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NSD-NRC-97-5057
DPC/NRC0804
Docket No.: STN-52-003

April 7, 1997

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. QUAY

SUBJECT: TRANSMITTAL OF OFFSITE AND MAIN CONTROL ROOM DOSE ANALYSIS RESULTS CONSIDERING AP600 SPENT FUEL POOL BOILING

References:
1. NSD-NRC-97-5024 (DCP/NRC0773), AP600 Design Changes to Address Post-72-Hour Actions, dated 3/14/97.
2. Letter from NRC to Westinghouse (Martin to Liparulo), List of Key Licensing Issues on the AP600 Design, dated 12/6/97.

Dear Mr. Quay:

The Westinghouse response to NRC Comment (4) of Reference 1 stated that analyses are being performed for offsite does and main control room operator doses considering spent fuel pool boiling. These analyses have been completed. A summary of the analysis results is attached as Enclosure 1.

This supports Key Licensing Issues 2d and 9 of Reference 2 (Open Item Tracking System items 4149 and 4163) as shown in the attached single-page report, Enclosure 2.

To meet the schedule in SECY-97-051 of having the final supporting documentation submitted to the NRC by May 30, 1997, your comments are requested by May 9, 1997. Please direct any questions or comments to Mr. Ron Vijuk (412) 374-4728.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

Enclosures

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cc: N. J. Liparulo, Westinghouse (w/o Enclosures)
A. Levin, NRC/NRR (w/Enclosures)
T. T. Martin, NRR (w/Enclosures)

AP600 Doses Offsite and in the Main Control Room Due to Spent Fuel Pool Boiling

In the event of an extended loss of the active spent fuel pool cooling system, the pool temperature could increase until boiling occurs. As water boils off from the pool, it is assumed that a portion of the radioactive iodine in the water also becomes airborne. An iodine partition factor of 100 is assumed for the evaporating water. This partition factor is consistent with the guidance of the Standard Review Plan for the steam generator tube rupture accident (section 15.6.3 of the SRP) in which there are similar conditions to those of the boiling spent fuel pool (SFP). The partition factor is not dependent on the pool water depth and so stays the same even if the water level drops to near the top of the stored fuel assemblies. The use of this partition factor is further supported by the fact that only iodine in the elemental form is volatile (iodine in the organic form is assumed to never have been retained in the water pool and the iodine in the iodide and iodate forms are not volatile under the conditions existing in the spent fuel pool). Based on the information in NUREG/CR-5950 (Reference 1), the conversion of iodine to the elemental form would be on the order of one percent or less considering the low iodine concentration (approximately 10^{-7} g-atoms/liter for the case with an activity release from a fuel handling accident and far lower for cases without such an accident), the high water temperature, and the moderate acidity in the SFP.

The doses offsite and in the main control room due to the release of radioactive iodine associated with SFP boiling have been determined and found to be acceptable for the following three cases:

Case 1: Fuel Handling Accident with Full Core Off-Load in the SFP

There is a fuel handling accident (FHA) such that the gap inventory from one assembly is assumed to be in the SFP. The heat load in the pool is the maximum defined heat load from one region recently placed in the racks due to refueling and the emergency off-load of an entire core.

The calculated doses from the pool boiling are:

Site Boundary Dose	No dose calculated because the onset of boiling would not occur until after the two hour dose interval. The two-hour site boundary dose is thus calculated only for the initial release associated with the FHA.
LPZ Dose	<1.0 rem TEDE
Main Control Room	<2.0 rem TEDE [The control room dose is calculated taking into consideration that the emergency habitability system is assumed to be operable only for the first 72 hours. After 72 hours it is assumed that the control room is opened and unfiltered air is drawn in.]

The LPZ dose due to pool boiling is within the dose limit of 6.25 rem TEDE (i.e., $\leq$25% of the dose limit of 25 rem TEDE defined in 10CFR50.34 - effective date 1/10/97)

The dose to an operator in the main control room is within the dose limit of 5.0 rem TEDE indicated by GDC 19.

