TEXAS UTILITIES GENERATING COMPANY
SKYWAY TOWER • 400 NORTH OLIVE STREET, L.B. 81 • DALLAS, TEXAS 75201

Log # TXX-4352
File # 906.2
10010

November 2, 1984

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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446
EVALUATION OF PAINT AND INSULATION DEBRIS
EFFECTS ON CONTAINMENT ENERGY SUMP PERFORMANCE

Dear Mr. Youngblood:

Enclosed please find the following:

1. Revision 1 to our June 1984 report relative to Containment Sump Performance which includes revisions to analyses which have occurred since the original report.

2. Westinghouse Letter WPT-7564 which provides specific responses to additional questions raised in the reference correspondence.

We trust this information is sufficient to complete the review on the subject matter.

Sincerely,

John W. Beck

J. W. Beck
Manager, Licensing

RGT:tv

B001
1/1

WPT-7564

Westinghouse Electric Corporation
Water Reactor Divisions
Nuclear Technology Division
Box 355
Pittsburgh Pennsylvania 15230

November 2, 1984

Mr. J. T. Merritt, Jr.
Assistant Project General Manager
Texas Utilities Generating Company
P.O. Box 1002
Glen Rose, Texas 76043

Ref: NRC Letter
dated 10/24/84

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
CONTAINMENT PAINT EVALUATION - NRC QUESTIONS

Dear Mr. Merritt:

The reference letter submitted to Texas Utilities, M.D. Spence, requested additional information related to the Westinghouse evaluation of the Emergency Core Cooling System (ECCS) based on the ingestation of containment paint and insulation debris following a postulated Loss of Coolant Accident (LOCA). These questions pertain to the Westinghouse evaluation report and to related information provided in several responses to previous NRC questions.

The NRC questions and Westinghouse reply are as follows:

Question

(1) Your submittal of July 26, 1984, indicates that a potential area for accumulation of fines would be in the small valves and small bore orifices in the high head safety injection (SI) piping, but that the high head system is not required for post-accident recirculation. However, the high head system would be utilized in the event of a small break LOCA, when the RHR pumps are operated in series with the SI and/or centrifugal charging pumps. Therefore, discuss the effect of paint fines accumulation in the high head, SI orifices and throttle valves. Consider also the effect of paint fines accumulation in pump recirculation lines.

Answer

(1) The thermal and pressure transient associated with a LOCA event has been assumed to be the mechanism which removes the paint from the containment building surfaces. During a postulated small break LOCA it is anticipated that smaller amounts of paint debris would be stripped from the painted surfaces than during a large break LOCA because the pressure and thermal transient associated with this type of event is less severe than with the large break LOCA. Makeup water from the Refueling Water Storage Tank (RWST) would be injected into the RCS at a much lower rate than that previously assumed for a large break LOCA and as a result there would be less water available to carry any potential debris to the containment sump. In addition the flow velocities for water assumed to spill from the RCS during a small LOCA would be low and any debris that would be available to be transported to the sump would tend to settle out at the various levels of the containment building. Any debris which could reach the sump would settle out quickly due to low turbulance and mixing in the sump. The time required to empty the RWST (assumed to be 20-30 minutes for Large LOCA) would be significantly increased due to the lower makeup rate.

In this evaluation the assumption has already been made that entrained debris in the ECCS fluid is $\leq$ 1% by volume for a large LOCA.

For small break LOCA this concentration is assumed to be less than 1% based on smaller amount of debris being available, lower flow velocities that transport the debris to the containment sump and a longer time period before the initiation of ECCS recirculation which permits the debris to settle out in the sump. The debris size which could potentially enter the ECCS is limited to 1/8 inch and less by the sump screen. The safety injection and changing sump lines sizes are 1 1/2 and 2 inches respectively, the minimum size orifices in these lines is approximately 1/2 inch (1 1/2 inch charging pump line), and the minimum seat gap for the throttling valves is greater than 1/4 inch. Fluid velocities in the safety injection and charging pump systems during operation range from 25 to 40 ft/sec. The high local fluid velocities through the systems orifices and throttling valves and the high line velocities will preclude any clogging with the low levels of debris anticipated to be entrained in the coolant during ECCs recirculation.

Question

(2) State how cooling of the CPSES RHR pump shaft seals is accomplished. If cooling is provided from the pump discharge, provide the line size (if the flow is external to the pump) or passage size (if the flow is internal). If external lines are used, state whether they contain cyclone separators. Discuss the potential of plugging of these lines or passages by paint fines.

