat	2000-2200	330-370
3.	Micropore International LTD	Micro Therm	5000-7000	600-870
4.	Owens-Corning	Intermediate Service Board	8000-10000	2000-2500
5.	Certain-Teed	850 Fiberglass		
6.	Pittsburgh Corning	Uni-Jac	200-500	50-125
7.	Johns Manville	Thermo-12	200-500	100-250
8.	Pittsburgh Corning	Temp Mat	500-900	60-110

Items 4 and 5 are both fiberglass insulation from different manufacturers, hence, the reference to the seven types of insulation on FSAR page 6.2-63. The square footage and volumes estimated above for Items 4 and 5 includes the combined total for fiberglass.

3.a (2) Metallic Reflective (Transco) insulation consists of multiple layers of .002" thick type 304 stainless steel foil suitably supported by stainless steel type 304 clips and spacers, enclosed by a casing of 24 gage type 304 stainless steel. The type 304 stainless steel foil does not breakdown when wet, but shredding and or tearing may occur if directly impinged upon by a high energy coolant jet. All material employed in this insulation has a specific gravity greater than one and thus would sink and is not likely to reach the screens. If it did reach the sump screens, it would not pass through the screens.

Temp Mat (Pittsburgh Corning) is a flexible lightweight fibrous glass insulation and is composed of 100 percent selected grade type E glass fibers fabricated in mat form. Temp Mat is not subject to deterioration when wet, therefore only direct impingement would cause a breakdown of the mat. If total separation of the mat occurred, the fibers would sink to the containment floor and would not be expected to block the sump screens as discussed in Topical Report OCF-1, "Nuclear Containment Insulation System" prepared by Owens Corning Fiberglass Corp. and accepted for reference in licensing applications in a letter dated December 8, 1978 from Robert L. Baer, Program Manager, Light Water Reactors Branch No. 2, Division of Project Management, Office of Nuclear Reactor Regulation.

Micro Therm (Micropore) is a high performance insulation with a micro porous structure of ceramic fibers which is in a powder form and is enclosed in a fiberglass cloth. The ceramic fibers are insoluble and when mixed with water have a silt type consistency which would not block the sump screens since it would pass through them.

Fiberglass (Owens Corning Intermediate Service Board) is a lightweight insulation composed of fiberglass fibers bonded together in semi-rigid boardlike form with a high temperature binder.

Fiberglass (Certain-Teed "850") is composed of extremely fine diameter glass fibers bonded together with a phenolic resin and molded in one piece sections. As discussed above for Temp Mat insulation, the fibers would not be expected to block the sump screens.

Foamglas Insulation (Pittsburgh Corning Uni-Jac) is an impermeable, insoluble, noncombustible cellular glass insulation composed of millions of completely sealed glass cells. Foamglas Insulation is all glass, completely inorganic without binders or filler, with an average density of 8.5 pounds per cubic foot. Upon direct impingement, Foamglas insulation could separate into pieces which would float and would not cause screen blockage. Crushing or shattering caused during pipe whip or jet impingement would form fine particles which would settle out on the floor or pass through the screens.

Calcium Silicate (Johns Manville Thermo-12) is composed of hydrous calcium silicate, which is light weight and insoluble in water. If directly impinged upon, Thermo-12 will break down in a fine silt which would pass through the sump screens and not block them.

Erco Mat is a completely encapsulated insulated blanket. The blanket consists of a filler of light weight fibrous glass (Temp-Mat), covered with silicone rubber covered cloth. These blankets are used around the steam generator supports. All blankets, except the inner layer blanket on the top of each support, have a covering of knitted stainless steel mesh outside of the cloth covering.

The blankets are designed to maintain their integrity when subjected to containment accident conditions. Direct impingement by a jet could cause a localized area of damage which may release Temp Mat fibers. These fibers are not expected to block the screens as previously discussed. The blankets themselves will remain in the steam generator cubicles.

3.a (3) As discussed above, the insulation to be evaluated is located in the steam generator cubicles. The response to 3.b (1) and (2) and 3.c discusses the mechanism for material to be transported to the containment sump.