Case 2: Emergency Off-Load of Full Core Soon After Return to Power Following a Refueling Outage

The heat load in the pool is the maximum defined heat load from one region recently placed in the racks due to refueling plus the emergency off-load of an entire core. This is the limiting case for the Condition 2 event of loss of cooling alone - no additional event occurring that would increase the release of activity. The initial I-131 inventory in the spent fuel pool is based on the maximum concentration that would result in a 2.5 mrem/hr dose rate at the pool surface plus the projected diffusion into the pool from the stored fuel. For this case the site boundary dose is calculated for the 30 day duration of the event instead of only the two hours that is used for a design basis accident.

The calculated doses from the pool boiling are:

Site Boundary Dose	<0.1 rem TEDE
LPZ Dose	<0.01 rem TEDE
Main Control Room	<0.1 rem TEDE

The offsite doses from 30 days of pool boiling are less than the 10 CFR 20 limit for annual dose associated with normal operation. From 10 CFR 20, the annual dose limit for an operator is 5.0 rem TEDE and, assuming that this dose is accumulated at a constant rate, the dose received in a month would be 0.42 rem TEDE. The dose from the pool boiling releases is well below the 10 CFR 20 limit for operators.

Case 3: Loss of SFP Cooling Coincident with Design Basis Accident

Since it is assumed that there is a loss of power associated with the design basis accidents, it must also be assumed that the cooling is lost to the SFP. This will contribute to the design basis accident doses. The heat load associated with this event is that from a recently discharged fuel region plus the heat from accumulated spent fuel in the SFP. It does not include the full core offload that is assumed in the first two cases. The initial I-131 inventory in the spent fuel pool is based on the maximum concentration that would result in a 2.5 mrem/hr dose rate at the pool surface plus the projected diffusion into the pool from the stored fuel.

The calculated doses from the pool boiling are:

Site Boundary Dose	No dose calculated because the onset of boiling would not occur until after the worst two hour dose interval for any of the design basis accidents.
LPZ Dose	<0.01 rem TEDE
Main Control Room	<0.01 rem TEDE

These doses are not significant and will not adversely impact the radiological consequence analyses for any of the design basis accidents.

References

1. NUREG/CR-5950, "Iodine Evolution and pH Control," 12/92, E. C. Beahm, R. A. Lorenz, & C. F. Weber

Assumptions and Inputs

Case 1: Fuel Handling Accident with Full Core Off-Load in the SFP

Initial iodine inventory in the spent fuel pool due to the fuel handling accident (release of fuel clad gap activity from one fuel assembly, 100 hours decay, radial peaking factor of 1.65)

I-131	1.604E4 Ci
I-132	1.307E4
I-133	1.604E4
Initial pool water mass	1.4444E6 lb
Time after shutdown at which accident occurs (time zero)	150 hr
Time delay to reach pool boiling	4.57 hr
Rate of evaporation at 4.57 hr	510 lb/min
Rate of evaporation at 30 days	284 lb/min
Iodine partition factor for water evaporating	100
Offsite breathing rate	See SSAR 15A
Offsite X/Q	See SSAR 15A
Control room model (emergency habitability system in operation for first 72 hours)	
CR volume	35,700
Unfiltered inflow	
0 - 72 hours	5 cfm
>72 hours	1400 - 2000 cfm
Compressed air inflow	
0 - 72 hours	23 cfm
>72 hours	0
Breathing rate	3.47E-4 m^3/sec
Occupancy factor	50%
Atmospheric dispersion factors (X/Q)	
0 - 2 hr	1.2E-3 sec/m^3
2 - 8	6.9E-4
8 - 24	5.4E-4
24 - 72	3.1E-4
72 - 96	6.2E-4
96 - 720	2.9E-4

Case 2: Emergency Off-Load of Full Core Soon After Return to Power Following a Refueling Outage

Initial I-131 inventory in the spent fuel pool (based on the maximum concentration that would result in a 2.5 mrem/hr dose rate at the pool surface plus the projected diffusion into the pool from the stored fuel)	8 Ci
Initial pool water mass	1.4444E6 lb
Time after shutdown at which accident occurs (time zero)	150 hr
Time delay to reach pool boiling	4.57 hr
Rate of evaporation at 4.57 hr	510 lb/min
Rate of evaporation at 30 days	284 lb/min
Iodine partition factor for water evaporating	100
Offsite breathing rate	See SSAR 15A
Site boundary X/Q	
0 - 8 hr	1.0E-3 sec/m^3
8 - 24	7.4E-4
24 - 96	4.0E-4
96 - 720	1.6E-4
LPZ X/Q	See SSAR 15A
Control room model	
CR volume	35,700
Unfiltered inflow	1400 - 2000 cfm
Breathing rate	3.47E-4 m^3/sec
Occupancy factor	50%
Atmospheric dispersion factors (X/Q)	
0 - 2 hr	2.2E-3 sec/m^3
2 - 8	1.3E-3
8 - 24	1.0E-3
72 - 96	6.2E-4
96 - 720	2.9E-4

