TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

July 21, 1980

Director of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Light Water Reactors Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Schwencer:

In the Matter of the Application of	)	Docket Nos. 50-327
Tennessee Valley Authority	)	50-328

References:
1. Letter from A. Schwencer to H. G. Parris dated June 19, 1980
2. Letter from L. M. Mills to A. Schwencer dated July 18, 1980

In your letter dated June 19, 1980, you requested additional information regarding four subjects: shielding design review, high range containment radiation monitor, access control of areas adjacent to spent fuel transfer tubes, and containment sump debris. The first three items were addressed in my letter dated July 18, 1980 (reference 2). Enclosed are TVA's responses to the questions on control of containment sump debris.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Regulation and Safety

Enclosures (41)

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Request for Additional Information - Containment Sump

Background

The safety issue of containment emergency sump performance under post-LOCA conditions can be viewed as two parts: (1) containment sump hydraulic performance (i.e., providing adequate NPSH to the recirculation pumps with up to 50 percent of the sump screen area blocked) and (2) the effects of debris. The first part, sump hydraulic performance, has previously been addressed in the Sequoyah Nuclear Plant, and has been acceptably resolved as is stated in Section 6.3.4 of the SER. The problem addressed herein is the potential for debris from insulation and other sources within containment to collect and compromise the ability of the ECCS to recirculate coolant from the containment sump through the RHR heat exchangers to the vessel. Please respond to the following items with the desired information.

Question

1. As stated in Section 6.3.4 of Supplement No. 1 to the SER, a scale model test of the SNP sump design has been successfully conducted to show that adverse hydraulic phenomena which could impede long-term cooling of the core following a LOCA will not occur. This testing was performed with up to 50 percent of the sump screens blocked. The responses to the following concerns are required to support this assumption.

   a) For each type of thermal insulation used in the containment, provide the following information:

      (1) The manufacture, 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, fiberglass, etc.) with respect to whether a mechanism exists for the material to be transported to the sump.

   b) Part four of the response to question 6.28 does not provide an estimate of the amount of debris that the sump inlet screens may be subjected to during a loss-of-coolant accident. Provide this information including the results of an analysis of the worst break in terms of the amount of insulation blown off by pipe whip and hydraulic jet forces, indicating where the insulation would come to rest. If a blockage problem is identified, propose corrective actions.

   c) Discuss the basis for 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 settling or holdup of debris prior to reaching the sump.

d) Discuss the significance of containment coating, e.g., paint, as a source of debris over the long-term post-LOCA recirculation phase. Have the coatings been environmentally qualified for the long-term post-LOCA environmental conditions?

e) Does metal mirro insulation house other materials, fibrous or otherwise, which could become debris if the insulation were blow off as a result of a LOCA?

f) Expand the discussion in response to question 6.28 on loose insulation to include examples of how the insulation will be precluded from reaching the sump.

g) Expand the discussion on containment and ice condenser insulation to include details on the reaction of various insulation types to the post-LOCA environment and to include examples of the use of foam concrete. What is the density of foam concrete and what tendency does it have to be broken up into small sized particles? Discuss the bases, including any analyses performed, for the protection of insulation from the effect of a LOCA.

Response

1(a)(1)

Manufacturer	Brand Name	Volume and Area Covered
Mirror Insulation Divison Diamond Power Specialty Corp.	Mirror Insulation	Reactor Vessel, Steam Generators, Pressurizer, Reactor Coolant Pumps and Piping, RHR Piping, SIS Piping, Main Steam, and Feedwater Piping
Pittsburgh Corning Corp.	Foamglass	Refrigerant lines and ducts to Instrument Room, 4-foot high band around Containment Vessel, 80 percent of Ice Condenser piping
Rubatex Corp.	Rubatex	20 percent of Ice Condenser piping
Owens/Corning Fiberglass Corp.	Fiberglass	Piping inside air handling units located in upper plenum area of Ice

		Condenser (approximately 1 foot of pipe per air handling unit. Also used for crane wall insulation, and wall insulation, and sealing joints of wall panels of Ice Condenser
Christiansen Foam Corporation	Polyurethane Foam	Wall panel insulation between steel air cooling ducts and the concentric steel containment shell
E. R. Carpenter	Polyurethane Foam	Top deck insulation of Ice Condenser
(Furnished by Westinghouse)	Urethane Foam	Insulating inside Ice Condenser doors
Forty-Eight Insulators Inc.	Mineral Wool	Main pipe penetrations of Containment Vessel

1(a)(2) and 1(a)(3)

<u>Mirror Insulation</u> is an all-metal reflective insulation constructed of austenetic stainless steel. The metallic reflective insulation is strong mechanically and composed of sections which are latched together when in place. The sections will not segment or breakup into small particles. The sections will sink to the bottom and will remain stationary. Insulation in the vicinity of the pipe break will be blown or stripped off. It is not considered that the sections would be torn apart due to their strong mechanical construction.

