New Hampshire Yankee
March 29, 1991

ENCLOSURE 1 TO NYN-91054

TABLE 4

Seabrook Station

Effluent and Waste Disposal Semiannual Report
1990

Maximum[a] Off-Site Doses and Dose Commitments to Members of the Public

Source		Dose (mrem)[b] 1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year[c]
Liquid Effluents:						
Total Body Dose		1.5e-09	6.0e-08	1.2e-05	1.1e-03	1.1e-03
Organ Dose		1.5e-09 (1)	2.2e-07 (1)	1.4e-05 (1)	6.4e-03 (1)	6.4e-03
Airborne Effluents:						
Iodines, Tritium and Particulates		---	4.1e-06 (2)	2.0e-06 (3)	7.8e-05 (4)	8.4e-05
Noble Gases	Beta Air (mrad)	---	2.0e-07 (5)	1.6e-05 (6)	1.5e-02 (7)	1.5e-02
	Gamma Air (mrad)	---	7.1e-07 (5)	3.5e-05 (6)	1.3e-02 (7)	1.3e-02
Doses (mrem) at Receptor Locations Inside Site Boundary[d]:						
Education Center (SW, 335m)						
Beta Air Dose (mrad)		---	3.0e-10	---	5.9e-10	8.9e-10
Gamma Air Dose (mrad)		---	5.7e-10	---	9.0e-10	1.5e-09
Organ Dose (mrem)		---	2.3e-09 (8)	---	3.4e-11 (8)	2.3e-09
The "Rocks" (ENE, 318m)						
Beta Air Dose (mrad)		---	---	2.8e-06	7.9e-04	7.9e-04
Gamma Air Dose (mrad)		---	---	3.4e-06	2.9e-04	2.9e-04
Organ Dose (mrem)		---	1.2e-07 (8)	7.3e-08 (8)	3.1e-07 (8)	5.0e-07

TABLE 4
(Continued)

Seabrook Station

Effluent and Waste Disposal Semiannual Report
1990

Maximum[a] Off-Site Doses and Dose Commitments to Members of the Public

	Dose (mrem)[b]				
Source	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year[c]
Direct Dose From Plant Operation[e]					0

(a) "Maximum" means the largest fraction of corresponding 10CFR50, Appendix I, dose design objective.

(b) The numbered footnotes indicate the age group, organ, and location of the dose receptor, where appropriate.

(1) Adult/GI-LLI.
(2) Child/whole body, ESE-2414 meters.
(3) Child/whole body, ENE-2414 meters.
(4) Child/whole body, SE-2414 meters.
(5) W-914 meters.
(6) ENE-2276 meters.
(7) SSE-914 meters.
(8) Teen/whole body.

(c) "Maximum" dose for the year is the sum of the maximum doses for each quarter. This results in a conservative yearly dose estimate, but still well within the limits of 10CFR50.

(d) For each special receptor location, the doses calculated for the duration of the airborne effluent releases were adjusted by the occupancy factor provided in Seabrook's ODCM (i.e., 0.0014 for the Education Center and 0.0076 for the "Rocks").

(e) Only station sources are considered since there are no other facilities within five miles of Seabrook Station. The annual dose at the closest receptor location in each sector (as listed in Table B.4-1 of Seabrook' ODCM) was determined from 1990 environmental TLD data and compared with the annual dose determined from pre-operational environmental TLD data. No statistical difference which could be attributed to station sources was identified.

Seabrook Station
Supplemental Effluent Release Report
Radiological Impact Assessment For 1990

I. Introduction

Doses resulting from liquid and gaseous effluents from Seabrook Station during 1990 were calculated in accordance with Method II as defined in the Seabrook Offsite Dose Calculation Manual (ODCM). The calculational methods used follow the models in Regulatory Guide 1.109. The calculations included maximum total body doses and organ doses from all liquid releases, maximum offsite organ doses resulting from airborne iodines, tritium and particulate radionuclides, and maximum offsite beta air and gamma air doses from airborne noble gases. In addition, the doses associated with gaseous effluents were also calculated for the special receptor locations inside the site boundary: the Education Center and the "Rocks". The airborne effluent doses presented in Table 4 are the summation of elevated and ground releases.