Answer

(2) The RHR pump shaft seal is cooled by an external heat exchanger located on the pump case. The liquid in the seal cavity is pumped out of the cavity by means of a integral pumping ring (attached to the pump shaft) through a 1/2 inch stainless steel tube into the heat exchanger and back into the seal cavity. There are not cyclone separators, filters or other devices located in the lines which could plug and potentially obstruct flow.

The seal cavity is "dead ended" and therefore essentially isolated from the pumpage flow. Close clearance between pump shaft ring bushing and the pump shaft isolates the seal cavity from the ECCS coolant pumpage

Any potential for plugging of the seal recirculation tubing is further reduced by the fact that the total length of this tubing is less than 6 feet and there is a continuous liquid flow at a velocity of 1 ft/sec through the recirculation lines while the pump is in operation.

Question

(3) State whether the information in your July 26, 1984 letter that the RHR pump hydraulic performance degradation due to paint fines "is negligible" has been verified by the pump vendor. Also discuss the effect of paint fines on the SI and centrifugal charging pumps during high head recirculation.

Answer

(3) NUREG/CR2792 "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions" stipulates that the long term effect of debris ingestion identified in this evaluation for the Comanche Peak RHR Pump performance is negligible. The information assembled in this report (NUREG/CR2792) as it pertains to pump performance under debris ingesting conditions was based on personal interviews conducted with several pump suppliers. The individuals interviewed included key Management and Engineering personnel from Ingersol-Rand Pump Co., suppliers of the Comanche Peak RHR pumps. Recent discussions with Ingersol Rand (P. Nagengast) were held to review pump performance data contained in NUREG/CR2792 and its applicability to the Comanche Peak RHR Pumps. The results of these discussions reconfirmed that the performance data contained in NUREG/CR2792 was applicable to the Comanche Peak RHR Pumps.

The centrifugal charging pumps and the safety injection pumps are designed to operate with entrained solids in the pumped fluid. The most troublesome areas for these pumps with solids entrained in the pumpage would be the running clearances (Impeller to casing wear rings, balance drum to bushing, etc.). The running fits have been made less sensitive to entrained solids by using wear ring materials that are more resistant to errosion and galling. In addition, the running fit surfaces have machined grooves which are designed to entrap entrained solids which could potentially cause surface galling. The stationary wear rings are made from SA276 type 440 A stainless steel which is a high chrome stainless steel alloy. The impellers are cast from A 296 CA 40 stainless steel. Both of these martensitic materials have excellent resistence to wear and errosion. The impeller wear surfaces are also flame hardened to provide additional wear resistance.

Although it is recognized that the multi stage pumps such as the centrifugal charging and safety injection pump would tend to be more sensitive to entrained solids than single stage pumps the time that the plant would be required to be on high head recirculation would be much less than that anticipated for low head recirculation. The amount of debris expected to enter the high head ECCS system during a small break LOCA should not deter system performance.

<u>Question</u>

(4) Your July 26, 1984 letter indicates that Stokes' Law was used to estimate the maximum size of paint fines that can be carried by vertical flow, and that spherical shapes were assumed for conservatism. However, an examintation of Figure 5-70, "Drag Coefficients for Spheres, Disks and Cylinders," Perry's Chemical Engineers Handbook, Fourth Edition, indicates that for Re>50, this assumption is not conservative. Our calculation for the inlet plenum indicate that Re>50. Therefore, reconsider your assumption and make any necessary changes in your calculations with regard to particle shape.

<u>Answer</u>

(4) The reference to Stokes' Law in the July 26, 1984 letter is incorrect. Stokes' Law was <u>not</u> used to estimate the maximum size of paint fines that can be carried by the vertical flow in the reactor vessel lower plenum. Stokes' Law relates that, at low Reynolds number, the drag exerted by a moving fluid is inversely proportional to Reynolds number. Recognizing that the Reynolds number of the flow in the lower plenum may exceed the range of applicability of Stokes' Law, an emprical curve-fit to data proposed by White (Viscus Fluid Flow, McGraw Hill Book Company, 1974) was used.

It should also be noted that the viscosity and density of water used in the estimation of maximum fine size that may enter the core was based on 60 psia (maximum containment pressure) and 200°F (RHR heat exchanger design outlet temperature).

Question

(5) With regard to your October 12, 1984, submittal, discuss whether the calculated reactor vessel lower plenum velocity considers only unidirectional vertical flow or whether it also considers cross flow.