3.b (1) The potential origin of debris due to a pipe or equipment failure which results in a LOCA is as follows:

1. Insulation in the path of the high energy coolant jet and/or a whipping pipe from the following areas:
    a. Steam generator cubicles
    b. Pressurizer cubicle
    c. Reactor cavity
    d. Adjacent to the portion of the pressurizer spray piping under the steam generator and pressurizer cubicles

2. Supplementary reactor shield material saddles (see FSAR, Appendix Q for description) located in the reactor cavity.

3. Particle debris of the type discussed in the letter of S. C. Brown, Jr., VEPCO, to Mr. E. G. Case, NRR, dated March 23, 1978 which is uniformly distributed throughout the containment.

4. Failure of non-safety related equipment within the containment. The debris that this failure could generate would be a small quantity of relatively large and heavy pieces. These items, if they were to reach the containment floor would sink rapidly and would not be expected to contribute to sump screen blockage.

No sand plugs, sand bags or loose insulation is located inside the containment.

As discussed in 3.a above, the steam generator cubicles contain the largest quantity of insulation that could be exposed to a high energy coolant jet and/or whipping pipe. No other mechanism for insulation dislodgement has been identified. The area of influence of a high energy coolant jet is also the largest in the steam generator cubicles due to the large pipe diameters present. Break areas inside the steam generator cubicles are discussed in the FSAR, Section 6.2.1.1.2.

The design of the steam generator cubicles is such that it is very difficult for insulation or debris to exit the cubicles. The personnel entrances at elevations 241'-0" and 262'-10" are arranged such that debris would have to transverse a labyrinth type path with several direction changes to get outside of the cubicles. Once outside the cubicles, the annulus floor grating and concrete would prevent significantly large pieces of insulation or debris from reaching the containment floor or sump.

Any insulation or debris of significant size that would be ejected upward and out of cubicle openings at the operating floor (elevation 291'-10") would not likely be transported from the operating floor to the containment sump due to the complex and torturous path through grating or down stairwells.

The grating or blow out panels in the floor of the steam generator cubicles at elevation 242'-6" adjacent to the primary shield wall represent the most likely exit location for debris. The design of the grating or the "egg crate" design of the blow out panels would prevent debris with a maximum dimension of more than approximately 5 x 10 inches from passing through it to the containment floor below, except for the potential rod-shaped piece which presents the proper aspect to the grating or blow out panel.

The response to 3.a (2) above describes the characteristics of insulation which could possibly migrate from the steam generator cubicles to the containment floor. All insulation or debris with a specific gravity less than unity which can float will not block the sump screens because, as can be seen in the schematic drawing response to question 5, the post-LOCA minimum containment water level is approximately 2.5 feet above the top of the containment sump screens after the RWST, accumulators, and casing cooling tank contents have been expended. Insulation or debris with a specific gravity greater than 1.0 would sink to the containment floor, and therefore, only a very small quantity of this insulation or debris would be expected to migrate to the containment sump screens.

Based on the above discussions, it is evident that only a limited amount of insulation in a steam generator cubicle would be dislodged by a LOCA high energy jet and/or whipping pipe. Of this dislodged insulation, most of it would not be expected to reach the containment floor at elevation 216'-11" due to the relatively small area of opening in the steam generator cubicle and the torturous path that the insulation or debris must transcend to reach the containment floor. Of that insulation or debris that does reach the containment floor, most would sink at a distance away from the screens, float, or pass through the screens.

The sump has several design features which prevent blockage. Inclined grating bars followed by coarse mesh followed by fine mesh are provided so that large pieces of debris will be caught at a distance from the pump suctions such that water can still flow around any obstruction.

Therefore, it is estimated that the amount of blockage by particles of all sizes, including those greater than 250 mils, that sump screens would be subjected to during a LOCA is less than that which could cause fifty percent of the screen vertical area to be blocked.

3.b (2) The pump tests were performed by constructing a dike in close proximity to the containment sump which held the water and debris that was continuously recirculated from the containment sump through the pump and associated piping.