The calculated maximum annual total body dose and the maximum organ dose from liquid effluents represent, respectively, 0.04% and 0.06% of the dose limits established by Technical Specification 3.11.1.2. The calculated annual maximum dose from airborne iodine, tritium and particulate radionuclides for offsite receptor locations represent 0.0006% of the dose limit established by Technical Specification 3.11.2.3, whereas the calculated maximum annual beta air and gamma air doses from airborne noble gases for offsite receptor locations represent, respectively, 0.08% and 0.13% of the dose limits established by Technical Specification 3.11.2.2. The calculated annual beta air and gamma air doses from airborne noble gases for the Education Center were, respectively, 4.5e-9% and 1.5e-8% of the limits in Technical Specification 3.11.2.2, whereas, for the "Rocks" the annual doses were, respectively, 0.004% and 0.003% of the Technical Specification limits. The calculated annual doses from airborne iodines, tritium and particulate radionuclides at the Education Center and the "Rocks" were, respectively, 1.5e-8% and 3.3e-6% of the limits in Technical Specification 3.11.2.3.

The sum of the maximum whole body doses from all exposure pathways for the liquid and gaseous effluents, plus the direct whole body dose from station operation, was 9.8e-03 mrem to a hypothetical individual. This total whole body dose

conservatively represents 0.04% of the whole body dose limit for a member of the public as set forth in 40CFR190, and demonstrates compliance with that code.

II. Method for Calculating the Total Body and Maximum Organ Doses Resulting from Liquid Releases

The computer code IDLE, which is consistent with the models in Regulatory Guide 1.109 (Reference 1), was used to calculate the total body and organ doses resulting from liquid effluents from Seabrook Station. The general equations A-3, A-4, A-5, A-6 and A-7 from Regulatory Guide 1.109 are applied in IDLE. The total body doses and the organ doses are evaluated for each of the four age groups (i.e., infant, child, teen and adult) to determine the maximum total body dose and maximum organ dose via all existing exposure pathways (i.e., fish and aquatic invertebrate ingestion, and shoreline exposure) to an age-dependent individual. The values for the various factors considered in equations A-3 through A-7 have been taken from Regulatory Guide 1.109 and the Seabrook Station Offsite Dose Calculation Manual (ODCM) (Reference 2). The specific values used for the usage factor (U_{ap}), mixing ratio (M_p), bioaccumulation factor (B_{ip}), dose factors (D_{aipj}), transit time (t_p), transfer constant from water to sediment (K_e), exposure time for sediment or soil (t_b), and shore width factor (W) are provided by the reference sources as summarized in Table A. The flow rate of the liquid effluent (F) and the release rates for radionuclides (Q_i) are measured specifically prior to each liquid release. The values for half lives for radionuclides (T_i) and their radioactive decay constants (λ_i) have been taken from Kocher (Reference 3).

The exposure pathways considered in the calculations of total body and maximum organ doses resulting from liquid discharges from Seabrook Station have been limited to ingestion of aquatic foods and exposure to shoreline deposits. The dose calculations do not include the ingestion of potable water and irrigated vegetation as potential exposure pathways because the liquid effluents from the plant are discharged into salt water.

Table 4 list the calculated liquid pathway doses for each calendar quarter and also the total for the year.