<u>Foamglass Insulation</u> is a rigid insulation composed of sealed glass cells. Each cell is an insulating air space. Foamglass is all-glass and is completely inorganic. The insulation on refrigerant lines, ducts, and piping is covered and banded by stainless steel jacketing to minimize or eliminate the conditions whereby the insulation could crumble. The insulation on the containment vessel is covered by a stainless steel sheath. This insulation is also located in areas least affected by postulated pipe breaks (i.e. in upper regions of the containment and outside the crane wall). In addition to it being completely encased as well as being located in areas protected from the effects of pipe breaks, this insulation will float and cannot enter the sump because of a 13.2 foot minimum water level which exists over the containment floor before recirculation begins.

<u>Rubatex Insulation</u> is a flexible closed cell rubber type insulation. This insulation is located on portions of the ice condenser system where it is least affected by postulated pipe breaks (i.e. upper plenum area of the ice condenser). This insulation is not expected to suffer damage

from any primary system pipe break; however, it should be noted that the insulation will float and could not enter the sump because of a 13.2 foot minimum water level which exists over the containment floor before recirculation begins.

Fiberglass Insulation is a glass fiber preformed pipe insulation encased in a vapor barrier jacket for the air handling units. For the Ice Condenser crane wall insulation, end wall insulation, and for sealing the joints in the ice condenser wall, the glass fiber is in blanket form enclosed in polyethylene bags and covered by metal panels. The insulation in all cases is behind metal (i.e. inside housing of air handling unit or under metal wall panels) to protect and assure it does not have a pathway to the sump.

Polyurethane and Urethane Foam Insulation is a closed cell urethane resin foam. The polyurethane foam between the air ducts and the containment vessel does not have a pathway to the sump. The polyurethane foam insulating the top deck of the Ice Condenser is a blanket between stainless steel sheaths. The assembly rests on floor grating and is hinged at the crane wall to form doors that open upon an LOCA. This assembly maintained its integrity when tested under blowdown conditions that exceeded the worst LOCA. The urethane foam insulating the Ice Condenser inlet doors is completely enclosed. Refer to FSAR Figures 6.5-20 and 6.5-23. These doors have been tested rigorously.

Mineral Wool Insulation is a refactory fiber block insulation laminated and bonded by high temperature binders. The insulation is between the process piping and the penetration sleeve and would not be subject to direct sprays and water from pipe breaks.

1(b) Restraints will prevent pipe whip thereby limiting the amount of insulation that could be blown off to that around the pipe at the break location. The worst case would be a break located immediately under the point at which two sections of mirror insulation abut in the longitudinal direction of the pipe. No more than half of the abutted insulation section could be blown toward the sump.

The mirror insulation is cylindrical on the straight portions of the primary system piping. Over elbows, the outside surface is composed of flat sections in the shape of rectangles on the outside and inside bends of the elbow, and in the shape of trapezoids on the elbow sides. The largest single flat outside surface area of the insulation covering an elbow is 6.88 square feet. In cross section, a section end has a parting surface area of 1.79 square feet and the longest straight length has a parting surface area in the longitudinal direction of 2.0 square feet.

Considering the curvature of the insulation over straight portions of the primary system piping and the angularity of the insulation over elbows, the outward slope of the sump screens, the curb around the sump, and the quantity of equipment and supports anchored to the containment floor that would prevent movement of settled insulation sections, the maximum possible sump screen area that could be blocked is very small. Any contact between an insulation section and the screen would most probably be along a line or at a point in the unlikely event that some of the mirror insulation were to fall against the sump screen. Since the insulation covering one elbow together with the insulationn covering one straight length of piping is all that could be affected by a given break, there is only one outer flat surface of insulation available to contact the sump screen. The only other flat surfaces either are along longitudinal or transverse parting surfaces.

