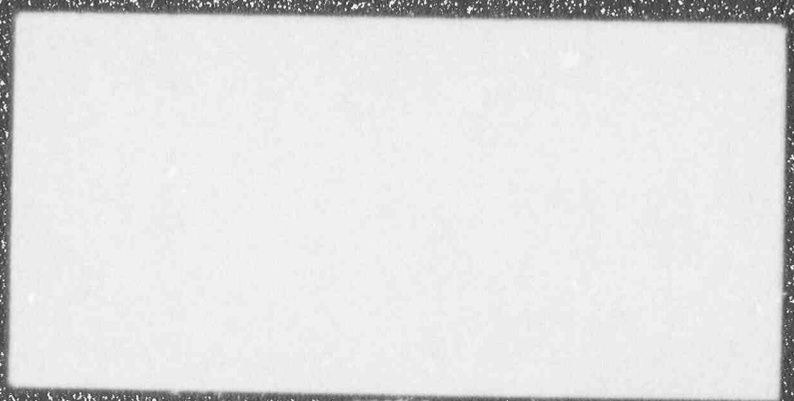

VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

VERNON, VERMONT

# EFFLUENT AND WASTE DISPOSAL
# SEMIANNUAL REPORT
# FOR
# THIRD AND FOURTH QUARTERS, 1993

Vermont Yankee Nuclear Power Station

R12\60

TABLE 1A

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters, 1993

Gaseous Effluents - Summation of All Releases

| | Unit | Quarter 3 | Quarter 4 | Est. Total Error, % |
|---|---|---|---|---|
| **A. Fission and Activation Gases** | | | | |
| 1. Total release | Ci | <8.85E+02 | <8.00E+02 | ±1.00E+02 |
| 2. Average release rate for period | uCi/sec | <1.13E+02 | <1.02E+02 | |
| 3. Percent of Tech. Spec. limit (1) | % | | | |
| **B. Iodines** | | | | |
| 1. Total Iodine-131 | Ci | 5.25E-03 | 7.48E-04 | ±5.00E+01 |
| 2. Average release rate for period | uCi/sec | 6.68E-04 | 9.52E-05 | |
| 3. Percent of Tech. Spec. limit (1) | % | | | |
| **C. Particulates** | | | | |
| 1. Particulates with T-1/2 > 8 days | Ci | 1.67E-03 | 1.19E-03 | ±5.00E+01 |
| 2. Average release rate for period | uCi/sec | 2.12E-04 | 1.51E-04 | |
| 3. Percent of Tech. Spec. limit (1) | % | | | |
| 4. Gross alpha radioactivity | Ci | 4.70E-06 | 5.18E-06 | |
| **D. Tritium** | | | | |
| 1. Total release | Ci | 6.05E+00 | 3.63E+00 | ±5.00E+01 |
| 2. Average release rate for period | uCi/sec | 7.69E-01 | 4.61E-01 | |
| 3. Percent of Tech. Spec. limit (1) | % | | | |

(1) Percent of Technical Specification limit will be provided in the Supplemental Effluent and Waste Disposal Report to be submitted per Technical Specification 6.7.C.1.

TABLE 1B

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters, 1993

Gaseous Effluents - Elevated Releases

| | | Continuous Mode | | Batch Mode(1) | |
|---|---|---|---|---|---|
| Nuclides Released | Unit | Quarter 3 | Quarter 4 | Quarter 3 | Quarter 4 |
| 1. Fission Gases | | | | | |
| Krypton-85 | Ci | <1.16E+01 | <8.56E+01 | | |
| Krypton-85m | Ci | <4.18E+00 | <2.72E+00 | | |
| Krypton-87 | Ci | <2.27E+01 | <1.98E+01 | | |
| Krypton-88 | Ci | <1.43E+01 | <9.16E+00 | | |
| Xenon-133 | Ci | <2.67E+02 | <1.03E+02 | | |
| Xenon-135 | Ci | <2.41E+01 | <1.59E+01 | | |
| Xenon-135m | Ci | <1.13E+02 | <1.17E+02 | | |
| Xenon-138 | Ci | <4.12E+02 | <4.43E+02 | | |
| Unidentified | Ci | | | | |
| Total for period | Ci | <8.69E+02 | <7.97E+02 | | |
| 2. Iodines | | | | | |
| Iodine-131 | Ci | 2.89E-03 | 7.24E-04 | | |
| Iodine-133 | Ci | 7.38E-03 | 3.21E-03 | | |
| Iodine-135 | Ci | ND | ND | | |
| Total for period | Ci | 1.03E-02 | 3.93E-03 | | |
| 3. Particulates | | | | | |
| Strontium-89 | Ci | 3.95E-04 | 3.93E-04 | | |
| Strontium-90 | Ci | <3.61E-06 | 8.09E-06 | | |
| Cesium-134 | Ci | ND | ND | | |
| Cesium-137 | Ci | 3.53E-05 | 3.19E-05 | | |
| Barium-Lanthanum-140 | Ci | 8.27E-04 | 4.37E-04 | | |
| Manganese-54 | Ci | 2.89E-05 | 7.55E-05 | | |
| Chromium-51 | Ci | ND | ND | | |
| Cobalt-58 | Ci | ND | ND | | |
| Cobalt-60 | Ci | 2.13E-04 | 2.15E-04 | | |
| Cerium-141 | Ci | 4.46E-06 | ND | | |
| Zinc-65 | Ci | ND | ND | | |
| Total for period | Ci | 1.51E-03 | 1.16E-03 | | |

(1) There were no batch mode gaseous releases for this reporting period.

ND - Not detected at the plant stack.

TABLE 1C

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters 1993

Gaseous Effluents - Ground Level Releases[2]

| | | Continuous Mode | | Batch Mode[1] | |
|---|---|---|---|---|---|
| Nuclides Released | Unit | Quarter 3 | Quarter 4 | Quarter 3 | Quarter 4 |
| 1. Fission Gases | | | | | |
| Krypton-85 | Ci | <8.24E-02 | <9.10E-01 | | |
| Krypton-85m | Ci | <9.94E-02 | <2.68E-03 | | |
| Krypton-87 | Ci | <5.24E-01 | <1.94E-02 | | |
| Krypton-88 | Ci | <3.36E-01 | <9.56E-03 | | |
| Xenon-133 | Ci | <2.48E+00 | <1.08E+00 | | |
| Xenon-135 | Ci | <5.74E-01 | <1.45E-02 | | |
| Xenon-135m | Ci | <2.58E+00 | <1.14E-01 | | |
| Xenon-138 | Ci | <9.36E+00 | <4.83E-01 | | |
| Xenon-131m | Ci | <5.48E-02 | <2.15E-01 | | |
| Total for period | Ci | <1.61E+01 | <2.85E+00 | | |
| 2. Iodines[2] | | | | | |
| Iodine-131 | Ci | 2.36E-03 | 2.49E-05 | | |
| Iodine-133 | Ci | 8.72E-04 | ND | | |
| Iodine-135 | Ci | ND | ND | | |
| Total for period | Ci | 3.23E-03 | 2.49E-05 | | |
| 3. Particulates[2] | | | | | |
| Strontium-89 | Ci | 5.11E-05 | ND | | |
| Strontium-90 | Ci | <1.41E-06 | ND | | |
| Cesium-134 | Ci | ND | ND | | |
| Cesium-137 | Ci | 7.13E-07 | ND | | |
| Barium-Lanthanum-140 | Ci | 9.87E-05 | ND | | |
| Manganese-54 | Ci | ND | 1.18E-05 | | |
| Chromium-51 | Ci | ND | ND | | |
| Cobalt-58 | Ci | ND | ND | | |
| Cobalt-60 | Ci | ND | 8.26E-06 | | |
| Cerium-141 | Ci | 6.12E-06 | ND | | |
| Zinc-65 | Ci | ND | 5.77E-06 | | |
| Total for period | Ci | 1.58E-04 | 2.58E-05 | | |

(1) There were no batch mode gaseous releases for this reporting period.
(2) Effluent sampling of the turbine roof ventilators as a ground level release point was initiated at the beginning of the fourth quarter 1991.
ND - Not detected at the Turbine Building roof.

TABLE 1D

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters 1993

Gaseous Effluents - Nonroutine Releases

There were no nonroutine or accidental gaseous releases during this reporting period.

TABLE 2A

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters 1993

Liquid Effluents - Summation of All Releases

There were no liquid releases during the third or fourth quarters of 1993.

TABLE 2B

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters 1993

Liquid Effluents - Nonroutine Releases

There were no liquid releases during the third or fourth quarters of 1993.

TABLE 3

Vermont Yankee

Effluent and Waste Disposal Semiannual Report

Third and Fourth Quarters, 1993

Solid Waste and Irradiated Fuel Shipments

A. Solid Waste Shipped Off-Site for Burial or Disposal (Not Irradiated Fuel):

| 1. Type of Waste | Unit | 6-Month Period | Est. Total Error, % |
|---|---|---|---|
| a. Spent resins, filter sludges, evaporator bottoms, etc. | $m^3$ | 2.42E+01 | |
| | Ci | 1.13E+02 | ±7.50E+01 |
| b. Dry compressible waste, contaminated equipment, etc. | $m^3$ | 4.27E+01 | |
| | Ci | 3.26E-01 | ±7.50E+01 |
| c. Irradiated components, control rods, etc. | $m^3$ | | |
| | Ci | | ±7.50E+01 |

2. Estimate of Major Nuclide Composition (By Type of Waste):

| a. | | | b. | | |
|---|---|---|---|---|---|
| Zinc-65 | % | 3.34E+01 | Iron-55 | % | 6.54E+01 |
| Cesium-137 | % | 2.42E+01 | Zinc-65 | % | 1.09E+01 |
| Cobalt-60 | % | 2.06E+01 | Cobalt-60 | % | 1.02E+01 |
| Cesium-134 | % | 8.44E+00 | Manganese-54 | % | 5.67E+00 |
| Manganese-54 | % | 8.70E+00 | Cesium-137 | % | 1.85E+00 |

3. Solid Waste Disposition:

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 5 Resin Shipments | Truck | Barnwell, SC |
| 59 Partial Shipments from Processor to Burial | Truck | Barnwell, SC |

B. Irradiated Fuel Shipments (Disposition): None

C. Supplemental information

1) Class of solid waste containers shipped: 85 A (unstable), 5B
2) Types of containers used: 85 Strong-tight Containers, 5 Type A
3) Solidification agent or absorbent: None

# TABLE 5A

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA  STABILITY CLASS A  CLASS FREQUENCY (PERCENT) = .52

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| (1) | 2.27 | .00 | .00 | 2.27 | .00 | .00 | .00 | 2.27 | .00 | .00 | .00 | .00 | .00 | 2.27 | .00 | .00 | .00 | 9.09 |
| (2) | .01 | .00 | .00 | .01 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .05 |
| 4-7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 4.55 | .00 | 4.55 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .02 | .00 | .02 |
| 8-12 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 16 |
| (1) | 4.55 | .00 | .00 | .00 | .00 | 2.27 | .00 | 9.09 | .00 | 2.27 | 2.27 | .00 | .00 | .00 | .00 | 15.91 | .00 | 36.36 |
| (2) | .02 | .00 | .00 | .00 | .00 | .01 | .00 | .05 | .00 | .01 | .01 | .00 | .00 | .00 | .00 | .08 | .00 | .19 |
| 13-18 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 8 | 0 | 16 |
| (1) | .00 | 2.27 | .00 | .00 | .00 | 2.27 | .00 | 2.27 | 2.27 | .00 | .00 | .00 | 2.27 | 2.27 | 4.55 | 18.18 | .00 | 36.36 |
| (2) | .00 | .01 | .00 | .00 | .00 | .01 | .00 | .01 | .01 | .00 | .00 | .00 | .01 | .01 | .02 | .09 | .00 | .19 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 0 | 6 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 2.27 | .00 | 11.36 | .00 | 13.64 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .06 | .00 | .07 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 3 | 1 | 0 | 1 | 0 | 2 | 0 | 6 | 1 | 1 | 1 | 0 | 1 | 3 | 2 | 22 | 0 | 44 |
| (1) | 6.82 | 2.27 | .00 | 2.27 | .00 | 4.55 | .00 | 13.64 | 2.27 | 2.27 | 2.27 | .00 | 2.27 | 6.82 | 4.55 | 50.00 | .00 | 100.00 |
| (2) | .04 | .01 | .00 | .01 | .00 | .02 | .00 | .07 | .01 | .01 | .01 | .00 | .01 | .04 | .02 | .26 | .00 | .52 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 5B

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA  STABILITY CLASS B  CLASS FREQUENCY (PERCENT) = 1.42

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| (1) | .83 | .00 | .00 | .00 | .83 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .83 | .00 | .00 | .00 | .00 | 2.48 |
| (2) | .01 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .04 |
| 4-7 | 4 | 0 | 0 | 0 | 1 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 20 |
| (1) | 3.31 | .00 | .00 | .00 | .83 | .00 | 1.65 | 1.65 | .83 | .83 | .00 | .00 | .00 | .00 | .00 | 7.44 | .00 | 16.53 |
| (2) | .05 | .00 | .00 | .00 | .01 | .00 | .02 | .02 | .01 | .01 | .00 | .00 | .00 | .00 | .00 | .11 | .00 | .24 |
| 8-12 | 5 | 3 | 0 | 0 | 0 | 0 | 5 | 8 | 5 | 2 | 0 | 0 | 0 | 0 | 1 | 10 | 0 | 39 |
| (1) | 4.13 | 2.48 | .00 | .00 | .00 | .00 | 4.13 | 6.61 | 4.13 | 1.65 | .00 | .00 | .00 | .00 | .83 | 8.26 | .00 | 32.23 |
| (2) | .06 | .04 | .00 | .00 | .00 | .00 | .06 | .09 | .06 | .02 | .00 | .00 | .00 | .00 | .01 | .12 | .00 | .46 |
| 13-18 | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 8 | 1 | 0 | 0 | 6 | 6 | 4 | 11 | 0 | 48 |
| (1) | 4.96 | .00 | .00 | .00 | .00 | .00 | .83 | 4.13 | 6.61 | .83 | .00 | .00 | 4.96 | 4.96 | 3.31 | 9.09 | .00 | 39.67 |
| (2) | .07 | .00 | .00 | .00 | .00 | .00 | .01 | .06 | .09 | .01 | .00 | .00 | .07 | .07 | .05 | .13 | .00 | .56 |
| 19-24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 2 | 1 | 2 | 0 | 11 |
| (1) | .83 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 1.65 | .00 | .00 | .00 | 2.48 | 1.65 | .83 | 1.65 | .00 | 9.09 |
| (2) | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .02 | .00 | .00 | .00 | .04 | .02 | .01 | .02 | .00 | .13 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 17 | 3 | 0 | 0 | 2 | 0 | 8 | 15 | 16 | 4 | 0 | 0 | 10 | 8 | 6 | 32 | 0 | 121 |
| (1) | 14.05 | 2.48 | .00 | .00 | 1.65 | .00 | 6.61 | 12.40 | 13.22 | 3.31 | .00 | .00 | 8.26 | 6.61 | 4.96 | 26.45 | .00 | 100.00 |
| (2) | .20 | .04 | .00 | .00 | .02 | .00 | .09 | .18 | .19 | .05 | .00 | .00 | .12 | .09 | .07 | .38 | .00 | 1.42 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

# TABLE 5C

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA STABILITY CLASS C CLASS FREQUENCY (PERCENT) = 3.43

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 3 | 0 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| (1) | 1.03 | .00 | .34 | .00 | .34 | .34 | .68 | .34 | .34 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 3.42 |
| (2) | .04 | .00 | .01 | .00 | .01 | .01 | .02 | .01 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .12 |
| 4-7 | 8 | 2 | 0 | 3 | 0 | 5 | 5 | 6 | 6 | 0 | 1 | 1 | 0 | 0 | 3 | 16 | 0 | 56 |
| (1) | 2.74 | .68 | .00 | 1.03 | .00 | 1.71 | 1.71 | 2.05 | 2.05 | .00 | .34 | .34 | .00 | .00 | 1.03 | 5.48 | .00 | 19.18 |
| (2) | .09 | .02 | .00 | .04 | .00 | .06 | .06 | .07 | .07 | .00 | .01 | .01 | .00 | .00 | .04 | .19 | .00 | .66 |
| 8-12 | 8 | 2 | 0 | 0 | 0 | 3 | 7 | 22 | 15 | 2 | 3 | 4 | 3 | 4 | 5 | 15 | 0 | 93 |
| (1) | 2.74 | .68 | .00 | .00 | .00 | 1.03 | 2.40 | 7.53 | 5.14 | .68 | 1.03 | 1.37 | 1.03 | 1.37 | 1.71 | 5.14 | .00 | 31.85 |
| (2) | .09 | .02 | .00 | .00 | .00 | .04 | .08 | .26 | .18 | .02 | .04 | .05 | .04 | .05 | .06 | .18 | .00 | 1.09 |
| 13-18 | 18 | 5 | 0 | 0 | 0 | 0 | 0 | 2 | 31 | 2 | 0 | 3 | 6 | 12 | 8 | 14 | 0 | 101 |
| (1) | 6.16 | 1.71 | .00 | .00 | .00 | .00 | .00 | .68 | 10.62 | .68 | .00 | 1.03 | 2.05 | 4.11 | 2.74 | 4.79 | .00 | 34.59 |
| (2) | .21 | .06 | .00 | .00 | .00 | .00 | .00 | .02 | .36 | .02 | .00 | .04 | .07 | .14 | .09 | .16 | .00 | 1.19 |
| 19-24 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 0 | 1 | 1 | 10 | 7 | 4 | 0 | 31 |
| (1) | .68 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 1.37 | .68 | .00 | .34 | .34 | 3.42 | 2.40 | 1.37 | .00 | 10.62 |
| (2) | .02 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .05 | .02 | .00 | .01 | .01 | .12 | .08 | .05 | .00 | .36 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .34 | .00 | .34 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .01 |
| ALL SPEEDS | 39 | 9 | 1 | 3 | 1 | 9 | 14 | 31 | 57 | 6 | 4 | 9 | 10 | 26 | 23 | 50 | 0 | 292 |
| (1) | 13.36 | 3.08 | .34 | 1.03 | .34 | 3.08 | 4.79 | 10.62 | 19.52 | 2.05 | 1.37 | 3.08 | 3.42 | 8.90 | 7.88 | 17.12 | .00 | 100.00 |
| (2) | .46 | .11 | .01 | .04 | .01 | .11 | .16 | .36 | .67 | .07 | .05 | .11 | .12 | .31 | .27 | .59 | .00 | 3.43 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 5D

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA STABILITY CLASS D CLASS FREQUENCY (PERCENT) = 49.92

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 48 | 33 | 30 | 31 | 35 | 32 | 67 | 52 | 30 | 25 | 12 | 11 | 17 | 13 | 27 | 43 | 0 | 506 |
| (1) | 1.13 | .78 | .71 | .73 | .82 | .75 | 1.58 | 1.22 | .71 | .59 | .28 | .26 | .40 | .31 | .64 | 1.01 | .00 | 11.92 |
| (2) | .56 | .39 | .35 | .36 | .41 | .38 | .79 | .61 | .35 | .29 | .14 | .13 | .20 | .15 | .32 | .51 | .00 | 5.95 |
| 4-7 | 110 | 35 | 19 | 19 | 39 | 69 | 175 | 121 | 92 | 31 | 20 | 12 | 10 | 22 | 40 | 186 | 0 | 1000 |
| (1) | 2.59 | .82 | .45 | .45 | .92 | 1.63 | 4.12 | 2.85 | 2.17 | .73 | .47 | .28 | .24 | .52 | .94 | 4.38 | .00 | 23.56 |
| (2) | 1.29 | .41 | .22 | .22 | .46 | .81 | 2.06 | 1.42 | 1.08 | .36 | .24 | .14 | .12 | .26 | .47 | 2.19 | .00 | 11.76 |
| 8-12 | 139 | 32 | 13 | 7 | 5 | 19 | 56 | 131 | 246 | 64 | 14 | 16 | 47 | 80 | 55 | 227 | 0 | 1151 |
| (1) | 3.27 | .75 | .31 | .16 | .12 | .45 | 1.32 | 3.09 | 5.80 | 1.51 | .33 | .38 | 1.11 | 1.88 | 1.30 | 5.35 | .00 | 27.11 |
| (2) | 1.63 | .38 | .15 | .08 | .06 | .22 | .66 | 1.54 | 2.89 | .75 | .16 | .19 | .55 | .94 | .65 | 2.67 | .00 | 13.53 |
| 13-18 | 213 | 45 | 6 | 4 | 3 | 4 | 13 | 16 | 138 | 40 | 14 | 17 | 56 | 154 | 99 | 219 | 0 | 1041 |
| (1) | 5.02 | 1.06 | .14 | .09 | .07 | .09 | .31 | .38 | 3.25 | .94 | .33 | .40 | 1.32 | 3.63 | 2.33 | 5.16 | .00 | 24.52 |
| (2) | 2.50 | .53 | .07 | .05 | .04 | .05 | .15 | .19 | 1.62 | .47 | .16 | .20 | .66 | 1.81 | 1.16 | 2.58 | .00 | 12.24 |
| 19-24 | 82 | 4 | 0 | 1 | 2 | 0 | 0 | 4 | 40 | 8 | 1 | 3 | 16 | 89 | 49 | 119 | 0 | 418 |
| (1) | 1.93 | .09 | .00 | .02 | .05 | .00 | .00 | .09 | .94 | .19 | .02 | .07 | .38 | 2.10 | 1.15 | 2.80 | .00 | 9.85 |
| (2) | .96 | .05 | .00 | .01 | .02 | .00 | .00 | .05 | .47 | .09 | .01 | .04 | .19 | 1.05 | .58 | 1.40 | .00 | 4.92 |
| GT 24 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 11 | 5 | 0 | 0 | 6 | 26 | 8 | 68 | 0 | 129 |
| (1) | .09 | .00 | .00 | .00 | .00 | .00 | .00 | .02 | .26 | .12 | .00 | .00 | .14 | .61 | .19 | 1.60 | .00 | 3.04 |
| (2) | .05 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .13 | .06 | .00 | .00 | .07 | .31 | .09 | .80 | .00 | 1.52 |
| ALL SPEEDS | 596 | 149 | 68 | 62 | 84 | 124 | 311 | 325 | 557 | 173 | 61 | 59 | 152 | 384 | 278 | 862 | 0 | 4245 |
| (1) | 14.04 | 3.51 | 1.60 | 1.46 | 1.98 | 2.92 | 7.33 | 7.66 | 13.12 | 4.08 | 1.44 | 1.39 | 3.58 | 9.05 | 6.55 | 20.31 | .00 | 100.00 |
| (2) | 7.01 | 1.75 | .80 | .73 | .99 | 1.46 | 3.66 | 3.82 | 6.55 | 2.03 | .72 | .69 | 1.79 | 4.52 | 3.27 | 10.14 | .00 | 49.92 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

# TABLE 5E

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA  STABILITY CLASS E  CLASS FREQUENCY (PERCENT) = 31.20

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .04 | .00 | .00 | .00 | .00 | .00 | .04 | .00 | .00 | .00 | .00 | .08 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .02 |
| C-3 | 82 | 55 | 49 | 35 | 48 | 54 | 72 | 52 | 22 | 13 | 9 | 8 | 21 | 14 | 19 | 62 | 0 | 615 |
| (1) | 3.09 | 2.07 | 1.85 | 1.32 | 1.81 | 2.04 | 2.71 | 1.96 | .83 | .49 | .34 | .30 | .79 | .53 | .72 | 2.34 | .00 | 23.18 |
| (2) | .96 | .65 | .58 | .41 | .56 | .63 | .85 | .61 | .26 | .15 | .11 | .09 | .25 | .16 | .22 | .73 | .00 | 7.23 |
| 4-7 | 134 | 20 | 5 | 8 | 12 | 36 | 127 | 147 | 83 | 32 | 12 | 11 | 19 | 27 | 52 | 236 | 0 | 961 |
| (1) | 5.05 | .75 | .19 | .30 | .45 | 1.36 | 4.79 | 5.54 | 3.13 | 1.21 | .45 | .41 | .72 | 1.02 | 1.96 | 8.90 | .00 | 36.22 |
| (2) | 1.58 | .24 | .06 | .09 | .14 | .42 | 1.49 | 1.73 | .98 | .38 | .14 | .13 | .22 | .32 | .61 | 2.78 | .00 | 11.30 |
| 8-12 | 76 | 10 | 0 | 1 | 1 | 8 | 36 | 111 | 85 | 31 | 18 | 17 | 40 | 54 | 43 | 166 | 0 | 697 |
| (1) | 2.86 | .38 | .00 | .04 | .04 | .30 | 1.36 | 4.18 | 3.20 | 1.17 | .68 | .64 | 1.51 | 2.04 | 1.62 | 6.26 | .00 | 26.27 |
| (2) | .89 | .12 | .00 | .01 | .01 | .09 | .42 | 1.31 | 1.00 | .36 | .21 | .20 | .47 | .63 | .51 | 1.95 | .00 | 8.20 |
| 13-18 | 42 | 2 | 0 | 0 | 0 | 0 | 15 | 17 | 42 | 24 | 4 | 2 | 19 | 54 | 23 | 68 | 0 | 312 |
| (1) | 1.58 | .08 | .00 | .00 | .00 | .00 | .57 | .64 | 1.58 | .90 | .15 | .08 | .72 | 2.04 | .87 | 2.56 | .00 | 11.76 |
| (2) | .49 | .02 | .00 | .00 | .00 | .00 | .18 | .20 | .49 | .28 | .05 | .02 | .22 | .63 | .27 | .80 | .00 | 3.67 |
| 19-24 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 8 | 4 | 1 | 0 | 1 | 9 | 1 | 20 | 0 | 56 |
| (1) | .34 | .00 | .00 | .00 | .00 | .00 | .00 | .11 | .30 | .15 | .04 | .00 | .04 | .34 | .04 | .75 | .00 | 2.11 |
| (2) | .11 | .00 | .00 | .00 | .00 | .00 | .00 | .04 | .09 | .05 | .01 | .00 | .01 | .11 | .01 | .24 | .00 | .66 |
| GT 24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 7 | 0 | 10 |
| (1) | .04 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .04 | .04 | .26 | .00 | .38 |
| (2) | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .01 | .08 | .00 | .12 |
| ALL SPEEDS | 344 | 87 | 54 | 44 | 61 | 98 | 251 | 330 | 240 | 104 | 44 | 38 | 101 | 159 | 139 | 559 | 0 | 2653 |
| (1) | 12.97 | 3.28 | 2.04 | 1.66 | 2.30 | 3.69 | 9.46 | 12.44 | 9.05 | 3.92 | 1.66 | 1.43 | 3.81 | 5.99 | 5.24 | 21.07 | .00 | 100.00 |
| (2) | 4.05 | 1.02 | .63 | .52 | .72 | 1.15 | 2.95 | 3.88 | 2.82 | 1.22 | .52 | .45 | 1.19 | 1.87 | 1.63 | 6.57 | .00 | 31.20 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 5F

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA STABILITY CLASS F CLASS FREQUENCY (PERCENT) = 11.27

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 34 | 45 | 28 | 17 | 20 | 20 | 34 | 21 | 22 | 12 | 4 | 9 | 8 | 6 | 9 | 31 | 0 | 320 |
| (1) | 3.55 | 4.70 | 2.92 | 1.77 | 2.09 | 2.09 | 3.55 | 2.19 | 2.30 | 1.25 | .42 | .94 | .84 | .63 | .94 | 3.24 | .00 | 33.40 |
| (2) | .40 | .53 | .33 | .20 | .24 | .24 | .40 | .25 | .26 | .14 | .05 | .11 | .09 | .07 | .11 | .36 | .00 | 3.76 |
| 4-7 | 44 | 25 | 2 | 5 | 14 | 20 | 61 | 62 | 30 | 9 | 8 | 15 | 6 | 12 | 19 | 73 | 0 | 405 |
| (1) | 4.59 | 2.61 | .21 | .52 | 1.46 | 2.09 | 6.37 | 6.47 | 3.13 | .94 | .84 | 1.57 | .63 | 1.25 | 1.98 | 7.62 | .00 | 42.28 |
| (2) | .52 | .29 | .02 | .06 | .16 | .24 | .72 | .73 | .35 | .11 | .09 | .18 | .07 | .14 | .22 | .86 | .00 | 4.76 |
| 8-12 | 20 | 1 | 0 | 1 | 1 | 2 | 11 | 22 | 10 | 11 | 6 | 3 | 5 | 22 | 12 | 78 | 0 | 205 |
| (1) | 2.09 | .10 | .00 | .10 | .10 | .21 | 1.15 | 2.30 | 1.04 | 1.15 | .63 | .31 | .52 | 2.30 | 1.25 | 8.14 | .00 | 21.40 |
| (2) | .24 | .01 | .00 | .01 | .01 | .02 | .13 | .26 | .12 | .13 | .07 | .04 | .06 | .26 | .14 | .92 | .00 | 2.41 |
| 13-18 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 1 | 0 | 1 | 3 | 2 | 0 | 10 | 0 | 26 |
| (1) | .42 | .00 | .00 | .00 | .00 | .00 | .10 | .10 | .31 | .10 | .00 | .10 | .31 | .21 | .00 | 1.04 | .00 | 2.71 |
| (2) | .05 | .00 | .00 | .00 | .00 | .00 | .01 | .01 | .04 | .01 | .00 | .01 | .04 | .02 | .00 | .12 | .00 | .31 |
| 19-24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| (1) | .10 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .10 | .00 | .21 |
| (2) | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .02 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 103 | 71 | 30 | 23 | 35 | 42 | 107 | 106 | 65 | 33 | 18 | 28 | 22 | 42 | 40 | 193 | 0 | 958 |
| (1) | 10.75 | 7.41 | 3.13 | 2.40 | 3.65 | 4.38 | 11.17 | 11.06 | 6.78 | 3.44 | 1.88 | 2.92 | 2.30 | 4.38 | 4.18 | 20.15 | .00 | 100.00 |
| (2) | 1.21 | .83 | .35 | .27 | .41 | .49 | 1.26 | 1.25 | .76 | .39 | .21 | .33 | .26 | .49 | .47 | 2.27 | .00 | 11.27 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

# TABLE 5G

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA  STABILITY CLASS G  CLASS FREQUENCY (PERCENT) = 2.25

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .52 | .00 | .00 | .00 | .00 | .00 | .00 | .52 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .01 |
| C-3 | 2 | 2 | 2 | 4 | 5 | 0 | 5 | 3 | 7 | 6 | 3 | 2 | 2 | 1 | 1 | 3 | 0 | 48 |
| (1) | 1.05 | 1.05 | 1.05 | 2.09 | 2.62 | .00 | 2.62 | 1.57 | 3.66 | 3.14 | 1.57 | 1.05 | 1.05 | .52 | .52 | 1.57 | .00 | 25.13 |
| (2) | .02 | .02 | .02 | .05 | .06 | .00 | .06 | .04 | .08 | .07 | .04 | .02 | .02 | .01 | .01 | .04 | .00 | .56 |
| 4-7 | 6 | 1 | 2 | 1 | 4 | 1 | 8 | 12 | 4 | 5 | 8 | 6 | 2 | 3 | 2 | 11 | 0 | 76 |
| (1) | 3.14 | .52 | 1.05 | .52 | 2.09 | .52 | 4.19 | 6.28 | 2.09 | 2.62 | 4.19 | 3.14 | 1.05 | 1.57 | 1.05 | 5.76 | .00 | 39.79 |
| (2) | .07 | .01 | .02 | .01 | .05 | .01 | .09 | .14 | .05 | .06 | .09 | .07 | .02 | .04 | .02 | .13 | .00 | .89 |
| 8-12 | 12 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | 2 | 1 | 2 | 0 | 1 | 6 | 1 | 17 | 0 | 50 |
| (1) | 6.28 | .00 | .00 | .00 | .00 | .52 | .00 | 3.66 | 1.05 | .52 | 1.05 | .00 | .52 | 3.14 | .52 | 8.90 | .00 | 26.18 |
| (2) | .14 | .00 | .00 | .00 | .00 | .01 | .00 | .08 | .02 | .01 | .02 | .00 | .01 | .07 | .01 | .20 | .00 | .59 |
| 13-18 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 10 | 0 | 15 |
| (1) | 1.05 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 1.57 | .00 | 5.24 | .00 | 7.85 |
| (2) | .02 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .04 | .00 | .12 | .00 | .18 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .52 | .00 | .52 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .01 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 22 | 3 | 4 | 5 | 9 | 2 | 13 | 22 | 13 | 12 | 14 | 8 | 5 | 13 | 4 | 42 | 0 | 191 |
| (1) | 11.52 | 1.57 | 2.09 | 2.62 | 4.71 | 1.05 | 6.81 | 11.52 | 6.81 | 6.28 | 7.33 | 4.19 | 2.62 | 6.81 | 2.09 | 21.99 | .00 | 100.00 |
| (2) | .26 | .04 | .05 | .06 | .11 | .02 | .15 | .26 | .15 | .14 | .16 | .09 | .06 | .15 | .05 | .49 | .00 | 2.25 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 5H

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

297.0 FT WIND DATA STABILITY CLASS ALL CLASS FREQUENCY (PERCENT) = 100.00

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .01 | .00 | .01 | .00 | .00 | .00 | .00 | .04 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .01 | .00 | .01 | .00 | .00 | .00 | .00 | .04 |
| C-3 | 171 | 135 | 110 | 88 | 110 | 107 | 180 | 130 | 82 | 56 | 28 | 30 | 49 | 35 | 56 | 139 | 0 | 1506 |
| (1) | 2.01 | 1.59 | 1.29 | 1.03 | 1.29 | 1.26 | 2.12 | 1.53 | .96 | .66 | .33 | .35 | .58 | .41 | .66 | 1.63 | .00 | 17.71 |
| (2) | 2.01 | 1.59 | 1.29 | 1.03 | 1.29 | 1.26 | 2.12 | 1.53 | .96 | .66 | .33 | .35 | .58 | .41 | .66 | 1.63 | .00 | 17.71 |
| 4-7 | 306 | 83 | 28 | 36 | 70 | 131 | 378 | 350 | 216 | 78 | 49 | 45 | 37 | 64 | 116 | 533 | 0 | 2320 |
| (1) | 3.60 | .98 | .33 | .42 | .82 | 1.54 | 4.44 | 4.12 | 2.54 | .92 | .58 | .53 | .44 | .75 | 1.36 | 6.27 | .00 | 29.63 |
| (2) | 3.60 | .98 | .33 | .42 | .82 | 1.54 | 4.44 | 4.12 | 2.54 | .92 | .58 | .53 | .44 | .75 | 1.36 | 6.27 | .00 | 29.63 |
| 8-12 | 262 | 48 | 13 | 9 | 7 | 34 | 115 | 305 | 363 | 112 | 44 | 40 | 96 | 166 | 117 | 520 | 0 | 2251 |
| (1) | 3.08 | .56 | .15 | .11 | .08 | .40 | 1.35 | 3.59 | 4.27 | 1.32 | .52 | .47 | 1.13 | 1.95 | 1.38 | 6.11 | .00 | 26.47 |
| (2) | 3.08 | .56 | .15 | .11 | .08 | .40 | 1.35 | 3.59 | 4.27 | 1.32 | .52 | .47 | 1.13 | 1.95 | 1.38 | 6.11 | .00 | 26.47 |
| 13-18 | 285 | 53 | 6 | 4 | 3 | 5 | 30 | 42 | 223 | 68 | 18 | 23 | 91 | 232 | 136 | 340 | 0 | 1559 |
| (1) | 3.35 | .62 | .07 | .05 | .04 | .06 | .35 | .49 | 2.62 | .80 | .21 | .27 | 1.07 | 2.73 | 1.60 | 4.00 | .00 | 18.33 |
| (2) | 3.35 | .62 | .07 | .05 | .04 | .06 | .35 | .49 | 2.62 | .80 | .21 | .27 | 1.07 | 2.73 | 1.60 | 4.00 | .00 | 18.33 |
| 19-24 | 95 | 4 | 0 | 1 | 2 | 0 | 0 | 7 | 54 | 14 | 2 | 4 | 21 | 111 | 58 | 152 | 0 | 525 |
| (1) | 1.12 | .05 | .00 | .01 | .02 | .00 | .00 | .08 | .63 | .16 | .02 | .05 | .25 | 1.31 | .68 | 1.79 | .00 | 6.17 |
| (2) | 1.12 | .05 | .00 | .01 | .02 | .00 | .00 | .08 | .63 | .16 | .02 | .05 | .25 | 1.31 | .68 | 1.79 | .00 | 6.17 |
| GT 24 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 11 | 5 | 0 | 0 | 6 | 27 | 9 | 76 | 0 | 140 |
| (1) | .06 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .13 | .06 | .00 | .00 | .07 | .32 | .11 | .89 | .00 | 1.65 |
| (2) | .06 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .13 | .06 | .00 | .00 | .07 | .32 | .11 | .89 | .00 | 1.65 |
| ALL SPEEDS | 1124 | 323 | 157 | 138 | 192 | 277 | 704 | 835 | 949 | 333 | 142 | 142 | 301 | 635 | 492 | 1760 | 0 | 8504 |
| (1) | 13.22 | 3.80 | 1.85 | 1.62 | 2.26 | 3.26 | 8.28 | 9.82 | 11.16 | 3.92 | 1.67 | 1.67 | 3.54 | 7.47 | 5.79 | 20.70 | .00 | 100.00 |
| (2) | 13.22 | 3.80 | 1.85 | 1.62 | 2.26 | 3.26 | 8.28 | 9.82 | 11.16 | 3.92 | 1.67 | 1.67 | 3.54 | 7.47 | 5.79 | 20.70 | .00 | 100.00 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

