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SUBJECT: Provides suppl to response to question 3 of 940505 ltr re loss of fuel pool cooling.

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JUL 1 1 1994

Director of Nuclear Reactor Regulation
Attn: Mr. C. L. Miller, Project Director
Project Directorate I-2
Division of Reactor Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
SUPPLEMENTAL RESPONSE PER JULY 1, 1994 TELECON
PLA-4170 FILE R41-2

Reference: PLA-4134, R. G. Byram to C. L. Miller "Response to Request for Additional Information Concerning Loss of Fuel Pool Cooling," dated May 5, 1994.

Dear Mr. Miller:

The purpose of this letter is to supplement the PP&L response to Question 3 provide in the above referenced letter. In that response, PP&L provided the results of a radiation dose analysis of personnel access doses inside the reactor building associated with providing Emergency Service Water (ESW) make-up to the spent fuel pool (SFP) under Design Basis Accident - Loss of Coolant Accident (DBA-LOCA) conditions; without a Loss of Offsite Power (LOOP). It is PP&L's understanding that this supplemental response is to provide the operator access doses associated with performing ESW make-up to an isolated SFP and monitor SFP level during a DBA-LOCA, where a DBA-LOCA means a Regulatory Guide 1.3 source term in all piping/components that could contain ACCIDENT water and NO airborne radiation. Also requested was a clarification as to specifically what time the operators would access the reactor building for the response to Question 3 of the referenced submittal.

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PP&L's position remains:

- that with the fuel pools isolated, initiation of ESW make-up from either spent fuel pool results in both pools being filled regardless of whether or not the pools are crossed-tied. Operators would perform fuel pool make-up from the non-accident unit, thus negating any significant radiological exposure.

- that fuel pool cooling would be restored, and boiling would not occur.

- in the unlikely event that the above was unsuccessful, immediate action would not be required, allowing sufficient time to take the appropriate operator actions and restore cooling.

The attached response consists of a summary of the requested event evaluation, including assumptions for both the radiological and time to make-up calculations, as well as, a copy of the calculations themselves. It should be noted, that while time to boil is a factor in determining the time to make-up, PP&L does not consider a boiling SFP concurrent with a LOCA to be part of the Design/Licensing Basis for Susquehanna.

Questions regarding this response should be directed to Mr. J. M. Kenny at (610) 774-7904.

Very truly yours,

R. G. Byram

Attachment

cc: NRC Document Control Desk (original)
NRC Region I
Mr. G. S. Barber, NRC Sr. Resident Inspector
Mr. C. Poslusny, NRC Sr. Project Manager

DISCUSSION

In PP&L's May 5, 1994 response to Question 3, operator access doses consistent with SSES FSAR Chapter 18.1.20 were provided for SFP make-up via ESW for evaporative losses where the normal SFP cooling system was assumed to remain in service, but the heat sink (service water) was lost. In that response, operator mission doses were provided for access to ESW valves on elevations 670' and 749'. With the normal SFP cooling system assumed to be in operation, access to elevation 818' to monitor SFP level is not necessary. The only water level concern in that case was assuring adequate skimmer surge tank level to maintain the SFP cooling system in operation. Skimmer surge tank level is provided on panel 1C206 located on elevation 749', just outside of the SFP cooling heat exchanger room.

In the May 5th response, doses were provided for operator access at 24, 40 and 82 hours. These doses were determined in calculation EC-RADN-1008, Revision 0 (Enclosure 1). The dose at 24 hours was provided for comparison to previous PP&L submittals, while the doses at 40 and 82 hours were provided as the upper and lower bounds of time at which the operator would provide make-up. The operator dose to access ESW valves on elevation 670' was identified as 4.8 rem for entry at 40 hours, while the dose associated with entry at 82 hours was identified as 2.75 rem. The operator dose for the valves on elevation 749' was identified as 1.41 rem at 24 hours, and the doses at 40 and 82 hours would be correspondingly less. Because access doses on elevation 749' were not specifically calculated for 40 hour entry time, the 24 hour dose of 1.41 rem should be used in the assessment and can be considered conservative.

