PSNH PUBLIC SERVICE
Company of New Hampshire

SEABROOK STATION
Engineering Office:
1671 Worcester Road
Framingham, MA 01701

January 4, 1982

SBN-203
T.F. B7.1.7

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. Louis Wheeler; Project Manager
Licensing Branch 3
Division of Licensing

Reference: (a) Construction Permits CPPR - 135 and CPPR - 136, Docket Nos. 50-443 and 50-444
(b) PSNH Letter dated November 27, 1981, "Response to Acceptance Review Requests for Additional Information (RAIs)", J. DeVincentis to D. Eisenhut

Subject: Submittal of Additional Information; Environmental Report RAI 240.25

Dear Mr. Wheeler:

PSNH responded to NRC Acceptance Review RAIs via Reference (b).

Environmental Report RAI 240.25 (Reference (b), Enclosure 2, page 32) committed to providing additional information. This information is attached.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

Allen J. Legendre Jr.

for: John DeVincentis
Project Manager

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240.25 Environmental Effects of Accidents
(7)
(ER)

Calculate the radiological consequences of a liquid pathway release from a postulated core melt accident. The analysis should assume, unless otherwise justified, that there has been a penetration of the reactor basemat by the molten core mass, and that a substantial portion of radioactively contaminated sump water was released to the ground. Doses should be compared to those calculated in the Liquid Pathway Generic Study (NUREG-0440, 1978). Provide a summary of your analysis procedures and the values of parameters used (such as permeabilities, gradients. populations affected, water use). It is suggested that meetings with the staff of the Hydrologic Engineering Section be arranged so that we may share with you the body of information necessary to perform this analysis.

RESPONSE: The Liquid Pathway Generic Study (LPGS)[1] calculated the population doses from accidents involving liquid pathways for design basis events and for events greater than the design basis. One of the conclusions reached by this study was that doses from design basis events were much lower (in the order of several hundred man-rem to the thyroid) than from events involving core melt. This analysis for Seabrook has therefore concentrated on core melt events in determining the relative risk of Seabrook from accidents involving liquid pathways.

This determination of relative risk was made by identifying those parameters used in the LPGS analysis to calculate population doses and comparing their values at the LPGS ocean site with that at the Seabrook Station site. The ratio of each parameter is the "multiplier" relating population doses between the two sites (see ER-OLS Table 240.25-1). Multipliers were determined for the following parts of the liquid pathways:

A. Source term

B. Groundwater transport

1. Travel time of groundwater
2. Source availability
3. Retardation by sorption

C. Surface water transport

D. Usage of the water bodies

1. Aquatic food
2. Shoreline usage

The foundations of the Seabrook Station reactors are located in the bedrock of the site. A large portion of the site, including Unit 1, is founded on a gneissoid phase of the Newburyport quartz diorite intrusive; a hard, durable crystalline igneous rock consisting of medium-to-course-grained quartz diorite matrix intimately enclosing inclusions of dark gray, fine-grained diorite. A small portion of the site, including much of Unit 2, is founded on Merrimack Group metaquartzite and granulite which occurs as a large relict inclusion welded into the enclosing Newburyport igneous mass along a broad, transitional-intrusive contact zone. The physical, chemical and mechanical qualities of the rock in the Merrimack Group metamorphic inclusion are comparable to those of the Newburyport igneous rock.

Groundwater at the site generally occurs between 10 and 15 feet mean sea level (MSL). The basemats of the reactors, approximately -70 feet MSL, are below the water table.

The groundwater gradient in the region is clearly toward the ocean. There are no wells between the site and the ocean, so no drinking water pathway could be affected by an accidental contamination of the groundwater. There is virtually no possibility of a reversal of the groundwater gradient due to heavy pumping inland, particularly because such a reversal would, at the same time, cause an unacceptable intrusion of saltwater into the aquifer. Therefore, liquid radioactivity released from a core melt accident could only cause contamination by being transported through the groundwater and subsequently released to the Atlantic Ocean.

A conservative estimate of the shortest groundwater path to the nearest down-gradient water body, the Browns River, is estimated to be 1,000 feet through the bedrock followed by approximately 110 feet through marine and swamp deposits. A conservative estimate of the groundwater travel time would be 48 years, 10.3 years through the bedrock portion and 37.7 years through the soil portion. Groundwater travel time in the bedrock was estimated by applying Darcy's Law and checked using dewatering information from the major excavations on site. To estimate the groundwater travel time through the soil portion of the pathway, Darcy's Law was applied using the most conservative measured or estimated parameters.