# TABLE 6A

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA STABILITY CLASS A CLASS FREQUENCY (PERCENT) = 1.26

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| (1) | .00 | .99 | .99 | .99 | 1.98 | .00 | .00 | 1.98 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .99 | .00 | 7.92 |
| (2) | .00 | .01 | .01 | .01 | .02 | .00 | .00 | .02 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .10 |
| 4-7 | 8 | 3 | 1 | 0 | 0 | 0 | 5 | 3 | 2 | 0 | 0 | 0 | 2 | 0 | 1 | 14 | 0 | 39 |
| (1) | 7.92 | 2.97 | .99 | .00 | .00 | .00 | 4.95 | 2.97 | 1.98 | .00 | .00 | .00 | 1.98 | .00 | .99 | 13.86 | .00 | 38.61 |
| (2) | .10 | .04 | .01 | .00 | .00 | .00 | .06 | .04 | .02 | .00 | .00 | .00 | .02 | .00 | .01 | .17 | .00 | .49 |
| 8-12 | 6 | 1 | 0 | 0 | 0 | 1 | 0 | 7 | 4 | 1 | 1 | 0 | 4 | 7 | 4 | 18 | 0 | 54 |
| (1) | 5.94 | .99 | .00 | .00 | .00 | .99 | .00 | 6.93 | 3.96 | .99 | .99 | .00 | 3.96 | 6.93 | 3.96 | 17.82 | .00 | 53.47 |
| (2) | .07 | .01 | .00 | .00 | .00 | .01 | .00 | .09 | .05 | .01 | .01 | .00 | .05 | .09 | .05 | .22 | .00 | .67 |
| 13-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 14 | 5 | 2 | 1 | 2 | 1 | 5 | 12 | 6 | 1 | 1 | 0 | 6 | 7 | 5 | 33 | 0 | 101 |
| (1) | 13.86 | 4.95 | 1.98 | .99 | 1.98 | .99 | 4.95 | 11.88 | 5.94 | .99 | .99 | .00 | 5.94 | 6.93 | 4.95 | 32.67 | .00 | 100.00 |
| (2) | .17 | .06 | .02 | .01 | .02 | .01 | .06 | .15 | .07 | .01 | .01 | .00 | .07 | .09 | .06 | .41 | .00 | 1.26 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 6B

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA  STABILITY CLASS B  CLASS FREQUENCY (PERCENT) = 1.68

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| (1) | .00 | .00 | .00 | .00 | 2.22 | .00 | .00 | .74 | .00 | .74 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 3.70 |
| (2) | .00 | .00 | .00 | .00 | .04 | .00 | .00 | .01 | .00 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .06 |
| 4-7 | 12 | 3 | 0 | 1 | 3 | 1 | 6 | 6 | 2 | 1 | 1 | 1 | 0 | 0 | 4 | 16 | 0 | 57 |
| (1) | 8.89 | 2.22 | .00 | .74 | 2.22 | .74 | 4.44 | 4.44 | 1.48 | .74 | .74 | .74 | .00 | .00 | 2.96 | 11.85 | .00 | 42.22 |
| (2) | .15 | .04 | .00 | .01 | .04 | .01 | .07 | .07 | .02 | .01 | .01 | .01 | .00 | .00 | .05 | .20 | .00 | .71 |
| 8-12 | 13 | 8 | 0 | 0 | 0 | 0 | 1 | 6 | 8 | 1 | 0 | 1 | 5 | 4 | 5 | 6 | 0 | 58 |
| (1) | 9.63 | 5.93 | .00 | .00 | .00 | .00 | .74 | 4.44 | 5.93 | .74 | .00 | .74 | 3.70 | 2.96 | 3.70 | 4.44 | .00 | 42.96 |
| (2) | .14 | .10 | .00 | .00 | .00 | .00 | .01 | .07 | .10 | .01 | .00 | .01 | .06 | .05 | .06 | .07 | .00 | .72 |
| 13-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 2 | 0 | 3 | 2 | 2 | 0 | 15 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 3.70 | .00 | .74 | 1.48 | .00 | 2.22 | 1.48 | 1.48 | .00 | 11.11 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .06 | .00 | .01 | .02 | .00 | .04 | .02 | .02 | .00 | .19 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 25 | 11 | 0 | 1 | 6 | 1 | 7 | 13 | 15 | 3 | 2 | 4 | 5 | 7 | 11 | 24 | 0 | 135 |
| (1) | 18.52 | 8.15 | .00 | .74 | 4.44 | .74 | 5.19 | 9.63 | 11.11 | 2.22 | 1.48 | 2.96 | 3.70 | 5.19 | 8.15 | 17.78 | .00 | 100.00 |
| (2) | .31 | .14 | .00 | .01 | .07 | .01 | .09 | .16 | .19 | .04 | .02 | .05 | .06 | .09 | .14 | .30 | .00 | 1.68 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 6C

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA STABILITY CLASS C CLASS FREQUENCY (PERCENT) = 3.81

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | 00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| C-3 | 2 | 0 | 1 | 5 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 15 |
| (1) | .65 | .00 | .33 | 1.63 | .00 | .33 | .00 | .65 | .33 | .00 | .00 | .00 | .00 | .00 | .00 | .98 | .00 | 4.90 |
| (2) | .02 | .00 | .01 | .06 | .00 | .01 | .00 | .02 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .04 | .00 | .19 |
| 4-7 | 15 | 5 | 2 | 4 | 12 | 11 | 18 | 10 | 15 | 3 | 1 | 3 | 4 | 4 | 6 | 20 | 0 | 133 |
| (1) | 4.90 | 1.63 | .65 | 1.31 | 3.92 | 3.59 | 5.88 | 3.27 | 4.90 | .98 | .33 | .98 | 1.31 | 1.31 | 1.96 | 6.54 | .00 | 43.46 |
| (2) | .19 | .06 | .02 | .05 | .15 | .14 | .22 | .12 | .19 | .04 | .01 | .04 | .05 | .05 | .07 | .25 | .00 | 1.66 |
| 8-12 | 21 | 8 | 0 | 0 | 4 | 1 | 2 | 11 | 27 | 2 | 5 | 3 | 12 | 13 | 8 | 16 | 0 | 133 |
| (1) | 6.86 | 2.61 | .00 | .00 | 1.31 | .33 | .65 | 3.59 | 8.82 | .65 | 1.63 | .98 | 3.92 | 4.25 | 2.61 | 5.23 | .00 | 43.46 |
| (2) | .26 | .10 | .00 | .00 | .05 | .01 | .02 | .11 | .34 | .02 | .06 | .04 | .15 | .16 | .10 | .20 | .00 | 1.66 |
| 13-18 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 1 | 5 | 7 | 3 | 0 | 25 |
| (1) | .65 | .33 | .00 | .00 | .00 | .00 | .00 | .00 | 1.63 | .00 | .33 | .00 | .33 | 1.63 | 2.29 | .98 | .00 | 8.17 |
| (2) | .02 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .06 | .00 | .01 | .00 | .01 | .06 | .09 | .04 | .00 | .31 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | 00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 40 | 14 | 3 | 9 | 16 | 13 | 20 | 23 | 48 | 5 | 7 | 6 | 17 | 22 | 21 | 42 | 0 | 306 |
| (1) | 13.07 | 4.58 | .98 | 2.94 | 5.23 | 4.25 | 6.54 | 7.52 | 15.69 | 1.63 | 2.29 | 1.96 | 5.56 | 7.19 | 6.86 | 13.73 | .00 | 100.00 |
| (2) | .50 | .17 | .04 | .11 | .20 | .16 | .25 | .29 | .60 | .06 | .09 | .07 | .21 | .27 | .26 | .52 | .00 | 3.81 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 6D

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA STABILITY CLASS D CLASS FREQUENCY (PERCENT) = 43.21

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 8 |
| (1) | .03 | .00 | .00 | .00 | .03 | .00 | .00 | .00 | .06 | .00 | .03 | .00 | .03 | .00 | .03 | .03 | .00 | .23 |
| (2) | .01 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .02 | .00 | .01 | .00 | .01 | .00 | .01 | .01 | .00 | .10 |
| C-3 | 84 | 57 | 59 | 47 | 58 | 36 | 40 | 66 | 63 | 41 | 25 | 25 | 27 | 43 | 59 | 81 | 0 | 811 |
| (1) | 2.42 | 1.64 | 1.70 | 1.36 | 1.67 | 1.04 | 1.15 | 1.90 | 1.82 | 1.18 | .72 | .72 | .78 | 1.24 | 1.70 | 2.34 | .00 | 23.39 |
| (2) | 1.05 | .71 | .74 | .59 | .72 | .45 | .50 | .82 | .79 | .51 | .31 | .31 | .34 | .54 | .74 | 1.01 | .00 | 10.11 |
| 4-7 | 198 | 69 | 25 | 31 | 61 | 71 | 77 | 139 | 153 | 42 | 18 | 17 | 46 | 52 | 114 | 290 | 0 | 1403 |
| (1) | 5.71 | 1.99 | .72 | .89 | 1.76 | 2.05 | 2.22 | 4.01 | 4.41 | 1.21 | .52 | .49 | 1.33 | 1.50 | 3.29 | 8.36 | .00 | 40.46 |
| (2) | 2.47 | .86 | .31 | .39 | .76 | .88 | .96 | 1.73 | 1.91 | .52 | .22 | .21 | .57 | .65 | 1.42 | 3.61 | .00 | 17.48 |
| 8-12 | 207 | 65 | 15 | 3 | 4 | 9 | 5 | 20 | 136 | 24 | 19 | 16 | 52 | 122 | 87 | 168 | 0 | 952 |
| (1) | 5.97 | 1.87 | .43 | .09 | .12 | .26 | .14 | .58 | 3.92 | .69 | .55 | .46 | 1.50 | 3.52 | 2.51 | 4.84 | .00 | 27.45 |
| (2) | 2.58 | .81 | .19 | .04 | .05 | .11 | .06 | .25 | 1.69 | .30 | .24 | .20 | .65 | 1.52 | 1.08 | 2.09 | .00 | 11.86 |
| 13-18 | 39 | 9 | 0 | 1 | 2 | 0 | 0 | 1 | 32 | 7 | 2 | 1 | 9 | 80 | 50 | 32 | 0 | 265 |
| (1) | 1.12 | .26 | .00 | .03 | .06 | .00 | .00 | .03 | .92 | .20 | .06 | .03 | .26 | 2.31 | 1.44 | .92 | .00 | 7.64 |
| (2) | .49 | .11 | .00 | .01 | .02 | .00 | .00 | .01 | .40 | .09 | .02 | .01 | .11 | 1.00 | .62 | .40 | .00 | 3.30 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 4 | 9 | 5 | 2 | 0 | 29 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .26 | .00 | .00 | .00 | .12 | .26 | .14 | .06 | .00 | .84 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .11 | .00 | .00 | .00 | .05 | .11 | .06 | .02 | .00 | .36 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 529 | 200 | 99 | 82 | 126 | 116 | 122 | 226 | 395 | 114 | 65 | 59 | 139 | 306 | 316 | 574 | 0 | 3468 |
| (1) | 15.25 | 5.77 | 2.85 | 2.36 | 3.63 | 3.34 | 3.52 | 6.52 | 11.39 | 3.29 | 1.87 | 1.70 | 4.01 | 8.82 | 9.11 | 16.55 | .00 | 100.00 |
| (2) | 6.59 | 2.49 | 1.23 | 1.02 | 1.57 | 1.45 | 1.52 | 2.82 | 4.92 | 1.42 | .81 | .74 | 1.73 | 3.81 | 3.94 | 7.15 | .00 | 43.21 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 6E

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA STABILITY CLASS E CLASS FREQUENCY (PERCENT) = 32.45

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 4 | 3 | 4 | 8 | 2 | 2 | 3 | 0 | 34 |
| (1) | .08 | .04 | .08 | .04 | .00 | .00 | .00 | .04 | .04 | .15 | .12 | .15 | .31 | .08 | .08 | .12 | .00 | 1.31 |
| (2) | .02 | .01 | .02 | .01 | .00 | .00 | .00 | .01 | .01 | .05 | .04 | .05 | .10 | .02 | .02 | .04 | .00 | .42 |
| C-3 | 85 | 45 | 26 | 25 | 29 | 34 | 57 | 67 | 76 | 115 | 164 | 121 | 130 | 120 | 147 | 142 | 0 | 1383 |
| (1) | 3.26 | 1.73 | 1.00 | .96 | 1.11 | 1.31 | 2.19 | 2.57 | 2.92 | 4.42 | 6.30 | 4.65 | 4.99 | 4.61 | 5.65 | 5.45 | .00 | 53.11 |
| (2) | 1.06 | .56 | .32 | .31 | .36 | .42 | .71 | .83 | .95 | 1.43 | 2.04 | 1.51 | 1.62 | 1.50 | 1.83 | 1.77 | .00 | 17.23 |
| 4-7 | 56 | 12 | 4 | 1 | 15 | 32 | 53 | 118 | 93 | 36 | 17 | 26 | 62 | 64 | 99 | 193 | 0 | 881 |
| (1) | 2.15 | .46 | .15 | .04 | .58 | 1.23 | 2.04 | 4.53 | 3.57 | 1.38 | .65 | 1.00 | 2.38 | 2.46 | 3.80 | 7.41 | .00 | 33.83 |
| (2) | .70 | .15 | .05 | .01 | .19 | .40 | .66 | 1.47 | 1.16 | .45 | .21 | .32 | .77 | .80 | 1.23 | 2.40 | .00 | 10.98 |
| 8-12 | 21 | 2 | 0 | 0 | 1 | 0 | 5 | 20 | 47 | 11 | 4 | 5 | 17 | 43 | 39 | 48 | 0 | 263 |
| (1) | .81 | .08 | .00 | .00 | .04 | .00 | .19 | .77 | 1.80 | .42 | .15 | .19 | .65 | 1.65 | 1.50 | 1.84 | .00 | 10.10 |
| (2) | .26 | .02 | .00 | .00 | .01 | .00 | .06 | .25 | .59 | .14 | .05 | .06 | .21 | .54 | .49 | .60 | .00 | 3.28 |
| 13-18 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 5 | 12 | 5 | 4 | 0 | 41 |
| (1) | .04 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .54 | .00 | .00 | .00 | .19 | .46 | .19 | .15 | .00 | 1.57 |
| (2) | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .17 | .00 | .00 | .00 | .06 | .15 | .06 | .05 | .00 | .51 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .04 | .04 | .00 | .00 | .08 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .01 | .00 | .00 | .02 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 165 | 60 | 32 | 27 | 45 | 66 | 115 | 206 | 231 | 166 | 188 | 156 | 222 | 242 | 293 | 390 | 0 | 2604 |
| (1) | 6.34 | 2.30 | 1.23 | 1.04 | 1.73 | 2.53 | 4.42 | 7.91 | 8.87 | 6.37 | 7.22 | 5.99 | 8.53 | 9.29 | 11.25 | 14.98 | .00 | 100.00 |
| (2) | 2.06 | .75 | .40 | .34 | .56 | .82 | 1.43 | 2.57 | 2.88 | 2.07 | 2.34 | 1.94 | 2.77 | 3.02 | 3.65 | 4.86 | .00 | 32.45 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

# TABLE 6F

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA STABILITY CLASS F CLASS FREQUENCY (PERCENT) = 13.52

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 9 |
| (1) | .00 | .00 | .00 | .00 | .09 | .00 | .00 | .00 | .28 | .00 | .09 | .18 | .09 | .00 | .09 | .00 | .00 | .83 |
| (2) | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .04 | .00 | .01 | .02 | .01 | .00 | .01 | .00 | .00 | .11 |
| C-3 | 30 | 14 | 12 | 14 | 11 | 22 | 17 | 41 | 51 | 107 | 174 | 143 | 88 | 68 | 75 | 45 | 0 | 912 |
| (1) | 2.76 | 1.29 | 1.11 | 1.29 | 1.01 | 2.03 | 1.57 | 3.78 | 4.70 | 9.86 | 16.04 | 13.18 | 8.11 | 6.27 | 6.91 | 4.15 | .00 | 84.06 |
| (2) | .37 | .17 | .15 | .17 | .14 | .27 | .21 | .51 | .64 | 1.33 | 2.17 | 1.78 | 1.10 | .85 | .93 | .56 | .00 | 11.36 |
| 4-7 | 12 | 1 | 1 | 0 | 0 | 0 | 2 | 9 | 8 | 18 | 23 | 11 | 11 | 13 | 23 | 31 | 0 | 163 |
| (1) | 1.11 | .09 | .09 | .00 | .00 | .00 | .18 | .83 | .74 | 1.66 | 2.12 | 1.01 | 1.01 | 1.20 | 2.12 | 2.86 | .00 | 15.02 |
| (2) | .15 | .01 | .01 | .00 | .00 | .00 | .02 | .11 | .10 | .22 | .29 | .14 | .14 | .16 | .29 | .39 | .00 | 2.03 |
| 8-12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .09 | .00 | .09 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .01 |
| 13-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 42 | 15 | 13 | 14 | 12 | 22 | 19 | 50 | 62 | 125 | 198 | 156 | 100 | 81 | 99 | 77 | 0 | 1085 |
| (1) | 3.87 | 1.38 | 1.20 | 1.29 | 1.11 | 2.03 | 1.75 | 4.61 | 5.71 | 11.52 | 18.25 | 14.38 | 9.22 | 7.47 | 9.12 | 7.10 | .00 | 100.00 |
| (2) | .52 | .19 | .16 | .17 | .15 | .27 | .24 | .62 | .77 | 1.56 | 2.47 | 1.94 | 1.25 | 1.01 | 1.23 | .96 | .00 | 13.52 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

## TABLE 6G

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA STABILITY CLASS G CLASS FREQUENCY (PERCENT) = 4.06

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| (1) | .00 | .00 | .00 | .00 | .31 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .31 | .00 | .00 | .00 | .61 |
| (2) | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .00 | .02 |
| C-3 | 9 | 6 | 4 | 2 | 5 | 3 | 2 | 10 | 14 | 26 | 52 | 21 | 26 | 23 | 24 | 24 | 0 | 251 |
| (1) | 2.76 | 1.84 | 1.23 | .61 | 1.53 | .92 | .61 | 3.07 | 4.29 | 7.98 | 15.95 | 6.44 | 7.98 | 7.06 | 7.36 | 7.36 | .00 | 76.99 |
| (2) | .11 | .07 | .05 | .02 | .06 | .04 | .02 | .12 | .17 | .32 | .65 | .26 | .32 | .29 | .30 | .30 | .00 | 3.13 |
| 4-7 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 14 | 6 | 5 | 2 | 8 | 29 | 0 | 73 |
| (1) | 1.23 | .00 | .00 | .00 | .00 | .00 | .00 | .31 | .61 | .61 | 4.29 | 1.84 | 1.53 | .61 | 2.45 | 8.90 | .00 | 22.39 |
| (2) | .05 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .02 | .02 | .17 | .07 | .06 | .02 | .10 | .36 | .00 | .91 |
| 8-12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| 13-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 13 | 6 | 4 | 2 | 6 | 3 | 2 | 11 | 16 | 28 | 66 | 27 | 31 | 26 | 32 | 53 | 0 | 326 |
| (1) | 3.99 | 1.84 | 1.23 | .61 | 1.84 | .92 | .61 | 3.37 | 4.91 | 8.59 | 20.25 | 8.28 | 9.51 | 7.98 | 9.82 | 16.26 | .00 | 100.00 |
| (2) | .16 | .07 | .05 | .02 | .07 | .04 | .02 | .14 | .20 | .35 | .82 | .34 | .39 | .32 | .40 | .66 | .00 | 4.06 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

# TABLE 6H

VERMONT YANKEE JAN 93 - DEC 93 METEOROLOGICAL DATA JOINT FREQUENCY DISTRIBUTION

35.0 FT WIND DATA  STABILITY CLASS ALL  CLASS FREQUENCY (PERCENT) = 100.00

WIND DIRECTION FROM

| SPEED(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | VRBL | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | 3 | 1 | 2 | 1 | 3 | 0 | 0 | 1 | 6 | 4 | 5 | 6 | 10 | 3 | 4 | 4 | 0 | 53 |
| (1) | .04 | .01 | .02 | .01 | .04 | .00 | .00 | .01 | .07 | .05 | .06 | .07 | .12 | .04 | .05 | .05 | .00 | .66 |
| (2) | .04 | .01 | .02 | .01 | .04 | .00 | .00 | .01 | .07 | .05 | .06 | .07 | .12 | .04 | .05 | .05 | .00 | .66 |
| C-3 | 210 | 123 | 103 | 94 | 108 | 96 | 116 | 189 | 205 | 290 | 415 | 310 | 271 | 254 | 305 | 296 | 0 | 3385 |
| (1) | 2.62 | 1.53 | 1.28 | 1.17 | 1.35 | 1.20 | 1.45 | 2.36 | 2.55 | 3.61 | 5.17 | 3.86 | 3.38 | 3.17 | 3.80 | 3.69 | .00 | 42.18 |
| (2) | 2.62 | 1.53 | 1.28 | 1.17 | 1.35 | 1.20 | 1.45 | 2.36 | 2.55 | 3.61 | 5.17 | 3.86 | 3.38 | 3.17 | 3.80 | 3.69 | .00 | 42.18 |
| 4-7 | 305 | 93 | 33 | 37 | 91 | 115 | 161 | 286 | 275 | 102 | 74 | 64 | 130 | 135 | 255 | 593 | 0 | 2749 |
| (1) | 3.80 | 1.16 | .41 | .46 | 1.13 | 1.43 | 2.01 | 3.56 | 3.43 | 1.27 | .92 | .80 | 1.62 | 1.68 | 3.18 | 7.39 | .00 | 34.26 |
| (2) | 3.80 | 1.16 | .41 | .46 | 1.13 | 1.43 | 2.01 | 3.56 | 3.43 | 1.27 | .92 | .80 | 1.62 | 1.68 | 3.18 | 7.39 | .00 | 34.26 |
| 8-12 | 268 | 84 | 15 | 3 | 9 | 11 | 13 | 64 | 222 | 39 | 29 | 25 | 90 | 189 | 143 | 257 | 0 | 1461 |
| (1) | 3.34 | 1.05 | .19 | .04 | .11 | .14 | .16 | .80 | 2.77 | .49 | .36 | .31 | 1.12 | 2.36 | 1.78 | 3.20 | .00 | 18.21 |
| (2) | 3.34 | 1.05 | .19 | .04 | .11 | .14 | .16 | .80 | 2.77 | .49 | .36 | .31 | 1.12 | 2.36 | 1.78 | 3.20 | .00 | 18.21 |
| 13-18 | 42 | 10 | 0 | 1 | 2 | 0 | 0 | 1 | 56 | 7 | 4 | 3 | 15 | 100 | 64 | 41 | 0 | 346 |
| (1) | .52 | .12 | .00 | .01 | .02 | .00 | .00 | .01 | .70 | .09 | .05 | .04 | .19 | 1.25 | .80 | .51 | .00 | 4.31 |
| (2) | .52 | .12 | .00 | .01 | .02 | .00 | .00 | .01 | .70 | .09 | .05 | .04 | .19 | 1.25 | .80 | .51 | .00 | 4.31 |
| 19-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 4 | 10 | 6 | 2 | 0 | 31 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .11 | .00 | .00 | .00 | .05 | .12 | .07 | .02 | .00 | .39 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .11 | .00 | .00 | .00 | .05 | .12 | .07 | .02 | .00 | .39 |
| GT 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (1) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| (2) | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| ALL SPEEDS | 828 | 311 | 153 | 136 | 213 | 222 | 290 | 541 | 773 | 442 | 527 | 408 | 520 | 691 | 777 | 1193 | 0 | 8025 |
| (1) | 10.32 | 3.88 | 1.91 | 1.69 | 2.65 | 2.77 | 3.61 | 6.74 | 9.63 | 5.51 | 6.57 | 5.08 | 6.48 | 8.61 | 9.68 | 14.87 | .00 | 100.00 |
| (2) | 10.32 | 3.88 | 1.91 | 1.69 | 2.65 | 2.77 | 3.61 | 6.74 | 9.63 | 5.51 | 6.57 | 5.08 | 6.48 | 8.61 | 9.68 | 14.87 | .00 | 100.00 |

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD
C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

APPENDIX A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT
Supplemental Information
Third and Fourth Quarters, 1993

Facility: Vermont Yankee Nuclear Power Station

Licensee: Vermont Yankee Nuclear Power Corporation

1A. TECHNICAL SPECIFICATION LIMITS - DOSE AND DOSE RATE

| Technical Specification and Category | | Limit |
|---|---|---|
| a. Noble Gases | | |
| 3.8.E.1 | Total body dose rate | 500 mrem/yr |
| 3.8.E.1 | Skin dose rate | 3000 mrem/yr |
| 3.8.F.1 | Gamma air dose | 5 mrad in a quarter |
| 3.8.F.1 | Gamma air dose | 10 mrad in a year |
| 3.8.F.1 | Beta air dose | 10 mrad in a quarter |
| 3.8.F.1 | Beta air dose | 20 mrad in a year |
| b. Iodine-131, Iodine-133, Tritium and Radionuclides in Particulate Form With Half-Lives Greater Than 8 Days | | |
| 3.8.E.1 | Organ dose rate | 1500 mrem/yr |
| 3.8.G.1 | Organ dose | 7.5 mrem in a quarter |
| 3.8.G.1 | Organ dose | 15 mrem in a year |
| c. Liquids | | |
| 3.8.B.1 | Total body dose | 1.5 mrem in a quarter |
| 3.8.B.1 | Total body dose | 3 mrem in a year |
| 3.8.B.1 | Organ dose | 5 mrem in a quarter |
| 3.8.B.1 | Organ dose | 10 mrem in a year |

APPENDIX A
(Continued)

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

2A. TECHNICAL SPECIFICATION LIMITS - CONCENTRATION

| Technical Specification and Category | Limit |
|---|---|
| a. Noble Gases | No MPC limits |
| b. Iodine-131, Iodine-133, Tritium and Radionuclides in Particulate Form With Half-Lives | |
| Greater Than 8 Days | No MPC limits |
| c. Liquids | |
| 3.8.A.1 Total fraction of MPC excluding noble gases (10CFR20, Appendix B, Table II, Column 2): | $\leq$1.0 |
| 3.8.A.1 Total noble gas concentration: | $\leq$2E-04 uCi/cc |

3. AVERAGE ENERGY

Provided below are the average energy ($\bar{E}$) of the radionuclide mixture in releases of fission and activation gases, if applicable.

| | | |
|---|---|---|
| a. Average gamma energy: | 3rd Quarter | 8.10E-01 MeV/dis |
| | 4th Quarter | 8.30E-01 MeV/dis |
| b. Average beta energy: | Not Applicable | |

4. MEASUREMENTS AND APPROXIMATIONS OF TOTAL RADIOACTIVITY

Provided below are the methods used to measure or approximate the total radioactivity in effluents and the methods used to determine radionuclide composition.

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

a. Fission and Activation Gases

Continuous stack monitors monitor gross Noble Gas radioactivity released from the plant stack. Total Noble Gas release rates are calculated using this monitor. To determine the isotopic breakdown of the release, samples are taken of the Steam Jet Air Ejector, which is the source gas for the releases. These samples are analyzed by gamma spectroscopy to determine the isotopic composition. The isotopic composition is then proportioned to the gross releases determined from the stack monitor to quantify the individual isotopic releases. These are indicated in Table 1B and the totals of Table 1A.

Beginning in the fourth quarter of 1991, grab samples were obtained from the Turbine Building roof vents. Fission and activation gases, and their daughters, were not detected in grab samples during the reporting period. In July and August, the activity of Xe-138 released from the Turbine Building roof vents was assumed to be the same as the LLD value of Xe-138. The remainder of the gases indicated was calculated by ratioing the indicated Xe-138 to the other gases using the Steam Jet Air Ejector samples as mentioned above. In September and and October, the activity of Xe-133 released from the Turbine Building roof vents was assumed to be the same as the LLD value of Xe-133. The remainder of the gases indicated was calculated by ratioing the indicated Xe-133 to the other gases using the Steam Jet Air Ejector samples mentioned above. On October 20, 1993, the Turbine Building roof vents were permanently sealed. No further releases from this release path can be made. These results are indicated in Table 1C and the totals of Table 1A.

The error involved in these steps may be approximately $\pm$100 percent.

b. Iodines

Continuous isokinetic samples are drawn from the plant stack through a particulate filter and charcoal cartridge. Beginning in the fourth quarter of 1991, continuous particulate and charcoal samples were also taken at the Turbine Building roof vents. The filters and

cartridges are normally removed weekly and are analyzed for Iodine-131, 132, 133, 134, and 135. The error involved in these steps may be approximately ±50 percent.

c. Particulates

The particulate filters described in b. above are also counted for particulate radioactivity. The error involved in this sample is also approximately ±50 percent.

d. Liquid Effluents

Radioactive liquid effluents released from the facility are continuously monitored. Measurements are also made on a representative sample of each batch of radioactive liquid effluents released. For each batch, station records are retained of the total activity (mCi) released, concentration (uCi/ml) of gross radioactivity, volume (liters), and approximate total quantity of water (liters) used to dilute the liquid effluent prior to release to the Connecticut River.

Each batch of radioactive liquid effluent releases is analyzed for gross gamma and gamma isotopic radioactivity. A monthly proportional composite sample, comprising an aliquot of each batch released during a month, is analyzed for tritium and gross alpha radioactivity. A quarterly proportional composite sample, comprising an aliquot of each batch released during a quarter, is analyzed for Sr-89, Sr-90, and Fe-55.

5. BATCH RELEASES

a. Liquid

There were no routine liquid batch releases during the reporting period.

b. Gaseous

There were no routine gaseous batch releases during the reporting period.

6. ABNORMAL RELEASES

a. Liquid

There were no nonroutine liquid releases during the reporting period.

b. Gaseous

There were no nonroutine gaseous releases during the reporting period.

7. OTHER SUPPLEMENTAL INFORMATION

a. On August 16, 1993, PRO (Potential Reportable Occurrence) No. 93-86 was written to evaluate a potential unmonitored release pathway through the Turbine Building wall. This potential pathway was created when wind blew the plastic coverings off of three holes that had been cut in the walls as part of the Turbine Building roof vent reroute. A subsequent evaluation determined that this did not constitute an unmonitored release pathway, since the release was accounted for through the Turbine Building roof vent monitoring system.

b. On September 29, 1993, PRO No. 93-103 was written to evaluate the detection of Co-60 and Cs-137 in silt that had been removed from the west cooling tower deep basin during the refueling outage. The measured concentrations were: 9.1E-08 uCi/cc Co-60, and 1.77E-07 uCi/cc Cs-137. Although these samples were taken from on-site, the Co-60 concentration was found to be well below the reporting level (Technical Specification Table 3.9.4) for environmental sediment samples. Since there is no reporting level for Cs-137 in sediment, the concentration was compared to the vegetation reporting level, and was found to be well below it. (The Cs-137 is believed to be

due to residual nuclear weapons testing fallout.) An evaluation concluded that there was no LER required for this event, and there were no other reporting requirements.

# APPENDIX B

## LIQUID HOLDUP TANKS

Requirement: Technical Specification 3.8.D.1 limits the quantity of radioactive material contained in any outside tank. With the quantity of radioactive material in any outside tank exceeding the limits of Technical Specification 3.8.D.1, a description of the events leading to this condition is required in the next Semiannual Effluent Release Report per Technical Specification 6.7.C.1.

Response: The limits of Technical Specification 3.8.D.1 were not exceeded during this reporting period.

# APPENDIX C

## RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Requirement: Radioactive liquid effluent monitoring instrumentation channels are required to be operable in accordance with Technical Specification Table 3.9.1. If an inoperable radioactive liquid effluent monitoring instrument is not returned to operable status prior to a release pursuant to Note 4 of Table 3.9.1, an explanation in the next Semiannual Effluent Release Report of the reason(s) for delay in correcting the inoperability are required per Technical Specification 6.7.C.1.

Response: Since the requirements of Technical Specification Table 3.9.1 governing the operability of radioactive liquid effluent monitoring instrumentation were met for this reporting period, no response is required.

# APPENDIX D

## RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Requirement: Radioactive gaseous effluent monitoring instrumentation channels are required to be operable in accordance with Technical Specification Table 3.9.2. If inoperable gaseous effluent monitoring instrumentation is not returned to operable status within 30 days pursuant to Note 5 of Table 3.9.2, an explanation in the next Semiannual Effluent Release Report of the reason(s) for the delay in correcting the inoperability is required per Technical Specification 6.7.C.1.

Response: Since the requirements of Technical Specification Table 3.9.2 governing the operability of radioactive gaseous effluent monitoring instrumentation were met for this reporting period, no response is required.

# APPENDIX E

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Requirement: The radiological environmental monitoring program is conducted in accordance with Technical Specification 3.9.C. With milk samples no longer available from one or more of the sample locations required by Technical Specification Table 3.9.3, Technical Specification 6.7.C.1 requires the following to be included in the next Semiannual Effluent Release Report: (1) identify the cause(s) of the sample(s) no longer being available, (2) identify the new location(s) for obtaining available replacement samples and (3) include revised ODCM figure(s) and table(s) reflecting the new location(s).

Response: No changes were needed in the milk sampling locations specified in Technical Specification Table 3.9.3 due to sample unavailability during the third and fourth quarters of 1993.

# APPENDIX F

## LAND USE CENSUS

Requirement: A land use census is conducted in accordance with Technical Specification 3.9.D. With a land use census identifying a location(s) which yields at least a 20 percent greater dose or dose commitment than the values currently being calculated in Technical Specification 4.8.G.1, Technical Specification 6.7.C.1 requires the identification of the new location(s) in the next Semiannual Effluent Release Report.

Response: The Land Use Census was completed in the third quarter of 1993. No locations yielded a 20 percent greater dose or dose commitment than the values currently being calculated in Technical Specification 4.8.G.1.

# APPENDIX G

## PROCESS CONTROL PROGRAM

Requirement: Technical Specification 6.12.A.1 requires that licensee initiated changes to the Process Control Program (PCP) be submitted to the Commission in the Semiannual Radioactive Effluent Release Report for the period in which the change(s) was made.

Response: There were no licensee initiated changes to the Process Control Program during this reporting period.

APPENDIX H

OFF-SITE DOSE CALCULATION MANUAL

Requirement: Technical Specification 6.13.A.1 requires that licensee initiated changes to the Off-Site Dose Calculation Manual (ODCM) be submitted to the Commission in the Semiannual Radioactive Effluent Release Report for the period in which the change(s) was made effective.

Response: There were two revisions to the Off-Site Dose Calculation Manual during this reporting period.

Amendment No. 15 updates the ODCM to reflect changes in the Effluent Controls Program to meet the revised 10CFR20, Standards for Protection Against Radiation, which was implemented at Vermont Yankee in July 1993. The changes are primarily editorial in nature in that they change terminology used in the old Part 20 to that in the new regulation. In addition, the original basis for limits on effluent releases to off-site areas was on dose rates equal to 500 mrem/yr. This basis has not changed. The NRC is currently allowing plants to stay with the same basis for instantaneous release rate limits since it is not in direct conflict with the annual average requirements of the new 10CFR20 to limit doses to members of the public to 100 mrem in a year. The existing ALARA requirements of Appendix I to 10CFR Part 50 provide sufficient indication of potential off-site dose accumulation before the new dose limits of 10CFR Part 20 are reached.

Since the methodology for determining off-site doses is not affected by the changes required for the new Part 20, this change does not reduce the accuracy or reliability of any of the dose calculations or setpoint determinations previously controlled by the ODCM.

Amendment No. 16 addresses four areas of interest in the ODCM. First, the ODCM was modified to provide the dose methodology necessary to account for the burning on-site of radioactively contaminated waste oil in the North Warehouse. This amendment designated the North Warehouse as a ground level radioactivity release point and developed the dose conversion factors applicable for use with the burning of waste oil at this location using the same exposure pathways, uptake assumptions, and model

approaches that have been previously applied to ODCM dose calculations. These dose factors also reflect an assessment of the meteorological dispersion characteristics associated with the North Warehouse using the same model approaches that are applied to other ODCM meteorological evaluations. Appendix D to the ODCM has also been updated to reflect that the North Warehouse is now designated as the location of contaminated waste oil incineration in place of the Containment Access Building (CAB). All other criteria concerning sampling, analysis, and dose projections are the same as originally stated in Appendix D.

Secondly, Amendment No. 16 also removed reference to the Turbine Building roof ventilators as a designated effluent release point to the atmosphere. A recent design change to the plant has rerouted ventilation flow from the Turbine Hall to the plant stack and capped off the roof ventilators, thereby eliminating this ground level release point. Figure 6-2 has been updated to reflect this change. In addition, this amendment notes that due to differences in building cross sectional areas and resulting wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those previously associated with the main plant buildings (ground level dose factors approximately 50% higher). As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the new Method I ground level dose equations as a first step in impact assessment.

Since the methodology for determining off-site doses from oil burning is the same as that originally applied to ground level release points covered by the ODCM, this proposed change will not reduce the accuracy or reliability of any dose calculations or setpoint determinations presently controlled by the Off-Site Dose Calculation Manual.

Third, Amendment No. 16 updated Figure 6-1, "Liquid Effluent Streams, Radiation Monitors, and Radwaste Treatment Systems." The flow diagram in this figure indicated that solid waste included spent resins dewatered by a centrifuge. Since the centrifuge has been taken out of service in favor of in-liner

dewatering, the figure has been revised. This is considered an administrative change which does not effect the methods or parameters involved in performing dose calculations.

Lastly, an update to Table 4.1 and Figure 4-2 have been made to reflect changes in the Radiological Environmental Monitoring Program (REMP) resulting from the 1993 Land Use Census which noted changes in the location of land use receptors from that found in previous census. This is considered an administrative change which does not effect the methods or parameters involved in performing dose calculations.

The revised ODCM pages for the above revisions are attached.

VERMONT YANKEE NUCLEAR POWER STATION

OFF-SITE DOSE CALCULATION MANUAL

REVISION # 15

Reviewed RC 9335 / 6/16/93
Plant Operations Review Committee — Date

Approved RJ Wanczyk / 6/22/93
Plant Manager — Date

Approved [signature] / 7/6/93
Vice President, Operations — Date

# LIST OF AFFECTED PAGES

| Page | Revision | Date |
|---|---|---|
| ii | 13 | 05/01/92 |
| iii | 15 | 07/08/93 |
| iv - v | 0 | 03/01/84 |
| vi - x | 15 | 07/08/93 |
| 1.1 - 1.22 | 15 | 07/08/93 |
| 2.1 - 2.4 | 15 | 07/08/93 |
| 3.1 - 3.59 | 15 | 07/08/93 |
| 4.1 | 10 | 04/04/91 |
| 4.1A | 9 | 03/02/90 |
| 4.1B | 4 | 12/30/87 |
| 4.2 - 4.5 | 13 | 05/01/92 |
| 4.6 - 4.9 | 10 | 04/04/91 |
| 5.1 - 5.21 | 15 | 07/08/93 |
| 6.1 - 6.9 | 15 | 07/08/93 |
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## 1.0 INTRODUCTION

This ODCM (Off-Site Dose Calculation Manual) provides formal and approved methods for the calculation of off-site concentration, off-site doses, and effluent monitor setpoints in order to comply with the Vermont Yankee Technical Specifications 3.8/4.8 and 3.9/4.9, hereafter referred to as the Radiological Effluent Technical Specifications. The ODCM forms the basis for plant procedures and is designed for use by the procedure writer. In addition, the ODCM will be useful to the writer of periodic reports required by the NRC on the dose consequences of plant operation. The dose methods contained herein follow accepted NRC guidance for calculation of doses necessary to demonstrate compliance with the dose objectives of Appendix I to 10CFR50 (Regulatory Guide 1.109) unless otherwise noted in the text.