The follow-up question requested information for a case where ESW make-up without cooling being re-established to prevent SFP boiling, and the specific time after the event when entry would be made. The time required to provide ESW make-up to a SFP without cooling has been determined by PP&L calculation EC-35-1005, Revision 0 (Enclosure 2). This time bounds that provided in PP&L's May 5, 1994 response to Question 3; i.e., the time to provide make-up determined in EC-35-1005 is shorter than that determined for the May 5th submittal. The May 5, 1994 time is documented in calculation EC-RADN-1008 (Enclosure 1). A comparison of EC-RADN-1008 and EC-35-1005 shows that the latter was performed selecting worse case parameters, whereas the former was performed using conservative, yet more realistic parameters. The time to make-up in EC-35-1005 has been conservatively calculated to be 41 hours based on the following conservative assumptions:

- Initial SFP temperature of 125°F vs. admin limit of 110°F;
- Limiting level drop to Tech Spec limit of 22 ft above the fuel;
- All decay heat goes into heating the water with no other losses.

Based on this calculation, the earliest entry time for an operator to provide ESW make-up with or without normal SFP cooling in operation is 40 hours after the event occurs. Therefore, the operator doses for 40 hours (24 hours for elevation 749') identified in the May 5th submittal and EC-RADN-1008, Rev. 0 should be used for assessing operator access dose for providing ESW make-up.

Operator access to the elevation 818' would not be required to determine SFP level. It would not be necessary in the boiling case since personnel access to the refueling floor would be prohibited by the boiling SFP environment. Instead, skimmer surge tank level will be utilized to determine when SFP level is restored to the weir height (SFP will overflow into the skimmer surge tank resulting in a change in tank level). The case where SFP cooling is in operation was discussed above. Additionally, use of the newly installed level instrumentation would eliminate the need for operator access to determine SFP level.

For crosstied SFPs, the time for entry would be significantly longer due largely to the increased time to boil, and thus would be bounded by the isolated SFP case. However, as discussed in PP&L's June 1, 1994 submittal, et. al., cooling will be restored to crosstied SFPs from the non-accident unit, which would be completely accessible under SSES FSAR Chapter 18.1.20 assumptions. Consequently use of the non-accident unit's normal SFP cooling system or RHR Fuel Pool Cooling mode would prevent the SFPs from boiling.

SUMMARY

For the response to Question 3 provided in PP&L's May 5, 1994 submittal, the operator access dose of 4.8 rem at 40 hours should be used for access to the ESW valves on elevation 670'. The operator access dose 1.41 rem at 24 hours should be conservatively used as the operator dose at 40 hours for the ESW valves on elevation 749'.

For the follow-up response, operator access would not be required until 40 hours and the same dose evaluation for the May 5, 1995 Question 3 response would apply.

PP&L continues to maintain that access to the accident unit is not required for ESW make-up with or without crosstied SFPs. PP&L has established in previous submittals and meetings with the NRC that the non-accident unit would have been accessed to provide ESW make-up and that water would cascade from one SFP to the other via the skimmer surge tanks' connection to the cask pit if the SFPs are isolated. PP&L is confident that given the time to take action and the implementation of the Emergency Plan would have assured such a response prior to the Part 21 report on this issue. Consequently, none of the operator dose discussed above would be incurred. Additionally, PP&L maintains that in a DBA LOCA cooling would be restored to the SFP(s) via the normal SFP Cooling system or the RHR Fuel Pool Cooling mode, as discussed in previous submittals.

ENCLOSURE 2

EC-35-1005, REVISION 0

FUEL POOL LEVEL IMPACT DUE TO

LOSS OF FUEL POOL COOLING

PP&L	NUCLEAR ENGINEERING CALCULATION / STUDY COVER SHEET and NUCLEAR RECORDS TRANSMITTAL SHEET	File # R2-1 1.Page1of6

*▹2.TYPE: CALC ▹3.NUMBER: EC-35-1005 ▹4.REV #: 0

5.TRANSMITTAL: ________ *▹6.UNIT: 3 *▹7.QUALITY CLASS: Q *▹8.DISCIPLINE: M

▹9.DESCRIPTION: FUEL POOL LEVEL IMPACT DUE TO LOSS OF FUEL POOL COOLING

10.Alternate #: N/A 11.Cycle: N/A

12.Computer Code or Model used: N/A

*▹13.AFFECTED SYSTEMS: 035 , , , , , , ** If N/A then line 18 is mandatory.