In the most conservative hypothetical case, the largest flat surfaces area of insulation covering an elbow together with the largest parting surface of the longest straight section could be assumed to be against the sump screen. The total area blocked by these two sections of mirror insulation would be 8.88 square feet of the sump screen area of 42.6 square feet. TVA report No. WM28-1-45-102 "Model Study of the Sequoyah RHR Sump" shows that a 50 percent blockage of the screen area has a negligible effect on the sump operation.

1(c) There would be a minimum time of 15 minutes following an LOCA before suction would be taken from the sump. This time interval will assure that debris with a specific gravity greater than unity would settle and come to rest before recirculation would begin. It should be noted that the mirror insulation is designed to be cleaned easily by internal flushing; thus, it contains no closed cells which trap air and with a metal density more than eight times that of water, will sink rapidly. In addition, the large amount of obstructions near and at the containment floor level, such as supporting structures for piping and other equipment, would impede the motion of any debris.

1(d) Peeling paint has been identified as a possible hazard to operation of the containment sump. To prevent this hazard, surface coatings used are qualified to withstand possible upset conditions by being subjected to simulated DBA conditions per ANSI Standard N101.2-1972, "Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities".

ANSI Standards N45.2, "Quality Assurance Program Requirements for Nuclear Facilities," and N101.4 "Quality Assurance for Protective Coatings Applied to Nuclear Facilities" are used to formulate a protective coating Quality Assurance Program to 1) ensure the quality of the materials used, 2) ensure that the application is as recommended by the manufacturer and within thicknesses ranges upon which primary containment qualifications are based, and 3) ensure that inspection is thorough and of a quality to assure a high level of credibility of coating performance during operating and upset conditions. Each batch of coating material used requires certification by the manufacturer as to its identity and conformance to manufacturing specifications. Each batch of field applied material is further tested by TVA to assure its conformance to manufacturing specifications. No field application can be made without prior approval.

Unqualified and unidentified coatings are held to the minimum practical, and represent an insignificant fraction of the total coated area within the primary containment. Unqualified and unidentified coatings areas are logged and reviewed. Should the total area of such coatings represent a hazard to the operation of equipment essential to safety, the area will be reduced by removal and application of a qualified coating system in order to lower unqualified and unidentified coatings to an insignificant level.

Paint used inside containment produces a hardened film having a specific gravity appreciably greater than unity. Hence, gravitational settling will help assure protection against plugging of the sump with paint particles.

1(e) Mirror insulation is made entirely of stainless steel sheet material and does not contain any other materials.

1(f) Mirror Insulation will not segment or break up into small particles. The sections will sink to the bottom and remain stationary.

Foamglas, and Rubatex are installed in a manner and/or in locations that will preclude damage from primary system pipe breaks; however it should be noted that the insulation will float and could not enter the sump because of a 13.2 foot minimum water level which exists over the containment floor. This insulation is located outside the crane wall.

Fiberglass is located within the housing of the air handling units used to cool the ice condenser or is covered by metal panels or sheaths. This protection assures that the insulation will not enter the sump.

Polyurethane and Urethane is sandwiched between the steel cooling ducts and the containment vessel or is covered by metal panels or sheaths. This will assure the insulation will not enter the sump.

Mineral Wool is located between the sleeve end the process pipe for the penetrations. The spider construction of the penetration will prevent the insulation from being pushed from within the penetration. There should be no turbulence or direct sprays directed into the penetration cavities. The penetrations are located outside the crane wall. This should prevent any passageway of the insulation to the sump.

1(g) Insulation inside the containment either is unaffected by a post LOCA environment or is installed in a manner to prevent any effect on operation of the sump, as described in the preceding dicussions.

The use of foam concrete and its properties are described in the FSAR in sections 6.5.1.2 and 6.5.1.3. Foam concrete has a density of 35 lb/ft^3. The "Insulation Section" shown in FSAR Figure 6.5-2 is the foam concrete. It is completely enclosed by structural concrete and steel plate.

2. The resolution of the concerns noted above plus the provision 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 RHR 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 vortex formation could be reduced by reducing the system flow rate. The operator should have the capability of throttling or terminating flow as required. 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

The following instrumentation is available to monitor the long-term performance of the RHR recirculation system: containment water level, containment sump level, RHR pump motor amps, seal water flow and temperature, RHR pump discharger pressure, RHR flow (downstream of heat exchanger), RHR system temperature upstream and downstream of heat exchanger.