Table A

Factor	Source
U_{ap}	Table B.7-1, Seabrook ODCM
M_p	Section B.7.1, Seabrook ODCM (value=0.1 was used)
B_{ip}	Table A-1, Reg. Guide 1.109
D_{aipj}	Tables E-11 through E-14, R.G. 1.109
t_p	Section B.7.1, Seabrook ODCM
K_c	Reg. Guide 1.109
t_f	Reg. Guide 1.109
W	Table A-2, Reg. Guide 1.109 (value=0.5)

III. Method for Calculating the Gamma and Beta Air Doses from Noble Gases

The computer codes AIRAD and AEOLUS 2 (Mod 02) were used for the calculation of both the gamma and beta air doses resulting from noble gases present in gaseous effluents released from Seabrook Station. The features and use of AEOLUS 2 (Mod 02) for the calculation of atmospheric dispersion factors (i.e., Chi/Q factors) from recorded meteorological data (i.e., meteorological data measurements taken during the time of the release) are described in section B.7.3.2 of Seabrook's ODCM. Meteorological dispersion factors concurrent with periods of batch gas releases are calculated along with the values for quarterly average dispersion factors. The atmospheric dispersion factors calculated using AEOLUS 2 (Mod 02) were, in turn, used in the gamma and beta air dose calculations by AIRAD. AIRAD is consistent with the models presented in Regulatory Guide 1.109, general equations B-4 and B-5. The values for the dose factors, DF_i^{γ} and DF_i^{β}, have been taken from Table B-1 in Regulatory Guide 1.109.

Table 4 list the calculated air doses for each calendar quarter, and the total for the year.

IV. Method for Calculating the Critical Organ Dose Resulting from Iodines, Tritium and Particulates with $T_{1/2}$ Greater than 8 Days in Gaseous Releases

The computer codes AEOLUS 2 (Mod 02) and ATMODOS were used for the calculation of the organ doses resulting from iodines, tritium and particulates with half-

lives greater than 8 days present in gaseous effluents released from Seabrook Station. The features and use of AEOLUS 2 (Mod 02) for the calculation of atmospheric dispersion factors (i.e., Chi/Q factors) from recorded meteorological data (i.e., meteorological data measurements taken during the time of the release) are described in section B.7.3.2 of Seabrook's ODCM. Meteorological dispersion factors concurrent with periods of batch gas releases were calculated along with the values for quarterly average dispersion factors. The atmospheric dispersion factors calculated using AEOLUS 2 (Mod 02) were, in turn, used in the dose calculations by ATMODOS. ATMODOS calculates the organ doses (i.e., dose to bone, liver, kidney, lung, lower large intestine, total body, and skin) due to the presence of radionuclides other than noble gases in gaseous effluents, and is consistent with the models presented in Appendix C of Regulatory Guide 1.109. The pathways considered in the dose calculations are the ground plane, inhalation, and ingestion of stored vegetables, fresh garden vegetables, milk and meat. The critical organ dose is determined for the offsite location (e.g., site boundary, nearest resident or farm) of receptor pathways as identified in the most recent annual land use census. The total body dose contributions via the ground plane and inhalation pathways as calculated by ATMODOS have also been included in the total body dose estimates for the special receptor locations inside the site boundary. Equations C-1 through C-13 are applied in the ATMODOS calculation of the critical organ doses. The input data and assumptions are those provided in Appendix C of Regulatory Guide 1.109, except where site-specific data and assumptions have been identified in Tables B.7-2 and B.7-3 of Seabrook's ODCM. These two ODCM tables provide the options for special conditions, depending on the type of receptor being evaluated at a specific location, that are to be applied in Method II calculations. The receptor type controls the exposure pathways for calculational purposes. The receptor types used in the dose calclations were a resident receptor (which considered the ground plane, inhalation and vegetable ingestion exposure pathways), a milk receptor (which considered the ground plane, inhalation, vegetable and milk ingestion exposure pathways) and a boundary and radius receptor (both of which considered the ground plane and inhalation exposure pathways). The resident and milk receptor locations for the various sector were based on the 1990 land use census data for Seabrook Station (see Table B for the latest land use census). The radius receptor locations were applied at several distances in each sector to insure that the location of the maximum doses were not overlooked.

Depletion of the plume during transport is considered by AEOLUS 2 (Mod 2) in the calculations of atmospheric dispersion factors (e.g., calculation of $[X/Q]^D$). A shielding factor (S_f) of 0.7 is applied for residential structures. The source for the values of the various factors used in equations C-1 through C-13 are summarized below.