Demonstration of compliance with the dose limits of 40CFR190 (see Technical Specification 3.8.M) will be considered as demonstrating compliance with the 0.1 rem limit of 10CFR20.1301(a)(1) for members of the public in unrestricted areas (Reference 5. FR 23374, third column).

It shall be the responsibility of the Chemistry Manager and Radiation Protection Manager to ensure that the ODCM is used in the performance of the surveillance requirements of the appropriate portions of Technical Specifications. The administration of the program for the disposal of slightly contaminated septic waste, as described in Appendix B, is the responsibility of the Senior Environmental Program Manager.

All changes to the ODCM must be reviewed by PORC and approved by MOO, in accordance with Technical Specification 6.13, prior to implementation. All approved changes shall be submitted to the NRC for their information in the Semiannual Radioactive Effluent Report for the period in which the change(s) was made effective. The plant's Document Control Center (DCC) shall maintain the current version of the ODCM and issue under controlled distribution all approved changes to it.

## 1.1 Summary of Methods, Dose Factors, Limits, Constants, Variables and Definitions

This section summarizes the methods for the user. The first-time user should read Chapters 2 through 6. The concentration and setpoint methods are documented in Table 1.1-2 through Table 1.1-7, as well as the Method I Dose equations. Where more accurate dose calculations are needed use the Method II for the appropriate dose as described in Sections 3.2 through 3.9 and 3.11. The dose factors used in the equations are in Tables 1.1-10 through 1.1-12 and the Regulatory Limits are summarized in Table 1.1-1.

The variables and special definitions used in this ODCM are in Tables 1.1-8 and 1.1-9.

TABLE 1.1-1

Summary of Radiological Effluent Technical Specifications and Implementing Equations

| | Technical Specification | Category | Method[1] | Limit |
|---|---|---|---|---|
| 3.8.A.1 | Liquid Effluent Concentration | Sum of the Fractions of Effluent Concentration Limits [Excluding Noble Gases] | Eq. 2-1 | ≤ 1.0 |
| | | Total Noble Gas Concentration | Eq. 2-2 | ≤ $2 \times 10^{-4}$ µCi/cc |
| 3.8.B.1 | Liquid Effluent Dose | Total Body Dose | Eq. 3-1 | ≤ 1.5 mrem in a qtr. |
| | | | | ≤ 3.0 mrem in a yr. |
| | | Organ Dose | Eq. 3-3 | ≤ 5 mrem in a qtr. |
| | | | | ≤ 10 mrem in a yr. |
| 3.8.C.1 | Liquid Radwaste Treatment Operability | Total Body Dose | Eq. 3-1 | ≤0.06 mrem in a mo. |
| | | Organ Dose | Eq. 3-3 | ≤ 0.2 mrem in a mo. |
| 3.8.E.1 | Gaseous Effluents Dose Rate | Total Body Dose Rate from Noble Gases | Eq. 3-5 | ≤ 500 mrem/yr. |
| | | Skin Dose Rate from Noble Gases | Eq. 3-7 | ≤ 3000 mrem/yr. |

TABLE 1.1-1
(Continued)

Summary of Radiological Effluent Technical Specifications
and Implementing Equations

| | Technical Specification | Category | Method[1] | Limit |
|---|---|---|---|---|
| 3.8.E.1 | (Continued) | Organ Dose Rate from Iodines, Tritium and Particulates with $T_{1/2}$ > 8 Days | Eq. 3-16 | ≤ 1500 mrem/yr. |
| 3.8.F.1 | Gaseous Effluents Dose from Noble Gases | Gamma Air Dose from Noble Gases | Eq. 3-21 | ≤ 5 mrad in a qtr. |
| | | | | ≤ 10 mrad in a yr. |
| | | Beta Air Dose from Noble Gases | Eq. 3-23 | ≤ 10 mrad in a qtr. |
| | | | | ≤ 20 mrad in a yr. |
| 3.8.G.1 | Gaseous Effluents Dose from Iodines, Tritium, and Particulates | Organ Dose from I-131, I-133, Tritium, and Particulates with $T_{1/2}$ > 8 Days | Eq. 3-25 | ≤ 7.5 mrem in a qtr. |
| | | | | ≤ 15 mrem in a yr. |
| 3.8.I.1 | Ventilation Exhaust Treatment | Organ Dose | Eq. 3-25 | ≤ 0.3 mrem in a mo. |
| 3.8.M.1 | Total Dose (from All Sources) | Total Body Dose | Footnote[2] | ≤ 25 mrem in a yr. |
| | | Organ Dose | | ≤ 25 mrem in a yr. |
| | | Thyroid Dose | | ≤ 75 mrem in a yr. |

TABLE 1.1-1
(Continued)

Summary of Radiological Effluent Technical Specifications and Implementing Equations

| | Technical Specification | Category | Method[1] | Limit |
|---|---|---|---|---|
| 3.9.A.1 | Liquid Effluent Monitor Setpoint | | | |
| | Liquid Radwaste Discharge Monitor | Alarm Setpoint | Eq. 5-1 | T.S. 3.8.A.1 |
| 3.9.B.1 | Gaseous Effluent Monitor Setpoint | | | |
| | Plant Stack and AGS Offgas System Noble Gas Activity Monitors | Alarm/Trip Setpoint for Total Body Dose Rate | Eq. 5-9 | T.S. 3.8.E.1a (Total Body) |
| | | Alarm/Trip Setpoint for Skin Dose Rate | Eq. 5-10 | T.S. 3.8.E.1a (Skin) |
| | SJAE Noble Gas Activity Monitors | Alarm Setpoint | Eq. 5-21 | T.S. 3.8.K.1 |

(1) More accurate methods may be available (see subsequent chapters).

(2) Technical Specification 3.8.M.2 requires this evaluation only if twice the limit of Equations 3-1, 3-3, 3-21, 3-23, or 3-25 is reached. If this occurs a Method II calculation, using actual meteorology and identified pathways for a real individual, shall be made.

TABLE 1.1-2

Summary of Methods to Calculate
Unrestricted Area Liquid Concentrations

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 2-1 | Sum of the Fractions of Combined Effluent Concentrations in Liquids [Except Noble Gases] | $F_1^{ENG} = \sum_i \frac{C_i}{ECL_i} \leq 1$ | 2.1 |
| 2-2 | Total Activity of Dissolved and Entrained Noble Gases from all Station Sources | $C_1^{NG} = \left(\frac{\mu Ci}{ml}\right) = \sum_i C_i^{NG}$ $\leq 2E\text{-}04$ | 2.1 |

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TABLE 1.1-3

Summary of Methods to Calculate
Off-Site Doses from Liquid Concentrations

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 3-1 | Total Body Dose | $D_{tb}\ (mrem) = \sum_i Q_i\ DFL_{itb}$ | 3.2.1 |
| 3-2 | Maximum Organ Dose | $D_{mo}\ (mrem) = \sum_i Q_i\ DFL_{imo}$ | 3.3.1 |

TABLE 1.1-4

Summary of Methods to Calculate Dose Rates

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 3-5 | Total Body Dose Rate from Noble Gases Released from Stack | $\dot{R}_{tbs}\left(\frac{mrem}{yr}\right) = 0.70 \sum_i \dot{Q}_i^{ST} DFB_i$ | 3.4.1 |
| 3-39 | Total Body Dose Rate from Noble Gases Released from Ground | $\dot{R}_{tbs}\left(\frac{mrem}{yr}\right) = 4.0 \sum_i \dot{Q}_i^{GL} DFB_i$ | 3.4.1 |
| 3-7 | Skin Dose Rate from Noble Gases Released from Stack | $\dot{R}_{skins}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{ST} DF'_{is}$ | 3.5.1 |
| 3-38 | Skin Dose Rate from Noble Gases Released from Ground | $\dot{R}_{sking}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{GL} DF'_{ig}$ | 3.5.1 |
| 3-16 | Critical Organ Dose Rate from Stack Release of I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days | $\dot{R}_{cos}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{STP} DFG'_{sico}$ | 3.6.1 |
| 3-40 | Critical Organ Dose Rate from Ground Level Release of I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days | $\dot{R}_{cog}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{GLP} DFG'_{gico}$ | 3.6.1 |

TABLE 1.1-5

Summary of Methods to Calculate
Doses to Air from Noble Gases

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 3-21 | Gamma Dose to Air from Noble Gases Released from Stack | $D^{\gamma}_{airs}\ (mrad) = 0.022 \sum_i Q_i^{ST}\ DF_i^{\gamma}$ | 3.7.1 |
| 3-41 | Gamma Dose to Air from Noble Gases Released from Ground Level | $D^{\gamma}_{airg}\ (mrad) = 0.13 \sum_i Q_i^{GL}\ DF_i^{\gamma}$ | 3.7.1 |
| 3-23 | Beta Dose to Air from Noble Gases Released from Stack | $D^{\beta}_{airs}\ (mrad) = 0.019 \sum_i Q_i^{ST}\ DF_i^{\beta}$ | 3.8.1 |
| 3-43 | Beta Dose to Air from Noble Gases Released from Ground Level | $D^{\beta}_{airg}\ (mrad) = 0.55 \sum_i Q_i^{GL}\ DF_i^{\beta}$ | 3.8.1 |

TABLE 1.1-6

Summary of Methods to Calculate
Dose to an Individual from Tritium, Iodine, and Particulates in
Gas Releases and Direct Radiation

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 3-25 | Dose to Critical Organ from Stack Release of I-131, I-133, Tritium, and Particulates | $D_{cos}\ (mrem) = \sum_i Q_i^{STP}\ DFG_{sico}$ | 3.9.1 |
| 3-44 | Dose to Critical Organ from Ground Level Release of I-131, I-133, Tritium, and Particulates | $D_{cog}(mrem) = \sum_i Q_i^{GLP}\ DFG_{gico}$ | 3.9.1 |
| | Direct Dose | | |
| 3-27 | Turbine Building | $D_d\ (mrem) = K_{N16}(L) * E$ | 3.11.1 |
| | North Warehouse | | |
| 3-29 | Shielded End | $D_S = 0.25 \times \dot{R}_S$ | 3.11.2 |
| 3-30 | Unshielded End | $D_U = 0.53 \times \dot{R}_U$ | 3.11.2 |
| | LLW Storage Pad | | |
| 3-31 | Direct Line (Module Short Side Out) | $D_{de} = 0.28 \times \dot{R}_d \times f_d$ | 3.11.3 |
| 3-32 | Direct Line (Module Long Side Out) | $D_{dS} = 0.39 \times \dot{R}_d \times f_d$ | 3.11.3 |
| 3-33 | Skyshine (Resin Liners) | $D_{SKR} = 0.016 \times \dot{R}_{SKR} \times f_{SK}$ | 3.11.3 |
| 3-34 | Skyshine (DAW) | $D_{SKD} = 0.015 \times \dot{R}_{SKD} \times f_{SK}$ | 3.11.3 |
| 3-35 | Resin Liner Transfer (Unshielded) | $D_{Tran} = 0.0025 \times \dot{R}_{Tran} \times T_{Tran}$ | 3.11.3 |
| 3-36 | Intermodular Gap Dose | $D_{Gap} = 2.44E\text{-}2 \times W_{Gap} \times A_{RL} \times f_{Gap}$ | 3.11.3 |

TABLE 1.1-7

Summary of Methods for
Setpoint Determinations

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 5-1 | Liquid Effluents: | | |
| | Liquid Radwaste Discharge Monitor (17/350) | $R_{spt}^{L}$ (cps) = $\frac{DF}{DF_{min}} S_1 \sum_i C_{mi}$ | 5.1.1.1 |
| | Gaseous Effluents: | | |
| | Plant Stack (RR-108-1A, RR-108-1B) and AOG Offgas System (3127, 3128) Noble Gas Activity Monitors | | |
| 5-9 | Total Body | $R_{spt}^{tb}$ (cpm) = 716 $S_g \frac{1}{F} \frac{1}{DFB_c}$ | 5.2.1.1 |
| 5-10 | Skin | $R_{spt}^{skin}$ (cpm) = 3000 $S_g \frac{1}{F} \frac{1}{DF'_c}$ | 5.2.1.1 |
| 5-21 | SJAE Noble Gas Activity Monitors (17/150A, 17/150B) | $R_{spt}^{SJAE}$ (mR/hr) = 1.6E+05 $S_g \frac{1}{F}$ | 5.2.1.1 |

TABLE 1.1-8

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $A_{RL}$ | = | Total gamma activity contained in a resin liner in storage directly in line with a gap between adjacent storage modules. | Ci |
| $C_{ij}^{NG}$ | = | Concentration at point of discharge to an unrestricted area of dissolved and entrained noble gas "i" in liquid pathways from all station sources. | $\mu$Ci/ml |
| $C_j^{NG}$ | = | Total activity of all dissolved and entrained noble gases in liquid pathways from all station sources. | $\frac{\mu Ci}{ml}$ |
| $C_{di}$ | = | Concentration of radionuclide "i" at the point of liquid discharge to an unrestricted area. | $\frac{\mu Ci}{ml}$ |
| $C_i$ | = | Concentration of radionuclide "i". | $\frac{\mu Ci}{cc}$ |
| $C_{pi}$ | = | Concentration, exclusive of noble gases, of radionuclide "i" from tank "p" at point of discharge to an unrestricted area. | $\frac{\mu Ci}{ml}$ |
| $C_{mi}$ | = | Concentration of radionuclide "i" in mixture at the monitor. | $\frac{\mu Ci}{ml}$ |
| $D_{airs}^{\beta}$ | = | Beta dose to air from stack release. | mrad |
| $D_{airg}^{\beta}$ | = | Beta dose to air from ground level release. | mrad |
| $D_{airs}^{\gamma}$ | = | Gamma dose to air from stack release. | mrad |
| $D_{airg}^{\gamma}$ | = | Gamma dose to air from ground level release. | mrad |
| $D_{cos}$ | = | Dose to critical organ from stack release. | mrem |
| $D_{cog}$ | = | Dose to the critical organ from ground level release. | mrem |
| $D_d$ | = | Direct dose (Turbine Building). | mrem |

TABLE 1.1-8
(Continued)

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $\dot{R}_d$ | = | Dose rate at 3' from unobstructed side of storage module facing site boundary. | $\frac{mrem}{hr}$ |
| $D_{dE}$ | = | Direct dose at site boundary per unobstructed storage module (short end). | $\frac{mrem}{yr\text{-}module}$ |
| $D_{dS}$ | = | Direct dose at site boundary per unobstructed storage module (long side). | $\frac{mrem}{yr\text{-}module}$ |
| $D^{\gamma}_{finite}$ | = | Gamma dose to air, corrected for finite cloud. | mrad |
| $D_{Gap}$ | = | Intermodular gap dose projected to the maximum site boundary location from resin waste not directly shielded by DAW modules. | $\frac{mrem}{yr}$ |
| $D_{mo}$ | = | Dose the maximum organ. | mrem |
| $D^{S}$ | = | Dose to skin from beta and gamma. | mrem |
| $\dot{R}_S$ | = | Dose rate at 1 meter from source in shielded end of North Warehouse. | $\frac{mrem}{hr}$ |
| $D_S$ | = | Annual dose at site boundary from fixed sources in shielded end of North Warehouse. | $\frac{mrem}{yr}$ |
| $\dot{R}_{SKD}$ | = | Maximum dose rate at 3' over top of DAW in a storage module. | $\frac{mrem}{hr}$ |
| $\dot{R}_{SKR}$ | = | Maximum dose rate at 3' over top of each resin liner in a storage module. | $\frac{mrem}{hr}$ |
| $D_{SKD}$ | = | Skyshine dose at the site boundary from DAW in storage modules (unobstructed top surfaces). | $\frac{mrem}{yr\text{-}module}$ |
| $D_{SKR}$ | = | Skyshine dose at the site boundary from resin liners in storage modules (unobstructed top surfaces). | $\frac{mrem}{yr\text{-}liner}$ |

TABLE 1.1-B
(Continued)

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $D_{tb}$ | = | Dose to the total body. | mrem |
| $K_{N/6}^{(L)}$ | = | The direct dose conversion factor for N-16 scatter from the turbine hall to Location (L) | $\frac{mrem}{MW_eh}$ |
| $\dot{R}_{Tran}$ | = | Dose rate at contact from the unshielded top surface of resin liner. | $\frac{rad}{hr}$ |
| $D_{Tran}$ | = | Dose at the site boundary from unshielded movement of resin liner between transfer cask and storage module. | mrem |
| $\dot{R}_U$ | = | Dose rate at 1 meter from source in unshielded end of North Warehouse. | $\frac{mrem}{hr}$ |
| $D_U$ | = | The annual dose at the site boundary from fixed sources in the unshielded end of North Warehouse. | $\frac{mrem}{yr}$ |
| DF | = | Dilution factor. | ratio |
| $DF_{min}$ | = | Minimum allowable dilution factor. | ratio |
| $DF_c'$ | = | Composite skin dose factor. | $\frac{mrem\text{-}sec}{pCi\text{-}yr}$ |
| $DFB_i$ | = | Total body gamma dose factor for nuclide "i". | $\frac{mrem\text{-}m^3}{pCi\text{-}yr}$ |
| $DFB_c$ | = | Composite total body dose factor. | $\frac{mrem\text{-}m^3}{pCi\text{-}yr}$ |
| $DFL_{itb}$ | = | Site-specific, total body dose factor for a liquid release of nuclide "i". | $\frac{mrem}{Ci}$ |
| $DFL_{imo}$ | = | Site-specific, maximum organ dose factor for a liquid release of nuclide "i". | $\frac{mrem}{Ci}$ |

TABLE 1.1-8
(Continued)

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $DFG_{sico}$ | = | Site-specific, critical organ dose factor for a stack gaseous release of nuclide "i". | $\frac{mrem}{Ci}$ |
| $DFG'_{sico}$ | = | Site-specific, critical organ dose rate factor for a stack gaseous release of nuclide "i". | $\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$ |
| $DFG_{gico}$ | = | Site-specific, critical organ dose factor for a ground level gaseous release of nuclide "i". | $\frac{mrem}{Ci}$ |
| $DFG'_{gico}$ | = | Site-specific, critical organ dose rate factor for a ground level gaseous release of nuclide "i". | $\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$ |
| $DFS_i$ | = | Beta skin dose factor for nuclide "i". | $\frac{mrem\text{-}m^3}{pCi\text{-}yr}$ |
| $DF'_{is}$ | = | Combined skin dose factor for nuclide "i" from a stack release. | $\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$ |
| $DF'_{ig}$ | = | Combined skin dose factor for nuclide "i" from a ground level release. | $\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$ |
| $DF_i^{\gamma}$ | = | Gamma air dose factor for nuclide "i". | $\frac{mrad\text{-}m^3}{pCi\text{-}yr}$ |
| $DF_i$ | | Beta air dose factor for nuclide "i". | $\frac{mrad\text{-}m^3}{pCi\text{-}yr}$ |
| $\dot{R}_{cos}$ | = | Critical organ dose rate due to iodines and particulates released from stack. | $\frac{mrem}{yr}$ |
| $\dot{R}_{cog}$ | = | Critical organ dose rate due to iodines and particulates released from ground. | $\frac{mrem}{yr}$ |
| $\dot{R}_{skins}$ | = | Skin dose rate due to stack release of noble gases. | $\frac{mrem}{yr}$ |
| $\dot{R}_{sking}$ | = | Skin dose rate due to ground release of noble gases. | $\frac{mrem}{yr}$ |

TABLE 1.1-8
(Continued)

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $\dot{R}_{tbs}$ | = | Total body dose rate due to noble gases from stack release. | $\frac{mrem}{yr}$ |
| $\dot{R}_{tbg}$ | = | Total body dose rate due to noble gases from ground level release. | $\frac{mrem}{yr}$ |
| D/Q | = | Deposition factor for dry deposition of elemental radioiodines and other particulates. | $\frac{1}{m^2}$ |
| E | = | Gross electric output over the period of interest. | $MW_e h$ |
| $f_d$ | = | Fraction of a year that a storage module is in use with an unobstructed side oriented toward west site boundary. | fraction |
| $f_{Gap}$ | = | Fraction of a year that the intermodular gap is not shielded. | fraction |
| $f_{SK}$ | = | Fraction of a year that a storage module is in use with an unobstructed top surface. | fraction |
| $F_d$ | = | Flow rate out of discharge canal. | gpm |
| $F_m$ | = | Flow rate past liquid radwaste monitor. | gpm |
| F | = | Flow rate past gaseous radwaste monitor. | $\frac{cc}{sec}$ |
| $F_1^{ENG}$ | = | Sum of the fractions of combined effluent concentrations in liquid pathways (excluding noble gases). | fraction |
| $ECL_i$ | = | Annual average effluent concentration limit for radionuclide "i" (10CFR20.1001-20.2401, Appendix B, Table 2, Column 2) | $\frac{\mu Ci}{cc}$ |
| $Q_i$ | = | Release for radionuclide "i" from the point of interest. | curies |

TABLE 1.1-8
(Continued)

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $\dot{Q}_i$ | = | Release rate for radionuclide "i" at the point of interest. | $\frac{\mu Ci}{sec}$ |
| $\dot{Q}_i^{ST}$ | = | The noble gas radionuclide "i" release rate at the plant stack. | $\frac{\mu Ci}{sec}$ |
| $\dot{Q}_i^{GL}$ | = | The noble gas radionuclide "i" release rate from ground level. | $\frac{\mu Ci}{sec}$ |
| $\dot{Q}_i^{SJAE}$ | = | The noble gas radionuclide "i" release rate at the steam jet air ejector. | $\frac{\mu Ci}{sec}$ |
| $\dot{Q}_i^{AOG}$ | = | The noble gas radionuclide "i" release rate at the exhaust of the augmented Off-Gas System | $\frac{\mu Ci}{sec}$ |
| $\dot{Q}_i^{STP}$ | = | The iodine, tritium, and particulate radionuclide "i" release rate from the plant stack. | $\frac{\mu Ci}{sec}$ |
| $\dot{Q}_i^{GLP}$ | = | The iodine, tritium, and particulate radionuclide "i" release rate from ground level. | $\frac{\mu Ci}{sec}$ |
| $Q_i^{ST}$ | = | The release of noble gas radionuclide "i" from the plant stack. | curies |
| $Q_i^{GL}$ | = | The release of noble gas radionuclide "i" from ground level. | curies |
| $Q_i^{STP}$ | = | The release of iodine, tritium, and particulate radionuclide "i" from the plant stack. | curies |
| $Q_i^{GLP}$ | = | The release of iodine, tritium, and particulate radionuclide "i" from ground level. | curies |
| $R_{spt}^{L}$ | = | Liquid monitor response for the limiting concentration at the point of discharge. | cps |

TABLE 1.1-8
(Continued)

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $R_{spt}^{skin}$ | = | Response of the noble gas monitor at the limiting skin dose rate. | cpm |
| $R_{spt}^{tb}$ | = | Response of the noble gas monitor to limiting total body dose rate. | cpm |
| $S_F$ | = | Shielding factor. | Ratio |
| $S_g$ | = | Detector counting efficiency from the most recent gas monitor calibration. | $\frac{cpm}{\mu Ci/cc}$ or $\frac{mR/hr}{\mu Ci/cc}$ |
| $S_{gi}$ | = | Detector counting efficiency for noble gas "i". | $\frac{cpm}{\mu Ci/cc}$ or $\frac{mR/hr}{\mu Ci/cc}$ |
| $S_l$ | = | Detector counting efficiency from the most recent liquid monitor calibration. | $\frac{cps}{\mu Ci/ml}$ |
| $S_{li}$ | = | Detector counting efficiency for radionuclide "i". | $\frac{cps}{\mu Ci/ml}$ |
| $T_{Tran}$ | = | Time that an unshielded resin liner is exposed in the storage pad area. | hours |
| $W_{Gap}$ | = | Intermodule gap width between adjacent DAW storage modules which shield resin liner storage modules from the west site boundary. | inches |
| $X/Q_s$ | = | Annual or long-term average undepleted atmospheric dispersion factor for stack release. | $\frac{sec}{m^3}$ |
| $X/Q_g$ | = | Annual or long-term average undepleted atmospheric dispersion factor for ground level release. | $\frac{sec}{m^3}$ |
| $[X/Q]_s^{\gamma}$ | = | Effective annual or long-term average gamma atmospheric dispersion factor. | $\frac{sec}{m^3}$ |
| $[X/Q]_g^{\gamma}$ | = | Effective annual or long-term average gamma atmospheric dispersion factor for a ground level release. | $\frac{sec}{m^3}$ |

TABLE 1.1-10

Dose Factors Specific for Vermont Yankee
for Noble Gas Releases

| Radionuclide | Gamma Total Body Dose Factor $DFB_i$ $\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$ | Beta Skin Dose Factor $DFS_i$ $\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$ | Combined Skin Dose Factor (Stack Release) $DF'_{is}$ $\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$ | Beta Air Dose Factor $DF_i^{\beta}$ $\left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$ | Gamma Air Dose Factor $DF_i^{\gamma}$ $\left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$ |
|---|---|---|---|---|---|
| Ar-41 | 8.84E-03* | 2.69E-03 | 8.81E-03 | 3.28E-03 | 9.30E-03 |
| Kr-83m | 7.56E-08 | ----- | 1.49E-05 | 2.88E-04 | 1.93E-05 |
| Kr-85m | 1.17E-03 | 1.46E-03 | 1.83E-03 | 1.97E-03 | 1.23E-03 |
| Kr-85 | 1.61E-05 | 1.34E-03 | 8.16E-04 | 1.95E-03 | 1.72E-05 |
| Kr-87 | 5.92E-03 | 9.73E-03 | 1.06E-02 | 1.03E-02 | 6.17E-03 |
| Kr-88 | 1.47E-02 | 2.37E-03 | 1.32E-02 | 2.93E-03 | 1.52E-02 |
| Kr-89 | 1.66E-02 | 1.01E-02 | 1.94E-02 | 1.06E-02 | 1.73E-02 |
| Kr-90 | 1.56E-02 | 7.29E-03 | 1.70E-02 | 7.83E-03 | 1.63E-02 |
| Xe-131m | 9.15E-05 | 4.76E-04 | 4.06E-04 | 1.11E-03 | 1.56E-04 |
| Xe-133m | 2.51E-04 | 9.94E-04 | 8.49E-04 | 1.48E-03 | 3.27E-04 |
| Xe-133 | 2.94E-04 | 3.06E-04 | 4.57E-04 | 1.05E-03 | 3.53E-04 |
| Xe-135m | 3.12E-03 | 7.11E-04 | 3.03E-03 | 7.39E-04 | 3.36E-03 |
| Xe-135 | 1.81E-03 | 1.86E-03 | 2.60E-03 | 2.46E-03 | 1.92E-03 |
| Xe-137 | 1.42E-03 | 1.22E-02 | 8.48E-03 | 1.27E-02 | 1.51E-03 |
| Xe-138 | 8.83E-03 | 4.13E-03 | 9.60E-03 | 4.75E-03 | 9.21E-03 |

*8.84E-03 = $8.84 \times 10^{-3}$

TABLE 1.1-10A

Combined Skin Dose Factors Specific for Vermont Yankee Ground Level Noble Gas Releases

| Radionuclide | $DF'_{ig}$ $\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$ |
|---|---|
| AR-41 | 8.75E-02 |
| KR-83M | 8.45E-05 |
| KR-85M | 3.08E-02 |
| KR-85 | 2.34E-02 |
| KR-87 | 1.96E-01 |
| KR-88 | 1.08E-01 |
| KR-89 | 2.52E-01 |
| KR-90 | 1.98E-01 |
| XE-131M | 8.97E-03 |
| XE-133M | 1.87E-02 |
| XE-133 | 6.87E-03 |
| XE-135M | 2.71E-02 |
| XE-135 | 4.08E-02 |
| XE-137 | 2.19E-01 |
| XE-138 | 1.12E-01 |

TABLE 1.1-11

Dose Factors Specific for Vermont Yankee
for Liquid Releases

| Radionuclide | Total Body Dose Factor $DFL_{itb}\left(\frac{mrem}{Ci}\right)$ | Maximum Organ Dose Factor $DFL_{imo}\left(\frac{mrem}{Ci}\right)$ |
|---|---|---|
| H-3 | 2.06E-04 | 2.06E-04 |
| Na-24 | 3.38E-02 | 3.38E-02 |
| Cr-51 | 3.10E-04 | 6.96E-02 |
| Mn-54 | 2.08E-01 | 3.00E+00 |
| Mn-56 | 8.53E-06 | 5.29E-03 |
| Fe-55 | 4.18E-02 | 2.54E-01 |
| Fe-59 | 2.49E-01 | 1.84E+00 |
| Co-58 | 5.97E-02 | 4.34E-01 |
| Co-60 | 2.13E-01 | 1.28E+00 |
| Zn-65 | 8.06E+00 | 1.64E+01 |
| Sr-89 | 2.55E-01 | 8.91E+00 |
| Sr-90 | 4.23E+01 | 1.67E+02 |
| Zr-95 | 4.21E-04 | 1.36E-01 |
| Mo-99 | 4.79E-03 | 4.51E-02 |
| Tc-99m | 5.04E-06 | 2.33E-04 |
| Ag-110m | 6.90E-03 | 7.02E-01 |
| Sb-124 | 8.44E-03 | 2.22E-01 |
| Sb-125 | 7.52E-03 | 1.15E-01 |
| I-131 | 2.57E-02 | 1.47E+01 |
| I-132 | 3.10E-06 | 1.29E-04 |
| I-133 | 3.31E-03 | 1.63E+00 |
| I-135 | 3.16E-04 | 5.90E-02 |
| Cs-134 | 1.28E+02 | 1.60E+02 |
| Cs-137 | 7.58E+01 | 1.21E+02 |
| Ba-140 | 4.08E-03 | 9.72E-02 |
| Ce-141 | 2.31E-05 | 4.10E-02 |
| W-187 | 1.18E-02 | 8.90E+00 |

TABLE 1.1-12

Dose and Dose Rate Factors Specific for Vermont Yankee
for Iodines, Tritium, and Particulate Releases

| | Stack Release | | Ground Level Release | |
|---|---|---|---|---|
| Radio-nuclide | Critical Organ Dose Factor $DFG_{sico}$ $\left(\frac{mrem}{Ci}\right)$ | Critical Organ Dose Rate Factor $DFG'_{sico}$ $\left(\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}\right)$ | Critical Organ Dose Factor $DFG_{gico}$ $\left(\frac{mrem}{Ci}\right)$ | Critical Organ Dose Rate Factor $DFG'_{gico}$ $\left(\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}\right)$ |
| H-3 | 1.81E-04 | 5.70E-03 | 5.24E-03 | 1.65E-01 |
| C-14 | 1.10E-01 | 3.47E+00 | 3.18E+00 | 1.00E+02 |
| Cr-51 | 3.80E-03 | 1.32E-01 | 4.33E-02 | 1.49E+00 |
| Mn-54 | 4.36E-01 | 1.72E+01 | 4.86E+00 | 1.92E+02 |
| Fe-55 | 1.97E-01 | 6.21E+00 | 2.20E+00 | 6.94E+01 |
| Fe-59 | 4.35E-01 | 1.44E+01 | 4.89E+00 | 1.62E+02 |
| Co-58 | 2.26E-01 | 8.07E+00 | 2.53E+00 | 9.05E+01 |
| Co-60 | 4.76E+00 | 2.12E+02 | 5.29E+01 | 2.35E+03 |
| Zn-65 | 2.32E+00 | 7.51E+01 | 2.57E+01 | 8.33E+02 |
| Sr-89 | 7.08E+00 | 2.23E+02 | 7.88E+01 | 2.49E+03 |
| Sr-90 | 2.69E+02 | 8.48E+03 | 3.01E+03 | 9.49E+04 |
| Zr-95 | 4.31E-01 | 1.42E+01 | 4.83E+00 | 1.59E+02 |
| Sb-124 | 7.86E-01 | 2.63E+01 | 8.86E+00 | 2.96E+02 |
| Sb-125 | 7.78E-01 | 3.04E+01 | 8.66E+00 | 3.37E+02 |
| I-131 | 4.80E+01 | 1.51E+03 | 5.38E+02 | 1.70E+04 |
| I-133 | 5.12E-01 | 1.61E+01 | 6.81E+00 | 2.15E+02 |
| Cs-134 | 9.88E+00 | 3.28E+02 | 1.10E+02 | 3.66E+03 |
| Cs-137 | 1.01E+01 | 3.44E+02 | 1.13E+02 | 3.85E+03 |
| Ba-140 | 7.02E-02 | 3.27E+00 | 1.10E+00 | 3.53E+01 |
| Ce-141 | 1.06E-01 | 3.37E+00 | 1.22E+00 | 3.88E+01 |
| Ce-144 | 2.40E+00 | 7.60E+01 | 2.69E+01 | 8.52E+02 |

## 2.0 METHOD TO CALCULATE OFF-SITE LIQUID CONCENTRATIONS

Chapter 2 contains the basis for plant procedures that the plant operator requires to meet Technical Specification 3.8.A.1 which limits the total fraction of combined effluent concentration in liquid pathways, excluding noble gases, denoted here as $F_1^{ENG}$, at the point of discharge at any time (see Figure 6-1). $F_1^{ENG}$ is limited to less than or equal to one, i.e.,

$$F_1^{ENG} \leq 1$$

The total concentration of all dissolved and entrained noble gases at the point of discharge from all station sources, denoted $C_1^{NG}$, is limited to 2E-04 µCi/ml, i.e.,

$C_1^{NG} \leq$ 2E-04 µCi/ml.

Evaluation of $F_1^{ENG}$ and $C_1^{NG}$ is required concurrent with the sampling and analysis program in Technical Specification Table 4.8.1.

### 2.1 Method to Determine $F_1^{ENG}$ and $C_1^{NG}$

Determine the total fraction of combined effluent concentrations at the point of discharge in liquid pathways (excluding noble gases), denoted $F_1^{ENG}$, and determine the total concentration at the point of discharge of all dissolved and entrained noble gases in liquid pathways from all station sources, denoted $C_1^{NG}$, as follows:

$$F_1^{ENG} = \sum_i \frac{C_{pi}}{ECL_i} \leq 1 \qquad (2\text{-}1)$$

$$\left(\frac{\mu Ci/ml}{\mu Ci/ml}\right)$$

and:

$$C_1^{NG} = \sum_i C_{1i}^{NG} \leq 2E\text{-}04 \qquad (2\text{-}2)$$

($\mu$Ci/ml) ($\mu$Ci/ml) ($\mu$Ci/ml)

where:

$F_1^{ENG}$ = Total fraction of combined effluent concentrations in liquid pathways, excluding noble gases, at the point of discharge to an unrestricted area.

$C_{pi}$ = Concentration at point of discharge to an unrestricted area of radionuclide "i", except for dissolved and entrained noble gases, from any tank or other significant source, p, from which a discharge may be made (including the floor drain sample tank, the waste sample tanks, the detergent waste tank and any other significant source from which a discharge can be made) ($\mu$Ci/ml). This concentration can be calculated from: $C_{pi} = C_{TK1} \times F_{TK}/[F_{DIL} + F_{TK}]$ where: $C_{TK1}$ equals the concentration of radionuclide i in the tank to be discharged ($\mu$Ci/ml); $F_{DIL}$ is equal to the dilution flow provided by the liquid radioactive waste dilution pumps (20,000 gpm); $F_{TK}$ equals the liquid waste discharge pump flow rate which regulates the rate at which liquid from a waste collection tank is discharged (gpm).

$ECL_i$ = Annual average effluent concentration limits of radionuclide "i", except for dissolved and entrained noble gases, from 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2 ($\mu$Ci/ml).

$C_1^{NG}$ = Total concentration at point of discharge to an unrestricted area of all dissolved and entrained noble gases in liquid pathways from all station sources ($\mu$Ci/ml).

$C_{1i}^{NG}$ = Concentration at point of discharge to an unrestricted area of dissolved and entrained noble gas "i" in liquid pathways from all station sources ($\mu$Ci/ml).

## 2.2 Method to Determine Radionuclide Concentration for Each Liquid Effluent Pathway

### 2.2.1 Sample Tanks Pathways

$C_{pi}$ is determined for each radionuclide above LLD from the activity in a representative grab sample of any of the sample tanks and the predicted flow at the point of discharge to an unrestricted area.

Most periodic batch releases are made from the two 10,000-gallon capacity waste sample tanks. These tanks serve to hold all the high purity liquid wastes after they have been filtered through the waste collector and processed by ion exchange in the fuel pool and waste demineralizers. Other periodic batch releases may also come from the detergent waste tank or the floor drain sample tank.

The tanks are sampled from the radwaste sample sink and the contents analyzed for water quality and radioactivity. If the sample meets all the high purity requirements, the contents of the tank may be re-used in the nuclear system. If the sample does not meet all the high purity requirements, the contents are recycled through the radwaste system or discharged.

Prior to discharge each sample tank is analyzed for tritium, dissolved noble gases and dissolved and suspended gamma emitters.

### 2.2.2 Service Water Pathway

The service water pathway shown on Figure 6-1, flows from the intake structure through the heat exchangers and the discharge structure. Under normal operating conditions, the water in this line is not radioactive. For this reason, the service water line is not sampled routinely but it is continuously monitored with the service water discharge monitor (No. 17/351).

The alarm setpoint on the service water discharge monitor is set at a level which is three times the background of the instrument. The service water is sampled if the monitor is out of service or if the alarm sounds.

Under expected or anticipated operating conditions, the concentration at any time of radionuclides at the point of discharge from the service water effluent pathway to an unrestricted area will not exceed the effluent concentration values of 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2.