Section III of the March 23, 1978 letter of S. C. Brown, VEPCO to Mr. E. G. Case, NRR discusses how the concentration of debris in the entire containment was determined by sampling. Table E of the above referenced letter shows that the pumped fluid during the test had significantly larger concentrations of particles than the containment analysis samples over the entire range of particle size.

Table C of the above referenced letter has been revised to show the total weight of debris in each particle size class and is attached to this response.

3.c The most plausible path for debris to exit the steam generator cubicles is through the grating or blowout panel openings at elevation 241'-0" adjacent to the primary shield wall. Debris passing through these openings would fall to the containment floor no closer than 32' from the sump screen. Any debris created by a LOCA in the pressurizer cubicle which could conceivably exit the cubicle would descend to the containment floor at a greater distance than 32 feet from the containment sump. The particle settling analysis forwarded in the letter of March 13, 1978 from S. C. Brown, VEPCO, to E. G. Case, NRR indicated that only a small percentage of debris with a specific gravity greater than one could be drawn into the sump at this distance.

A significant quantity of debris created by a LOCA in the reactor cavity would not be expected to reach the containment sump since the reactor cavity is completely enclosed on the bottom and sides and any debris blown upward to the operating floor at elevation 291'-10' would have to migrate a very torturous and complex path through grating and down stairwells before it could reach the containment sump.

An insignificant amount of debris generated by a LOCA could migrate to the annulus grating at elevation 241'-0" over the containment sumps. Any debris of significant size which may reach this grating would be restrained by the grating. Any small size debris which might pass through the grating would have minimal affect on sump performance.

Therefore, flow paths do not exist which direct significant quantities of debris into the lower containment in the vicinity of the sump.

3.d Mirror (Metallic Reflective) insulation houses only multiple layers of 304 stainless steel foil, as described in response 3.a (2).

3.e The containment structure contains no loose insulation. All insulation is either: 1) metal jacketed with type 304 austenitic stainless steel; 2) completely encapsulated in a silicone rubber coated cloth; 3) completely encapsulated in a silicone rubber coated cloth with additional encapsulation of stainless steel knitted mesh.

Question:

4. The resolution of the concerns noted above plus the provisions of adequate NPSH under non-debris conditions, and adequate housekeeping practices are expected to reduce the likelihood of problems during recirculation. However, in the event that LHSI recirculation system problems such as pump cavitation or air entrainment do occur, the operator should have the capability to recognize and contend with the problems.

Both cavitation and air entrainment could be expected to cause pump vibration and oscillations in system flow rate and pressure. Show that the operator will be provided with sufficient instrumentation and appropriate indications to allow and enable detection of these problems. List the instrumentation available giving both the location of the sensor and the readout.

The incidence of cavitation, air entrainment or votex formation could be reduced by reducing the system flow rate. The operator should have the capability to perform indicated actions (e.g., throttling or terminating flow, resort to alternate cooling system, etc.). Show that the emergency operating instructions and the operator training consider the need to monitor the long-term performance of the recirculation system and consider the need for corrective actions to alleviate problems.

Response:

4. The operator is provided with sufficient instrumentation and appropriate indications to detect the effects of cavitation or air entrainment on the outside and inside recirculation spray (ORS and IRS) and low head safety injection (LHSI) pumps. The specific instrumentation available is as follows:

Pump	FSAR(1) Figure	Instrumentation Available	Sensor Location	Readout Location
LHSI (2-SI-P-1A)	6.3-1	Pump Flow Rate (FE-2945)	Safeguards Area Building (Line 10-SI-425-153A-Q2)	Main Control Room
	6.3-1	Pump Discharge Pressure (PI-2943)	Safeguards Area Building (Line 10-SI-425-153A-Q2)	Local
LHSI (2-SI-P-1B)	6.3-1	Pump Flow Rate (FE-2946)	Safeguards Area Building (Line 10-SI-464-153A-Q2)	Main Control Room
	6.3-1	Pump Discharge Pressure (PI-2944)	Safeguards Area Building (Line 10-SI-464-153A-Q2)	Local
ORS (2-RS-P-2A)	6.2-64	Pump Discharge Pressure (PI-RS-200A)	Safeguards Area Building (Line 10-RS-409-153A-Q2)	Main Control Room
	6.2-64	Pump/Motor Vibration (VT-RS-201A)	Safeguards Area Building (Pump Motor)	Main Control Room
ORS (2-RS-P-2B	6.2-64	Pump Discharge Pressure (PI-RS-200B)	Safeguards Area Building (Line 10-RS-410-150A-Q2)	Main Control Room
	6.2-64	Pump/Motor Vibration (VT-RS-201B)	Safeguards Area Building (Pump Motor)	Main Control Room