Factor	Source
t_b	Reg. Guide 1.109
λ_i	Kocher (Reference 3)
DFG_{ij}	Table E-6, Reg. Guide 1.109
$[X/Q]^D$	Calculated by AEOLUS 2 (Mod 2)
R_a	Table B.7-3, Seabrook ODCM
DFA_{ija}	Tables E-7 through E-10, R.G.1.109
d_i	Reg. Guide 1.109
P, t_e, t_h and Y_v	Table B.7-2, Seabrook ODCM
r	Table E-15, Reg. Guide 1.109
B_{iv}	Table E-1, Reg. Guide 1.109
p	Reg. Guide 1.109
H	Table B.7-2, Seabrook ODCM
F_m	Tables E-1 and E-2, R.G. 1.109
Q_F	Table E-3, Reg. Guide 1.109
t_f	Reg. Guide 1.109
f_p	Table B.7-2, Seabrook ODCM
f_s	Table B.7-2, Seabrook ODCM
F_r	Table E-1, Reg. Guide 1.109
t_s	Table E-15, Reg. Guide 1.109
DFI_{ija}	Tables E-11 through E-14, R.G.1.109
U_a^V, U_a^m	Table B.7-3, Seabrook ODCM
U_a^F, U_a^L	Table B.7-3, Seabrook ODCM

Factor	Source
f_g, f_l	Reg. Guide 1.109
σ_i	Calculated by AEOLUS 2 (Mod 2)
λ_w	Table E-15, Reg. Guide 1.109
Q_F	Table E-3, Reg. Guide 1.109

V. References

1. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purposes of Evaluating Compliance with 10CFR Part 50, Appendix I, Reg. Guide 1.109, Rev 1, Oct. 1977.

2. Seabrook Station Offsite Dose Calculation Manual.

3. Kocher, D.C., Dose-Rate Conversion Factors for Exposure to Photons and Electrons, Health Physics, Vol. 45, No. 3, Sept. 1983.

TABLE B

Receptor Locations for Seabrook Station

Sector	Nearest Receptor Location[a] mile(km)	Nearest Resident[b] mile(km)	Nearest Garden[b] mile(km)	Nearest Milk Animal[b] mile(km)
NNW	0.6(0.9)	0.7(1.1)	0.7(1.1)	3.4(5.5)
N	0.6(0.9)	0.6(1.0)	2.5(4.0)	-
NNE	1.8(2.9)	2.0(3.2)	2.0(3.2)	3.7(5.9)
NE	1.4(2.3)	1.5(2.4)	2.0(3.2)	-
ENE	1.4(2.3)	1.5(2.4)	-	-
E	1.5(2.4)	1.6(2.6)	-	-
ESE	1.4(2.3)	1.5(2.4)	-	-
SE	1.4(2.3)	1.5(2.4)	2.2(3.5)	-
SSE	0.6(0.9)	0.6(1.0)	0.7(1.1)	-
S	0.6(0.9)	0.6(1.0)	0.8(1.3)	4.3(6.9)
SSW	0.6(0.9)	0.6(1.0)	0.8(1.3)	-
SW	0.6(0.9)	0.6(1.0)	1.0(1.6)	3.2(5.2)
WSW	0.6(0.9)	0.7(1.1)	1.2(1.9)	4.0(6.4)
W	0.6(0.9)	0.6(1.0)	0.7(1.1)	-
WNW	0.6(0.9)	0.6(1.0)	1.0(1.6)	3.0(4.8)
NW	0.6(0.9)	0.6(1.0)	0.7(1.1)	4.4(7.1)

(a) The nearest receptor location is taken to be the site boundary for all sectors except the NNE through SE sectors. The actual site boundary for each of these six sectors is located over marsh (e.g., water). Consequently, the nearest receptor locations in these sectors represents the closest dry land beyond the site boundary.

(b) The location given is based on data from the Seabrook Station 1990 Land Use Census.