2.2.3 Circulating Water Pathway

The circulating water pathway shown on Figure 6-1, flows from the intake structure through the condenser and the discharge structure. Under normal operating conditions, the water in this line is not radioactive. For this reason, the circulating water line is not sampled routinely but it is monitored continuously by the discharge process monitor (No. 17/359) located in the discharge structure.

The alarm setpoint on the discharge process monitor is set at a level which is three times the background of the instrument. The circulating water is sampled if the monitor is out of service of if the alarm sounds.

Under normal operating conditions, the average concentration of radionuclides at the point of discharge from the circulating water pathway to an unrestricted area will not exceed the annual effluent concentration limits in 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2.

## 3.0 OFF-SITE DOSE CALCULATION METHODS

Chapter 3 provides the basis for plant procedures required to meet the 10CFR50, Appendix I, ALARA dose objectives, and the 40CFR190 total dose limits to members of the public in unrestricted areas, as stated in the Radiological Effluent Technical Specifications (hereafter called RETS). A simple, conservative method (called Method I) is listed in Tables 1.1-2 to 1.1-7 for each of the requirements of the RETS. Each of the Method I equations is presented, along with their bases in Sections 3.2 through 3.9 and Section 3.11. Appendix A provides example calculations for all Method I dose equations as guidance to their use. In addition, reference is provided to more sophisticated methods (called Method II) for use when more accurate results are needed. This chapter provides the methods, data, and reference material with which the operator can calculate the needed doses and dose rates. Setpoint methods for effluent monitor alarms are described in Chapter 5.

Demonstration of compliance with the dose limits of 40CFR190 is considered to be a demonstration of compliance with the 0.1 rem limit of 10CFR20.1301(a)(1) for members of the public in unrestricted areas (Reference 56 FR23374, 3rd column).

## 3.1 Introductory Concepts

The Radiological Effluent Technical Specifications (RETS) either limit dose or dose rate. The term "Dose" for ingested or inhaled radioactivity means the dose commitment, measured in mrem, which results from the exposure to radioactive materials that, because of uptake and deposition in the body, will continue to expose the body to radiation for some period of time after the source of radioactivity is stopped. The time frame over which the dose commitment is evaluated is 50 years. The phrases "annual Dose" or "Dose in one year" then refers to the fifty-year dose commitment from one year's worth of releases. "Dose in a quarter" similarly means a fifty-year dose commitment from one quarter's releases. The term "Dose," with respect to external exposures, such as to noble gas clouds, refer only to the doses received during the actual time period of exposure to the radioactivity released from the plant. Once the source of the radioactivity is removed, there is no longer any additional accumulation to the dose commitment.

Gaseous effluents from the plant are also controlled such that the maximum "dose rates" at the site boundary at any time are limited to 500 mrem/year. This instantaneous dose rate limit allows for operational flexibility when off normal occurrences may temporarily increase gaseous effluent release rates from the plant, while still providing controls to ensure that licensees meet the dose objectives of Appendix I to 10CFR50.

It should also be noted that a dose rate due to noble gases that exceeds for a short time period (less than one hour in duration) the equivalent 500 mrem/year dose rate limit stated in Technical Specification 3.8.E.1.a, does not necessarily, by itself, constitute a Licensee Event Report (LER) under 10CFR Part 50.73 unless it is determined that the air concentration of radioactive effluents in unrestricted areas has also exceeded 20 times applicable concentration limits specified in Appendix B to 20.1001 - 20.2401, Table 2, Column 1 (four-hour notification per 10CFR50.72, and 30-day LER per 10CFR50.73).

The quantities D and $\dot{R}$ are introduced to provide calculable quantities, related to off-site dose, or dose rate which demonstrates compliance with the RETS.

The dose D is the quantity calculated by the Chapter 3 dose equations. The D calculated by "Method I" equations is not necessarily the actual dose

received by a real individual but usually provides an upper bound for a given release because of the conservative margin built into the dose factors and the selection and definition of critical receptors. The radioisotope specific dose factors in each "Method I" dose equation represent the greatest dose to any organ of any age group accounting for existing or potential pathways of exposure. The critical receptor assumed by "Method I" equations is typically a hypothetical individual whose behavior - in terms of location and intake - results in a dose which is expected to be higher than any real individual. Method II allows for a more exact dose calculation for real individuals, if necessary, by considering only existing pathways of exposure, or actual concurrent meteorology with the recorded release.

$\dot{R}$ is the quantity calculated in the Chapter 3 dose rate equations. It is calculated using the plant's effluent monitoring system reading and an annual average or long-term atmospheric dispersion factor. Dispersion factors based on actual concurrent meteorology during effluent releases can also be used via Method II, if necessary, to demonstrate compliance with off-site dose rate limits.

Each of the methods to calculate dose or dose rate are presented in separate sections of Chapter 3, and are summarized in Tables 1.1-1 to 1.1-7. Each method has two levels of complexity and conservative margin and are called Method I and Method II. Method I has the greatest margin and is the simplest; generally a linear equation. Method II is a more detailed analysis which allows for use of site-specific factors and variable parameters to be selected to best fit the actual release. Guidance is provided but the appropriate margin and depth of analysis are determined in each instance at the time of analysis under Method II.

The plant has both elevated and ground level gaseous release points: the main vent stack (elevated release), the Turbine Building roof vents (ground level release), and the waste oil burner (ground level release). Therefore, total dose calculations for skin, whole body, and the critical organ from gaseous releases will be the sum of the elevated and ground level doses. Appendix D provides an assessment of the surveillance needs for waste oil to ensure that off-site doses from its incineration is maintained within the ALARA limits of the Technical Specifications.

## 3.2 Method to Calculate the Total Body Dose from Liquid Releases

Technical Specification 3.8.B.1 limits the total body dose commitment to a Member of the Public from radioactive material in liquid effluents to 1.5 mrem per quarter and 3 mrem per year. Technical Specification 3.8.C.1 requires liquid radwaste treatment when the total body dose estimate exceeds 0.06 mrem in any month. Technical Specification 3.8.M.1 limits the total body dose commitment to any real member of the public from all station sources (including liquids) to 25 mrem in a year. Dose evaluation is required at least once per month. If the liquid radwaste treatment system is not being used, dose evaluation is required before each release.

Use Method I first to calculate the maximum total body dose from a liquid release to the Connecticut River as it is simpler to execute and more conservative than Method II.

Use Method II if a more accurate calculation of total body dose is needed (i.e., Method I indicates the dose is greater than the limit), or if Method I cannot be applied.

If the radwaste system is not operating, the total body dose must be estimated prior to a release (Specification 3.8.C.1). To evaluate the total body dose, use Equation 3.1 to estimate the dose from the planned release and add this to the total body dose accumulated from prior releases during the month.

### 3.2.1 Method I

The increment in total body dose from a liquid release is:

$$D_{tb} = \sum_i Q_i \, DFL_{itb} \qquad (3\text{-}1)$$

$$(\text{mrem}) \; (\text{Ci}) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

where:

$DFL_{itb}$ = Site-specific total body dose factor (mrem/Ci) for a liquid release. See Table 1.1-11.

$Q_i$ = Total activity (Ci) released for radionuclide "i". (For strontiums and Fe-55, use the most recent measurement available.)

Equation 3-1 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event),

2. Liquid releases were to the Connecticut River, and

3. Any continuous or batch release over any time period.

3.2.2 Basis for Method I

This section serves three purposes: (1) to document that Method I complies with appropriate NRC regulations, (2) to provide background and training information to Method I users, and (3) to provide an introductory user's guide to Method II.

Method I may be used to show that the Technical Specifications which limit off-site total body dose from liquids (3.8.B.1 and 3.8.C.1) have been met for releases over the appropriate periods. Technical Specification 3.8.B.1 is based on the ALARA design objectives in 10CFR50, Appendix I Subsection II A. Technical Specification 3.8.C.1 is an "appropriate fraction", determined by the NRC, of that design objective (hereafter called the Objective). Technical Specification 3.8.M.1 is based on Environmental Standards for Uranium Fuel Cycle in 40CFR190 (hereafter called the Standard) which applies to direct radiation as well as liquid and gaseous effluents.

Exceeding the Objective or the Standard does not immediately limit plant operation but requires a report to the NRC within 30 days. In addition, a waiver may be required.

Method I was developed such that "the actual exposure of an individual ... is unlikely to be substantially underestimated" (10CFR50, Appendix I). The definition, below, of a single "critical receptor" (a hypothetical individual whose behavior results in an unrealistically high dose) provides part of the conservative margin to the calculation of total body dose in Method I. Method II allows that actual individuals, with real behaviors, be taken into account for any given release. In fact, Method I was based on a Method II analysis for the critical receptor with maximum exposure conditions instead of any real individual. That analysis was called the "base case"; it was then reduced to form Method I.

The steps performed in the Method I derivation follow. First, in the base case, the dose impact to the critical receptor (in the form of dose factors $DFL_{itb}$, mrem/Ci) for a 1 curie release of each radioisotope in liquid effluents was derived. The base case analysis uses the methods, data and assumptions in Regulatory Guide 1.109 (Equations A-2, A-3, A-7, A-13 and A-16, Reference A). The liquid pathways identified as contributing to an individual's dose are the consumption of fish from the Connecticut River, the ingestion of vegetables and leafy vegetation which were irrigated by river water, the consumption of milk and meat from cows and beef cattle who had river water available for drinking as well as having feed grown on irrigated land, and the direct exposure from the ground plane associated with activity deposited by the water pathway. A plant discharge flow rate of 44.6 $ft^3$/sec was used with a mixing ratio of 0.0346 which corresponds to a minimum regulated river flow of 1250 cfs at the Vernon Dam just below the plant discharge outfall.* Tables 3.2-1 and 3.2-2 outline human consumption and environmental parameters used in the analysis. The resulting, site-specific, total body dose factors appear in Table 1.1-11.

For any liquid release, during any period, the increment in annual average total body dose from radionuclide "i" is:

$$\Delta D_{tb} = Q_i \, DFL_{itb} \qquad (3\text{-}2)$$

$$(\text{mrem}) \; (\text{Ci}) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

* An Mp equal to 1.0 for the fish pathway is assumed between the discharge structure and the dam.

where:

$DFL_{itb}$ = Site-specific total body dose factor (mrem/Ci) for a liquid release. See Table 1.1.11.

$Q_i$ = Total activity (Ci) released from radionuclide "i".

Method I is conservative because it is based on dose factors $DFL_{itb}$ which were chosen from the base case to be the highest of the four age groups for each radionuclide, as well as assuming minimum river dilution flow.

3.2.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit or if a more exact calculation is required, then Method II should be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable, such as the use of actual river flow at the time of actual discharge as opposed to the minimum river flow of 1,260 cfs that is assumed in the Method I dose factors (except for the fish pathway). The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

TABLE 3.2-1

Environmental Parameters for Liquid Effluents at Vermont Yankee
(Derived from Reference A)

| VARIABLE | | | POTABLE WATER | AQUATIC FOOD | SHORELINE ACTIVITY | FOOD GROWN WITH CONTAMINATED WATER | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | VEGETABLES | LEAFY VEG. | MEAT | COW MILK |
| MP | Mixing Ratio | | - | 1.0 | 0.0356 | 0.0356 | 0.0356 | 0.0356 | 0.0356 |
| TP | Transit Time | (HRS) | - | 24.0 | 0.0 | 0.0 | 0.0 | 480.0 | 48.0 |
| YV | Agricultural Productivity | ($KG/M^2$) | | | | 2.0 | 2.0 | 2.0 | 2.0 |
| P | Soil Surface Density | ($KG/M^2$) | | | | 240.0 | 240.0 | 240.0 | 240.0 |
| IRR | Irrigation Rate | ($L/M^2/HR$) | | | | 0.152 | 0.152 | 0.152 | 0.152 |
| TE | Crop Exposure Time | (HRS) | | | | 1440.0 | 1440.0 | 1440.0 | 1440.0 |
| TH | Holdup Time | (L/D) | | | | 1440.0 | 24.0 | 2160.0 | 2160.0 |
| QAW | Water Uptake Rate for Animal | (KG/D) | | | | | | 50.0 | 60.0 |
| QF | Feed Uptake Rate for Animal | | | | | | | 50.0 | 50.0 |
| FI | Fraction of Year Crops Irrigated | | | | | 0.5 | 0.5 | 0.5 | 0.5 |
| | Location of Critical Receptor | | Connecticut River Below Vernon Dam | | | | | | |

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TABLE 3.2-2

Usage Factors for Various Liquid Pathways at Vermont Yankee
(From Reference A, Table E-5. Zero Where No Pathway Exists)

| AGE | VEG. | LEAFY VEG. | MILK | MEAT | FISH | INVERT. | POTABLE WATER | SHORELINE |
|---|---|---|---|---|---|---|---|---|
| | (KG/YR) | (KG/YR) | (LITER/YR) | (KG/YR) | (KG/YR) | (KG/YR) | (LITER/YR) | (HR/YR) |
| Adult | 520.00 | 64.00 | 310.00 | 110.00 | 21.00 | 0.00 | 0.00 | 12.00 |
| Teen | 630.00 | 42.00 | 400.00 | 65.00 | 16.00 | 0.00 | 0.00 | 67.00 |
| Child | 520.00 | 26.00 | 330.00 | 41.00 | 6.90 | 0.00 | 0.00 | 14.00 |
| Infant | 0.00 | 0.00 | 330.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## 3.3 Method to Calculate Maximum Organ Dose from Liquid Releases

Technical Specification 3.8.B.1 limits the maximum organ dose commitment to a Member of the Public from radioactive material in liquid effluents to 5 mrem per quarter and 10 mrem per year. Technical Specification 3.8.C.1 requires liquid radwaste treatment when the maximum organ dose estimate exceeds 0.2 mrem in any month. Technical Specification 3.8.M.1 limits the maximum organ dose commitment to any real member of the public from all station sources (including liquids) to 25 mrem in a year except for the thyroid, which is limited to 75 mrem in a year. Dose evaluation is required at least once per month if releases have occurred. If the liquid radwaste treatment system is not being used, dose evaluation is required before each release.

Use Method I first to calculate the maximum organ dose from a liquid release to the Connecticut River as it is simpler to execute and more conservative than Method II.

Use Method II if a more accurate calculation of organ dose is needed (i.e., Method I indicates the dose is greater than the limit), or if Method I cannot be applied.

If the radwaste system is not operating, the maximum organ dose must be estimated prior to a release (Specification 3.8.C.1). To evaluate the maximum organ dose, use Equation 3-3 to estimate the dose from the planned release and add this to the maximum organ dose accumulated from prior releases during the month.

### 3.3.1 Method I

The increment in maximum organ dose from a liquid release is:

$$D_{mo} = \sum_i Q_i \, DFL_{imo} \qquad (3\text{-}3)$$

$$(\text{mrem (Ci)}) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

where:

$DFL_{imo}$ = Site-specific maximum organ dose factor (mrem/Ci) for a liquid release. See Table 1.1-11.

$Q_i$ = Total activity (Ci) released for radionuclide "i". (For strontiums and Fe-55, use the most recent measurement available.)

Equation 3-3 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event),
2. Liquid releases were to the Connecticut River, and
3. Any continuous or batch release over any time period.

3.3.2 Basis for Method I

This section serves three purposes: (1) to document that Method I complies with appropriate NRC regulations, (2) to provide background and training information to Method I users, and (3) to provide an introductory user's guide to Method II. The methods to calculate maximum organ dose parallel the total body dose methods (see Section 3.2.2). Only the differences are presented here.

For each radionuclide, a dose factor (mrem/Ci) was determined for each of seven organs and four age groups. The largest of these was chosen to be the maximum organ dose factor ($DFL_{imo}$) for that radionuclide.

For any liquid release, during any period, the increment in annual average dose from radionuclide "i" to the maximum organ is:

$$\Delta D_{mo} = Q_i \, DFL_{imo} \qquad (3\text{-}4)$$

$$(\text{mrem}) \; (\text{Ci}) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

where:

$DFL_{imo}$ = Site-specific maximum organ dose factor (mrem/Ci) for a liquid release. See Table 1.1-11.

$Q_i$ = Total activity (Ci) released for radionuclide "i".

Because of the assumptions about receptors, environment, and radionuclides; and because of the low Objective and Standard, the lack of immediate restriction on plant operation, and the adherence to 10CFR20 concentrations (which limit public health consequences) a failure of Method I (i.e., the exposure of a real individual being underestimated) is improbable and the consequences of a failure are minimal.

3.3.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit or if a more exact calculation is required, then Method II should be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

## 3.4 Method to Calculate the Total Body Dose Rate From Noble Gases

Technical Specification 3.8.E.1 limits the instantaneous dose rate at any time to the total body from all release sources of noble gases at any location at or beyond the site boundary equal to or less than 500 mrem/year.

Use Method I first to calculate the Total Body Dose Rate from the peak release rate via both elevated and ground level release points. The dose rate limit of Technical Specification 3.8.E.1.a is the total contribution from both ground and elevated releases occurring during the period of interest.

Use Method II if Method I predicts a dose rate greater than the Technical Specification limit (i.e., use of actual meteorology over the period of interest) to determine if, in fact, Technical Specification 3.8.E.1 had actually been exceeded during a short time interval.

Compliance with the dose rate limits for noble gases are continuously demonstrated when effluent release rates are below the plant stack noble gas activity monitor alarm setpoint by virtue of the fact that the alarm setpoint is based on a value which corresponds to the off-site dose rate limit of Technical Specification 3.8.E.1, or a value below it, taking into account the potential contribution of releases from all ground level sources.

Determinations of dose rates for compliance with Technical Specifications (3.8.E.1) are performed when the effluent monitor alarm setpoint is exceeded and the corrective action required by Specification 3.8.E.2 is unsuccessful, or as required by the notations to Technical Specification Table 3.9.2 when the stack noble gas monitor is inoperable.

### 3.4.1 Method I

The Total Body Dose Rate due to noble gases can be determined by multiplying the individual radionuclide release rates by their respective dose factors, summing all the products together, and then multiplying this total by a conversion constant (0.70), as seen in the following Equation 3-5 (an example calculation is provided in Appendix A):

$$\dot{R}_{tbs} = 0.70 \sum_i \dot{Q}_i^{ST} \; DFB_i \qquad (3\text{-}5)$$

$$\left(\frac{mrem}{yr}\right) \quad \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) \quad \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

$\dot{Q}_i^{ST}$ = In the case of noble gases, the release rate from the plant stack (μCi/sec) for each radionuclide, "i", identified. The release rate at the plant stack is based on the measured radionuclide distribution in the off-gas at the Steam Jet Air Ejector (SJAE) during plant operation when the activity at the stack is below detectable levels, and the recorded total gas effluent count rate from the Stack Gas Monitor I or II. The release rate at the stack can also be stated as follows:

$$\dot{Q}_i^{ST} = \frac{\dot{Q}_i^{SJAE}}{\sum_i \dot{Q}_i^{SJAE}} \; M \; \frac{1}{S_g} \; F \qquad (3\text{-}28)$$

$$\frac{uCi}{sec} = (cpm)\left(\frac{\mu Ci/cc}{cpm}\right)\frac{(cc)}{sec}$$

M = Plant Stack Gas Monitor I or II count rate (cpm).

$S_g$ = Appropriate or conservative plant stack monitor detector counting efficiency for the given nuclide mix (cpm/(μCi/cc)).

F = Stack flow rate (cc/sec).

$\dot{Q}_i^{SJAE}$ = The last measured release rate at the steam jet air ejector of noble gas i (μCi/sec).

$DFB_i$ = Total body gamma dose factor (see Table 1.1-10).

For ground level noble gas releases, the total body dose rate is calculated as follows:

$$\dot{R}_{tbg} = 4.0 \sum_i \dot{Q}_i^{GL} \quad DFB_i \qquad (3\text{-}39)$$

$$\left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

$\dot{Q}_i^{GL}$ = Ground level release rate (μCi/sec) of noble gas.

The total body dose rate for the site is equal to $\dot{R}_{tbs} + \dot{R}_{tbg}$.

During periods (beyond the first five days) when the plant is shutdown and no radioactivity release rates can be measured at the SJAE, Xe-133 may be used in place of the last SJAE measured mix as the referenced radionuclide to determine off-site dose rate and monitor setpoints. In this case, the ratio of each $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation 3-28 above is assumed to reduce to a value of 1, and the total body gamma dose factor $DFB_i$ for Xe-133 (2.94 E-04 mrem-$m^3$/pCi-yr) is used in Equation 3-5. Alternately, a relative radionuclide "i" mix fraction ($f_i$) may be taken from Table 5.2-1 as a function of time after shutdown, and substituted in place of the ratio of $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation (3-28) above to determine the relative fraction of each noble gas potentially available for release to the total (example calculations can be found in Appendix A). Just prior to plant startup before a SJAE sample can be taken and analyzed, the monitor alarm setpoints should be based on Xe-138 as representing the most prevalent high dose factor noble gas expected to be present shortly after the plant returns

to power. Monitor alarm setpoints which have been determined to be conservative under any plant conditions may be utilized at any time in lieu of the above assumptions.

Equations 3-5 and 3-39 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via the elevated and ground level vents to the atmosphere.

3.4.2 Basis for Method I

Method I may be used to show that the Technical Specification which limits total body dose rate from noble gases released to the atmosphere (Technical Specification 3.8.E.1) has been met for the peak noble gas release rate.

Method I for stack releases was derived from Regulatory Guide 1.109 as follows:

$$R_{tbs} = 1E+06\ S_F\ [X/Q]_S^T \sum_i \dot{Q}_i^{ST}\ DFB_i \qquad (3\text{-}6)$$

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi}{\mu Ci}\right)(\#)\left(\frac{sec}{m^3}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

$S_F$ = Shielding factor = 1.0 for dose rate determination.

$[X/Q]_S^T$ = Maximum annual average gamma atmospheric dispersion factor for stack (elevated) releases; = 6.98E-07 ($sec/m^3$).

$\dot{Q}_i^{ST}$ = Release rate from the plant stack of noble gas "i" ($\mu$Ci/sec).

$DFB_i$ = Gamma total body dose factor, $\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$. See Table 1.1-10.

Equation 3-6 reduces to:

$$\dot{R}_{tbs} = 0.70 \sum_i \dot{Q}_i^{ST} \; DFB_i \qquad (3\text{-}5)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) = \left(\frac{\text{pCi-sec}}{\mu\text{Ci-m}^3}\right)\left(\frac{\mu\text{Ci}}{\text{sec}}\right)\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$$

For ground level releases, the ground level maximum annual average gamma atmospheric dispersion factor = 3.95E-06 sec/$m^3$, thus leading to:

$$\dot{R}_{tbg} = 1E+06 * 3.95E\text{-}06 \sum_i \dot{Q}_i^{GL} \; DFB_i \qquad (3\text{-}39)$$

or

$$\dot{R}_{tbg} = 4.0 \sum_i \dot{Q}_i^{GL} \; DFB_i$$

The selection of critical receptor, outlined in Section 3.10, is inherent in Method I, as are the maximum expected off-site annual or long-term average atmospheric dispersion factors. Due to the holdup and decay of gases allowed in the AOG, off-gas concentrations at the plant stack during routine plant operations are usually too low for determination of the radionuclide mix at the plant stack. It is then conservatively assumed that most of the noble gas activity at the plant stack is the result of in-plant steam leaks which are removed to the plant stack by building ventilation air flow, and that this air flow has an isotopic distribution consistent with that routinely measured at the SJAE.

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Regarding the calculation of ground level release doses from the Turbine Building Roof Vents or waste oil burner vent, the ground level atmospheric dispersion factors are based on the same methodologies as used for the stack dispersion factors (same noble gas mix, meteorological history [1981-1985], and meteorological models), and are for the site boundary location that will have the highest dose.

In the case of noble gas dose rates, Method II cannot provide much extra realism because $\dot{R}_{tbs}$ and $\dot{R}_{tbg}$ are already based on several factors which make use of current plant parameters. However, should it be needed, the dose rate analysis for critical receptor can be performed making use of current meteorology during the time interval of recorded peak release rate in place of the default atmospheric dispersion factor used in Method I.

3.4.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

## 3.5 Method to Calculate the Skin Dose Rate from Noble Gases

Technical Specification 3.8.E.1 limits the instantaneous dose rate at any time to the skin from all release sources of noble gases at any location at or beyond the site boundary to 3,000 mrem/year.

Use Method I first to calculate the Skin Dose Rate from both elevated and ground level release points to the atmosphere. The dose rate limit of Technical Specification 3.8.E.1.a is the total contribution from both ground and elevated releases occurring during the period of interest. Method I applies at all release rates.

Use Method II if Method I predicts a dose rate greater than the Technical Specification limits (i.e., use of actual meteorology over the period of interest) to determine if, in fact, Technical Specification 3.8.E.1 had actually been exceeded during a short time interval.

Compliance with the dose rate limits for noble gases are continuously demonstrated when effluent release rates are below the plant stack noble gas activity monitor alarm setpoint by virtue of the fact that the alarm setpoint is based on a value which corresponds to the off-site Technical Specification dose rate limit, or a value below it, taking into account the potential contribution releases from all ground level sources.

Determinations of dose rate for compliance with Technical Specifications (3.8.E.1) are performed when the effluent monitor alarm setpoint is exceeded and the corrective action required by Specification 3.8.E.2 is unsuccessful, or as required by the notations to Technical Specification Table 3.9.2 when the stack noble gas monitor is inoperable.

### 3.5.1 Method I

The skin dose rate due to noble gases is determined by multiplying the individual radionuclide release rates by their respective dose factors, and summing all the products together as seen in the following Equation 3-7 (an example calculation is provided in Appendix A):

### 3.6.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

## 3.7 Method to Calculate the Gamma Air Dose from Noble Gases

Technical Specification 3.8.F.1 limits the gamma dose to air from all release sources of noble gases at any location at or beyond the site boundary to 5 mrad in any quarter and 10 mrad in any year. Dose evaluation is required at least once per month.

Use Method I first to calculate the gamma air dose for elevated and ground level vent releases during the period. The total gamma air dose limit of Technical Specification 3.8.F.1 is the total contribution from both ground and elevated releases occurring during the period of interest.

Use Method II if a more accurate calculation is needed.

### 3.7.1 Method I

The gamma air dose from plant stack releases is:

$$D_{airs}^{\gamma} = 0.022 \sum_{i} Q_i^{ST} \quad DF_i^{\gamma} \qquad (3\text{-}21)$$

$$(\text{mrad}) \quad \left(\frac{\text{pCi-yr}}{\text{Ci-m}^3}\right) \quad (\text{Ci}) \left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$$

where:

$Q_i^{ST}$ = total noble gas activity (Curies) released to the atmosphere via the plant stack of each radionuclide "i" during the period of interest.

$DF_i^{\gamma}$ = gamma dose factor to air for radionuclide "i". See Table 1.1-10

For ground level noble gas releases, the gamma air dose is calculated as follows:

$$D^{\gamma}_{airg} = 0.13 \sum_{i} Q_i^{GL} DF_i^{\gamma} \qquad (3\text{-}41)$$

where:

$Q_i^{GL}$ = Total noble gas activity (curies) released to the atmosphere via ground level vents of each radionuclide, "i", during the period of interest.

The gamma air dose for the site is equal to $D^{\gamma}_{airs} + D^{\gamma}_{airg}$.

Equations 3-21 and 3-41 can be applied under the following conditions (otherwise justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via the plant stack, Turbine Building vents, and waste oil burner to the atmosphere.

3.7.2 Basis for Method I

Method I may be used to show that the Technical Specification which limits off-site gamma air dose from gaseous effluents (3.8.F.1) has been met for releases over appropriate periods. This Technical Specification is based on the Objective in 10CFR50, Appendix I, Subsection B.1, which limits the estimated annual gamma air dose at unrestricted area locations.

Exceeding the Objective does not immediately limit plant operation but requires a report to the NRC.

For any noble gas release, in any period, the dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109 with the added assumption that $D^{\gamma}_{finite} = D^{\gamma}[X/Q]^{\gamma}/[X/Q]$:

$$D^{\Upsilon}_{airs} = 3.17E{+}04\ [X/Q]^{\Upsilon}_{S} \sum_{i} Q_i^{ST}\ DF_i^{\Upsilon} \qquad (3\text{-}22)$$

$$(\text{mrad})\left(\frac{\text{pCi-yr}}{\text{Ci-sec}}\right)(\text{sec/m}^3)\ (\text{Ci})\left(\frac{\text{mrad-m}^3}{\text{yr-pCi}}\right)$$

where:

$[X/Q]^{\Upsilon}_{S}$ = maximum annual average gamma atmospheric dispersion factor for a stack release.

= 6.98E-07 ($\text{sec/m}^3$)

$Q_i^{ST}$ = number of curies of noble gas "i" released from the plant stack

which leads to:

$$D^{\Upsilon}_{airs} = 0.022 \sum_{i} Q_i^{ST}\ DF_i^{\Upsilon} \qquad (3\text{-}21)$$

$$(\text{mrad})\left(\frac{\text{pCi-yr}}{\text{Ci-m}^3}\right)\ (\text{Ci})\left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$$

For the ground level release:

$$D^{\Upsilon}_{airg} = 3.17E{+}04\ [X/Q]^{\Upsilon}_{g} \sum_{i} Q_i^{GL}\ DF_i^{\Upsilon} \qquad (3\text{-}42)$$

where:

$(X/Q)_g^Y$ = Maximum annual average gamma atmospheric dispersion factor for a ground level release

= 3.95E-06 $sec/m^3$

leading to:

$$D_{airg}^{Y} = 0.13 \sum_i Q_i^{GL} DF_i^{Y} \qquad (3\text{-}41)$$

Regarding the calculation of ground level release doses from the Turbine Building roof vent and waste oil burner, the ground level atmospheric dispersion factors are based on the same methodologies as used for the stack dispersion factors (same noble gas mix, meteorological history [1981-1985], and meteorological models), and are for the site boundary location that will have the highest dose.

The main difference between Method I and Method II is that Method II would allow the use of actual meteorology to determine $[X/Q]^Y$ rather than use the maximum long-term average value obtained for the years 1981 to 1985.

3.7.3 Method II

If the Method I dose determination indicates that the Technical Specification limit may be exceeded, or if a more exact calculation is required, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

## 3.8 Method to Calculate the Beta Air Dose from Noble Gases

Technical Specification 3.8.F.1 limits the beta dose to air from all release sources of noble gases at any location at or beyond the site boundary to 10 mrad in any quarter and 20 mrad in any year. Dose evaluation is required at least once per month.

Use Method I first to calculate the beta air dose for elevated and ground level vent releases during the period. The total beta air dose limit of Technical Specification 3.8.F.1 is the total contribution from both ground and elevated releases occurring during the period of interest.

Use Method II if a more accurate calculation is needed or if Method I cannot be applied.

### 3.8.1 Method I

The beta air dose from plant vent stack releases is:

$$D^{\beta}_{airs} = 0.019 \sum_{i} Q_i^{ST} \, DF_i^{\beta} \qquad (3\text{-}23)$$

$$(\text{mrad}) \left(\frac{\text{pCi-yr}}{\text{Ci-m}^3}\right) (\text{Ci}) \left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$$

where:

$DF_i^{\beta}$ = beta dose factor to air for radionuclide "i". See Table 1.1-10.

$Q_i^{ST}$ = total noble gas activity (Curies) released to the atmosphere via the plant stack of each radionuclide "i" during the period of interest.

For ground level noble gas releases, the beta air dose is calculated as follows:

$$D^{\beta}_{air_g} = 0.55 \sum_i Q_i^{GL} DF_i^{\beta} \qquad (3\text{-}43)$$

where:

$Q_i^{GL}$ = Total noble gas activity (curies) released to the atmosphere via the ground level vents of each radionuclide "i" during the period of interest.

The beta air dose for the site is equal to $D^{\beta}_{airs} + D^{\beta}_{airg}$.

Equations 3-23 and 3-43 can be applied under the following conditions (otherwise justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via the plant stack, Turbine Building vents, and waste oil burner to the atmosphere.

3.8.2 Basis for Method I

This section serves three purposes: (1) to document that Method I complies with appropriate NRC regulations, (2) to provide background and training information to Method I users, and (3) to provide an introductory user's guide to Method II. The methods to calculate beta air dose parallel the gamma air dose methods in Section 3.7.3. Only the differences are presented here.

Method I may be used to show that the Technical Specification which limits off-site beta air dose from gaseous effluents (3.8.A.1) has been met for releases over appropriate periods. This Technical Specification is based on the Objective in 10CFR50, Appendix I, Subsection B.1, which limits the estimated annual beta air dose at unrestricted area locations.

Exceeding the Objective does not immediately limit plant operation but requires a report to the NRC within 30 days.

For any noble gas release, in any period, the dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109:

$$D^{\beta}_{airs} = 3.17E{+}04 \quad X/Q_s \sum_i Q_i^{ST} \quad DF_i^{\beta} \qquad (3\text{-}24)$$

$$(\text{mrad}) \quad \left(\frac{\text{pCi-yr}}{\text{Ci-sec}}\right)\left(\frac{\text{sec}}{\text{m}^3}\right) \quad (\text{Ci}) \left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$$

substituting

$X/Q_s$ = Maximum annual average undepleted atmospheric dispersion factor for a stack release.

= 5.99E-07 $sec/m^3$

We have

$$D^{\beta}_{airs} = 0.019 \sum_i Q_i^{ST} \quad DF_i^{\beta} \qquad (3\text{-}23)$$

$$(\text{mrad}) \quad \left(\frac{\text{pCi-yr}}{\text{Ci-m}^3}\right) \quad (\text{Ci}) \left(\frac{\text{mrad-m}^3}{\text{pCi-yr}}\right)$$

For the ground level release:

$$D^{\beta}_{airg} = 3.17E{+}04 \, (X/Q)_g \sum_i Q_i^{GL} \, DF_i^{\beta} \qquad (3\text{-}44)$$

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where:

$(X/Q)_g$ = Maximum annual average undepleted atmospheric dispersion factor for a ground level release.

= 1.74E-05 $sec/m^3$

leading to:

$$D^{\beta}_{airg} = 0.55 \sum_i Q_i^{GL} DF_i^{\beta} \qquad (3\text{-}43)$$

Regarding the calculation of ground level release doses from the Turbine Building roof vents and waste oil burner, the ground level atmospheric dispersion factors are based on the same methodologies as used for the stack dispersion factors (same noble gas mix, meteorological history [1981-1985], and meteorological models), and are for the site boundary location that will have the highest dose.

3.8.3 Method II

If Method I cannot be applied, or if the Method I dose determination indicates that the Technical Specification limit may be exceeded, or if a more exact calculation is required, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

## 3.9 Method to Calculate the Critical Organ Dose from Iodines, Tritium and Particulates

Technical Specification 3.8.G.1 limits the critical organ dose to a Member of the Public from all release sources of I-131, I-133, Tritium, and particulates with half-lives greater than 8 days (hereafter called "I+P") in gaseous effluents to 7.5 mrem per quarter and 15 mrem per year.

Use Method I first to calculate the critical organ dose from both elevated and ground level vent releases. The total critical organ dose limit of Technical Specification 3.8.G.1 is the total contribution from both ground level and elevated releases occurring during the period of interest.

Use Method II if a more accurate calculation of critical organ dose is needed (i.e., Method I indicates the dose is greater than the limit).

### 3.9.1 Method I

$$D_{cos} = \sum_i Q_i^{STP} \, DFG_{sico} \qquad (3\text{-}25)$$

(mrem) (Ci) $\left(\frac{\text{mrem}}{\text{Ci}}\right)$

$Q_i^{STP}$ = Total activity (Ci) released from the stack to the atmosphere of radionuclide "i" during the period of interest. For strontiums and tritium, use the most recent measurement.

$DFG_{sico}$ = Site-specific critical organ dose factor for a stack gaseous release of radionuclide "i" (mrem/Ci). For each radionuclide it is the age group and organ with the largest dose factor. See Table 1.1-12.

The critical organ dose is calculated for ground level releases as follows:

$$D_{cog} = \sum_i Q_i^{GLP} \, DFG_{gico} \qquad (3\text{-}44)$$

(mrem) (Ci) $\left(\frac{\text{mrem}}{\text{Ci}}\right)$

$Q_i^{GLP}$ = Total activity (Ci) released from ground level vents to the atmosphere of radionuclide "i" during the period of interest. For tritium, strontiums, and Fe-55 use the most recent measure.

$DFG_{gico}$ = Site-specific critical organ dose factor for a ground level release of nuclide "i" (mrem/Ci). For each radionuclide it is the age group and organ with the largest dose factor. See Table 1.1-12.

The critical organ dose for the site is equal to $D_{cos} + D_{cog}$.

Equations 3-25 and 3-44 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event),

2. I+P releases via the plant stack, Turbine Building, and waste oil burner (see Appendix D for surveillance criteria on waste oil burning), to the atmosphere, and

3. Any continuous or batch release over any time period.

3.9.2 Basis for Method I

This section serves three purposes: (1) to document that Method I complies with appropriate NRC regulations, (2) to provide background and training information to Method I users, and (3) to provide an introductory user's guide to Method II.

Method I may be used to show that the Technical Specifications which limit off-site organ dose from gases (3.8.G.1) have been met for releases over the appropriate periods.

Method I was developed such that "the actual exposure of an individual ... is unlikely to be substantially underestimated" (10CFR50, Appendix I). The use below of a single "critical receptor" provides part of the conservative margin to the calculation of critical organ dose in Method I. Method II allows that actual individuals, with real behaviors, be taken into account for any given release. In fact, Method I was based on a Method II analysis of the critical receptor for the annual average conditions. For purposes of complying with the Technical Specifications 3.8.G.2 maximum annual average atmospheric dispersion factors are appropriate for batch and continuous releases. That analysis was called the "base case"; it was then reduced to form Method I. The base case, the method of reduction, and the assumptions and data used are presented below.

The steps performed in the Method I derivation follow. First, in the base case, the dose impact to the critical receptor in the form of dose factors (mrem/Ci) of 1 curie release of each I+P radionuclide to gaseous effluents was derived. Then Method I was determined using simplifying and further conservative assumptions. The base case analysis uses the methods, data and assumptions in Regulatory Guide 1.109 (Equations C-2, C-4 and C-13 in Reference A). Tables 3.9-1 and 3.9-2 outline human consumption and environmental parameters used in the analysis. It is conservatively assumed that the critical receptor lives at the "maximum off-site atmospheric dispersion factor location" as defined in Section 3.10. However, he is exposed, conservatively, to all pathways (see Section 3.10). The resulting site-specific dose factors are for the maximum organ and the age group with the highest dose factor for that organ. These critical organ, critical age dose factors are given in Table 1.1-12.