Pump	FSAR(1) Figure	Instrumentation Available	Sensor Location	Readout Location
IRS (2-RS-P-1A)	6.2-64	Pump/Motor Vibration (VT-RS-200A)	Containment (Pump Motor)	Main Control Room
	6.2-64	Pump Discharge Pressure (PI-RS-252A)	Containment (Line 10-RS-401-153A-Q2)	Main Control Room
IRS (2-RS-P-1B)	6.2-64	Pump/Motor Vibration (VT-RS-P-1B)	Containment (Pump Motor)	Main Control Room
	6.2-64	Pump Discharge Pressure (PI-RS-252B)	Containment (Line 10-RS-402-153A-Q2)	Main Control Room
All Pumps	6.2-64	Sump Level (LI-251A and B)	Containment Sump	Main Control Room

(1)FSAR figures show lables for Unit 1 components, Unit 2 is similar.

As part of emergency operating procedure EP-2, LOSS OF COOLANT ACCIDENT, the operator is instructed to monitor the long-term performance of the recirculation system and fulfill the requirements of the POST LOCA LOG. This procedure specifically instructs the operator to pay particular attention to "trends developing" which would indicate pump performance degradation. The POST LOCA LOG trends those system parameters (e.g., discharge flow, motor amps, pressures and temperatures) which would indicate performance degradation. Detailed instructions are outlined for cold leg recirculation, hot leg recirculation, termination/initiation of hot and cold leg recirculation, and single or redundant train operation. All operators are licensed and trained in these emergency procedures. This training and subsequent re-training through comprehensive written exam and use of the control room simulator, condition the operators for adept recognition and execution of the instrumentation and controls which mitigate the consequences of LOCA as well as equipment performance degradation.

Question:

5. Provide a schematic drawing of the post-LOCA water level in the containment during the recirculation mode relative to the elevation of the ECCS sump floor. Include on this drawing the location of the containment water level sensor and the elevations correspond to readings of zero and 100% pf range on the control room indicator.

Response:

5. See enclosed drawing entitled:

Typical Arrangement
Containment Sump Screen
North Anna Power Station
Units 1 and 2
Amend 65

Question:

6. Provide several large scale drawings of the containment structures, systems and components at elevations.

Response:

6. See the following enclosed drawings:

12050-FM-1A-10
12050-FM-1B-9
12050-FM-1C-8
12050-FM-1D-9
12050-FM-1E-8
12050-FM-1F-6
12050-FM-1G-7

Question:

7. Does North Anna Unit 2 utilize sand or similar materials in the containment during power operation for purposes such as reactor cavity annulus biological shielding (e.g., sand tanks or sand bags) or reactor cavity blow out sand plugs?

Response:

7. North Anna Unit 2 does not utilize sand or any similar material in the containment during power operator for purposes such as reactor cavity annulus biological shielding or reactor cavity blow out plugs.

SUMMARY TABLE C
PARTICLE DISTRIBUTION
ALL PARTICLE SIZES
CONTAINMENT PARTICLE SAMPLING ANALYSIS

Particle Size Mils	Total Weight of Debris in Pounds	PPM
50 to 120	0.43	0.13
> 50	0.43	0.13
19 to 50	0.32	0.10
> 19	0.75	0.23
9.5 to 19	0.14	0.04
> 9.5	0.89	0.27
4.7 to 9.5	0.25	0.08
> 4.7	1.14	0.35
2.0 to 4.7	1.03	0.32
> 2.0	2.17	0.67
< 2.0	3.12	0.96

Note: Particles >120 Mils not included since these particles will not pass through the fine mesh screens.