Conservative values of the retardation factors, which reflect the effects of sorption on geologic materials, were estimated for the bedrock and soil, for the two radionuclides that were important contributors to the population dose in the LPGS, i.e., Sr-90 and Cs-137. In the bedrock, retardation factors of 8.6 for Sr-90 and 154 for Cs-137 were used for the fractured crystalline bedrock(3). In the soil underlying the marsh, the retardation factors were conservatively estimated to be 15 for Sr-90 and 141 for Cs-137. These retardation factors were estimated using Equation B-35 of the LPGS study. The equilibrium distribution coefficients for Sr and Cs were conservatively chosen as 2 and 20, respectively. The mean transport times from the Unit 1 reactor building to the Atlantic Ocean is, therefore, conservatively estimated to be about 650 years for Sr-90 and about 6,900 years for Cs-137. When these travel times are compared to 5.7 years for Sr-90 and 51 years for Cs-137 in the LPGS land-based ocean site case, virtually all of the Sr-90 and Cs-137 would have decayed before reaching the surface water. Parameters used to calculate radionuclide travel times and relative doses are listed in ER-OLS Table 240.25-2.

Contaminants released from the shoreline would disperse in the oceanic turbulence. The LPGS made no distinction between the turbulence that would be found in the east, Gulf, or west coasts of the United States. The only assumption which can be made without site-specific data is that the mixing at the Seabrook Station and LPGS sites is similar.

The two major liquid exposure pathways for an ocean site without a drinking water pathway, are aquatic food consumption and direct shoreline exposure. The commercial and recreational finfish and shellfish harvest for a rectangular block 80 km alongshore and stretching 40 km offshore from Seabrook Station has been estimated to be about 24.0×10^6 kg. This estimate is based on information and data obtained from the National Marine Fisheries Service. For comparison, the same size block using the LPGS ocean site fish catch densities would yield about 5.8×10^6 kg of finfish.

Therefore, fish production from the ocean in the vicinity of the Seabrook Station has been estimated to be approximately four times the generic ocean site in the LPGS. Most of the dose from fish consumption resulted from the two radionuclides discussed above however, and, since these will effectively decay the dose from this pathway will be much lower for Seabrook than for the LPGS site.

The annual population beach usage factor within the 50-mile radius of Seabrook was estimated in two parts. For the 0 to 10-mile radius of beach, the summer (June-August) transient population in the NNE through south sectors, with respect to the site, were derived from the seasonal resident, hotel/motel, campground and daily transient population groups as given on Figures 2.1-10, 2.1-11, 2.1-12, 2.1-13, 2.1-15 and 2.1-19 of the SB-FSAR. In the case of daily transients associated with beach parking lots and on-street parking, the maximum capacity figures given on FSAR Figures 2.1-15 and 2.1-19 were multiplied by 0.79 to represent the maximum observed population associated with these two categories in three years of observation. This single day (Sunday) peak observed beach population was then adjusted by applying the average observed daily population loading factor as derived from Figure 2.1-17 of the SB-FSAR. For weekdays, this factor represented 46% of the single day peak observed values, while the Saturdays' loading factor was estimated to be 66% of the Sunday observed peak. These results were then added to the other seasonal transient groups noted above. These daily population beach area inventories were then multiplied by the number of weekdays (64) or weekend days (13 Saturdays, 13 Sundays) assumed to represent the summer beach season. These values were then multiplied by a daily average beach population loading factor (0.27) which corrected the peak observed population values that relate to the maximum number of people on the beach during the height of the beach day to an hourly average value over an entire

24-hour period. This hourly loading factor was derived from the time-of-day vehicle distribution data in SB-FSAR Figure 2.1.16. Finally, a multiplier of 0.25 is used to estimate the fraction of time that beach users, while on the beach, are in the active area of radioactivity deposition at the ocean-shoreline interface. The resulting multiplication of peak observed population, times daily usage factor, times hourly average loading factor, times shoreline exposure period gives an estimate of the number of person-hours/year of beach use. The total 0-10 mile population occupancy factor is estimated to be 9.8×10^6 person-hours/year.

The second part of the estimate involves the beach usage between 10 and 50 miles from the site. For beaches north of the site, an estimate of beach capacity of 33,148 persons (FSAR-Section 2.1.3.3.f.1.a.) was multiplied by 90 days per year summer season, the 0.27 average hourly loading factor per day, plus the 0.25 shoreline exposure fraction. For beaches south of the site, no specific beach capacity estimates were identified. Therefore for the 40 miles of beach area assumed to be south of the site, an average capacity loading of 1 person per 2 feet of beach was used to estimate the beach capacity, and this then corrected as noted above.