For any gas release, during any period, the increment in annual average dose from radionuclide "i" is:

$$\Delta D_{ico} = Q_i DFG_{ico} \qquad (3\text{-}26)$$

where $DFG_{ico}$ is the critical dose factor for radionuclide "i" and $Q_i$ is the activity of radionuclide "i" released in curies.

Method I is more conservative than Method II in the region of the Technical Specification limits because it is based on the following reduction of the base case. The dose factors $DFG_{ico}$ used in Method I were chosen from the base case to be the highest of the set for that radionuclide. In effect each radionuclide is conservatively represented by its own critical age group and critical organ.

### 3.9.3 METHOD II

If Method I cannot be applied, or if the Method I dose exceeds the limit or if a more exact calculation is required, then Method II should be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

TABLE 3.9-1

Environmental Parameters for Gaseous Effluents at Vermont Yankee
(Derived from Reference A)*

| | Variable | | Vegetables | | Cow Milk | | Goat Milk | | Meat | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Stored | Leafy | Pasture | Stored | Pasture | Stored | Pasture | Stored |
| YV | Agricultural Productivity | ($Kg/M^2$) | 2. | 2. | 0.70 | 2. | 0.70 | 2. | 0.70 | 2. |
| | Soil Surface Density | ($KG/M^2$) | 240. | 240. | 240. | 240. | 240. | 240. | 240. | 240. |
| T | Transport Time to User | (HRS) | | | 48. | 48. | 48. | 48. | 480. | 480. |
| TB | Soil Exposure Time(1) | (HRS) | 131400. | 131400. | 131400. | 131400. | 131400. | 131400. | 131400. | 131400. |
| TF | Crop Exposure Time to Plume | (HRS) | 1440. | 1440. | 720. | 1440. | 720. | 1440. | 720. | 1440. |
| TH | Holdup After Harvest | (HRS) | 1440. | 24. | 0. | 2160. | 0. | 2160. | 0. | 2160. |
| QF | Animals Daily Feed | (KG/DAY) | | | 50. | 50. | 6. | 6. | 50. | 50. |
| FP | Fraction of Year on Pasture(2) | | | | 0.50 | | 0.50 | | 0.50 | |
| FS | Fraction Pasture When on Pasture(3) | | | | 1. | | 1. | | 1. | |
| FG | Fraction of Stored Veg. Grown in Garden | | 0.76 | | | | | | | |
| FL | Fraction of Leafy Veg. Grown in Garden | | | 0.50 | | | | | | |
| FI | Fraction Elemental Iodine = 0.5 | | | | | | | | | |
| A | Absolute Humidity = 5.6 ($gm/M^3$)(4) | | | | | | | | | |

*Regulatory Guide 1.109, Revision 1.

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TABLE 3.9-1
(Continued)

Notes:

(1) For Method II dose/dose rate analyses of identified radioactivity releases of less than one year, the soil exposure time for that release may be set at 8760 hours (1 year) for all pathways.

(2) For Method II dose/dose rate analyses performed for releases occurring during the first or fourth calendar quarters, the fraction of time animals are assumed to be on pasture is zero (nongrowing season). For the second and third calendar quarters, the fraction of time on pasture (FP) will be set at 1.0. FP may also be adjusted for specific farm locations if this information is so identified and reported as part of the land use census.

(3) For Method II analyses, the fraction of pasture feed while on pasture may be set to less than 1.0 for specific farm locations if this information is so identified and reported as part of the land use census.

(4) For all Method II analyses, an absolute humidity value equal to 5.6 ($gm/m^3$) shall be used to reflect conditions in the Northeast (Reference: Health Physics Journal, Vol. 39 (August), 1980; Page 318-320, Pergammon Press).

TABLE 3.9-2

Usage Factors for Various Gaseous Pathways at Vermont Yankee
(from Regulatory Guide 1.109, Table E-5)

| Age Group | Vegetables (kg/yr) | Leafy Vegetables (kg/yr) | Milk (l/yr) | Meat (kg/yr) | Inhalation ($m^3$/yr) |
|---|---|---|---|---|---|
| Adult | 520.00 | 64.00 | 310.00 | 110.00 | 8000.00 |
| Teen | 630.00 | 42.00 | 400.00 | 65.00 | 8000.00 |
| Child | 520.00 | 26.00 | 330.00 | 41.00 | 3700.00 |
| Infant | 0.00 | 0.00 | 330.00 | 0.00 | 1400.00 |

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## 3.10 Receptor Points and Annual Average Atmospheric Dispersion Factors for Important Exposure Pathways

The gaseous effluent dose methods have been simplified by assuming an individual whose behavior and living habits inevitably lead to a higher dose than anyone else. The following exposure pathways to gaseous effluents listed in Regulatory Guide 1.109 (Reference A) have been considered:

1. Direct exposure to contaminated air;
2. Direct exposure to contaminated ground;
3. Inhalation of air;
4. Ingestion of vegetables;
5. Ingestion of cow's milk; and
6. Ingestion of meat.

Section 3.10.1 details the selection of important off-site locations and receptors. Section 3.10.2 describes the atmospheric model used to convert meteorologic data into atmospheric dispersion factors. Section 3.10.3 presents the maximum atmospheric dispersion factors calculated at each of the off-site receptor locations.

### 3.10.1 Receptor Locations

Three important receptor locations are considered in the dose and dose rate equations for gaseous radioactive effluents. They are:

1. The point of maximum gamma exposure from an overhead noble gas cloud;

2. The point of maximum ground level air concentration and deposition of radionuclides.

The point of maximum gamma exposure (S sector, 400 meters) was determined by finding the maximum five-year average gamma X/Q at any off-site location. The location of the maximum ground level air concentration and deposition of radionuclides (NW sector, 2900 meters) was determined by finding the maximum five-year average depleted X/Q and D/Q at any off-site location. For the purposes of determining the Method I dose factors for iodines, tritium, and particulates, a milk animal was assumed to exist at the location

of highest calculated ground level air concentration and deposition as noted above. This location then conservatively bounds the deposition of radionuclides at all real milk animal locations.

Regarding the calculation of ground level release doses from the Turbine Building roof vents or waste oil burner, the selection of a critical receptor is based on the site boundary with the highest ground level atmospheric dispersion factor (based on same meteorological history as used for the stack) and the assumption that all of the exposure pathways used for the stack release occur at this site boundary.

3.10.2 Vermont Yankee Atmospheric Dispersion Model

The annual average atmospheric dispersion factors are computed for routine (long-term) releases using Yankee Atomic Electric Company's (YAEC) AEOLUS Computer Code (Reference B). AEOLUS is based, in part, on the straight-line airflow model discussed in Regulatory Guide 1.111 (Reference C). The valley in which the plant is located is considered by the model.

AEOLUS produces the following annual average atmospheric dispersion factors for each location:

1. Undepleted X/Q dispersion factors for evaluating ground level concentrations;

2. Depleted X/Q dispersion factors for evaluating ground level concentrations;

3. Gamma X/Q dispersion factors for evaluating gamma dose rates from a sector averaged finite cloud (multiple energy undepleted source); and

4. D/Q deposition factors for evaluating dry deposition of elemental radioiodines and other particulates.

The deposition velocity concept presented in "Meteorology and Atomic Energy - 1968" (Reference E, Section S-3.2) is used to determine the depleted X/Q and D/Q factors, assuming a constant deposition velocity of 1 cm/sec.

Gamma dose rate is calculated throughout this ODCM using the finite cloud model presented in "Meteorology and Atomic Energy - 1968" (Reference E, Section 7-5.2.5). That model is implemented through the definition of an effective gamma atmospheric dispersion factor, $[X/Q^{\gamma}]$ (Reference B, Section 6), and the replacement of X/Q in infinite cloud dose equations by the $[X/Q^{\gamma}]$.

3.10.3 Annual Average Atmospheric Dispersion Factors for Receptors

Actual measured meteorological data for the five-year period, 1981 through 1985, were analyzed to determine all the values and locations of the maximum off-site annual average atmospheric dispersion factors. Each dose and dose rate calculation incorporates the maximum applicable off-site annual average atmospheric dispersion factor. The values used and their locations are summarized in Table 3.10-1. Table 3.10-1 also indicates which atmospheric dispersion factors are used to calculate the various doses or dose rates of interest.

TABLE 3.10-1

Vermont Yankee Dilution Factors

| | Dose Rate to Individual | | | Dose to Air | |
|---|---|---|---|---|---|
| | Total Body | Skin | Critical Organ | Gamma | Beta |
| X/Q depleted $\left(\frac{sec}{m^3}\right)$ | - | - | 5.85E-07(2)<br>(1.65E-05)(3) | - | - |
| X/Q undepleted $\left(\frac{sec}{m^3}\right)$ | - | 5.99E-07(2)<br>(1.74E-05)(3) | - | - | 5.99E-07(2)<br>(1.74E-05)(3) |
| D/Q $\left(\frac{1}{m^2}\right)$ | - | - | 5.85E-09(2)<br>(6.50E-08)(3) | - | - |
| $X/Q^Y$ depleted $\left(\frac{sec}{m^3}\right)$ | 6.98E-07(1)<br>(3.95E-06)(3) | 6.98E-07(1)<br>(3.95E-06)(3) | - | 6.98E-07(1)<br>(3.95E-06)(3) | - |

(1) Maximum gamma exposure point: S sector, 400 meters (0.25 miles), for stack release.
(2) Maximum ground level concentration: NW sector, 2900 meters (1.80 miles), for stack release.
(3) Turbine Building (ground level release) maximum dilution factors: S Sector, 366 meters (0.23 miles).

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## 3.11 Method to Calculate Direct Dose From Plant Operation

Technical Specification 3.8.M.1 restricts the dose to the whole body or any organ to any member of the public from all station sources (including direct radiation from fixed sources on-site) to 25 mrem in a calendar year (except the thyroid, which is limited to 75 mrem).

### 3.11.1 Turbine Building

The maximum contribution of direct dose to the whole body or to any organ due to N-16 decay from the turbine is:

$$D_d = K_{N16}(L) * E \qquad (3\text{-}27)$$

$$(\text{mrem}) \quad \frac{(\text{mrem})}{MW_e h} \quad (MW_e h)$$

where:

$D_d$ = The dose contribution from N-16 decay at either the site boundary of maximum impact (west site boundary) or closest off-site residence - (mrem).

$E$ = Gross electric output over the period of interest ($MW_e h$).

$K_{N16}(L)$ = The N-16 dose conversion factor for (L) equal to either:
(1) 3.23E-06 for the maximum west site boundary; or
(2) 1.29E-06 for the closest residence ($mrem/MW_e h$).

### 3.11.2 North Warehouse

Radioactive materials and low level waste can be stored in the north warehouse. The maximum annual dose contributions to off-site receptors (west site boundary line) from sources in the shielded (east) end and the unshielded (west) end of the north warehouse are:

$$D_S = 0.25 \times \dot{R}_S \quad \text{for the shielded end} \qquad (3\text{-}28)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right)$$

$$\text{and} \qquad D_U = 0.53 \times \dot{R}_U \quad \text{for the unshielded end} \qquad (3\text{-}29)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right)$$

where:

$D_S$ = The annual dose contribution at the maximum site boundary location from fixed sources of radiation stored in the shielded east end of the North Warehouse $\left(\frac{\text{mrem}}{\text{yr}}\right)$.

$D_U$ = The annual dose contribution at the maximum site boundary location from fixed sources of radiation stored in the unshielded west end of the North Warehouse $\left(\frac{\text{mrem}}{\text{yr}}\right)$.

$\dot{R}_S$ = Dose rate measured at 1 meter from the source in the shielded end of the north warehouse $\left(\frac{\text{mrem}}{\text{hr}}\right)$.

$\dot{R}_U$ = Dose rate measured at 1 meter from the source in the unshielded end of the north warehouse $\left(\frac{\text{mrem}}{\text{hr}}\right)$.

0.25 = Dose rate to dose conversion factor which relates mrem/yr at the west site boundary per mrem/hr measured at 1 meter from the source in the shielded end of the warehouse assuming it is full to capacity for one year $\left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right)$.

0.53 = Dose rate to dose conversion factor which relates mrem/yr at the west site boundary per mrem/hr measured at 1 meter from the source in the unshielded end of the warehouse assuming it is full to capacity for one year $\left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right)$.

3.11.3 Low Level Waste Storage Pad

Interim storage of packaged Dry Active Waste (DAW) and spent ion exchange and filter media is permitted in modular concrete storage overpacks on the LLW storage pad facility adjacent to the north warehouse. The arrangement of the storage modules is such that DAW is placed in modules which shield higher activity ion exchange media from the west site boundary. The dose at the maximum site boundary receptor from both direct radiation and skyshine scatter can be calculated as follows:

(a) Direct Dose (line of sight)

$$D_{dE} = 0.28 \times \dot{R}_d \times f_d \qquad (3\text{-}30)$$

$$\left(\frac{\text{mrem}}{\text{yr-module}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right) \quad (\#)$$

or

$$D_{dS} = 0.39 \times \dot{R}_d \; f_d \qquad (3\text{-}31)$$

$$\left(\frac{\text{mrem}}{\text{yr-module}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right) (\#)$$

where:

$D_{dE}$ = The annual direct dose contribution at the maximum site boundary from a single rectangular storage module which has an unobstructed short end surface (not shielded by other modules) orientated toward the west site boundary $\left(\frac{\text{mrem}}{\text{yr-module}}\right)$.

$D_{dS}$ = The annual direct dose contribution at the maximum site boundary from a single rectangular storage module which has an unobstructed long side surface (not shielded by other modules) orientated toward the west site boundary $\left(\frac{\text{mrem}}{\text{yr-module}}\right)$.

$\dot{R}_d$ = Maximum dose rate measured at 3' from the side of the storage module whose unobstructed face (i.e., a side or end surface which is not shielded by other waste modules) is toward the west site boundary.

$f_d$ = The fraction of a year that a storage module is in use on the storage pad.

0.28 = Dose rate to dose conversion factor which relates mrem/yr at the west site boundary per mrem/hr measured at 3' from the narrow end of the rectangular storage module when that face is orientated toward the west boundary.

0.39 = Dose rate to dose conversion factor which relates mrem/yr at the west site boundary per mrem/hr measured at 3' from the long side of the rectangular storage module when that face is orientated toward the west boundary.

(b) Scatter From Skyshine

$$D_{SKR} = 0.016 \times \dot{R}_{SKR} \times f_{sk} \qquad (3\text{-}32)$$

$$\left(\frac{\text{mrem}}{\text{yr-liner}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right) \quad (\#)$$

and

$$D_{SKD} = 0.015 \times \dot{R}_{SKD} \times f_{SK} \qquad (3\text{-}33)$$

$$\left(\frac{\text{mrem}}{\text{yr-module}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right) \quad (\#)$$

where:

$R_{SKR}$ = The annual skyshine scatter contribution to the dose at the maximum site boundary from a single spent ion exchange media liner in a storage module whose top surface is not obstructed due to stacking of modules $\left(\frac{\text{mrem}}{\text{yr-liner}}\right)$.

$R_{SKD}$ = The annual skyshine scatter contribution to the dose at the maximum site boundary from a rectangular storage module containing DAW whose top surface is not obstructed due to stacking of modules $\left(\frac{\text{mrem}}{\text{yr-module}}\right)$.

$\dot{R}_{SKR}$ = For Resins, the maximum dose rate measured at 3' over the top of each liner in a storage module (mrem/hr).

$\dot{R}_{SKD}$ = For DAW, the maximum dose rate measured at 3' over the top surface of a storage module with DAW (mrem/hr).

$f_{SK}$ = The fraction of a year that a storage module is in use on the storage pad.

0.016 = Dose rate to dose conversion factor for the scatter dose from each resin liner so[illegible] storage which relates mrem/yr at the west site boundary per mrem/hour at 3' from the top of the module.

0.015 = Dose rate to dose conversion factor for the scatter dose from DAW boxes in storage which relat[illegible]m/yr at the west site boundary per mrem/hr at 3'[illegible]e top of the module.

(c) Dose From Resin Liners During Transfer

During the movement of resin liners from transfer casks to the storage modules, the liners will be unshielded in the storage pad area for a short period of time. The maximum contribution at the site boundary during the unshielded movemen[illegible] of resin liners can be calculated from:

$$D_{trans} = 0.0025 \times \dot{R}_{tran} \times T_{trans} \qquad (3\text{-}34)$$

$$(mrem) \quad \left(\frac{mrem/hr}{rad/hr}\right) \quad \left(\frac{rad}{hr}\right) \quad (hr)$$

where:

$D_{trans}$ = The dose contribution to maximum site boundary resulting from the unshielded movement of resin

liners between a transfer cask and a storage module (mrem).

$\dot{R}_{trans}$ = Dose rate measured at contact (2") from the unshielded trans top surface of the resin liner in R/hr.

$T_{tran}$ = The time (in hours) that an unshielded resin liner is exposed in the storage pad area.

0.0025 = The dose rate to dose conversion factor for an unshielded resin liner which relates mrem/hour at the west site boundary per rad/hr at contact (2") from the unshielded surface of the liner.

(d) Intermodular Gap Dose

In addition to the above methods for determining doses at the west site boundary from the LLW storage pad, another dose assessment model has been included to address the possible condition of spaces or gaps existing between the placement of the DAW storage modules situated along the west facing side of the pad. This could result in a radiation streaming condition existing if ion exchange resin liners were placed in storage directly behind the gap. The direct dose equations (3-30 and 3-31) consider that the storage modules situated on the outside of the pad area provide a uniform shield to storage modules placed behind them. The intermodular gap dose equation (3-35) accounts for any physical spacing between the outside storage modules which have not been covered by additional external shielding.

$$D_{Gap} = 2.44E\text{-}2 \times W_{Gap} \times A_{RL} \times f_{Gap} \qquad (3\text{-}36)$$

$$\left(\frac{mrem}{yr}\right) \quad \left(\frac{mrem}{yr\text{-}in\text{-}Ci}\right) \quad (in) \quad (Ci) \quad (\#)$$

where:

$D_{Gap}$ = The annual dose contribution at the maximum site boundary (west) from radiation streaming through the intermodular gap between DAW storage modules used to shield resin modules from direct radiation (mrem/yr).

$W_{Gap}$ = The intermodular gap width (inches) between adjacent DAW storage modules facing the west site boundary.

$A_{RL}$ = The total gamma activity contained in a condensate resin liner stored directly in line with the intermodular gap adjacent DAW modules ( Ci).

$f_{Gap}$ = The fraction of a year that the intermodular gap is not shielded.

2.44E-2 = The activity to site boundary dose conversion factor for a one-inch wide intermodular gap $\left(\frac{\text{mrem}}{\text{yr-in-Ci}}\right)$.

The site boundary dose from waste materials placed into storage on the Low Level Waste Storage Pad Facility is determined by combining the dose contribution due to direct radiation (line of sight) from Part (a) above with the skyshine scatter dose from Part (b), resin liner transfer dose from Part (c), and any intermodular gap dose from Part (d).

3.11.4 Total Direct Dose Summary

The dose contributions from the N-16 source in the Turbine Building, fixed sources in the north warehouse, and fixed sources on the Low Level Waste Storage Pad Facility, shall be combined to obtain the estimate of total off-site dose to any member of the public from all fixed sources of radiation located on-site.

## 3.12 Cumulative Doses

Cumulative Doses for a calendar quarter and a calendar year must be maintained to demonstrate a compliance with Technical Specifications 3.8.B.1, 3.8.F.1 and 3.8.G.1 (10CFR50, Appendix I dose objectives). In addition, if the requirements of Technical Specification 3.8.M.2 dictate, cumulative doses over a calendar year must be determined for Technical Specification 3.8.M.1 (demonstration of compliance with total dose, including direct radiation per requirements of 40CFR190). To ensure the limits are not exceeded, a running total must be kept for each release.

Demonstration of compliance with the dose limits of 40CFR190 is considered as demonstrating compliance with the 0.1 rem limit of 10CFR20.1301(a)(1) for members of the public in unrestricted areas.

## 5.0 SETPOINT DETERMINATIONS

Chapter 5 contains the basis for plant procedures that the plant operator requires to meet the setpoint requirements of the Radioactive Effluent Monitoring Systems Technical Specifications. They are Specification 3.9.A.1 for liquids and Specification 3.9.B.1 for gases. Each outlines the instrumentation channels and the basis for each setpoint.

## 5.1 Liquid Effluent Instrumentation Setpoints

Technical Specification 3.9.A.1 requires that the radioactive liquid effluent instrumentation in Table 3.9.1 of the Technical Specifications have alarm setpoints in order to ensure that Specification 3.8.A.1 is not exceeded. Specification 3.8.A.1 limits the activity concentration at any time in liquid effluents to the appropriate effluent concentration values in Appendix B, Table 2, Column 2 of 10CFR20, and a total noble gas concentration limit of 2E-04 µCi/ml.

### 5.1.1 Liquid Radwaste Discharge Monitor (17/350)

The sample tank pathways shown on Figure 6-1 are monitored by the liquid radwaste discharge monitor (17/350). Periodic batch releases may be made from the waste sample tanks, detergent waste tank or floor drain sample tank.

#### 5.1.1.1 Method to Determine the Setpoint of the Liquid Radwaste Discharge Monitor (17/350)

The instrument response (in counts per second) for the limiting concentration at the point of discharge is the setpoint, denoted $R_{setpoint}$, and is determined as follows:

$$R_{setpoint} = \frac{DF}{DF_{min}} \quad S_1 \quad \sum_i \quad C_{mi} \qquad (5\text{-}1)$$

$$(cps) \quad (\#) \quad \left(\frac{cps\text{-}ml}{\mu Ci}\right) \quad \left(\frac{\mu Ci}{ml}\right)$$

Where:

$DF = \frac{F_d}{F_m}$ = Dilution factor (as a conservative measure, a DF of at least 1000 is used) (dimensionless). (5-2)

$F_m$ = Flow rate past monitor (gpm)

$F_d$ = Flow rate out of discharge canal (gpm)

$DF_{min}$ = Minimum allowable dilution factor (dimensionless)

$$= \sum_i \frac{C_{mi}}{ECL_i} \qquad (5\text{-}3)$$

$ECL_i$ = Effluent concentration values for radionuclide "i" from 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2 (µCi/ml)

$C_{mi}$ = Activity concentration of radionuclide "i" in mixture at the monitor (µCi/ml)

$S_l$ = Detector counting efficiency from the most recent liquid radwaste discharge monitor calibration curve (cps/(µCi/ml))

5.1.1.2 Liquid Radwaste Discharge Monitor Setpoint Example

The following alarm setpoint example is for a discharge of the floor drain sample tank. The liquid radwaste discharge monitor has a typical counting efficiency, $S_l$, of 4.9E+06 cps per 1 µCi/ml of gamma emitters which emit one photon per disintegration.

The activity concentration of each radionuclide, $C_{mi}$, in the floor drain sample tank is determined by analysis of a representative grab sample obtained at the radwaste sample sink. This setpoint example is based on the following data:

| i | $C_{mi}$ (µCi/ml) | $ECL_i$ (µCi/ml) |
|---|---|---|
| Cs-134 | 2.15E-05 | 9E-07 |
| Cs-137 | 7.48E-05 | 1E-06 |
| Co-60 | 2.56E-05 | 3E-06 |

$$\sum_i C_{mi} = 2.15E\text{-}05 + 7.48E\text{-}05 + 2.56E\text{-}05$$

$$\left(\frac{\mu Ci}{ml}\right) \quad \left(\frac{\mu Ci}{ml}\right) \quad \left(\frac{\mu Ci}{ml}\right) \quad \left(\frac{\mu Ci}{ml}\right)$$

$$= 1.22E\text{-}04$$

$$\left(\frac{\mu Ci}{ml}\right)$$

$$DF_{min} = \sum_i \frac{C_{mi}}{ECL_i} \qquad (5\text{-}3)$$

$$\left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right)$$

$$= \left[\frac{2.15E\text{-}05}{9E\text{-}07} + \frac{7.48E\text{-}05}{1E\text{-}06} + \frac{2.56E\text{-}05}{3E\text{-}06}\right]$$

$$\left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right) \quad \left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right) \quad \left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right)$$

$$= 107.2$$

The minimum dilution factor, $DF_{min}$, needed to discharge the mixture of radionuclides in this example is 108 (roundup). As a conservative measure, an actual dilution factor, DF, of 1,000 is usually used. The release rate of the floor drain sample tank may be adjusted from 0 to 50 gpm and the dilution pumps can supply up to 20,000 gpm of dilution water. With the dilution flow taken as 18,000 gpm, the release rate from the floor drain sample tank may be determined as follows:

$$F_m = \frac{Fd}{DF} \qquad (5\text{-}4)$$

(gpm) (gpm)

$$= \frac{18,000 \text{ gpm}}{1,000} = 18 \text{ gpm}$$

Under these conditions, the setpoint of the liquid radwaste discharge monitor is:

$$R_{setpoint} = \frac{DF}{DF_{min}} \quad S_1 \quad \sum_i C_{mi} \qquad (5\text{-}1)$$

$$(cps) \quad (\#) \quad \left(\frac{cps\text{-}ml}{\mu Ci}\right) \quad \left(\frac{\mu Ci}{ml}\right)$$

$$= \frac{1.000}{108} \quad 4.9E{+}06 \quad 1.22E{-}04$$

$$(cps) \quad (\#) \quad \left(\frac{cps\text{-}ml}{\mu Ci}\right) \quad \left(\frac{\mu Ci}{ml}\right)$$

$$= 5,535 \text{ cps}$$

In this example, the count rate alarm of the liquid radwaste discharge monitor should be set at 5,535 cps above background.

5.1.1.3 Basis for the Liquid Radwaste Discharge Monitor Setpoint

The liquid radwaste discharge monitor setpoint must ensure that Specification 3.8.A.1 is not exceeded for the appropriate in-plant pathways. The liquid radwaste discharge monitor is placed upstream of the major source of dilution flow and responds to the concentration of radioactivity as follows:

$$R = \sum_i C_{mi} \quad S_{1i} \qquad (5\text{-}5)$$

$$(cps) \quad \left(\frac{\mu Ci}{ml}\right) \left(\frac{cps\text{-}ml}{\mu Ci}\right)$$

Where:

$R$ = Response of the monitor (cps)

$S_{1i}$ = Detector counting efficiency for radionuclide "i" (cps/(μCi/ml))

$C_{mi}$ = Activity concentration of radionuclide "i" in mixture at the monitor (μCi/ml)

The detector calibration procedure establishes a counting efficiency for a given mix of nuclides seen by the detector. Therefore, in Equation 5-5 one may substitute $S_1$ for $S_{1i}$, where $S_1$ represents the counting efficiency determined for the current mix of nuclides. If the mix of nuclides changes significantly, a new counting efficiency should be determined for calculating the setpoint.

$$R = S_1 \sum_i C_{mi} \qquad (5\text{-}6)$$

$$(cps) \quad \left(\frac{cps\text{-}ml}{\mu Ci}\right) \quad \left(\frac{\mu Ci}{ml}\right)$$

The effluent concentration for a given radionuclide must not exceed 10 times the 10 CFR Part 20 ECL at the point of discharge to an unrestricted area at any time. When a mixture of radionuclides is present, the concentration at the point of discharge to an unrestricted area shall be limited as follows:

$$\sum_i \frac{C_{di}}{ECL_i} \leq 1 \qquad (5\text{-}7)$$

$$\left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right)$$

Where:

$C_{di}$ = Activity concentration of radionuclide "i" in the mixture at the point of discharge to an unrestricted area ($\mu$Ci/ml)

$ECL_i$ = Effluent concentration limit for radionuclide "i" from 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2 ($\mu$Ci/ml)

The activity concentration of radionuclide "i" at the point of discharge is related to the activity concentration of radionuclide "i" at the monitor as follows:

$$C_{di} = C_{mi} \cdot \frac{F_m}{F_d} \qquad (5\text{-}8)$$

$$\left(\frac{\mu Ci}{ml}\right) \left(\frac{\mu Ci}{ml}\right) \left(\frac{gpm}{gpm}\right)$$

Where:

$C_{di}$ = Activity concentration of radionuclide "i" in the mixture at the point of discharge (μCi/ml)

$F_m$ = Flow rate past monitor (gpm)

$F_d$ = Flow rate out of discharge canal (gpm)

Substituting the right half of Equation 5-8 for $C_{di}$ in Equation 5-7 and solving for $F_d/F_m$ yields the minimum dilution factor needed to comply with Equation 5-7:

$$DF_{min} \leq \frac{F_d}{F_m} \geq \sum_i \frac{C_{mi}}{ECL_i} \qquad (5\text{-}3)$$

$$\left(\frac{gpm}{gpm}\right) \qquad \left(\frac{\mu Ci\text{-}ml}{ml\text{-}\mu Ci}\right)$$

Where:

$F_d$ = Flow rate out of discharge canal (gpm)

$F_m$ = Flow rate past monitor (gpm)

$C_{mi}$ = Activity concentration of radionuclide "i" in mixture at the monitor (μCi/ml)

$ECL_i$ = Effluent concentration limit for radionuclide "i" from 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2 (μCi/ml)

If $F_d/F_m$ is less than $DF_{min}$, then the tank may not be discharged until either $F_d$ or $F_m$ or both are adjusted such that:

$$\frac{F_d}{F_m} \geq DF_{min} \qquad (5\text{-}3)$$

$$\left(\frac{gpm}{gpm}\right)$$

Usually $F_d/F_m$ is greater than $DF_{min}$ (i.e., there is more dilution than necessary to comply with Equation 5-7). The response of the liquid radwaste discharge monitor at the setpoint is therefore:

$$R_{setpoint} = \frac{DF}{DF_{min}} S_1 \sum_i C_{mi} \qquad (5\text{-}1)$$

$$(cps) \quad (\#) \left(\frac{cps\text{-}ml}{\mu Ci}\right) \left(\frac{\mu Ci}{ml}\right)$$

5.1.2 Service Water Discharge Monitor (17/351)

The service water pathway shown on Figure 6-1 is continuously monitored by the service water discharge monitor (17/351). The water in this line is not radioactive under normal operating conditions. The alarm setpoint on this monitor is set at a level which is three times the background of the instrument. The service water is sampled if the monitor is out of service or if the alarm sounds.

Under normal operating conditions, the concentration of radionuclides at the point of discharge to an unrestricted area from the service water effluent pathway will not exceed the effluent concentration limits specified in 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2.

## 5.2 Gaseous Effluent Instrumentation Setpoints

Technical Specification 3.9.B.1 requires that the radioactive gaseous effluent instrumentation in Table 3.9.2 of the Technical Specifications have their alarm setpoints set to insure that Technical Specifications 3.8.E.1 and 3.8.K.1 are not exceeded. Technical Specification 3.8.K.1 limits the gross radioactivity release rate at the steam jet air ejector (SJAE) to 0.16 Ci/sec.

### 5.2.1 Plant Stack Noble Gas Activity Monitors (RR-108-1A and RR-108-1B) and Augmented Off-Gas System Noble Gas Activity Monitors (3127 and 3128)

The plant stack and AOG noble gas activity monitors are shown on Figure 6-2.

#### 5.2.1.1 Method to Determine the Setpoint of the Plant Stack Noble Gas Activity Monitors (RR-108-1A and RR-108-1B) and the Augmented Off-Gas System Noble Gas Activity Monitors (3127 and 3128)

The setpoints of the plant stack and AOG system noble gas activity monitors are determined in the same manner. The plant stack or AOG system noble gas activity monitor response in counts per minute at the limiting off-site noble gas dose rate to the total body or to the skin is the setpoint, denoted $R_{spt}$. $R_{spt}$ is the lesser of:

$$R_{spt}^{tb} = 716 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DFB_c} \qquad (5\text{-}9)$$

$$(cpm) \quad \left(\frac{mrem\text{-}\mu Ci\text{-}m^3}{yr\text{-}pCi\text{-}sec}\right) \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right) \left(\frac{sec}{cm^3}\right) \left(\frac{pCi\text{-}yr}{mrem\text{-}m^3}\right)$$

and:

$$R_{spt}^{skin} = 3{,}000 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DF_c} \qquad (5\text{-}10)$$

$$(cpm) \quad \left(\frac{mrem}{yr}\right) \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right) \left(\frac{sec}{cm^3}\right) \left(\frac{\mu Ci\text{-}yr}{mrem\text{-}sec}\right)$$

where:

$R_{spt}^{tb}$ = Response of the monitor at the limiting total body dose rate (cpm)

$716 = \frac{500}{(1E+06)\ (6.98E-07)} \left(\frac{mrem\text{-}\mu Ci^3m}{yr\text{-}pCi\text{-}sec}\right)$

500 = Limiting total body dose rate (mrem/yr)

1E+06 = Number of pCi per µCi (pCi/µCi)

6.98E-07 = $[X/Q]^{\gamma}$, maximum five-year average gamma atmospheric dispersion factor ($sec/m^3$)

$S_g$ = Appropriate (plant stack or AOG system) detector counting efficiency from the most recent calibration (cpm/(μCi/cc))

F = Appropriate (plant stack or AOG system) flow rate ($cm^3/sec$)

$DFB_c$ = Composite total body dose factor (mrem-$m^3$/pCi-yr)

$$= \frac{\sum_i \dot{Q}_i \, DFB_i}{\sum_i \dot{Q}_i} \qquad (5\text{-}11)$$

$\dot{Q}_i$ = The relative release rate of noble gas "i" in the mixture at the monitor (either the stack, $\dot{Q}^{ST}$ or the AOG, $\dot{Q}^{AOG}$) for noble gases identified (μCi/sec)

$DFB_i$ = Total body dose factor (see Table 1.1-10) (mrem-$m^3$/pCi-yr)

$R_{spt}^{skin}$ = Response of the monitor at the limiting skin dose rate (cpm)

3,000 = Limiting skin dose rate (mrem/yr)

$DF'_c$ = Composite skin dose factor (mrem-sec/μCi-yr)

$$= \frac{\sum_i \dot{Q}_i \, DF'_i}{\sum_i \dot{Q}_i} \qquad (5\text{-}12)$$

$DF'_i$ = Combined skin dose factor (see Table 1.1-10) (mrem-sec/μCi-yr)

5.2.1.2 Plant Stack Noble Gas Activity Monitor Setpoint Example

The following setpoint example for the plant stack noble gas activity monitors demonstrates the use of equations 5-9 and 5-10 for determining setpoints.

The plant stack noble gas activity monitors, referred to as "Stack Gas I" (RR-108-1A) and "Stack Gas II" (RR-108-1B), consist of beta sensitive scintillation detectors, electronics, an analog ratemeter readout, and a digital scaler which counts the detector output pulses. A strip chart recorder provides a permanent record of the ratemeter output. The monitors have typical calibration factors, $S_g$, of 1E+08 cpm per 1 µCi/cc of noble gas. The nominal plant stack flow is 7.5E+07 cc/sec ((160,000 cfm x 28,300 $cc/ft^3$)/60 sec/min).

When monitor responses indicate that activity levels are below the LLDs at the stack (or AOG) monitors, the relative contribution of each noble gas radionuclide can conservatively be approximated by analysis of a sample of off-gas obtained during plant operations at the steam jet air ejector (SJAE). This setpoint example is based on the following data (see Table 1.1-10 for $DFB_i$ and $DF'_i$):

| i | $\dot{Q}_i^{SJAE}$ $(\frac{\mu Ci}{sec})$ | $DFB_i$ $(\frac{mrem\text{-}m^3}{pCi\text{-}yr})$ | $DF'_i$ $(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr})$ |
|---|---|---|---|
| Xe-138 | 1.03E+04 | 8.83E-03 | 9.60E-03 |
| Kr-87 | 4.73E+02 | 5.92E-03 | 1.06E-02 |
| Kr-88 | 2.57E+02 | 1.47E-02 | 1.32E-02 |
| Kr-85m | 1.20E+02 | 1.17E-03 | 1.83E-03 |
| Xe-135 | 3.70E+02 | 1.81E-03 | 2.60E-03 |
| Xe-133 | 1.97E+01 | 2.94E-04 | 4.57E-04 |

$$DFB_C = \frac{\sum_i \dot{Q}_i^{SJAE} DFB_i}{\sum_i \dot{Q}_i^{SJAE}} \qquad (5\text{-}11)$$

$$\sum_i \dot{Q}_i^{SJAE} DFB_i = (1.03E+04)(8.83E-03) + (4.73E-02)(5.92E-03)$$
$$+ (2.57E+02)(1.47E-02) + (1.20E+02)(1.17E-03)$$
$$+ (3.70E+02)(1.81E-03) + (1.97E+01)(2.94E-04)$$
$$= 9.83E+01 \ (\mu Ci\text{-}mrem\text{-}m^3/sec\text{-}pCi\text{-}yr)$$

$$\sum_i \dot{Q}_i^{SJAE} = 1.03E+04 + 4.73E+02 + 2.57E+02$$
$$+ 1.20E+02 + 3.70E+02 + 1.97E+01$$
$$= 1.15E+04 \ \mu Ci/sec$$

$$DFB_C = \frac{9.83E+01}{1.15E+04}$$

$$= 8.52E-03 \ (mrem\text{-}m^3/pCi\text{-}yr)$$

$$R_{spt}^{tb} = 716 \ S_g \frac{1}{F} \frac{1}{DFB_C}$$

$$= (716)\ (1E+08) \frac{1}{(7.5E+07)} \frac{1}{(8.52E-03)}$$

$$= 112{,}050 \ cpm$$

Next:

$$DF'_c = \frac{\sum_i \dot{Q}_i^{SJAE} DF'_i}{\sum_i \dot{Q}_i^{SJAE}} \qquad (5\text{-}11)$$

$$\sum_i \dot{Q}_i^{SJAE} DF'_i = (1.03E+04)(9.60E-03) + (4.73E-02)(1.06E-03)$$
$$+ (2.57E+02)(1.32E-02) + (1.20E+02)(1.83E-03)$$
$$+ (3.70E+02)(2.60E-03) + (1.97E+01)(4.57E-04)$$
$$= 1.04E+02 \ (\mu Ci\text{-}mrem\text{-}sec/sec\text{-}\mu Ci\text{-}yr)$$

$$DF'_c = \frac{1.04E+02}{1.15E+04}$$

$$= 9.04E-03 \ (mrem\text{-}sec/\mu Ci\text{-}yr)$$

$$R_{skin}^{spt} = 3,000 \ S_g \ \frac{1}{F} \ \frac{1}{DF'_c}$$

$$= (3,000) \ (1E+08) \ \frac{1}{(7.5E+07)} \ \frac{1}{(9.04E-03)}$$

$$= 442,478 \text{ cpm}$$

The setpoint, $R_{spt}$, is the lesser of $R_{spt}^{tb}$ and $R_{spt}^{skin}$. For the noble gas mixture in this example $R_{spt}^{tb}$ is less than $R_{spt}^{skin}$, indicating that the total body dose rate is more restrictive. Therefore, in this example the "Stack Gas I" and "Stack Gas II" noble gas activity monitors should each be set at 112,050 cpm above background or at some conservative value below this (such as that which might be based on controlling release rates from the plant in order to maintain off-site air concentrations below 20 x ECL when averaged over an hour), or to account for other minor releases from the Turbine Building roof vents or waste oil burner. For example, if an administrative limit of 70 percent of the Technical Specification whole body dose limit 500 rem/yr (112,050 cpm) is chosen, then the noble gas monitor alarms should be set at 78,435 cpm above background (0.7 x 112,050 = 78,435).

