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August 24, 2000 (2:22PM)

In an August 18, 2000, e-mail message, NRR (DSSA/PSAB) requested RES (DSARE/SMSAB) estimate spent fuel pool accident consequences at one, two, five, and ten years following final shutdown due to the lower inventories available for release as a result of radioactive decay. NRR stated that these estimates were needed to evaluate the reduction in consequences as a function of time. NRR also requested that, for each of these four times, consequence estimates be made for three evacuation cases: (a) no evacuation, but with relocation at 24 hours, (b) evacuation beginning three hours before the release begins, and (c) evacuation 1.4 hours after the release begins. NRR stated that consequences estimates were needed for these three evacuation cases to evaluate the importance of evacuation to spent fuel pool accident risk.

Spent fuel pool accident consequences will decline from one to ten years, because of radioactive decay. Radioactive decay has five effects on spent fuel pool accident progression, which are listed in Table 1. Each of these effects will result in lower offsite consequences. The first effect is that the decay heat is lower allowing more time to mitigate the fission product release. The second effect is that fewer assemblies will have a high enough decay heat to heat up to the temperatures needed to release fission products. The third effect is that there is a lower fission product inventory in each assembly available for release. The fourth effect is that, after a long enough period of time, the assemblies will not be able to heat up to the temperatures needed to release fission products from the fuel pellets, resulting in a drop in the release fraction. The fifth effect is that the longer heat-up time provides more time to evacuate.

Table 1 Effect of Radioactive Decay On Accident Progression

Effect of Radioactive Decay on Accident Progression	Analysis Needed to Estimate Consequence Decrease
longer heat-up time providing more time to mitigate release	heat-up of assemblies and timing of mitigation
lower decay heat resulting in fewer assemblies releasing fission products	heat-up of assemblies
lower fission product inventory per assembly available for release	radioactive decay
lower release fraction per assembly	heat-up of assemblies
longer heat-up time providing more time to evacuate	heat-up of assemblies and timing of evacuation

As noted above, NRR requested that RES investigate the third effect, that is, the lower fission product inventory in each assembly available for release using release fractions of .75 for iodine, cesium, and ruthenium and .01 for fuel fines. As requested by NRR, RES performed these consequence calculations and the results are documented below. However, because these consequence calculations were performed without considering (a) the smaller amount

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released as a result of mitigation, (b) the smaller number of assemblies releasing fission products, and (c) the smaller release fraction per assembly, the results are believed to be a severe underestimate of the decline in consequences as a function of time.

NRR also plans to investigate the benefits of a pre-planned versus ad hoc evacuation for a spent fuel pool accident for a decommissioning reactor. In this regard, NRR has requested calculations of offsite consequences with evacuation before release and evacuation after release for one, two, five, and ten years of decay. As requested by NRR, RES performed these consequence calculations and the results are documented below with the exception of evacuation after release for five and ten years of decay for the reasons discussed below.

With regard to evacuation modeling, past consequence assessments have assumed a pre-planned evacuation of people near the plant (e.g., within ten miles) to take a couple of hours and an ad hoc evacuation to take about ten hours. If the heat-up time to fission product release is more than ten hours, then a pre-planned evacuation and an ad hoc evacuation would both be before the release begins. Therefore, in this case it is unnecessary to perform consequence calculations for late evacuation. An e-mail message from J. Staudenmeier to G. Kelly of August 15, 2000, gives adiabatic heat-up times for accidents involving an immediate loss of water from the spent fuel pool. These heat-up times are reproduced in Table 2 for fuel with 60 Gwd/t burnup. For these adiabatic heat-up times, both pre-planned and ad hoc would be early evacuation. Therefore, we did not do the cases for 5 and 10 years. To determine whether early or late evacuation cases are representative of pre-planned evacuation and which are representative of ad hoc evacuation for one and two years, a realistic assessment of the time to heat up to the point of releasing fission products is required.

Decay time (years)	Time until start of fission product release (hours)		Evacuate before release	
	BWR	PWR	Pre-planned evacuation	Ad hoc evacuation
1	7	4	yes	no
2	12	7	yes	no
5	27	17	yes	yes
10	39	26	yes	yes

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