14.References: EC-070-1003, EC-035-0508, EC-035-0509, EC-049-0651, EC-035-0511, SEA-ME-418, NFE-B-NA-055 ,

15.Affected Documents: NONE , , , , , , 16.Equipment/Component # : N/A , ,

17.Application: N/A

*▹18.NON-SYSTEM DESIGNATOR: N/A , ,

19.DBD Number: DBD031

▹20. PREPARED BY	▹21. REVIEWED BY	▹22. APPROVED BY / DATE
Print Name MICHAEL H CROWTHERS	Print Name KEVIN G BROWNING	Print Name DAVID G KOSTELNIK
Signature	Signature	Signature 7/6/94

To be completed by Nuclear Records

NR-DCS Signature	Date

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FUEL POOL LEVEL IMPACT DUE TO LOSS OF FUEL POOL COOLING

1.0 OBJECTIVE:

This calculation is performed to determine the affect a fuel pool boiling event could have on the level of a boiling fuel pool. It determines, based on assumed initial conditions, how long it will take the level to reach the technical specification limit and the top of the active fuel. The initial conditions will be chosen to be consistent with those assumed in the FSAR.

2.0 CONCLUSIONS/RECOMMENDATIONS:

For the assumed conditions it is determined that;

2.1 It will take minimally 41 hours after pool cooling is lost for the level to reach the technical specification limit of 22 feet above the active fuel.

2.2 It will take 252 hours until the level reaches the design limit of the top of active fuel.

2.3 For a connected pool configuration, the times to reach these same levels would be much longer.

3.0 ASSUMPTIONS/INPUTS:

3.1 Both pools are filled; U2 pool heat load = 8.2 MBTU/HR (just completed a 40 day outage); U1 pool heat load = 6.27 MBTU/HR (last outage began 135 days ago); Pool Temp = 125F. The heat load values are based on calculation NFE-B-NA-055 rev 1 nominal values. These are consistent with those used in M-FPC-011 rev 1 and safety evaluation NL-93-001 and are reflected in the SSES FSAR. These are also consistent with the SGTS evaluations performed in EC-070-1003.

3.2 An initial pool temperature of 125F at the start of the event is chosen to be consistent with the design basis maximum temperature for the fuel pool cooling system. It should be noted that the system would maintain much cooler pool temperatures than 125F. Per calculation M-FPC-013, with 3 pumps operating and a heat load of 8.2 MBTU/HR in one pool, extrapolation of the data reveals service water temperature would have to be on the order of 105F for the system to maintain 125F fuel pool water temperature. The service water maximum design temperature is 95F. With 3 pumps running, 8.2 MBTU/HR in the pool and service water temperature at 95F, the fuel pool temperature would be maintained at approximately 114F. A fuel pool temperature of 110F would be

4.0 METHOD:

Fuel pool level will be affected during two distinct phases. The first phase will be the "Heat Up Phase" during which the fuel pool temperature increases from the initial temperature to the boiling temperature which will be assumed to occur at 210F. During this phase, the pool level will be influenced by evaporative losses and pool water density change caused by the increasing water temperature. The second phase will be the "Boiling Phase" during which the pool is boiling. During this phase, the pool temperature will remain constant at 210F, thus pool water density change will not occur. Mass loss from the pool will occur due to the boiling, not evaporation. Each phase will be evaluated separately to determine their impact on pool water level.

An isolated pool will be initially evaluated.

5.0 RESULTS:

Note that all water data, such as specific volume have been obtained from Cameron.

5.1 "Heat up Phase"

During the pool heat up phase, the pool temperature will increase from the initial pool temperature (Ti) to 210F. As the temperature increases, the evaporative losses will increase. Calculation M-FPC-010 revision 0 page 14 concludes that this evaporative loss has an insignificant affect on the time to boil. Thus, time to boil, assuming conservatively that all decay heat is transfered directly to the fuel pool water is:

$$T = \{(M)\ (Cp)\ (DT)\}/Q$$

where;
T = time in hours
DT = {210 - Ti) in degrees F
M = pool mass (lbm)
Cp = specific heat of water (1.0 BTU/LB F)
Q = Heat Load

The pool level upon the loss of the fuel pool cooling system will drop to the level of the fuel pool weir, which is at elevation 817'1/2" (M-RHR-039).