5.2.1.3 Basis for the Plant Stack and AOG System Noble Gas Activity Monitor Setpoints

The setpoints of the plant stack and AOG system noble gas activity monitors must ensure that Technical Specification 3.8.E.1.a is not exceeded. Sections 3.4 and 3.5 show that Equations 3-5 and 3-7 are acceptable methods for determining compliance with that Technical Specification. Which equation (i.e., dose to total body or skin) is more limiting depends on the noble gas mixture. Therefore, each equation must be considered separately. The derivations of Equations 5-9 and 5-10 begin with the general equation for the response R of a radiation monitor:

$$R = \sum_i S_{gi} \quad C_{mi} \tag{5-13}$$

$$(cpm) \quad \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right)\left(\frac{\mu Ci}{cm^3}\right)$$

where:

$R$ = Response of the instrument (cpm)

$S_{gi}$ = Detector counting efficiency for noble gas "i" ($cpm/(\mu Ci/cm^3)$)

$C_{mi}'$ = Activity concentration of noble gas "i" in the mixture at the noble gas activity monitor ($\mu Ci/cm^3$)

The relative release rate of each noble gas, $\dot{Q}_i$ ($\mu Ci/sec$), in the total release rate is normally determined by analysis of a sample of off-gas obtained at the Steam Jet Air Ejector (SJAE). Noble gas release rates at the plant stack and the AOG discharge are usually so low that the activity concentration is below the Lower Limit of Detection (LLD) for sample analysis. As a result, the release rate mix ratios measured at the SJAE are used to present any radioactivity being discharged from the stack, such as may have resulted from plant steam leaks that have been collected by building ventilation. For the AOG monitor downstream of the charcoal delay beds, this leads to a conservative setpoint since several short-lived (high dose factor) noble gas radionuclides are then assumed to be present at the monitor, which in reality, would not be expected to be present in the system at that point. During periods when the plant is shutdown (after five days), and no radioactivity release rates can be measured at the SJAE, Xe-133 is the dominant long-lived noble gas and may be used as the referenced radionuclide to determine off-site dose rates and monitor setpoints. Alternately, a relative radionuclide, "i", mix fraction, ($f_i$), may be taken from Table 5.2-1 as a function of time after shutdown (including periods shorter than five

$$R = S_g \quad \frac{1}{F} \sum_i \dot{Q}_i \qquad (5\text{-}16)$$

$$(cpm)\ \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right)\ \left(\frac{sec}{cm^3}\right) \quad \left(\frac{\mu Ci}{sec}\right)$$

The total body dose rate due to noble gases is determined with Equation 3-5:

$$\dot{R}_{tbs} = 0.70 \sum_i \dot{Q}_i \ DFB_i \qquad (3\text{-}5)$$

$$\left(\frac{mrem}{yr}\right)\ \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) \quad \left(\frac{\mu Ci}{sec}\right)\ \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

Where:

$\dot{R}_{tbs}$ = total body dose rate (mrem/yr) due to noble gases from stack release

0.70 = (1.0E+06) x (6.98E-07) (pCi-sec/$\mu$Ci-$m^3$)

1E + 06 = number of pCi per $\mu$Ci (pCi/$\mu$Ci)

6.98E - 07 = $[X/Q]^{\gamma}$, maximum annual average gamma atmospheric dispersion factor ($sec/m^3$)

$\dot{Q}_i$ = the release rate of noble gas "i" in the mixture for each noble gas identified ($\mu$Ci/sec) (Equivalent to $\dot{Q}_i^{ST}$ for noble gases released at the plant stack.)

$DFB_i$ = total body dose factor (see Table 1.1-10) (mrem-$m^3$/pCi-yr)

A composite total body gamma dose factor, $DFB_c$, may be defined such that:

$$DFB_C \sum_i \dot{Q}_i = \sum_i \dot{Q}_i \; DFB_i \qquad (5\text{-}17)$$

$$\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right) \quad \left(\frac{\mu\text{Ci}}{\text{sec}}\right) \qquad \left(\frac{\mu\text{Ci}}{\text{sec}}\right)\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$$

Solving Equation 5-23 for $DFB_C$ yields:

$$DFB_C = \frac{\sum_i \dot{Q}_i \; DFB_i}{\sum_i \dot{Q}_i} \qquad (5\text{-}11)$$

Technical Specification 3.8.E.1.a limits the dose rate to the total body from noble gases at any location at or beyond the site boundary to 500 mrem/yr. By setting $\dot{R}_{tb}$ equal to 500 mrem/yr and substituting $DFB_C$ for $DFB_i$ in Equation 3-5, one may solve for $\sum_i \dot{Q}_i$ at the limiting whole body noble gas dose rate:

$$\sum_i \dot{Q}_i = 716 \quad \frac{1}{DFB_C} \qquad (5\text{-}18)$$

$$\left(\frac{\mu\text{Ci}}{\text{sec}}\right) \left(\frac{\text{mrem-}\mu\text{Ci-m}^3}{\text{yr-pCi-sec}}\right) \quad \left(\frac{\text{pCi-yr}}{\text{mrem-m}^3}\right)$$

Substituting this result for $\sum_i \dot{Q}_i$ in Equation 5-16 yields $R_{spt}^{tb}$, the response of the monitor at the limiting noble gas total body dose rate:

$$R_{spt}^{tb} = 716 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DFB_C} \qquad (5\text{-}9)$$

$$(\text{cpm}) \left(\frac{\text{mrem-}\mu\text{Ci-m}^3}{\text{yr-pCi-sec}}\right) \left(\frac{\text{cpm-cm}^3}{\mu\text{Ci}}\right) \left(\frac{\text{sec}}{\text{cm}^3}\right) \left(\frac{\text{pCi-yr}}{\text{mrem-m}^3}\right)$$

The skin dose rate due to noble gases is determined with Equation 3-7:

$$\dot{R}_{spt}^{skin} = \sum_i \dot{Q}_i \; DF'_i \qquad (3\text{-}7)$$

$$\left(\frac{mrem}{yr}\right) \quad \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

Where:

$\dot{R}_{spt}^{skin}$ = Skin dose rate (mrem/yr)

$\dot{Q}_i$ = The release rate of noble gas "i" in the mixture for each noble gas identified (μCi/sec) (Equivalent to $\dot{Q}_i^{ST}$ for noble gases released at the plant stack).

$DF'_i$ = Combined skin dose factor (see Table 1.1-10) (mrem-sec/μCi-yr).

A composite combined skin dose factor, $DF'_c$, may be defined such that:

$$DF'_c \sum_i \dot{Q}_i = \sum_i \dot{Q}_i \; DF'_i \qquad (5\text{-}19)$$

$$\left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right) \quad \left(\frac{\mu Ci}{sec}\right) \qquad \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

Solving Equation 5-19 for DF' yields:

$$DF'_c = \frac{\sum_i \dot{Q}_i \, DF'_i}{\sum_i \dot{Q}_i}$$

Technical Specification 3.8.E.1.a limits the dose rate to the skin from noble gases at any location at or beyond the site boundary to 3,000 mrem/yr. By setting $\dot{R}^{skin}$ equal to 3,000 mrem/yr and substituting $DF'_c$ for $DF'_i$ in Equation 3-7 one may solve for $\sum_i \dot{Q}_i$ at the limiting skin noble gas dose rate:

$$\sum_i \dot{Q}_i = 3{,}000 \quad \frac{1}{DF'_c}$$

$$\left(\frac{\mu Ci}{sec}\right) \left(\frac{mrem}{yr}\right) \left(\frac{\mu Ci\text{-}yr}{mrem\text{-}sec}\right)$$

Substituting this result for $\sum_i \dot{Q}_i$ in Equation 5-16 yields $R_{spt}^{skin}$, the response of the monitor at the limiting noble gas skin dose rate:

$$R_{spt}^{skin} = 3{,}000 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DF'_c} \qquad (5\text{-}10)$$

$$(cpm) \quad \left(\frac{mrem}{yr}\right) \left(\frac{cpm\text{-}cm^3}{\mu Ci}\right) \left(\frac{sec}{cm^3}\right) \left(\frac{\mu Ci\text{-}yr}{mrem\text{-}sec}\right)$$

TABLE 5.2-1

Relative Fractions of Core Inventory
Noble Gases After Shutdown

| Time | Kr-83m | Kr-85m | Kr-85 | Kr-87 | Kr-88 | Xe-131m | Xe-133m | Xe-133 | Xe-135m | Xe-135 | Xe-138 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| t < 24 h | .02 | .043 | .001 | .083 | .118 | .002 | .010 | .306 | .061 | .093 | .263 |
| 24 hr ≤ t < 48 h | -- | .003 | .004 | -- | .001 | .004 | .022 | .758 | .010 | .198 | -- |
| 48 h ≤ t < 5 d | -- | -- | .005 | -- | -- | .006 | .024 | .907 | .001 | .058 | -- |
| 5 d ≤ t < 10 d | -- | -- | .007 | -- | -- | .008 | .016 | .969 | -- | -- | -- |
| 10 d ≤ t < 15 d | -- | -- | .014 | -- | -- | .014 | .006 | .966 | -- | -- | -- |
| 15 ≤ t < 20 d | -- | -- | .026 | -- | -- | .022 | .002 | .950 | -- | -- | -- |
| 20 ≤ t < 30 d | -- | -- | .048 | -- | -- | .034 | .001 | .917 | -- | -- | -- |
| 30 ≤ t < 40 d | -- | -- | .152 | -- | -- | .070 | -- | .777 | -- | -- | |
| 40 ≤ t < 50 d | -- | -- | .378 | -- | -- | .105 | -- | .517 | -- | -- | -- |
| 50 ≤ t < 60 d | -- | -- | .652 | -- | -- | .108 | -- | .240 | -- | -- | -- |
| 60 ≤ t < 70 d | -- | -- | .835 | -- | -- | .083 | -- | .082 | -- | -- | -- |
| t ≥ 70 d | -- | -- | .920 | -- | -- | .055 | -- | .024 | -- | -- | -- |

5.2.2 Steam Jet Air Ejector (SJAE) Noble Gas Activity Monitors (17/150A and 17/150B)

The SJAE noble gas activity monitors are shown in Figure 6-2.

5.2.2.1 Method to Determine the Setpoints of the Steam Jet Air Ejector Offgas Activity Monitors (17/150A and 17/150B)

The SJAE noble gas activity monitor response in mR/hr at the limiting release rate is the setpoint, denoted $R_{spt}^{SJAE}$, and is determined as follows:

$$R_{spt}^{SJAE} = 1.6E+05 \quad S_g \quad \frac{1}{F} \qquad (5\text{-}21)$$

$$(mR/hr) \quad \left(\frac{\mu Ci}{sec}\right) \quad \left(\frac{mR\text{-}cc}{hr\text{-}\mu Ci}\right) \quad \left(\frac{sec}{cc}\right)$$

Where:

$R_{spt}^{SJAE}$ = Response of the monitor at the limiting release rate (mR/hr)

1.6E+05 = Limiting release rate for the SJAE specified in Technical Specification 3.8.K.1 (μCi/sec)

$S_g$ = Detector counting efficiency from the most recent calibration ((mR/hr)/(μCi/cc))

F = SJAE gaseous discharge flow (cc/sec)

5.2.2.2 Basis for the SJAE Noble Gas Activity Monitor Setpoint

The SJAE noble gas activity monitor setpoint must ensure that Technical Specification 3.8.K.1 is not exceeded. The derivation of Equation 5-21 is straightforward. Simply taking Equation 5-16 and substituting the limiting release rate at the SJAE for Q yields Equation 5-21, the setpoint equation for the SJAE noble gas activity monitor.

## 6.0 LIQUID AND GASEOUS EFFLUENT STREAMS, RADIATION MONITORS AND RADWASTE TREATMENT SYSTEMS

Figure 6-1 shows the liquid effluent streams, radiation monitors, and the appropriate Liquid Radwaste Treatment System. Figure 6-2 shows the gaseous effluent systems, radiation monitors, and the appropriate Gaseous Radwaste Treatment System.

### 6.1 In-Plant Liquid Effluent Pathways

The Liquid Radwaste System collects, processes, stores, and disposes of all radioactive liquid wastes. Except for the cleanup phase separator equipment, the condensate backwash receiving tank and pump and waste sample tanks, floor drain sample tank and waste surge tank, the entire Radwaste System is located in the Radwaste Building. The Radwaste System is controlled from a panel in the Radwaste Building Control Room.

The Liquid Radwaste System consists of the following components:

1. Floor and equipment drain system for handling potentially radioactive wastes.

2. Tanks, piping, pumps, process equipment, instrumentation and auxiliaries necessary to collect, process, store, and dispose of potentially radioactive wastes.

The liquid radwastes are classified, collected, and treated as either high purity, low purity, chemical or detergent wastes. "High" purity and "low" purity mean that the wastes have low conductivity and high conductivity, respectively. The purity designation is not a measure of the amount of radioactivity in the wastes.

High purity liquid wastes are collected in the 25,000-gallon waste collector tank. They originate from the following sources:

1. Drywell equipment drains.
2. Reactor Building equipment drains.
3. Radwaste Building equipment drains.
4. Turbine Building equipment drains.
5. Decanted liquids from cleanup phase separators.
6. Decanted liquids from condensate phase separators.
7. Resin rinse.

Low purity liquid wastes are collected in the 25,000-gallon floor drain collector tank. They originate from the following sources:

1. Drywell floor drains.
2. Reactor Building floor drains.
3. Radwaste Building floor drains.

4. Turbine Building floor drains.
5. Other floor drains in RCA (e.g., AOG and Service Building, stack, etc.).

Chemical wastes are collected in the 4,000-gallon chemical waste tank and then pumped to the floor drain collector tank. Chemical wastes arise from the chemical laboratory sinks, the laboratory drains and sample sinks. Radioactive decontamination solutions are classified as detergent waste and collected in the 1,000-gallon detergent waste tank.

Once the wastes are collected in their respective waste tanks, they are processed in the most efficient manner and discharged or reused in the nuclear system. From the waste collector tank, the high purity wastes are processed in one of three alternative filter demineralizers and then, if needed, in one "polishing" demineralizer. After processing, the liquid is pumped to a waste sample tank for testing and then recycled for additional processing, transferred to the condensate storage tank for reuse in the nuclear system or discharged.

The low purity liquid wastes are normally processed through the floor drain filter demineralizer and collected in the floor drain sample tank for discharge or they are combined with high purity wastes and processed as high purity wastes.

Chemical wastes are neutralized and combined with low purity wastes for processing as low purity wastes.

Although there is only one discharge pathway from the Radwaste System to the river, there are three locations within the Radwaste System from which releases can be made. They are: the detergent waste tank (detergent wastes), the floor drain sample tank (chemical and low purity wastes), and waste sample tank (high purity wastes). The contents of any of these tanks can be released directly to the river.

The liquid wastes collected in the tanks are handled on a batch basis. The tanks are sampled from the radwaste sample sink and the contents analyzed for radioactivity and water purity. A release is allowed once it is determined that the activity in the liquid wastes will not exceed Technical Specification release limits.

A discharge from any of the tanks is accomplished by first starting the sample pumps, opening the necessary valves, and positioning the flow controller. The release rate in the discharge line is set between 0 and 50 gpm. The dilution pumps which supply 20,000 gpm of dilution water are then started. An interlock does not allow discharge to the river when dilution water is unavailable.

The effluent monitor (No. 17/350) in the discharge line provides an additional check during the release. The alarm or trip setpoint on the

monitor is set according to the Technical Specification limits and an analysis of the contents of the tank. The monitor warns the operator if the activity of the liquid waste approaches regulatory limits. In response to a warning signal from the monitor, the operator may reduce the flow rate or stop the discharge.

## 6.2 In-Plant Gaseous Effluent Pathways

The gaseous radwaste system includes subsystems that dispose of gases from the main condenser air ejectors, the startup vacuum pump, the gland seal condenser, the standby gas treatment system and station ventilation exhausts.

The processed gases are routed to the plant stack for dilution and elevated release to the atmosphere.

The plant stack provides an elevated release point for the release of waste gases. Stack drainage is routed to the liquid radwaste collection system through loop seals.

The air ejector Advanced Off-Gas Subsystem (AOG) reduces the ejector radioactive gaseous release rates to the atmosphere. The AOG System consists of a hydrogen dilution and recombiner subsystem, a dual moisture removal/dryer subsystem, a single charcoal absorber subsystem, and dual vacuum pumps. Equipment is located in shielded compartments to minimize the exposure of maintenance personnel.

Radioactive releases from the air ejector off-gas system consist of fission product noble gases, activation product gases, halogens, and particulate daughter products from the noble gases. The particulates and halogens are effectively removed by the charcoal beds and high efficiency particulate filters in the AOG System. The activation product gases that are generated in significant quantities have very short half-lives and will decay to low levels in the holdup pipe, as well as in the absorber beds. The noble gases, therefore, are expected to provide the only significant contribution to off-site dose. The charcoal off-gas system is designed to provide holdup of 24 hours for krypton and 16.6 days for xenon at a condenser air inleakage rate of 30 scfm.

Steam dilution, process control, and instrumentation systems are designed to prevent an explosive mixture of hydrogen from propagating beyond the air ejector stages. An explosive mixture of hydrogen should never exist in the recombiner subsystem, "30-minute" delay pipe, condenser/dryer, or charcoal absorber beds. To prevent a hydrogen explosion in the recombiner/preheater and upstream lines during shutdown, the residual off-gas steam mixture containing hydrogen is purged with steam or air. Starting procedures insure sufficient steam is introduced upstream of the preheater to dilute any hydrogen entering the AOG System as the air ejector line is prepared for operation. To prevent operating unsafely, instrumentation is used to detect an explosive mixture.

Hydrogen control is accomplished by providing redundant hydrogen analyzers on the outlet from the Recombiner System. These analyzers initiate recombiner system shutdown and switchover if the hydrogen concentration at the system outlet exceeds 2% by volume. During an automatic shutdown, two main air process valves close to isolate the recombiner system. Additionally, the

recombiner bed temperatures and recombiner outlet temperature provide information about recombiner performance to insure that inflammable hydrogen mixtures do not go beyond the recombiner.

Should a number of unlikely events occur, it would be hypothetically possible for a hydrogen explosion to occur in the off-gas system. Such an explosion within the recombiner system could propagate into the large "30-minute" delay pipe, through the condenser/dryer subsystem, and into the charcoal absorber tanks. However, the recombiner/absorber subsystems, piping, and vessels are designed to withstand hydrogen detonation pressures of 500 psi at a minimum so that no loss of integrity would result. Furthermore, the seven tanks of charcoal would significantly attenuate a detonation shock wave and prevent damage to the downstream equipment.

During normal operation, the dryer/absorber subsystem may be bypassed if it becomes unavailable provided the releases are within Technical Specification limits. With the dryer/absorber subsystem bypassed, the air ejector off-gas exhausts through the recombiner/condenser subsystems, and the 30-minute delay pipe.

The off-gas mixture combines with steam at the air ejector stage to prevent an inflammable hydrogen mixture of 4% by volume from entering the downstream hydrogen recombiners. Approximately 6,400 lb/hr of steam introduced at the second stage air ejector reduces the concentration of hydrogen to less than 3% by volume.

The recombiner subsystem consists of a single path leading from the hydrogen dilution steam jet ejectors to two parallel flow paths for hydrogen recombination. Each recombination subsystem is capable of operating independently of the other and each is capable of handling the condenser off-gas at a startup design flow of 1,600 lb/hr air and the normal off-gas design flow rate of 370 lb/hr. The major components of each recombiner flow path are a preheater, a hydrogen-oxygen recombiner, and a desuperheating condenser.

The preheater assures that the vapor entering the hydrogen-oxygen recombiner is heated to approximately 300°F. At this temperature, the water vapor in the stream becomes superheated steam, thereby, protecting the recombiner catalyst.

During passages through the recombiner, the recombination of $H_2$ and $O_2$ in an exothermic reaction increases the stream temperature to approximately 520°F. This recombination results in a maximum effluent $H_2$ concentration of 0.1% by volume.

The desuperheating condenser is designed to remove the heat of recombination and condense the steam from the remaining off-gas. The condensers discharge the off-gas through moisture separators into the initial portion of an underground 24-inch diameter delay pipe which allows for 40% of

the total system holdup volume. The pipe slopes away from the off-gas particulate (HEPA) filters in both directions for drainage purposes. Loop seals prevent gas escaping through drainage connections. Shorter lived radionuclides undergo a substantial decrease in activity in this section of the system. The preheaters/recombiners operate at pressures slightly above atmospheric; the condenser and the subsystems that follow operate at subatmospheric pressures.

Particulate (HEPA) filters with flame suppressant prefilters are located at the exit side of the delay pipe ahead of the moisture removal subsystem to remove radioactive particulates generated in the delay pipe.

In the moisture removal/dryer subsystem, the moisture of the gas is reduced to increase the effectiveness of the charcoal absorber beds downstream. The subsystem consists of two parallel cooling condensers and gas dryer units. Each condenser is cooled by a mechanical glycol/water refrigeration system that cools the off-gas to -40°F as it removes bulk moisture. The dryer is designed to remove the remaining moisture by a molecular sieve desiccant to a dew point of less than -40°F (1% RH). One of the dryers absorbs moisture from the off-gas; the other desorbs moisture by circulating heated air through the bed in closed cycle.

The mixed refrigerant/dryer concept improves the reliability of the system. If the refrigerant system fails, the two dryer beds operate in parallel to remove the moisture and maintain the off-gas near the design dew point (-40°F). If the dryer fails, the -40°F dew point air leaving the mechanical system can enter the guard bed for over 6 hours without affecting the performance of the charcoal beds downstream.

The charcoal absorber subsystem consists of seven tanks of charcoal preceded by a smaller charcoal guard bed upstream. The guard bed protects the seven main tanks from excessive radioactivity levels or moisture in the event of a malfunction upstream in the moisture removal subsystem. The guard bed also removes compounds which might hinder noble gas delay. The seven tanks hold a minimum of approximately 90,000 pounds of charcoal.

The first two main tanks can be bypassed and used for storing a "batch of high activity" gas for static decay. The remaining five are all in series with no bypassing features so that the off-gas to the stack must be delayed.

Redundant particulate (HEPA) after-filters are used to remove charcoal fines prior to the vacuum pumps.

A water-sealed vacuum pump boosts the gas stream pressure to slightly over-atmospheric pressure before it is vented through the stack. To assure maintaining constant operating pressures in the system, a modulating bypass valve will recirculate process gas around the pump as required. During periods of high flow rates, both pumps can be operated in parallel.

Discharge of the vacuum pump then passes through the remaining 60% of the delay pipe prior to being vented through the station stack.

The gland seal off-gas subsystem collects gases from the gland seal condenser and the mechanical vacuum pump and passes them through a charcoal filter (if required) and then through holdup piping prior to release to the stack. The gases from the gland seal condenser system are discharged to the atmosphere via the ventilation stack after passing through the filter for iodine removal (if required) and then through the same 1-3/4 minute holdup piping that is used for the startup vacuum pump system. One automatic valve on the discharge side of each steam packing exhauster closes upon the receipt of high level radiation signal from the main steam line radiation monitoring subsystem to prevent the release of excessive radioactive material to the atmosphere. The exhausters are shut down at the same time the valves close. In addition, the mechanical vacuum pump is automatically isolated and stopped by a main steam line high radiation signal. The filter assembly is located in the air ejector room.

The release of significant quantities of gaseous and particulate radioactive material is prevented by the combination of the design of the air ejector AOG system and automatic isolation of the system from the stack. Gas flow from the main condenser stops when the air ejectors are automatically isolated from the main condenser by either a high radiation signal in the main steam line or by high temperature and/or pressure signals from the AOG System. The gland seal off-gas system is automatically isolated and stopped by a main steam line high radiation signal. In addition, monitoring the stack release provides a backup warning of abnormal conditions.

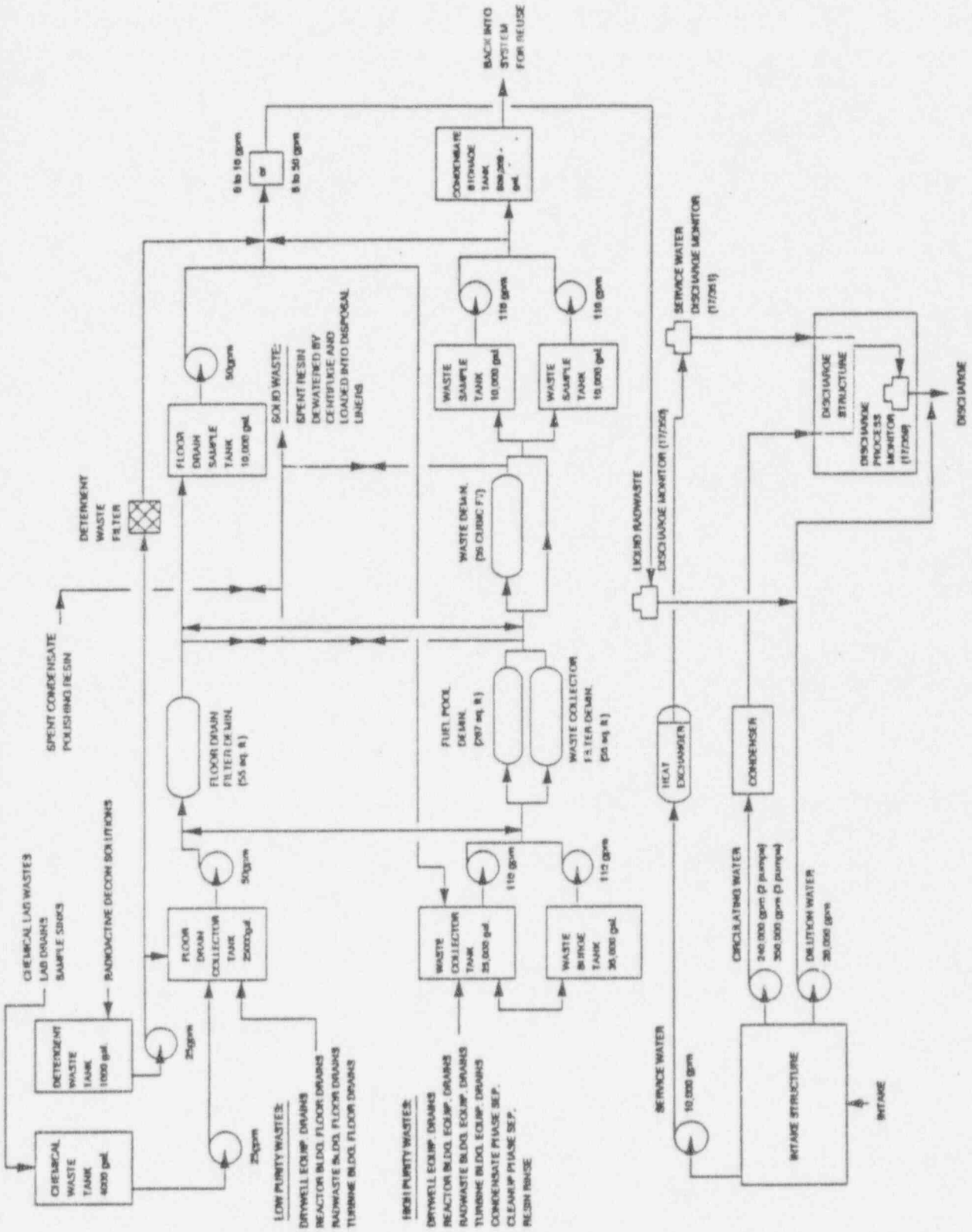


Figure 6-1, Liquid Effluent Stream, Radiation Monitors, and Radwaste Treatment System at Vermont Yankee

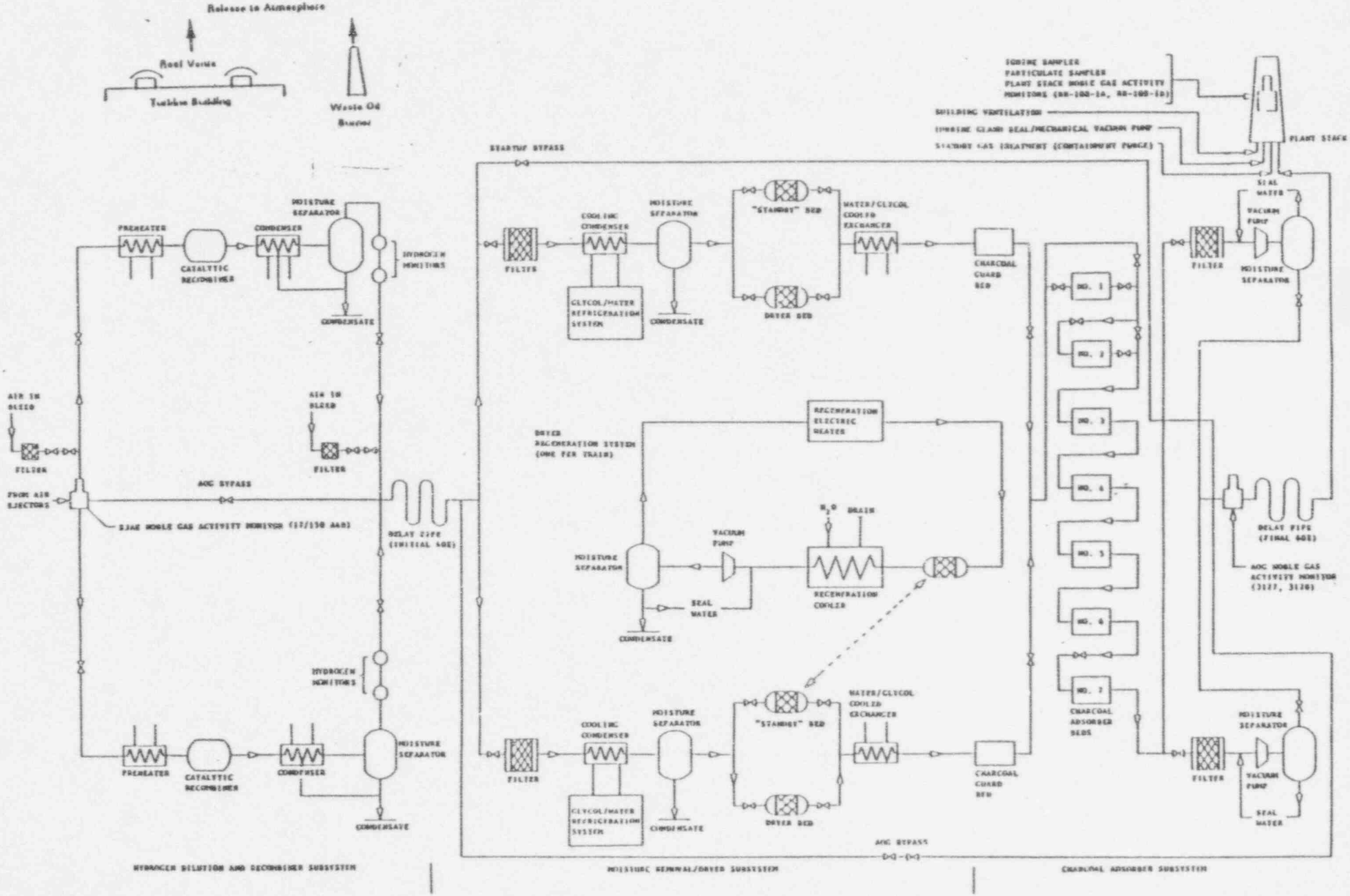


Figure 6-2 Gaseous Effluent Streams, Radiation Monitors, and Radwaste Treatment System at Vermont Yankee

# APPENDIX A

## METHOD I EXAMPLE CALCULATIONS

## EXAMPLE CALCULATION NO. 1

Type

Total Body Dose From Liquid Effluents

References

a) ODCM Sections 3.2 and 3.3 (Method I).

b) Technical Specifications 3.8.B.1 and 3.8.C.1.

Problem

Calculate the off-site dose to the total body and maximum organ resulting from the batch release of radioactive liquid effluents.

Plant Data

a) Analysis from a representative grab sample of the liquid waste volume to be discharged indicates the following radionuclide activities were released to the Connecticut River:

| i | Activity $Q_i$ Released (Ci) | $DFL_{itb}$* (mrem/Ci) | $DFL_{imo}$** (mrem/Ci) |
|---|---|---|---|
| H-3 | 3.40E-01 | 2.60E-04 | 2.06E-04 |
| Co-60 | 1.72E-05 | 2.13E-01 | 1.28E+00 |
| Co-134 | 3.51E-05 | 1.28E+02 | 1.60E+02 |
| I-131 | 7.20E-04 | 2.57E-02 | 1.47E+01 |

*Total body dose factor from Table 1.1-11.

**Maximum organ dose factor from Table 1.1-11.

Calculation

The total body dose is calculated from Equation (3-1):

$$D_{tb} = \sum_i Q_i \; DFL_{itb} \qquad (3\text{-}1)$$

(mrem) (Ci) (mrem/Ci)

Therefore:

$$D_{tb} = (3.40E\text{-}01)(2.06E\text{-}04) + (1.72E\text{-}05)(2.13E\text{-}01) + (3.51E\text{-}05)(1.28E+02) + (7.20E\text{-}04)(2.57E\text{-}02) =$$

Answer (1)

$D_{tb}$ = 4.59E-03 mrem to the total body.

Next, the maximum organ dose is calculated from Equation (3-3):

$$D_{mo} = \sum_i Q_i \; DFL_{imo}$$

(mrem) (Ci) (mrem/Ci)

Therefore:

$$D_{mo} = (3.40E\text{-}01)(2.06E\text{-}04) + (1.72E\text{-}05)(1.28E+00) + (3.51E\text{-}05)(1.60E+02) + (7.20E\text{-}04)(1.47E+01) =$$

Answer (2)

$D_{mo}$ = 1.63E-02 mrem to maximum organ.

## EXAMPLE CALCULATION NO. 2

Type

Total Body Dose Rate From Noble Gases

References

a) ODCM Section 3.4 (Method I).

b) Technical Specification 3.8.E.1.a.

Problem

Calculate the off-site total body dose rate resulting from the release of noble gases from the plant stack during power operations.

Plant Data

a) Maximum plant stack gas monitor (I or II) Count rate during period of interest (M): 80,000 cpm

b) Stack flow rate during release (F): 7.55E+07 cc/sec

(160,000 cfm x 4.72E+02 $\frac{cc/sec}{cfm}$ = )

c) Plant stack monitor detector counting efficiency (Sg): 1E+08 cpm per µCi/cc

d) The last measured release rate mix of $Q_i^{SJAE}$ noble gas from the SJAE and corresponding dose factor $DFB_i$ from Table 1.1-10.

| i | $Q^{SJAE}$ (µCi/sec) | $DFB_i$ (mrem-$m^3$/pCi-yr) |
|---|---|---|
| Xe-138 | 5.15E+03 | 8.83E-03 |
| Kr-87 | 2.37E+02 | 5.92E-03 |
| Kr-88 | 1.29E+02 | 1.47E-02 |
| Xe-135 | 1.85E+02 | 1.81E-03 |

Calculation

The dose rate is calculated from Equations (3-5) and (3-28):

$$\dot{R}_{tbs} = 0.70 \sum_i \dot{Q}_i^{ST} \quad \dot{DFB}_i \qquad (3\text{-}5)$$

$$\left(\frac{mrem}{yr}\right) \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) \left(\frac{\mu Ci}{sec}\right) \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

and where the stack release rate is determined from:

$$\dot{Q}_i^{ST} = \frac{\dot{Q}_i^{SJAE}}{\sum_i \dot{Q}_i^{SJAE}} \quad M \quad \frac{1}{Sg} \quad F \qquad (3\text{-}28)$$

$$(cpm) \left(\frac{\mu Ci/cc}{cpm}\right) \left(\frac{cc}{sec}\right)$$

$$\left(\frac{\mu Ci}{sec}\right)$$

First, determine the sum $\left(\sum_i\right)$ of all $\dot{Q}_i^{SJAE}$ and the fraction that each noble gas i represents in the total gas mix.

$$\sum_i \dot{Q}_i^{SJAE} = (5.15E+03) + (2.37E+02) + (1.29E+02) + (1.85E+02)$$

$$= 5.70E+03 \ \mu Ci/sec$$

and the relative fraction of each noble gas:

EXAMPLE CALCULATION NO. 2
(Continued)

| i | $\hat{Q}_i^{SJAE}$ /5.70E+03 | | $f_i$ Relative Fraction of Total |
|---|---|---|---|
| Xe-138 | 5.15E+03/5.70E+03 | = | 0.904 |
| Kr-87 | 2.37E+02/5.70E+03 | = | 0.042 |
| Kr-88 | 1.29E+02/5.70E+03 | = | 0.023 |
| Xe-135 | 1.85E+02/5.70E+03 | = | 0.032 |

Next, the stack release rate of each noble gas i from Equation (3-28) can be substituted into Equation (3-5) to give the dose rate as:

$$\dot{R}_{tbs} = 0.70 \; M \; \frac{1}{Sg} \; F \; \sum_i \; f_i \; DFB_i$$

$$= 0.70 \quad 80,000 \quad 1/1E+08 \quad 7.55E+07 \; \sum_i \; f_i \; DFB_i$$

$$= 4.23E+04 \; [(0.904)(8.83E-03) + (0.042)(5.92E-03) +$$

$$(0.023)(1.47E-02) + (0.032)(1.81E-03)] =$$

Answer

$\dot{R}_{tbs}$ = 365 mrem/year noble gas total body dose rate.