Case 3: Loss of SFP Cooling Coincident with Design Basis Accident

Initial I-131 inventory in the spent fuel pool (based on the maximum concentration that would result in a 2.5 mrem/hr dose rate at the pool surface plus the projected diffusion into the pool from the stored fuel)	5 Ci
Initial pool water mass	1.455E6 lb
Time after shutdown at which accident occurs (time zero)	0 hr
Time delay to reach pool boiling	20.27 hr
Rate of evaporation at 20.27 hr	114 lb/min
Rate of evaporation at 30 days	84 lb/min
Iodine partition factor for water evaporating	100
Offsite breathing rate	See SSAR 15A
Offsite X/Q	See SSAR 15A
Control room model (emergency habitability system in operation for first 72 hours)	
CR volume	35,700
Unfiltered inflow	
0 - 72 hours	5 cfm
>72 hours	1400 - 2000 cfm
Compressed air inflow	
0 - 72 hours	23 cfm
>72 hours	0
Breathing rate	3.47E-4 m^3/sec
Occupancy factor	50%
Atmospheric dispersion factors (X/Q)	
0 - 2 hr	1.2E-3 sec/m^3
2 - 8	6.9E-4
8 - 24	5.4E-4
24 - 72	3.1E-4
72 - 96	6.2E-4
96 - 720	2.9E-4

AP600 Open Item Tracking System Database: Executive Summary

Date: 4/9/97

Selection: [item no] between 4000 And 5000 And [w st code]='Action W' And [Description] like '*post*72*' Sorted by Item #

Item No	Branch	DSER Section/ Question	Type	Title/Description Detail Status	Resp Engineer	(W) Status	NRC Status	Letter No /	Date
4149	NRR/SRXB		KEY ISSUE		Vijuk/Nydes	Action W	Action W		

Key Issue Number:
2d. Post-72 Hour Support Actions (Discussed in SECY-96-128, dated June 12, 1996) (SRXB) (see Item 9)

See OITS item 4163. rkn 4/3

Item No	Branch	DSER Section/ Question	Type	Title/Description Detail Status	Resp Engineer	(W) Status	NRC Status	Letter No /	Date
4163	NRR/SRXB		KEY ISSUE		Vijuk/Nydes	Action W	Action W		

Key Issue Number:

9. Post-72 Hour Support Actions (SRXB lead)

The passive safety systems are designed with sufficient capability to mitigate all design basis events for 72 hours without operator actions and without non-safety-related onsite or offsite power. For long-term safety (post-72 hours), Westinghouse states that the AP600 design includes safety-related connections for use with transportable equipment and supplies to provide the extended support actions for safety-related functions. These support actions include, for example, using portable engine-driven pumps and ac generators that connect to safety-related connections for water makeup to passive cooling control system (PCS) and spent fuel pool inventories and electrical power to supply the post accident and spent fuel pool (SFP) monitoring instrumentation and air for control room habitability. In addition, these extended support actions are implemented as part of the combined license applicant's "Site Emergency Response Plan" to provide support for continued long-term operation of the passive safety systems. These actions are accomplished by the site support personnel, in coordination with the main control room operators, and are performed separate from but in parallel with other actions taken by the plant operators to directly mitigate the consequences of an event.

In SECY-96-128, the staff stated that local communities struggling with disaster response should not be given the additional burden of providing for nuclear power safety. In addition, the staff is concerned that equipment not under the plant operator's control may be susceptible to damage from environmental conditions. The staff recommended the Commission approve the position that the site be capable of sustaining all design basis events with onsite equipment and supplies for the long term. After 7 days, replenishment of consumables such as diesel fuel oil from offsite suppliers can be credited.

The offsite and MCR dose analysis results were issued for management review 4/3/97. This completes the Westinghouse commitment to provide those results per NSD-NRC-97-054 item 4. rkn

Enclosure 2