The beach usage factor for the 10-50 mile radius was estimated to be 2.0×10^7 person-hour per year. The total 0-50 mile radius beach usage population value is thus estimated to be 3.0×10^7 person-hours/year.

The shoreline usage factors discussed above show that the total man-hours may be slightly higher than was assumed in the LPGS. Essentially, all of the shoreline and swimming exposure in the LPGS ocean site came from Cs-137. However, since decay will remove Cs-137 before it reaches the ocean at Seabrook, this pathway can be eliminated.

The LPGS determined that accidents involving liquid pathways did not contribute significantly to public risk. This analysis has shown that liquid pathway accidents involving the Seabrook Station would be of much lower consequence than was reported for the LPGS site. Therefore these types of accidents are not expected to significantly increase the risk from the operation of Seabrook.

Mitigating actions which could be undertaken to decrease liquid pathway impacts following a core-melt accident include the following:

1. Injection or withdrawal of water;
2. Lowering of the watertable;
3. Installation of a grout curtain.

For Seabrook Station; the third method, installation of a grout curtain, would be the most reasonable approach to source interdiction. The first two methods would probably not be feasible due to the local topography, location of the melt debris, and proximity of the site to the ocean.

Injection of a chemical grout slurry curtain through holes slant-drilled to a depth below the core debris could be engineered to form an effective waterproof seal around the debris creating a permanent isolation barrier.

REFERENCES TO 240.25

1. U.S. Nuclear Regulatory Commission, 1978, "Liquid Pathway Generic Study", NUREG-0440, February 1978.

2. FSAR Seabrook Station, Units 1 and 2.

3. Draft Environmental Statement, V.C. Summer Station/Unit No. 1, NUREG-0534 Supplement, USNRC, November 1980.

TABLE 240.25-1

Summary of Factors in Seabrook and LPGS Ocean Site Comparison

Factor	LPGS	Seabrook	Multiplier
A. Source Term	3411 Mwth	3411 Mwth	Equal to unity
B. Groundwater Transport			
1. Travel time of water	6.7 ft/day	0.26 ft/day in bedrock 0.008 ft/day in soil	Much less than unity
2. Source availability	Source directly immersed in flowing groundwater	Source directly immersed in flowing groundwater	Equal to unity
3. Retardation coefficients	9.2 for Sr 83 for Cs	8.6 for Sr, bedrock 154 for Cs, bedrock 15 for Sr, soil 141 for Cs, soil	Less than unity
C. Surface Water Transport	-	-	Assumed equal to unity
D. Usage			
1. Aquatic food	5.8×10^6 kg finfish	24.0×10^6 kg finfish and shellfish	Approximately equal to 4
2. Shoreline usage	1.1×10^7 man-hrs/yr	3×10^7 man-hrs/yr	Approximately equal to 3

TABLE 240.25-2

Parameters Used for Seabrook Station

Parameter	Value	
Permeabilities	$K_{bedrock}$ = 2.1 gpd/ft^2	
	K_{soil} = 0.6 gpd/ft^2	
Groundwater gradients	$I_{bedrock}$ = 0.014 ft/ft	
	I_{soil} = 0.02 ft/ft	
Distance from reactor to nearest surface water leading to ocean	$L_{bedrock}$ = 1,000 ft	
	L_{soil} = 110 ft	
	L_{total} = 1,110 ft	
Retardation factors for ion exchange in soil	Sr - 8.6 bedrock, [illegible] soil	
	Cs - 154 bedrock, 141 soil	
Porosity	Bedrock = 0.015	
	Soil = 0.2	
Fish harvest statistics		
Commercial	0-3 miles	214 kg/ha/yr
	3-12 miles	42 kg/ha/yr
	12-200 miles	17.3 kg/ha/yr
Recreational	0-3 miles	87 kg/ha/yr
	3-12 miles	26.5 kg/ha/yr
	12-25 miles	7.6 kg/ha/yr
Shoreline usage		
beach season duration	weekdays	64 days
	Saturdays	13 days
	Sundays	13 days
beach population (daily peak values)	weekdays (0-10 miles)	59,216 persons
	Saturdays (0-10 miles)	78,601 persons

TABLE 240.25-2

Parameters Used for Seabrook Station
(Continued)

	Sundays (0-10 miles)	93,799 persons
	All days (10-50 miles)	138,748 persons
Shoreline usage		
average daily population beach loading factor		.27
fraction of time persons on beach are in active land-ocean interface zone		.25