## EXAMPLE CALCULATION NO. 3

Type

Total Body Dose Rate From Noble Gases

References

a) ODCM Section 3.4 (Method I).

b) Technical Specification 3.8.E.1.a.

Problem

Calculate the off-site total body dose rate resulting from the release of noble gases from the plant stack recorded to have occurred 32 days after plant shutdown.

Plant Data

a) Maximum plant stack gas monitor (I or II) Count rate during period of interest (M): 80,000 cpm

b) Stack flow rate during release (F): 7.55E+07 cc/sec

(160,000 cfm x 4.72E+02 $\frac{cc/sec}{cfm}$ = )

c) Plant stack monitor detector counting efficiency (Sg): 1E+08 cpm per µCi/cc

d) The noble gas mix fractions $f_i(t)$ corresponding to 32 days taken from Table 5.2-1.

| i | $f_i$ (32 day)* | $DFB_i$** |
|---|---|---|
| Kr-85 | 0.152 | 1.61E-05 |
| Xe-131m | 0.070 | 9.15E-05 |
| Xe-133 | 0.777 | 2.94E-04 |

---

* Fraction of nuclide in mix as function of time (see Table 5.2-1).

** Dose factors from Table 1.1-10.

Calculation

The dose rate is calculated from Equations (3-5) and (3-28):

$$\dot{R}_{tbs} = 0.70 \sum_i \dot{Q}_i^{ST} \quad DFB_i \qquad (3\text{-}5)$$

$$\left(\frac{mrem}{yr}\right) \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) \left(\frac{\mu Ci}{sec}\right) \left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

and where the stack release rate is determined from:

$$\dot{Q}_i^{ST} = \frac{\dot{Q}_i^{SJAE}}{\sum_i \dot{Q}_i^{SJAE}} \quad M \quad \frac{1}{Sg} \quad F \qquad (3\text{-}28)$$

$$\left(\frac{\mu Ci}{sec}\right) \qquad (cpm) \left(\frac{\mu Ci/cc}{cpm}\right) \left(\frac{cc}{sec}\right)$$

However, for a time (t) after shutdown, the ratio of $\dot{Q}_i^{SJAE}$ to the sum release rate of all noble gases can be replaced in Equation (3-28) by the relative fraction $[f_i(t)]$ of each noble gas available in the system; therefore, Equation (3-28) can be written:

$$\dot{Q}_i^{ST} = f_i(t) \quad M \quad \frac{1}{Sg} \quad F$$

Therefore, using the above data for a time period 32 days after shutdown, the dose rate equation can also be written as:

$$\dot{R}_{tbs} = 0.70 \quad M \quad \frac{1}{Sg} \quad F \sum_i \quad f_i(t) \quad DFB_i$$

$$= 0.70 \quad 80{,}000 \quad 1/1E{+}08 \quad 7.55E{+}07 \; [(0.152)(1.61E{-}05) +$$

$$(0.070)(9.15E{-}05) + (0.777)(2.94E{-}04)] =$$

Answer

$\dot{R}_{tbs}$ = 10.0 mrem/year noble gas total body dose rates at 32 days after shutdown.

## EXAMPLE CALCULATION NO. 4

Type

Skin Dose Rate From Noble Gases

References

a) ODCM Section 3.5 (Method I).

b) Technical Specification 3.8.E.1.a.

Problem

Calculate the off-site skin dose rate resulting from the release of noble gases from the plant stack during power operations.

Plant Data

a) Maximum plant stack gas monitor (I or II) Count rate during period of interest (M): 80,000 cpm

b) Stack flow rate during release (F): 7.55E+07 cc/sec

(160,000 cfm x 4.72E+02 $\frac{cc/sec}{cfm}$ = )

c) Plant stack monitor detector counting efficiency (Sg): 1E+08 cpm per µCi/cc

d) The last measured release rate mix of noble gas from the SJAE ($\dot{Q}_i^{SJAE}$), and corresponding dose factor $DF_i'$ from Table 1.1-10.

| i | $\dot{Q}_i^{SJAE}$ (µCi/sec) | $DF'_{is}$ (mrem-sec/µCi-yr) |
|---|---|---|
| Xe-138 | 5.15E+03 | 9.60E-03 |
| Kr-87 | 2.37E+02 | 1.06E-02 |
| Kr-88 | 1.29E+02 | 1.32E-02 |
| Xe-135 | 1.85E+02 | 2.60E-03 |

Calculation

The skin dose rate is calculated from Equations (3-7) and (3-28):

$$\dot{R}_{skins} = \sum_i \dot{Q}_i^{ST} \quad DF'_{is} \qquad (3\text{-}7)$$

$$\left(\frac{mrem}{yr}\right) \qquad \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

and where the stack release rate is determined from:

$$\dot{Q}_i^{ST} = \frac{\dot{Q}_i^{SJAE}}{\sum_i \dot{Q}_i^{SJAE}} \quad M \quad \frac{1}{Sg} \quad F \qquad (3\text{-}28)$$

$$\left(\frac{\mu Ci}{sec}\right) \qquad (cpm)\left(\frac{\mu Ci/cc}{cpm}\right)\left(\frac{cc}{sec}\right)$$

First, determine the sum ($\sum_i$) of all $\dot{Q}_i^{SJAE}$ and the fraction that each noble gas i represents in the total gas mix.

$$\sum_i \dot{Q}_i^{SJAE} = (5.15E{+}03) + (2.37E{+}02) + (1.29E{+}02) + (1.85E{+}02)$$

$$= 5.70E{+}03 \ \mu Ci/sec$$

and the relative fraction of each noble gas:

| i | $\dot{Q}_i^{SJAE}$ /5.70E+03 | | $f_i$ Relative Fraction of Total |
|---|---|---|---|
| Xe-138 | 5.15E+03/5.70E+03 | = | 0.904 |
| Kr-87 | 2.37E+02/5.70E+03 | = | 0.042 |
| Kr-88 | 1.29E+02/5.70E+03 | = | 0.023 |
| Xe-135 | 1.85E+02/5.70E+03 | = | 0.032 |

Next, the stack release rate of each noble gas i from Equation (3-28) can be substituted into Equation (3-5) to give the skin dose rate as:

$$\dot{R}_{skins} = M \frac{1}{Sg} F \sum_i f_i DF'_{is}$$

$$= 80{,}000 \quad 1/1E+08 \quad 7.55E+07 \,[(0.904)(9.60E-03) +$$

$$(0.042)(1.06E-02) + (0.023)(1.32E-02) + (0.032)(2.60E-03)] =$$

$$= 6.04E+04 \,(8.68E-03 + 4.45E-04 + 3.04E-04 + 8.32E-05)$$

$$= 6.04E+04 \,(9.51E-03)$$

Answer

$\dot{R}_{skins}$ = 574 mrem/year noble gas skin dose rate.

## EXAMPLE CALCULATION NO. 5

Type

Skin Dose Rate From Noble Gases

References

a) ODCM Section 3.5 (Method I).

b) Technical Specification 3.8.E.1.a.

Problem

Calculate the off-site skin dose rate resulting from the release of noble gases from the plant stack six days after plant shutdown.

Plant Data

a) Maximum plant stack gas monitor (I or II) Count rate during period of interest (M): 120,000 cpm

b) Stack flow rate during release (F): 7.55E+07 cc/sec

(160,000 cfm x 4.72E+02 $\frac{cc/sec}{cfm}$ = )

c) Plant stack monitor detector counting efficiency (Sg): 1E+08 cpm per µCi/cc

d) Since the plant is shut down for more than five days, Xe-133 may be used as the referenced radionuclide in place of the ratio of $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation (3-28).

| i | $f_i$ (t >5 days) | $DF'_{is}$ $\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$ |
|---|---|---|
| Xe-133 | 1. | 4.57E-04 |

Calculation

The skin dose rate is calculated from Equations (3-7) and (3-28):

$$\dot{R}_{skins} = \sum_i \dot{Q}_i^{ST} \quad DF'is \qquad (3\text{-}7)$$

$$\left(\frac{mrem}{yr}\right) \quad \left(\frac{\mu Ci}{sec}\right) \quad \left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

and, the stack release rate is determined from:

$$\dot{Q}_i^{ST} = \frac{\dot{Q}_i^{SJAE}}{\sum_i \dot{Q}_i^{SJAE}} \quad M \quad \frac{1}{Sg} \quad F \qquad (3\text{-}28)$$

However, for times greater than five days after shutdown, Xe-133 may be used as the referenced radionuclide alone. Therefore, in Equation (3-28) the ratio of $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ can be replaced by a value of 1 which indicates that all the contribution to the release is from Xe-133.

Therefore:

$$\dot{Q}_{Xe\text{-}133}^{ST} = 1.0 \times 120{,}000 \times 1/1E{+}08 \times 7.55E{+}07$$

$$(cpm) \quad \left(\frac{\mu Ci/cc}{cpm}\right) \quad (cc/sec)$$

$$\dot{Q}_{Xe\text{-}133}^{ST} = 90{,}600\ \mu Ci/sec$$

Therefore, replacing this value of $\dot{Q}_i^{ST}$ into Equation (3-7) we find the skin dose rate as:

$$\dot{R}_{skins} = 90{,}600 \times 4.57E\text{-}04 \left(\frac{mrem}{yr}\right) \left(\frac{\mu Ci}{sec}\right) \left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

Answer

$\dot{R}_{skins}$ = 41.4 mrem/year.

## EXAMPLE PROBLEM NO. 6

Type

Critical Organ Dose Rate From Iodine, Tritium, and Particulates

References

a) ODCM Section 3.8 (Method I).

b) Technical Specification 3.8.E.1.b.

Problem

Calculate the critical organ dose rate due to measured effluent data taken from the plant stack for a seven-day sample collection period.

Plant Data

a) Stack particulate analysis for the seven-day period of interest.

| i | Activity $Q_i^{STP}$ ($\mu$Ci-sec) | $DFG'_{sico}$ (1) ($\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}$) |
|---|---|---|
| Sr-89* | 1.42E-04* | 2.23E+02 |
| Sr-90* | 3.50E-03* | 8.48E+03 |
| Co-60 | 4.89E-02 | 2.12E+02 |
| Cs-137 | 3.90E-03 | 3.44E+02 |
| Zn-65 | 1.01E-02 | 7.51E+01 |
| Na-24** | 2.76E-03** | -- |
| Mn-54+ | <2.87E-06+ | 1.72E+01 |

Notes

(1) $DFG'_{ico}$ dose rate factor for each radionuclide is taken from Table 1.1-12.

* For Sr-89/90, use the most recent available measurement from quarters composite analysis.

** Na-24 has a half life of less than 8-1/2 days, and therefore is not included in the dose analysis per requirements of Technical Specification 3.8.E.1.b even though it was detected.

+ Mn-54 is not included in the dose analysis since it was not detected as being present after counting to at least the LLD.

b) Stack iodine (charcoal and particulate activities combined for the seven-day period of interest):

| i | Activity $\dot{Q}_i^{STP}$ ($\mu$Ci-sec) | $DFG'_{sico}$ (1) ($\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}$) |
|---|---|---|
| I-131 | 1.16E-03 | 1.51E+03 |
| I-133* | <6.35E-05* | 1.61E+01 |
| I-135** | 7.21E-03** | 5.14E-01 |
| and | | |
| H-3+ | 3.17E-02 | 5.70E-03 |

Notes

* I-133 is not included in the dose analysis for this case since it was not detected is being present in the stack analysis.

** I-135 is not included in the dose analysis because it has a half life less than 8-1/2 for particulates, and is not included as a required iodine in Technical Specification 3.8.E.1.b.

+ Tritium value based as latest available stack grab sample.

Calculation

The dose rate is calculated from Equation (3-16):

$$\dot{R}_{cos} = \sum_i \dot{Q}_i^{STP} \; DFG'_{sico} \qquad (3\text{-}16)$$

($\frac{mrem}{yr}$) ($\frac{\mu Ci}{sec}$) ($\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}$)

## EXAMPLE PROBLEM NO. 6
(Continued)

The dose rate factors ($DFG'_{ico}$) for each of the radionuclides detected in the plant stack charcoal and particulate filter sample (plus tritium) is taken from Table 1.1-12 of the ODCM.

Therefore:

$$\dot{R}_{cos} = (1.42E\text{-}04)(2.23E+02) + (3.50E\text{-}03)(8.48E+03) + (4.89E\text{-}02)(2.12E+02) + (3.90E\text{-}03)(3.44E+02) + (1.01E\text{-}02)(7.51E+01) + (1.16E\text{-}03)(1.51E+03) + (3.17E\text{-}02)(5.70E\text{-}03) =$$

Answer

$\dot{R}_{cos}$ = 43.9 mrem/year critical organ dose rate from iodine, tritium, and particulate.

## EXAMPLE PROBLEM NO. 7

Type

Gamma Air Dose From Noble Gases released from stack

References

a) ODCM Section 3.7 (Method I).

b) Technical Specification 3.8.F.1.

Problem

Calculate the maximum gamma air dose resulting from noble gases released from the plant stack over a calendar month.

Plant Data

Based on the daily off-gas analysis, the total activity released during the month of interest is:

| i | Activity $Q_i^{ST}$ (Ci) | $DF_i^{\gamma *}$ (mrad-$m^3$ pCi-yr) |
|---|---|---|
| Kr-88 | 3.55E-01 | 1.52E-02 |
| Kr-85m | 4.71E+00 | 1.23E-03 |
| Xe-138 | 2.75E+00 | 9.21E-03 |
| Xe-135 | 3.51E+01 | 1.92E-03 |
| Xe-133 | 9.42E+01 | 3.53E-04 |

*Gamma air dose factors taken from Table 1.1-10.

## EXAMPLE PROBLEM NO. 7
(Continued)

Calculation

The maximum gamma air dose off-site is calculated from Equation (3-21):

$$D^{\gamma}_{airs} = 0.022 \sum_{i} Q_i^{ST} \; DF_i^{\gamma} \qquad (3\text{-}21)$$

$$(mrad)\left(\frac{pCi\text{-}yr}{Ci\text{-}m^3}\right) \qquad (Ci)\left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$$

Therefore:

$$D^{\gamma}_{airs} = 0.022\,[(3.55E\text{-}01)(1.52E\text{-}02) + (4.71E+00)(1.23E\text{-}03) + (2.75E+00)(9.21E\text{-}03) + (3.51E+01)(1.92E\text{-}03) + (9.42E+01)(3.52E\text{-}04)]$$

$$= 0.022\,(5.40E\text{-}03 + 5.79E\text{-}03 + 2.53E\text{-}02 + 6.74E\text{-}02 + 3.31E\text{-}02)$$

Answer

$D^{\gamma}_{airs}$ = 3.01E-03 mrad gamma air dose during the month.

## EXAMPLE CALCULATION NO. 8

Type

Beta Air Dose From Noble Gases released from stack

References

a) ODCM Section 3.8 (Method I).

b) Technical Specification 3.8.F.1.

Problem

Calculate the maximum beta air dose resulting from the same noble gas releases given in Example Calculation No. 7.

Plant Data

From Example No. 7, the total activity determined to be released during the month is:

| i | Activity $Q_i^{ST}$ (Ci) | $DF_i^{\beta *}$ $\frac{(mrad\text{-}m^3}{pCi\text{-}yr)}$ |
|---|---|---|
| Kr-88 | 3.55E-01 | 2.93E-03 |
| Kr-85m | 4.71E+00 | 1.97E-03 |
| Xe-138 | 2.75E+00 | 4.75E-03 |
| Xe-135 | 3.51E+01 | 2.46E-03 |
| Xe-133 | 9.42E+01 | 1.05E-03 |

*Beta air dose factors taken from Table 1.1-10.

Calculation

The maximum beta air dose off-site is calculated from Equation (3-23):

$$D^{\beta}_{airs} = 0.019 \sum_{i} Q_i^{ST} \; DF_i^{\beta} \qquad (3\text{-}23)$$

$$(mrad)\left(\frac{pCi\text{-}yr}{Ci\text{-}m^3}\right) \qquad (Ci)\left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$$

Therefore:

$$D^{\beta}_{airs} = 0.019\,[(3.55E\text{-}01)(2.93E\text{-}03) + (4.71E+00)(1.97E\text{-}03) + (2.75E+00)(4.75E\text{-}03) + (3.51E+01)(2.46E\text{-}03) + (9.42E+01)(1.05E\text{-}03)]$$

$$= 0.019\,(1.04E\text{-}03 + 9.28E\text{-}03 + 1.31E\text{-}02 + 8.63E\text{-}02 + 9.89E\text{-}02)$$

Answer

$D^{\beta}_{airs}$ = 3.96E-03 mrad beta air dose during the month.

## EXAMPLE PROBLEM NO. 9

Type

Critical Organ Dose From Iodine, Tritium, and Particulates

References

a) ODCM Section 3.9 (Method I).

b) Technical Specification 3.8.G.1

Problem

Calculate the critical organ dose due to the total activity recorded as being released from the plant stack during a calendar month.

Plant Data

a) From the combined stack analyses during the month, the following activity released is:

| i | $Q_i^{STP}$ (Ci) | $DFG_{sico}$ (1) $(\frac{mrem}{Ci})$ |
|---|---|---|
| Sr-89* | 5.42E-04* | 7.08E+00 |
| Sr-90* | 1.10E-02* | 2.69E+02 |
| Co-60 | 2.30E-01 | 4.76E+00 |
| Cs-137 | 1.15E-02 | 1.01E+01 |
| Zn-65 | 2.60E-02 | 2.32E+00 |
| Na-24** | 7.11E-03** | -- |
| Mn-54 | <2.76E+06+ | 4.36E-01 |

Notes for Plant Data a) Above

(1) Critical organ dose factor taken from Table 1.1-12.

* For Sr-89/90, use the most recent available measurement from the quarterly composite analysis.

** Na-24 has a half life of less than 8-1/2 days, and therefore is not included in accordance with Technical Specification 3.8.G.1.

+ Mn-54 is not included in the dose analysis since it was not detected as being present after counting to at least the LLD.

b) Total iodine release for the month based on the combined charcoal and particulate filter samples taken during the month:

| i | $Q_i^{STP}$ (Ci) | $DFG_{sico}$ $(\frac{mrem}{Ci})$ |
|---|---|---|
| I-131 | 4.30E-03 | 4.80E+01 |
| I-133* | 1.12E-04* | 5.12E-01 |
| I-135** | 2.01E-02** | |
| and | | |
| H-3+ | 0.15 | 1.81E-04 |

Calculation

The dose is calculated from Equation (3-25):

$$D_{cos} = \sum_i Q_i^{STP} \; DFG_{sico} \qquad (3\text{-}25)$$

(mrem) (Ci) (mrem/Ci)

Notes for Plant Data b) Above

* In this case, I-133 was found in one of the weekly stack samples to be present, and therefore based on that value is included in the dose analysis.

** I-135 is not included in the dose analysis because it has a half life less than 8-1/2 days for particulates and is not included as a required iodine in Technical Specification 3.8.B.1.

+ Tritium value based on the monthly stack grab sample.

The dose factor ($DFG_{sico}$) for each radionuclide detected in the plant stack charcoal and particulate filter sample (plus tritium) is taken from Table 1.1-12 of the ODCM.

Therefore:

$$D_{cos} = (5.42E\text{-}04)(7.08E+00) + (1.10E\text{-}02)(2.69E+02) + (2.30E\text{-}01)(4.76E\text{-}00) + (1.15E\text{-}02)(1.01E+01) + (2.60E\text{-}02)(2.32E\text{-}00) + (4.30E\text{-}03)(4.80E+01) + (1.12E\text{-}04)(5.12E\text{-}01) + (0.15)(1.81E\text{-}04) =$$

Answer

$D_{cos}$ = 4.44 mrem maximum organ dose for the month.

## EXAMPLE CALCULATION NO. 10

Type

Releases Limited to 20 times the effluent concentration limits of 10CFR20.1001-20.2401, Table 2, Column 1

References

a) 10CFR50.72

b) 10CFR50.73

Problem

Find the minimum stack gas monitor response which would require an assessment to determine if a four-hour notification to NRC is required per 10CFR50.72.

Assumptions

| | | |
|---|---|---|
| a) | Maximum expected stack flow rate (F)<br>(185,000 cfm x 4.72E+02 $\frac{cc/sec}{cfm}$ = ) | 8.73E+07 cc/sec |
| b) | Plant stack monitor detector counting efficiency (Sg) | 1E+08 cpm per µCi/cc |
| c) | Maximum off-site ground level dispersion parameter (X/Q undepleted) (from ODCM Table 3.10-1) | 5.99-07 $sec/m^3$ |
| d) | Most restrictive ECL value for noble gases (10CFR20, Appendix B, Table 2, Column 1) for Kr-88) | 9E-09 µCi/cc |

Calculation (Part I)

The setpoint $R_{spt}$ for the stack monitor which would correspond to an instantaneous off-site air concentration of 20 x ELC for the most restrictive noble gas can be calculated by:

$$R_{spt} = 20\ ECL \quad Sg \quad \frac{1}{X/Q} \quad 1E+06 \quad \frac{1}{F}$$

$$(cpm)\ \left(\frac{\mu Ci}{cc}\right)\ \left(\frac{cpm}{\mu Ci/cc}\right)\ \left(\frac{m^3}{sec}\right)\ \left(\frac{cc}{m^3}\right)\ \left(\frac{sec}{cc}\right)$$

$$= 20 \times (9E-09)(1E+08)(1/5.99E-07)(1E+06)(1/8.73E+07)$$

$R_{spt}$ = 344,200 cpm setpoint alarm value

dispersion factors for the these two sectors are approximately half of the maximum site boundary dispersion factors determined for the Turbine Building, it is unlikely that the maximum site boundary Waste oil Burner dispersion factors would exceed the maximum site boundary atmospheric dispersion factors. Therefore, for simplicity in evaluating the releases from oil incineration, the dispersion factors for the Turbine Building will also be used to assess releases from this release point.

The Waste Oil Burner can process oil at a rate of 2 gal./hour from a 500 gallon day tank. The offgas flow rate for the burner is rated as 199 cfm. This provides an air to oil dilution during the incineration of 44,800.

Waste Oil Sampling / Surveillance Requirements:

The oil burner stack is not equipped with continuous air monitoring or sampling capability for the direct determination of radiological effluent releases during the incineration process. As a consequence, sampling and analysis of the waste oil prior to its incineration is necessary to project the dose and dose rate consequences of burning contaminated oil. Calculations of projected dose from the incineration of total quantity of oil to be added to the Waste Oil Burn Day Tank for each series of burns will be performed in accordance with the methods in the ODCM and compared to the accumulated site total dose for that period before initiation of incineration. Dose rate determinations will be determined by averaging the projected dose for the quantity of radioactivity determined to be present in the oil over the expected duration of the burn necessary to incinerate the total volume to be added to the Day Tank. Inherent in this determination is the assumption that all radioactivity found to be present in each batch of oil will be released to the atmosphere during the incineration. No retention of activity

VERMONT YANKEE NUCLEAR POWER STATION

OFF-SITE DOSE CALCULATION MANUAL

REVISION # 16

Reviewed 93-98 / 10/27/93
Plant Operations Review Committee — Date

Approved Robert J Wanczyk / 10/28/93
Plant Manager — Date

Approved / 10/28/93
Vice President, Operations — Date

# INSTRUCTIONS

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| 3.50 | 3.50 |
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TABLE 1.1-4

Summary of Methods to Calculate
Dose Rates

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 3-5 | Total Body Dose Rate from Noble Gases Released from Stack | $\dot{R}_{tbs}\left(\frac{mrem}{yr}\right) = 0.70 \sum_i \dot{Q}_i^{ST} DFB_i$ | 3.4.1 |
| 3-39 | Total Body Dose Rate from Noble Gases Released from Ground | $\dot{R}_{tbg}\left(\frac{mrem}{yr}\right) = 5.5 \sum_i \dot{Q}_i^{GL} DFB_i$ | 3.4.1 |
| 3-7 | Skin Dose Rate from Noble Gases Released from Stack | $\dot{R}_{skins}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{ST} DF'_{is}$ | 3.5.1 |
| 3-38 | Skin Dose Rate from Noble Gases Released from Ground | $\dot{R}_{sking}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{GL} DF'_{ig}$ | 3.5.1 |
| 3-16 | Critical Organ Dose Rate from Stack Release of I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days | $\dot{R}_{cos}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{STP} DFG'_{sico}$ | 3.6.1 |
| 3-40 | Critical Organ Dose Rate from Ground Level Release of I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days | $\dot{R}_{cog}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{GLP} DFG'_{gico}$ | 3.6.1 |

TABLE 1.1-5

Summary of Methods to Calculate
Doses to Air from Noble Gases

| Equation Number | Category | Equation | Reference Section |
|---|---|---|---|
| 3-21 | Gamma Dose to Air from Noble Gases Released from Stack | $D^{\gamma}_{airs}\ (mrad) = 0.022 \sum_i Q_i^{ST}\ DF_i^{\gamma}$ | 3.7.1 |
| 3-41 | Gamma Dose to Air from Noble Gases Released from Ground Level | $D^{\gamma}_{airg}\ (mrad) = 0.17 \sum_i Q_i^{GL}\ DF_i^{\gamma}$ | 3.7.1 |
| 3-23 | Beta Dose to Air from Noble Gases Released from Stack | $D^{\beta}_{airs}\ (mrad) = 0.019 \sum_i Q_i^{ST}\ DF_i^{\beta}$ | 3.8.1 |
| 3-43 | Beta Dose to Air from Noble Gases Released from Ground Level | $D^{\beta}_{airg}\ (mrad) = 0.99 \sum_i Q_i^{GL}\ DF_i^{\beta}$ | 3.8.1 |

TABLE 1.1-8

Summary of Variables

| Variable | | Definition | Units |
|---|---|---|---|
| $A_{RL}$ | - | Total gamma activity contained in a resin liner in storage directly in line with a gap between adjacent storage modules. | Ci |
| $C_{1i}^{NG}$ | - | Concentration at point of discharge to an unrestricted area of dissolved and entrained noble gas "i" in liquid pathways from all station sources. | µCi/ml |
| $C_1^{NG}$ | - | Total activity of all dissolved and entrained noble gases in liquid pathways from all station sources. | $\frac{\mu Ci}{ml}$ |
| $C_{di}$ | - | Concentration of radionuclide "i" at the point of liquid discharge to an unrestricted area. | $\frac{\mu Ci}{ml}$ |
| $C_i$ | - | Concentration of radionuclide "i". | $\frac{\mu Ci}{cc}$ |
| $C_{pi}$ | - | Concentration, exclusive of noble gases, of radionuclide "i" from tank "p" at point of discharge to an unrestricted area. | $\frac{\mu Ci}{ml}$ |
| $C_{mi}$ | - | Concentration of radionuclide "i" in mixture at the monitor. | $\frac{\mu Ci}{ml}$ |
| $D_{airs}^{\beta}$ | - | Beta dose to air from stack release. | mrad |
| $D_{airg}^{\beta}$ | - | Beta dose to air from ground level release. | mrad |
| $D_{airs}^{\gamma}$ | - | Gamma dose to air from stack release. | mrad |
| $D_{airg}^{\gamma}$ | - | Gamma dose to air from ground level release. | mrad |
| $D_{cos}$ | - | Dose to critical organ from stack release. | mrem |
| $D_{cog}$ | - | Dose to the critical organ from ground level release. | mrem |
| $D_d$ | - | Direct dose (Turbine Building). | mrem |

TABLE 1.1-10A

Combined Skin Dose Factors Specific for Vermont Yankee Ground Level Noble Gas Releases

| Radionuclide | $DF'_{ig}$ $\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$ |
|---|---|
| AR-41 | 1.41E-01 |
| KR-83M | 1.18E-04 |
| KR-85M | 5.30E-02 |
| KR-85 | 4.19E-02 |
| KR-87 | 3.41E-01 |
| KR-88 | 1.67E-01 |
| KR-89 | 4.20E-01 |
| KR-90 | 3.27E-01 |
| XE-131M | 1.58E-02 |
| XE-133M | 3.30E-02 |
| XE-133 | 1.17E-02 |
| XE-135M | 4.26E-02 |
| XE-135 | 6.97E-02 |
| XE-137 | 3.90E-01 |
| XE-138 | 1.85E-01 |

TABLE 1.1-12

Dose and Dose Rate Factors Specific for Vermont Yankee
for Iodines, Tritium, and Particulate Releases

| Radio-nuclide | Stack Release: Critical Organ Dose Factor $DFG_{sico}$ $\left(\frac{mrem}{Ci}\right)$ | Stack Release: Critical Organ Dose Rate Factor $DFG'_{sico}$ $\left(\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}\right)$ | Ground Level Release*: Critical Organ Dose Factor $DFG_{gico}$ $\left(\frac{mrem}{Ci}\right)$ | Ground Level Release*: Critical Organ Dose Rate Factor $DFG'_{gico}$ $\left(\frac{mrem\text{-}sec}{yr\text{-}\mu Ci}\right)$ |
|---|---|---|---|---|
| H-3 | 1.81E-04 | 5.70E-03 | 9.39E-03 | 2.96E-01 |
| C-14 | 1.10E-01 | 3.47E+00 | 5.70E+00 | 1.80E+02 |
| Cr-51 | 3.80E-03 | 1.32E-01 | 6.05E-02 | 2.09E+00 |
| Mn-54 | 4.36E-01 | 1.72E+01 | 6.74E+00 | 2.66E+02 |
| Fe-55 | 1.97E-01 | 6.21E+00 | 3.06E+00 | 9.65E+01 |
| Fe-59 | 4.35E-01 | 1.44E+01 | 6.81E+00 | 2.25E+02 |
| Co-58 | 2.26E-01 | 8.07E+00 | 3.53E+00 | 1.26E+02 |
| Co-60 | 4.76E+00 | 2.12E+02 | 7.31E+01 | 3.25E+03 |
| Zn-65 | 2.32E+00 | 7.51E+01 | 3.55E+01 | 1.15E+03 |
| Sr-89 | 7.08E+00 | 2.23E+02 | 1.09E+02 | 3.44E+03 |
| Sr-90 | 2.69E+02 | 8.48E+03 | 4.19E+03 | 1.32E+05 |
| Zr-95 | 4.31E-01 | 1.42E+01 | 6.71E+00 | 2.21E+02 |
| Sb-124 | 7.86E-01 | 2.63E+01 | 1.23E+01 | 4.10E+02 |
| Sb-125 | 7.78E-01 | 3.04E+01 | 1.20E+01 | 4.70E+02 |
| I-131 | 4.80E+01 | 1.51E+03 | 7.47E+02 | 2.36E+04 |
| I-133 | 5.12E-01 | 1.61E+01 | 1.02E+01 | 3.22E+02 |
| Cs-134 | 9.88E+00 | 3.28E+02 | 1.53E+02 | 5.08E+03 |
| Cs-137 | 1.01E+01 | 3.44E+02 | 1.55E+02 | 5.30E+03 |
| Ba-140 | 7.02E-02 | 3.27E+00 | 1.98E+00 | 6.31E+01 |
| Ce-141 | 1.06E-01 | 3.37E+00 | 1.71E+00 | 5.46E+01 |
| Ce-144 | 2.40E+00 | 7.60E+01 | 3.74E+01 | 1.18E+03 |

The release point reference is the North Warehouse. These dose and dose rate factors are conservative for potential release applications associated with ground level effluents from other major facilities (i.e., Turbine Building, Reactor Building, AOG, and CAB).

received by a real individual but usually provides an upper bound for a given release because of the conservative margin built into the dose factors and the selection and definition of critical receptors. The radioisotope specific dose factors in each "Method I" dose equation represent the greatest dose to any organ of any age group accounting for existing or potential pathways of exposure. The critical receptor assumed by "Method I" equations is typically a hypothetical individual whose behavior - in terms of location and intake - results in a dose which is expected to be higher than any real individual. Method II allows for a more exact dose calculation for real individuals, if necessary, by considering only existing pathways of exposure, or actual concurrent meteorology with the recorded release.

$\dot{R}$ is the quantity calculated in the Chapter 3 dose rate equations. It is calculated using the plant's effluent monitoring system reading and an annual average or long-term atmospheric dispersion factor. Dispersion factors based on actual concurrent meteorology during effluent releases can also be used via Method II, if necessary, to demonstrate compliance with off-site dose rate limits.

Each of the methods to calculate dose or dose rate are presented in separate sections of Chapter 3, and are summarized in Tables 1.1-1 to 1.1-7. Each method has two levels of complexity and conservative margin and are called Method I and Method II. Method I has the greatest margin and is the simplest; generally a linear equation. Method II is a more detailed analysis which allows for use of site-specific factors and variable parameters to be selected to best fit the actual release. Guidance is provided but the appropriate margin and depth of analysis are determined in each instance at the time of analysis under Method II.

The plant has both elevated and ground level gaseous release points: the main vent stack (elevated release) and the North Warehouse waste oil burner (ground level release). Therefore, total dose calculations for skin, whole body, and the critical organ from gaseous releases will be the sum of the elevated and ground level doses. Appendix D provides an assessment of the surveillance needs for waste oil to ensure that off-site doses from its incineration is maintained within the ALARA limits of the Technical Specifications.

$\dot{Q}_i^{SJAE}$ - The last measured release rate at the steam jet air ejector of noble gas i (μCi/sec).

$DFB_i$ - Total body gamma dose factor (see Table 1.1-10).

For ground level noble gas releases, the total body dose rate is calculated as follows:

$$\dot{R}_{tbg} = 5.5 \sum_i \dot{Q}_i^{GL} \; DFB_i \qquad (3\text{-}39)$$

$$\left(\frac{\text{pCi-sec}}{\mu\text{Ci-m}^3}\right)\left(\frac{\mu\text{Ci}}{\text{sec}}\right)\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$$

where:

$\dot{Q}_i^{GL}$ - Ground level release rate (μCi/sec) of noble gas.

The total body dose rate for the site is equal to $\dot{R}_{tbs} + \dot{R}_{tbg}$.

During periods (beyond the first five days) when the plant is shutdown and no radioactivity release rates can be measured at the SJAE, Xe-133 may be used in place of the last SJAE measured mix as the referenced radionuclide to determine off-site dose rate and monitor setpoints. In this case, the ratio of each $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation 3-28 above is assumed to reduce to a value of 1, and the total body gamma dose factor $DFB_i$ for Xe-133 (2.94 E-04 mrem-$m^3$/pCi-yr) is used in Equation 3-5. Alternately, a relative radionuclide "i" mix fraction ($f_i$) may be taken from Table 5.2-1 as a function of time after shutdown, and substituted in place of the ratio of $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation (3-28) above to determine the relative fraction of each noble gas potentially available for release to the total (example calculations can be found in Appendix A). Just prior to plant startup before a SJAE sample can be taken and analyzed, the monitor alarm setpoints should be based on Xe-138 as representing the most prevalent high dose factor noble gas expected to be present shortly after the plant returns

to power. Monitor alarm setpoints which have been determined to be conservative under any plant conditions may be utilized at any time in lieu of the above assumptions.

Equations 3-5 and 3-39 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via either elevated or ground level vents to the atmosphere.

3.4.2 Basis for Method I

Method I may be used to show that the Technical Specification which limits total body dose rate from noble gases released to the atmosphere (Technical Specification 3.8.E.1) has been met for the peak noble gas release rate.

Method I for stack releases was derived from Regulatory Guide 1.109 as follows:

$$\dot{R}_{tbs} = 1E+06\ S_F\ [X/Q]_S^{\gamma} \sum_i \dot{Q}_i^{ST}\ DFB_i \qquad (3\text{-}6)$$

$$\left(\frac{mrem}{yr}\right) = \left(\frac{pCi}{\mu Ci}\right)(\#)\left(\frac{sec}{m^3}\right) \quad \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

where:

$S_F$ = Shielding factor = 1.0 for dose rate determination.

$[X/Q]_S^{\gamma}$ = Maximum annual average gamma atmospheric dispersion factor for stack (elevated) releases; = 6.98E-07 ($sec/m^3$).

$\dot{Q}_i^{ST}$ = Release rate from the plant stack of noble gas "i" ($\mu$Ci/sec).

$DFB_i$ = Gamma total body dose factor, $\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$. See Table 1.1-10.

Equation 3-6 reduces to:

$$\dot{R}_{tbs} = 0.70 \sum_i \dot{Q}_i^{ST} \; DFB_i \qquad (3\text{-}5)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) = \left(\frac{\text{pCi-sec}}{\mu\text{Ci-m}^3}\right)\left(\frac{\mu\text{Ci}}{\text{sec}}\right)\left(\frac{\text{mrem-m}^3}{\text{pCi-yr}}\right)$$

For ground level releases, the ground level maximum long-term average gamma atmospheric dispersion factor = 5.49E-06 sec/m$^3$, thus leading to:

$$\dot{R}_{tbg} = 1E{+}06 * 5.49E{-}06 \sum_i \dot{Q}_i^{GL} \; DFB_i \qquad (3\text{-}39)$$

or

$$\dot{R}_{tbg} = 5.5 \sum_i \dot{Q}_i^{GL} \; DFB_i$$

The selection of critical receptor, outlined in Section 3.10, is inherent in Method I, as are the maximum expected off-site annual or long-term average atmospheric dispersion factors. Due to the holdup and decay of gases allowed in the AOG, off-gas concentrations at the plant stack during routine plant operations are usually too low for determination of the radionuclide mix at the plant stack. It is then conservatively assumed that most of the noble gas activity at the plant stack is the result of in-plant steam leaks which are removed to the plant stack by building ventilation air flow, and that this air flow has an isotopic distribution consistent with that routinely measured at the SJAE.

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

In the case of noble gas dose rates, Method II cannot provide much extra realism because $\dot{R}_{tbs}$ and $\dot{R}_{tbg}$ are already based on several factors which make use of current plant parameters. However, should it be needed, the dose rate analysis for critical receptor can be performed making use of current meteorology during the time interval of recorded peak release rate in place of the default atmospheric dispersion factor used in Method I.