The pool volume per M-FPC-010 adjusted for an elevation of 817'1/2" is:

48690 - .5"(1350 FT2/FT) = 48633 FT2
corresponding pool mass = 48633 FT3 /(.016225 ft3/lbm) = 2997411 lbm

Assuming Ti = 125 F, Q = 8.2 MBTU/HR;
Time to boil is:

T = (2997411)(210-125)/8.2 E6 = 31 hours

Pool level, as stated earlier, will be influenced by evaporation and thermal expansion due to the water temperature density change.

Evaporation:

Using evaporation rate data from M-FPC-010 Rev 1 page 13 at 170 F and assuming this rate occurs over the entire heat up phase, the evaporation loss is:

Rate = 796.5 lbm/hr (Calculated based on correlations provided in ASHRAE for pool evaporation.)

Thus 796.5 lbm/hr (31 hours) = 24,691.5 lbm
The volume loss @ 210 F will be = 24691.5 lbm (.016705 FT3/lbm)
= 412.5 FT3

At the end of the heat up phase when the pool is at 210F, the pool mass will be;

mass = 2997411 - 24691.5 = 2972719.5 lbm

Density Affects:

The density affects will increase the pool volume. The volume of the remaining water mass when at 210F is:

2972719.5 lbm (.016705 ft3/lbm) = 49659 FT3

THIS VOLUME IS GREATER THAN THE INTIAL POOL VOLUME OF 48633 FT3.

Thus accounting for the evaporative losses and thermal expansion effects, the final pool volume will increase as the thermal affects overcome the evaporative loss effects. The increased volume will however not be seen in additional fuel pool level as the additional volume will flow to the skimmer surge tank.

Thus at the end of the heat up phase, the pool level will be at 817'1/2", the temperature will be 210 F.

5.2 "Boiling Phase"

Once boiling begins, mass loss will occur at a much faster rate than that occurring during the heatup phase. This loss rate is given by:

M = Q/Hfg where Q = Heat load (BTU/HR)
Hfg = evaporation enthalpy = 971.6 BTU/LBM @ 210F

M = 8440 LBM/HR

Volumetrically this is;

8440 LBM/HR (.016705 FT3/LBM) = 141 FT3/LBM

From M-RHR-039 rev 0, the fuel pool is 1350 FT3/FT of level, thus the rate of level loss during boiling is given by:

(141 FT3/HR}/1350 FT3/FT = .104 FT/HR

SEA-ME-418 Rev 0 identifies that the technical specification height limit above the top of the active fuel is at elevation 816'. The time at which this level is reached after event occurence would be based on the time to boil and the level loss during boiling given by :

31 HRS + {817'1/2" - 816'}/.104 FT/HR = 41 hours

Note that the technical specification limit is an operating limit. The fuel pool design limit is to maintain level above the top of active fuel. Per SEA-ME-418, top of active fuel is at elevation 794'. Thus, the time to reach the top of active fuel is:

31 HRS + {817'1/2" - 794}/.104 FT/HR = 252 HOURS.

Use of more realistic initial pool temperatures (i.e., 110F versus 125F) and accounting for the heat lost off the surface through evaporation and lost through the fuel pool walls will extend the time at which these levels would be reached.

For a connected pool configuration, the times to reach these same levels would be would be longer. This would be due to a longer time to boil for the connected pool configuration versus the isolated pool configuration. The pool water mass would be more than double that used above (two fuel pools plus the cask pit) and the heat load would be less than double that used above. The thermal expansion affect would occur as described above but to a greater degree due to the larger pool mass..

6.0 REFERENCES:

6.1 NFE-B-NA-055 Rev 1
6.2 M-FPC-011 Rev 1 (EC-035-0509 REV 0)
6.3 EC-070-1003 Rev 1
6.4 M-FPC-010 Rev 0 (EC-035-0508 REV 0)
6.5 Cameron Hydraulic Data 15th Edition
6.6 M-RHR-039 Rev 0 (EC-049-0651 REV 0)
6.7 SEA-ME-418 Rev 0
6.8 M-FPC-013 Rev 0 (EC-035-0511 REV 0)