All instruments read out in the main control room on panel M-6.

When the RHR pumps are operating, plant operating instructions require stationing an operator in the control room with no other duties than to monitor RHR system performance. This precaution is taken to prevent damage to the RHR pumps cuased by a loss of suction.

Question 3

Discuss the effect of debris entrained in the recirculating coolant on the long term operability of the RHR, safety injection and charging pumps and motors. For each pump/motor type discuss the applicable operating experience and the design aspects of the seals, bearings and other components with respect to whether the design is susceptible to failure resulting from interaction of the components with debris entrained in the recirculating coolant. Include in the response information on the means of lubricating and cooling [illegible] motor bearings and on the means of cooling the pump seals, [illegible] seal cooling water at a higher pressure than the pumped fluid during the recirculation mode.

Response

Reactor building sumps are designed so that an adequate supply of water with a minimum amount of particulate matter will be provided to the safeguards recirculation pumps following a loss-of-coolant accident (LOCA). Pump intakes are protected by placing screens and trash racks (coarse outer screens) in the sump intake.

Within the ECCS, the most restrictive clearances are located in the core; consequently, the largest diameter particle that could flow freely through the core region, either in a radial or axial direction, is approximately 1/8 inch in diameter.

With regard to ECCS pumps, the running clearances for these pumps are smaller than the restrictive flow passages in the core. However, since only a small percentage of the total pump flow passes through the wearing rings, the running clearances are not physical restrictions to the major flow path. The suspended particulate in the recirculation water would not be hard or abrasive (such particles would settle out in the low velocity areas of the sump) but rather less dense material which is not likely to significantly damage the rotating parts. In the event that small abrasive particles were present, the damage to the pump would not result in catastrophic seizure of the pump but rather a gradual degradation of the pump performance. This gradual degradation would be acceptable during the long-term post-accident recirculation phase operation of the pump.

Furthermore, all of the Westinghouse active pump applications have gathered extensive operating time.

Each pump is tested in the vendor's shop to verify hydraulic and mechanical performance. Performance is again checked at the plant site during preoperational system checks and monthly per ASME Section XI. Pump design is specified with strong consideration given to shaft critical speed, bearing, and seal design. Thermal transient and 100-hour endurance tests have been completed on the centrifugal charging and the safety injection pumps. Additional rotor dynamics tests have been performed on the centrifugal charging pumps which are the highest speed applications. A thermal transient analysis has been performed on the RHR pump and this analysis supported by the vendor's test on a similar design.

Endurance and leak determination testing has been completed on the mechanical seals by the seal supplier. This testing included various temperature, pressure, radiation, and boric acid concentration levels. These conditions were all substantially elevated over those expected during normal or post accident conditions.

All pumps have seal coolers; a portion of the pump discharge flow passes through the seal cooler, where it is cooled by component cooling water then it is returned to the pump seals where it flushes the sealing faces.

An integral unit to the pump/drivers provides bearing lubrication and cooling.

Questi n

4. 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 (elevation 667.0 ft) as shown on FSAR Figure 1.2-13. Include on this drawing the location of the containment water level sensors and the elevations which corresponds to readings of zero and 100 percent of range on the control room indicator.

Response

4. Two copies each of a marked-up copy of TVA drawing No. 47W200-11 are enclosed to show the locations of the containment water level sensors and transmitters. The transmitters are mounted outside the crane wall at El. 698'-0". The sensors are mounted inside the crane wall at El. 680'-6" to measure the water level from El. 680'-6" to 700'-6".

The post-LOCA water level inside the crane wall would be at El. 693'-0". (Refer to FSAR Figure 1.2-13.)

Question

5. Provide several large scale drawings of the containment structures, systems and components at elevations ranging from 679 to 732 feet.

Response

5. Two full-size copies each f TVA drawings 47W2500-1 through 12 are being provided to show the containment structures, systems, and components at elevations ranging from 679 to 732 feet.

Question

6. Does the SNP utilize sand or similar materials in the containment during power operation for purpose such as reactor cavity annulus biological shielding (e.g., sand tanks or sand bags) or reactor cavity blow out sand plugs?

Response

6. Sand totally enclosed in steel boxes once was considered for removable radiation shielding to fill the inspection ports for the reactor vessel nozzles. The design has been changed. This shielding now is provided by steel plugs.

   No sand or similar material is utilized at any time inside containment.