3.4.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

substituting

$[X/Q]^{\gamma}$ = 6.98E-07 sec/$m^3$
$X/Q$ = 5.99E-07 sec/$m^3$
$S_F$ = Shielding factor = 1.0 for dose rate determinations

gives

$$\dot{R}_{skins} = 0.77 \sum_i \dot{Q}_i^{ST} DF_i^{\gamma} + 0.60 \sum_i \dot{Q}_i^{ST} DFS_i \quad (3\text{-}13)$$

$$\left(\frac{mrem}{yr}\right) \left(\frac{pCi\text{-}sec\text{-}mrem}{\mu Ci\text{-}m^3\text{-}mrad}\right) \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right) \left(\frac{pCi\text{-}sec}{\mu Ci\text{-}m^3}\right) \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$$

$$= \sum_i \dot{Q}_i^{ST}[0.77\ DF_i^{\gamma} + 0.60\ DFS_i] \quad (3\text{-}14)$$

define

$$DF'_{is} = 0.77\ DF_i^{\gamma} + 0.60\ DFS_i \quad (3\text{-}15)$$

then

$$\dot{R}_{skins} = \sum_i \dot{Q}_i^{ST} DF'_{is} \quad (3\text{-}7)$$

$$\left(\frac{mrem}{yr}\right) \left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$$

For determining combined skin doses for ground level releases, a $[X/Q]_g^{\gamma}$ = 5.49E-06 sec/$m^3$ and an undepleted $X/Q_g$ = 3.12-05 sec/$m^3$ have been substituted into Equation 3-12 to give:

$$\dot{R}_{sking} = \sum_i \dot{Q}_i^{GL} (6.09\ DF_i^{\gamma} + 31.2\ DFS_i)$$

then $$DF'_{ig} = 6.09\ DF_i^{\gamma} + 31.2\ DFS_i \quad (3\text{-}37)$$

and $$\dot{R}_{sking} = \sum_i Q_i^{GL}\ DF'_{ig} \quad (3\text{-}38)$$

where:

$\dot{Q}_i^{GL}$ = The noble gas release rate from ground level release points (μCi/sec) for each radionuclide "i" identified.

$DF'_{ig}$ = Combined skin dose factor for a ground level release [see Table 1.1-10A].

The selection of critical receptor, outlined in Section 3.10 is inherent in Method I, as it determined the maximum expected off-site atmospheric dispersion factors based on past long-term site-specific meteorology.

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

3.5.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base

case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

## 3.6 Method to Calculate the Critical Organ Dose Rate from Iodines, Tritium and Particulates with $T_{1/2}$ Greater Than 8 Days

Technical Specification 3.8.E.1.b limits the dose rate to any organ, denoted $\dot{R}_{CO}$, from all release sources of I-131, I-133, H-3, and radionuclides in particulate form with half lives greater than 8 days to 1500 mrem/year to any organ. The peak release rate averaging time in the case of iodines and particulates is commensurate with the time the iodine and particulate samplers are in service between changeouts (typically a week).

Use Method I first to calculate the critical organ dose rate from both elevated and ground level release points to the atmosphere. The dose rate limit of Technical Specification 3.8.E.1.b is the total contribution from both ground and elevated releases occurring during the period of interest. Method I applies at all release rates.

Use Method II if Method I predicts a dose rate greater than the Technical Specification limits (i.e., use of actual meteorology over the period of interest) to determine if, in fact, Technical Specification 3.8.E.1.b had actually been exceeded during the sampling period.

### 3.6.1 Method I

The critical organ dose rate from stack releases can be determined by multiplying the individual radionuclide release rates by their respective dose factors and summing all their products together, as seen in the following Equation 3-16 (an example calculation is provided in Appendix A):

$$\dot{R}_{COS} = \sum_i \dot{Q}_i^{STP} \; DFG'_{sico} \qquad (3\text{-}16)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) \qquad \left(\frac{\mu\text{Ci}}{\text{sec}}\right)\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$$

where:

$\dot{Q}_i^{STP}$ - Stack activity release rate determination of radionuclide "i" (Iodine-131, Iodine-133, particulates with half-lives greater than 8 days, and tritium), in µCi/sec. For i = Sr89, Sr90 or tritium, use the best estimates (such as most recent measurements).

$DFG'_{sico}$ - Site specific critical organ dose rate factor $\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$

for a ground level gaseous release. See Table 1.1-12.

For ground releases (North Warehouse waste oil burner) the critical organ dose rate from Iodine, Tritium, and Particulates with T 1/2 greater than 8 days is calculated as follows:

$$\dot{R}_{cog} = \sum_i \dot{Q}_i^{GLP} DFG'_{gico} \qquad (3\text{-}40)$$

where:

$\dot{Q}_i^{GLP}$ - Ground activity release rate determination of radionuclide "i" (Iodine-131, Iodine-133, particulates with half-lives greater than 8 days, and tritium), in µCi/sec. For i = Sr89, Sr90, Fe-55, or tritium, use the best estimates (such as most recent measurements). For waste oil, the release rate is the total activity by radionuclide divided by the estimated burn time. (See Appendix D for surveillance criteria on waste oil burning.

$DFG'_{gico}$ - Site specific critical organ dose rate factor $\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$

for a ground level gaseous release. See Table 1.1-12.

The critical organ dose rate for the site is equal to $\dot{R}_{cos} + \dot{R}_{cog}$.

Equations 3-16 and 3-40 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Tritium, iodine, and particulate releases via either elevated or ground level vents to the atmosphere.

3.6.2 Basis for Method I

The methods to calculate critical organ dose rate parallel the total body dose rate methods in Section 3.4.3. Only the differences are presented here.

Method I may be used to show that the Technical Specification which limits organ dose rate from iodines, tritium and radionuclides in particulate form with half lives greater than 8 days (hereafter called Iodines and Particulates or "I+P") released to the atmosphere (Technical Specification 3.8.E.1.b) has been met for the peak I + P release rates.

The equation for $\dot{R}_{cos}$ and $\dot{R}_{cog}$ is derived by modifying Equation 3-25 from Section 3.9 as follows:

$$\dot{D}_{cos} = \sum_i Q_i \; DFG_{ico} \qquad (3\text{-}17)$$

$$(\text{mrem}) \qquad (\text{Ci}) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

applying the conversion factor, 31.54 (Ci-sec/μCi-yr) and converting Q to $\dot{Q}$ in μCi/sec as it applies to the plant stack yields:

$$\dot{R}_{cos} = 31.54 \sum_i \dot{Q}_i^{STP} \; DFG_{sico} \qquad (3\text{-}18)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) \left(\frac{\text{Ci-sec}}{\mu\text{Ci-yr}}\right) \left(\frac{\mu\text{Ci}}{\text{sec}}\right) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

Equation 3.8 is written in the form:

$$\dot{R} = 31.54 \sum_i \dot{Q}_i^{STP} DFG_{sico} \qquad (3\text{-}19)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) \left(\frac{\text{Ci-sec}}{\mu\text{Ci-yr}}\right) \left(\frac{\mu\text{Ci}}{\text{sec}}\right) \left(\frac{\text{mrem}}{\text{Ci}}\right)$$

$DFG'_{sico}$ and $DFG'_{gico}$ (North Warehouse waste oil burner vent releases) incorporates the conversion constant of 31.54 and has assumed that the shielding factor ($S_F$) applied to the direct exposure pathway from radionuclides deposited on the ground plane is equal to 1.0 in place of the $S_F$ value of 0.7 assumed in the determination of $DFG_{sico}$ and $DFG_{gico}$ for the integrated doses over time.

The selection of critical receptor (based on the combination of exposure pathways which include direct dose from the ground plane, inhalation and ingestion of vegetables, meat, and milk) which is outlined in Section 3.10 is inherent in Method I, as are the maximum expected off-site atmospheric dispersion factors based on past long-term site-specific meteorology.

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake efferts, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

Should Method II be needed, the analysis for critical receptor critical pathway(s) and atmospheric dispersion factors may be performed with actual meteorologic and latest land use census data to identify the location of those pathways which are most impacted by these type of releases.

For ground level noble gas releases, the gamma air dose is calculated as follows:

$$D^{\gamma}_{airg} = 0.17 \sum_{i} Q_i^{GL} DF_i^{\gamma} \qquad (3\text{-}41)$$

where:

$Q_i^{GL}$ = Total noble gas activity (curies) released to the atmosphere via ground level vents of each radionuclide, "i", during the period of interest.

The gamma air dose for the site is equal to $D^{\gamma}_{airs} + D^{\gamma}_{airg}$.

Equations 3-21 and 3-41 can be applied under the following conditions (otherwise justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via either elevated or ground level vents to the atmosphere.

3.7.2 Basis for Method I

Method I may be used to show that the Technical Specification which limits off-site gamma air dose from gaseous effluents (3.8.F.1) has been met for releases over appropriate periods. This Technical Specification is based on the Objective in 10CFR50, Appendix I, Subsection B.1, which limits the estimated annual gamma air dose at unrestricted area locations.

Exceeding the Objective does not immediately limit plant operation but requires a report to the NRC.

For any noble gas release, in any period, the dose is taken from Equations B-4 and B-5 of Regulatory Guide 1.109 with the added assumption that $D^{\gamma}_{finite} = D^{\gamma}[X/Q]^{\gamma}/[X/Q]$:

$(X/Q)_g^{\Upsilon}$ = Maximum long-term average gamma atmospheric dispersion factor for a ground level release

= 5.49E-06 $sec/m^3$

leading to:

$$D_{airg}^{\Upsilon} = 0.17 \sum_i Q_i^{GL} DF_i^{\Upsilon} \qquad (3\text{-}41)$$

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

The main difference between Method I and Method II is that Method II would allow the use of actual meteorology to determine $[X/Q]^{\Upsilon}$ rather than use the maximum long-term average value obtained for the years 1981 to 1985.

3.7.3 Method II

If the Method I dose determination indicates that the Technical Specification limit may be exceeded, or if a more exact calculation is required, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

For ground level noble gas releases, the beta air dose is calculated as follows:

$$D^{\beta}_{air_g} = 0.99 \sum_i Q^{GL}_i \, DF^{\beta}_i \qquad (3\text{-}43)$$

where:

$Q^{GL}_i$ = Total noble gas activity (curies) released to the atmosphere via the ground level vents of each radionuclide "i" during the period of interest.

The beta air dose for the site is equal to $D^{\beta}_{airs} + D^{\beta}_{airg}$.

Equations 3-23 and 3-43 can be applied under the following conditions (otherwise justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via either elevated or ground level vents to the atmosphere.

3.8.2 Basis for Method I

This section serves three purposes: (1) to document that Method I complies with appropriate NRC regulations, (2) to provide background and training information to Method I users, and (3) to provide an introductory user's guide to Method II. The methods to calculate beta air dose parallel the gamma air dose methods in Section 3.7.3. Only the differences are presented here.

Method I may be used to show that the Technical Specification which limits off-site beta air dose from gaseous effluents (3.8.A.1) has been met for releases over appropriate periods. This Technical Specification is based on the Objective in 10CFR50, Appendix I, Subsection B.1, which limits the estimated annual beta air dose at unrestricted area locations.

where:

$(X/Q)_g$ = Maximum long-term average undepleted atmospheric dispersion factor for a ground level release.

= 3.12E-05 $sec/m^3$

leading to:

$$D^{\beta}_{airg} = 0.99 \sum_i Q_i^{GL} DF_i^{\beta} \qquad (3\text{-}43)$$

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

### 3.8.3 Method II

If Method I cannot be applied, or if the Method I dose determination indicates that the Technical Specification limit may be exceeded, or if a more exact calculation is required, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. Analyses requiring Method II calculations should be referred to YNSD to be performed and documented.

The critical organ dose is calculated for ground level releases as follows:

$$D_{cog} = \sum_i Q_i^{GLP} \, DFG_{gico} \qquad (3\text{-}44)$$

(mrem) (Ci) $\left(\frac{\text{mrem}}{\text{Ci}}\right)$

$Q_i^{GLP}$ = Total activity (Ci) released from ground level vents to the atmosphere of radionuclide "i" during the period of interest. For tritium, strontiums, and Fe-55 use the most recent measure.

$DFG_{gico}$ = Site-specific critical organ dose factor for a ground level release of nuclide "i" (mrem/Ci). For each radionuclide it is the age group and organ with the largest dose factor. See Table 1.1-12.

The critical organ dose for the site is equal to $D_{cos} + D_{cog}$ .

Equations 3-25 and 3-44 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event),

2. I+P releases via either elevated or ground level vents to the atmosphere, and

3. Any continuous or batch release over any time period.

## 3.10 Receptor Points and Annual Average Atmospheric Dispersion Factors for Important Exposure Pathways

The gaseous effluent dose methods have been simplified by assuming an individual whose behavior and living habits inevitably lead to a higher dose than anyone else. The following exposure pathways to gaseous effluents listed in Regulatory Guide 1.109 (Reference A) have been considered:

1. Direct exposure to contaminated air;
2. Direct exposure to contaminated ground;
3. Inhalation of air;
4. Ingestion of vegetables;
5. Ingestion of cow's milk; and
6. Ingestion of meat.

Section 3.10.1 details the selection of important off-site locations and receptors. Section 3.10.2 describes the atmospheric model used to convert meteorologic data into atmospheric dispersion factors. Section 3.10.3 presents the maximum atmospheric dispersion factors calculated at each of the off-site receptor locations.

### 3.10.1 Receptor Locations

Three important receptor locations are considered in the dose and dose rate equations for gaseous radioactive effluents. They are:

1. The point of maximum gamma exposure from an overhead noble gas cloud;

2. The point of maximum ground level air concentration and deposition of radionuclides.

The point of maximum gamma exposure from stack releases (S sector, 400 meters) was determined by finding the maximum five-year average gamma X/Q at any off-site location. The location of the maximum ground level air concentration and deposition of radionuclides (NW sector, 2900 meters) was determined by finding the maximum five-year average depleted X/Q and D/Q at any off-site location. For the purposes of determining the Method I dose factors for iodines, tritium, and particulates, a milk animal was assumed to exist at the location of highest calculated ground level air concentration and deposition as noted above. This location then conservatively bounds the deposition of radionuclides at all real milk animal locations.

Regarding the calculation of ground level release doses, the selection of a critical receptor (S, 299 meters from the North Warehouse as the reference release points) is based on the site boundary with the highest ground level atmospheric dispersion factor (based on same meteorological history as used for the stack) and the assumption that all of the exposure pathways used for the stack release occur at this site boundary.

### 3.10.2 Vermont Yankee Atmospheric Dispersion Model

The annual average atmospheric dispersion factors are computed for routine (long-term) releases using Yankee Atomic Electric Company's (YAEC) AEOLUS Computer Code (Reference B). AEOLUS is based, in part, on the straight-line airflow model discussed in Regulatory Guide 1.111 (Reference C). The valley in which the plant is located is considered by the model.

AEOLUS produces the following annual average atmospheric dispersion factors for each location:

1. Undepleted X/Q dispersion factors for evaluating ground level concentrations;

2. Depleted X/Q dispersion factors for evaluating ground level concentrations;

3. Gamma X/Q dispersion factors for evaluating gamma dose rates from a sector averaged finite cloud (multiple energy undepleted source); and

4. D/Q deposition factors for evaluating dry deposition of elemental radioiodines and other particulates.

The deposition velocity concept presented in "Meteorology and Atomic Energy - 1968" (Reference E, Section S-3.2) is used to determine the depleted X/Q and D/Q factors, assuming a constant deposition velocity of 1 cm/sec.

TABLE 3.10-1

Vermont Yankee Dilution Factors

| | Dose Rate to Individual | | | Dose to Air | |
|---|---|---|---|---|---|
| | Total Body | Skin | Critical Organ | Gamma | Beta |
| X/Q depleted $\left(\frac{sec}{m^3}\right)$ | - | - | 5.85E-07(2)<br>(2.98E-05)(3) | - | - |
| X/Q undepleted $\left(\frac{sec}{m^3}\right)$ | - | 5.99E-07(2)<br>(3.12E-05)(3) | - | - | 5.99E-07(2)<br>(3.12E-05)(3) |
| D/Q $\left(\frac{1}{m^2}\right)$ | - | - | 5.85E-09(2)<br>(8.98E-08)(3) | - | - |
| X/Q' depleted $\left(\frac{sec}{m^3}\right)$ | 6.98E-07(1)<br>(5.49E-06)(3) | 6.98E-07(1)<br>(5.49E-06)(3) | - | 6.98E-07(1)<br>(5.49E-06)(3) | - |

(1) Maximum gamma exposure point: S sector, 400 meters (0.25 miles), for stack release.
(2) Maximum ground level concentration: NW sector, 2900 meters (1.80 miles), for stack release.
(3) Ground level release maximum dilution factors (reference release point is the North Warehouse): S Sector (45 degree width), 299 meters (0.19 miles).

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## Table 4.1

## Radiological Environmental Monitoring Stations[1]

| Exposure Pathway and/or Sample | | Sample Location and Designated Code[2] | | Distance (km)[6] | Direction[6] |
|---|---|---|---|---|---|
| 1. | AIRBORNE (Radioiodine and Particulate) | | | | |
| | | AP/CF-11 | River Station No. 3.3 | 1.9 | SSE |
| | | AP/CF-12 | N. Hinsdale, NH | 3.6 | NNW |
| | | AP/CF-13 | Hinsdale Substation | 3.1 | E |
| | | AP/CF-14 | Northfield, MA | 11.3 | SSE |
| | | AP/CF-15 | Tyler Hill Road[4] | 3.2 | WNW |
| | | AP/CF-21 | Spofford Lake | 16.1 | NNE |
| 2. | WATERBORNE | | | | |
| | a. Surface | WR-11 | River Station No. 3.3 | 1.9 | Downriver |
| | | WR-21 | Rt. 9 Bridge | 12.8 | Upriver |
| | b. Ground | WG-11 | Plant Well | -- | On-Site |
| | | WG-12 | Vernon Nursing Well | 2.0 | SSE |
| | | WG-22 | Skibniowsky Well | 14.3 | N |
| | c. Sediment From Shoreline | SE-11 | Shoreline Downriver | 0.8 | SSE |
| | | SE-12 | North Storm Drain Outfall[3] | 0.15 | E |
| 3. | INGESTION | | | | |
| | a. Milk | TM-11 | Miller Farm | 0.8 | WNW |
| | | TM-12 | Dominick[5] | 5.2 | E |
| | | TM-14 | Brown Farm | 2.1 | S |
| | | TM-16 | Meadow Crest Farm | 4.4 | WNW/NW |
| | | TM-18 | Blodgett Farm[4] | 3.4 | SE |
| | | TM-24 | County Farm | 22.5 | N |
| | b. Mixed Grasses | TG-11 | River Station No. 3.3 | 1.9 | SSE |
| | | TG-12 | N. Hinsdale, NH | 3.6 | NNW |
| | | TG-13 | Hinsdale Substation | 3.1 | E |
| | | TG-14 | Northfield, MA | 11.3 | SSE |
| | | TG-15 | Tyler Hill Rd.[4] | 3.2 | WNW |
| | | TG-21 | Spofford Lake | 16.1 | NNE |

Table 4.1
(Continued)

Radiological Environmental Monitoring Stations[1]

| Exposure Pathway and/or Sample | Sample Location and Designated Code[2] | | Distance (km)[6] | Direction[6] |
|---|---|---|---|---|
| c. Silage | TC-11 | Miller Farm | 0.8 | WNW |
| | TC-12 | Dominick[5] | 5.2 | E |
| | TC-14 | Brown Farm | 2.1 | S |
| | TC-16 | Meadow Crest Farm | 4.4 | WNW/NW |
| | TC-18 | Blodgett Farm[4] | 3.4 | SE |
| | TC-24 | County Farm | 22.5 | N |
| d. Fish | FH-11 | Vernon Pond | (7) | (7) |
| | FH-21 | Rt. 9 Bridge | 12.8 | Upriver |
| 4. DIRECT RADIATION | | | | |
| | DR-1 | River Station No. 3.3 | 1.6 | SSE |
| | DR-2 | N. Hinsdale, NH | 3.9 | NNW |
| | DR-3 | Hinsdale Substation | 3.0 | E |
| | DR-4 | Northfield, MA | 11.0 | SSE |
| | DR-5 | Spofford Lake | 16.3 | NNE |
| | DR-6 | Vernon School | 0.46 | WSW |
| | DR-7 | Site Boundary | 0.27 | W |
| | DR-8 | Site Boundary | 0.25 | SW |
| | DR-9 | Inner Ring | 2.1 | N |
| | DR-10 | Outer Ring | 4.6 | N |
| | DR-11 | Inner Ring | 2.0 | NNE |
| | DR-12 | Outer Ring | 3.6 | NNE |
| | DR-13 | Inner Ring | 1.4 | NE |
| | DR-14 | Outer Ring | 4.3 | NE |
| | DR-15 | Inner Ring | 1.4 | ENE |
| | DR-16 | Outer Ring | 2.9 | ENE |
| | DR-17 | Inner Ring | 1.2 | E |
| | DR-18 | Outer Ring | 3.0 | E |
| | DR-19 | Inner Ring | 3.5 | ESE |
| | DR-20 | Outer Ring | 5.3 | ESE |
| | DR-21 | Inner Ring | 1.8 | SE |
| | DR-22 | Outer Ring | 3.2 | SE |
| | DR-23 | Inner Ring | 1.8 | SSE |
| | DR-24 | Outer Ring | 3.9 | SSE |
| | DR-25 | Inner Ring | 2.0 | S |

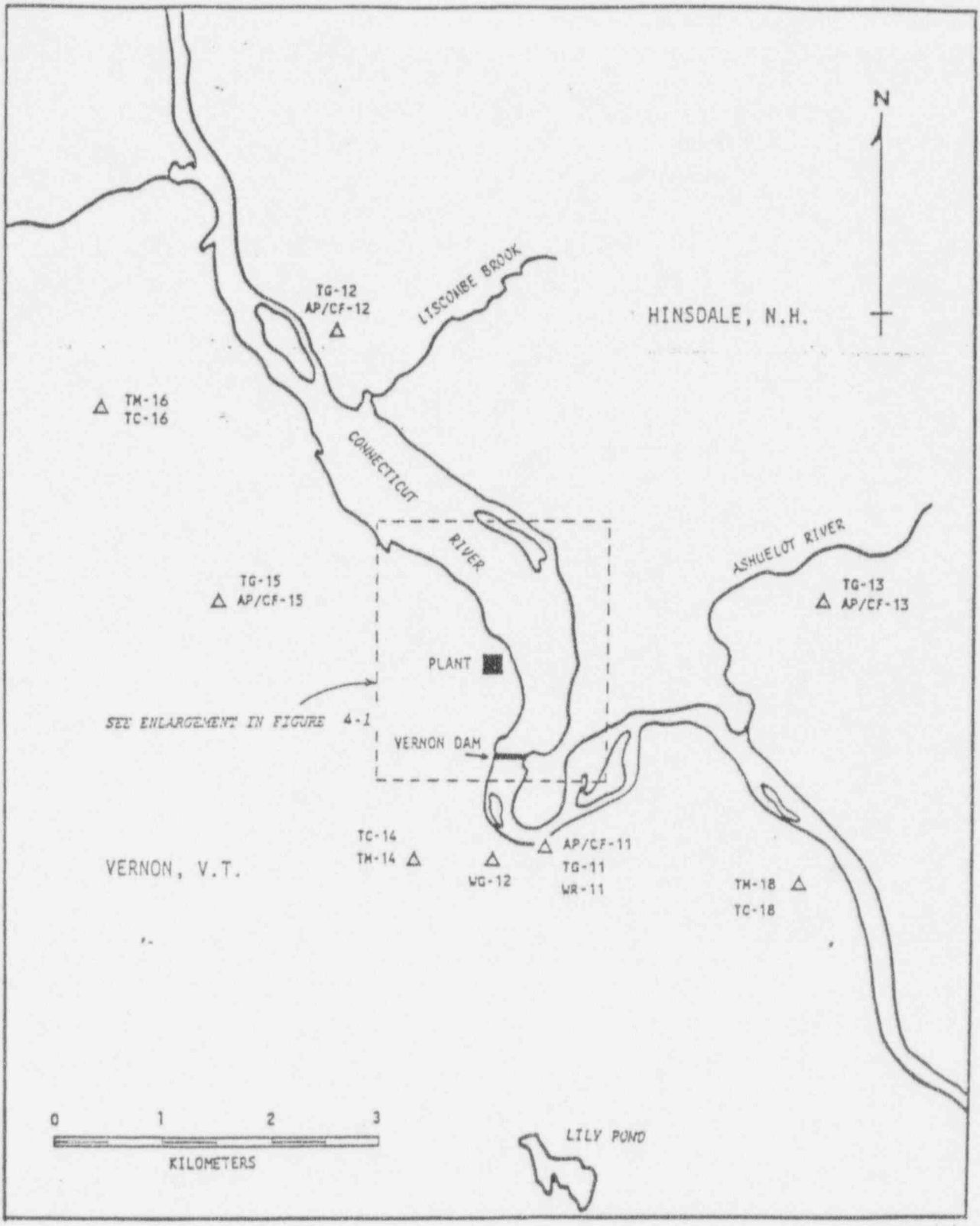


Figure 4-2 Environmental Sampling Locations Within 5 km of Plant

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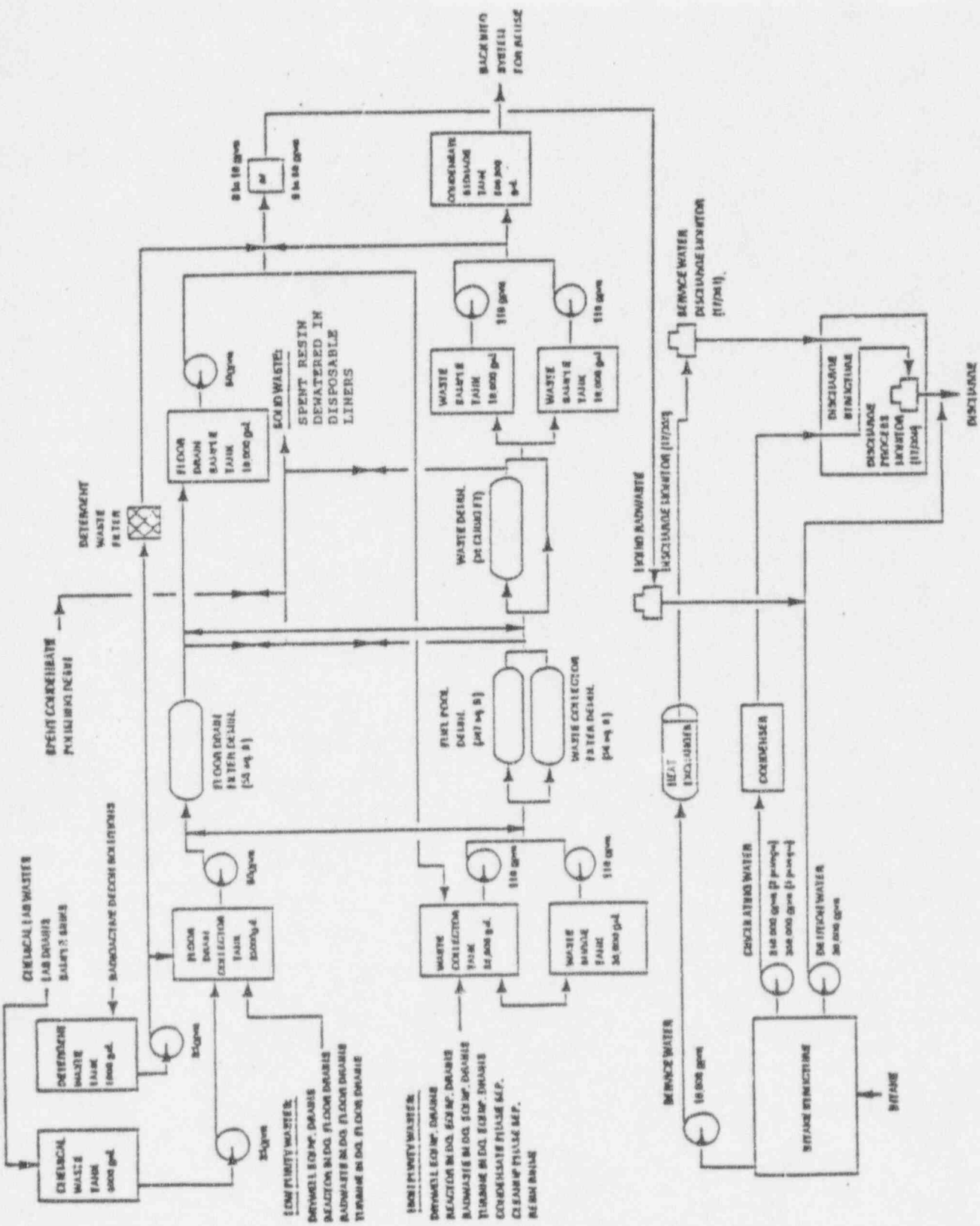


Figure 6-1, Liquid Effluent Stream, Radiation Monitors, and Radwaste Treatment System at Vermont Yankee

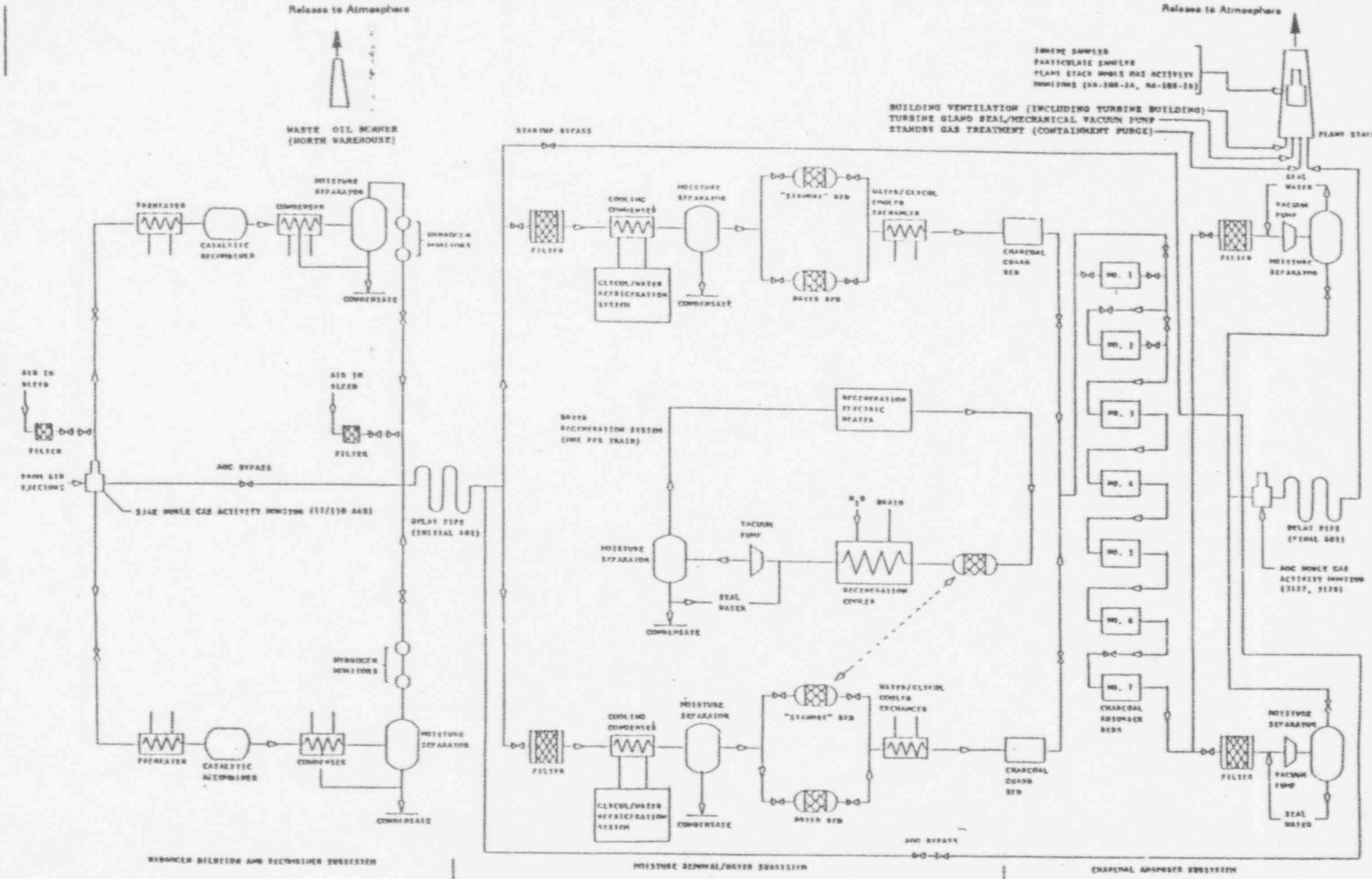


Figure 6-2 Gaseous Effluent Streams, Radiation Monitors, and Radwaste Treatment System at Vermont Yankee

# APPENDIX D

## ASSESSMENT OF SURVEILLANCE CRITERIA FOR GAS RELEASES FROM WASTE OIL INCINERATION

APPENDIX D

ASSESSMENT OF SURVEILLANCE CRITERIA FOR GAS
RELEASES FROM WASTE OIL INCINERATION

INTRODUCTION:

The Nuclear Regulatory Commission amended its regulations (10CFR20) in a Federal Register Notice (Vol. 57, No. 235; page 57649 / Monday, December 7, 1992) that permitted the on-site incineration of contaminated waste oil generated at licensed nuclear power plants without the need to amend existing operating licenses. This action will help to ensure that the limited capacity of licensed low level waste disposal facilities is used efficiently while maintaining releases from operating nuclear power plants at levels which are "as low as reasonably achievable." Incineration of this class of waste must be in full compliance with the Commission's current regulations that restrict the release of radioactive materials to the environment. Any other applicable Federal, State, or local requirements that relate to the toxic or hazardous characteristics of the waste oil would also have to be satisfied.

Incineration of waste oil is to be carried out under existing effluent limits, recordkeeping and reporting requirements. Specifically, licensees must comply with the effluent release limitations of 10CFR Part 20, and Part 50; Appendix I. This includes the site gaseous pathway dose and dose rate limits contained in the plant's Technical Specifications (Section 3.8). The dose contribution to members of the public resulting from the on-site incineration of contaminated waste oil must not cause the total dose or dose rate from all effluent sources to exceed the dose or concentration limits imposed by 10CFR20, 10CFR50; Appendix I, and the Radiological Effluent Technical Specifications (RETS). It is expected that the actual contribution to public exposures caused by waste oil burning will be a small fraction of the site's effluent limits, as well as a small portion of the total releases from the site.

SOURCE DESCRIPTION

Contaminated waste oil suitable for on-site incineration can be burned in the Waste Oil Burner located in the North Warehouse. The burner has its own exhaust stack situated on the roof of the warehouse. However, due to the short height of the exhaust stack above the roof line, this release point is considered to be a ground level point source for modeling discharges to the environment. In addition, the building wake effects from the North Warehouse are assumed to be independent of the larger Turbine Hall/Reactor Building complex due to its distance from these main structures. Consequently, the relatively small size of the North Warehouse leads to

meteorological dispersion factors that are conservative with respect to the dispersion factors for the main plant structures.

The waste oil burner is rated to process oil at a 2 gal./hour from a 500 gallon day tank. The offgas flow rate for the burner is rated as 199 cfm. This provides an air to oil dilution during the incineration of 44,800.

WASTE OIL SAMPLING/SURVEILLANCE REQUIREMENTS

The oil burner stack is not equipped with continuous air monitoring or sampling capability for the direct determination of radiological effluent releases during the incineration process. As a consequence, sampling and analysis of the waste oil prior to its incineration is necessary to project the dose and dose rate consequences of burning contaminated oil. Calculations of projected dose from the incineration of total quantity of oil to be added to the Waste Oil Burn Day Tank for each series of burns will be performed in accordance with the methods in the ODCM and compared to the accumulated site total dose for that period before initiation of incineration. Dose rate determinations will be determined by averaging the projected dose for the quantity of radioactivity determined to be present in the oil over the expected duration of the burn necessary to incinerate the total volume to be added to the Day Tank. Inherent in this determination is the assumption that all radioactivity found to be present in each batch of oil will be released to the atmosphere during the incineration. No retention of activity in the combustion chamber is assumed in calculating the offsite radiological impact.

Normal sampling and analysis methods for gaseous release streams cannot be applied directly to liquids (waste oil). Therefore, the sampling and analysis requirements for liquids as identified in Technical Specification Table 4.8.1 shall be used to determine the level of contamination in waste oil. The stated Lower Limits of Detection (LLD) given on Table 4.8.1 provide assurance that undetectable levels of contamination up to the LLD values will not result in a significant dose impact to the maximum offsite receptor. If waste oil was burned continuously for an entire calendar quarter, and the radionuclides listed in the ODCM Dose Conversion Factor Table 1.1-12 were assumed to be present in the oil at the LLD values specified in Technical Specification Table 4.8.1, the resultant maximum organ dose would amount to only 0.28% of the ALARA quarterly limit of 7.5 mrem.

The principle limitation in the incineration of waste oil is that the site release limits contained in RETS, and implemented by the ODCM methodology, shall not be exceeded. The use of the liquid LLDs on waste oil sample analyses provide sufficient sensitivity to ensure that site dose limits will not be exceeded as a consequence of burning slightly contaminated oil.

# APPENDIX I

## RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS

Requirement: Technical Specification 6.14.A requires that licensee initiated major changes to the radioactive waste systems (liquid, gaseous, and solid) be reported to the Commission in the Semiannual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Plant Operation Review Committee.

Response: There were no licensee initiated major changes to the radioactive waste systems (liquid, gaseous, and solid) during this reporting period.

# APPENDIX J

## ON-SITE DISPOSAL OF SEPTIC WASTE

Requirement: Off-Site Dose Calculational Manual, Appendix B requires that the dose impact due to on-site disposal of septic waste during the reporting year and from previous years be reported to the Commission in the Semiannual Radioactive Effluent Report filed after January 1, if disposals occur during the reporting year.

Response: There was one on-site disposal of septic waste during the reporting year. The total volume of septage spread was approximately 12,000 gallons. The total activity spread on the 1.9 acres (southern) on-site disposal field during 1993 and from previous years was:

| Nuclide | Activity (Ci) |
|---|---|
| Mn-54 | 2.11E-07 |
| Co-60 | 1.32E-05 |
| Zn-65 | 7.77E-07 |
| Cs-134 | 7.03E-08 |
| Cs-137 | 2.16E-06 |

The projected hypothetical dose from on-site disposals of septic waste is 1.48E-02 mrem/year. This dose was calculated according to the model and the assumptions of Off-Site Dose Calculational Manual, Appendix B.