Answer

(5) The reactor vessel lower plenum fluid velocities identified in the October 12, 1984 submittal are the vertical components of the fluid motion in the lower plenum. For paint fines to enter the core region from the reactor vessel lower plenum, they must move in a vertical direction. This vertical movement can only be initiated and maintained by fluid flowing in a vertical direction. Thus, it is the vertical component of the reactor vessel lower plenum fluid velocity that determines the maximum size of paint fines that my enter the core region.

Question

(6) Your July 26, 1984, submittal states that no credit is taken for settling out of debris in the contaiment building (Page 5). However, the maximum debris volume accumulating the reactor vessel lower plenum is given as 400 cubic feet (Page 7). Clarify the apparent discrepancy between these two statements.

Answer

(6) There is no discrepancy between the two statements cited from the July 26, 1984 submittal. Note that not taking credit for the settling out of debris in the containment was an assumption used in evaluating "the rate at which the mass concentration of paint debris in solution would change due to settling out in the RV lower plenum" (page 5 of the July 26, 1984 submittal). The assumption was made so as to conservatively maximize the predicted system cleanup times by limiting the location at which settleout can occur to the reactor vessel lower plenum. Subsequent system cleanup time predications were made on an initial nondimensional debris mass concentration of 1.0 (Figure 2 of the July 26, 1984 submittal) and not a specific debris volume or weight. Thus, the assumption was used only to predict maximum system cleanup time, and <u>not</u> total initial debris in the system <u>nor</u> the total mass collected in the reactor vessel lower plenum.

The text of pages 6 and 7 of the July 26, 1984 submittal refers to the possibility of reentrainment of debris from the lower plenum when the ECCS is realigned from cold leg recirculation to hot leg recirculation at about 18 hours following hypothetical LOCA. That text does specifically

identify a debris bed volume of 400 cubic feet or less as not likely to promote reentrainment of debris sizes large enough to result in the development of core blockage during hot leg recirculation. The 400 cubic foot limit represents a 100 cubic foot margin over the 300 cubic foot volume of paint predicted to reach the containment sump by Gibbs and Hill, the utility's A/E.

Question

(7) Discuss what indication the operators would have that blockage is occurring in either the core or the ECCS, and what remedial action could be taken.

Answer

(7) It has been shown that paint fines in the core or ECCS are not likely to result in blockage. Further discussion on core blockage is presented in the response to Question (8). However, safety grade in-core thermocouples are available to monitor for inadequate core cooling (ICC) conditions..

Question

(8) Your conclusion in your October 12, 1984 submittal that the paint particles with diameter less than .019 inches will pass through the core because the minimum flow area in the core is .040 inches does not consider the case that the paint particles may be stuck on the grid strips and/or dimples. Provide a discussion on the consequeces of the case where the paint particles may be stuck on the grid strips and dimples. The discussion should include (a) accumulation of paint particles stuck on the strips and dimples, (b) the effects on local flow area reduction and flow degradation, (c) the effects on degradation of heat transfer effectiveness, especially in the hot spots and (4) the effectiveness of long term core coolability.

Answer

(8) At initiation of cold leg recirculation, fluid temperatures at the entrance to the core are low, being about 200°F (ie. the RHR outlet temperature). At these temperatures, the paint debris is brittle, not sticky or tacky. Therefore, there is no tendency for paint debris to stick either to grids, fuel rods, or other paint particles to form blockage in subchannels.

The fluid velocities in the core region are low under cold leg recirculation conditions. The densities of the paint debris and that of the water are similar, being 96 lb/cu.ft. (conservatively low value) and about 61 lb/cu.ft., respectively. Also, the dimples on the grids are blunt shapes in the flow path. Thus, the debris will tend to pass around the grid dimples, rather than collect behind them. The same is true for grid springs. It is conceivable that there may be a chance collection of paint debris behind some dimples or springs. Such a chance collection will be very local with the only mechanism to hold the debris collection together being small perturbations in the flow field around the springs and dimples, and will not lead to blockage. Also, the decay heat of the core is low (less than 2 per cent) when cold leg recirculation is initated. Thus, chance local collections of paint debris behind grid springs will not effect long term core coolability.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

T. G. Brugel for

R. S. Howard, Manager
WRD Comanche Peak Projects

TB/rs
Attachment

cc: J. T. Merritt 1L
R. D. Calder 1L
J. W. Beck 1L
C. B. Hartong 1L
J. C. Kuykendall 1L
ARMS 1L
J. LB. George 1L
R. A. Jone 1L