# NINE MILE POINT NUCLEAR STATION - UNIT 1

# SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

# JULY - DECEMBER 1993

***NIAGARA MOHAWK POWER CORPORATION***

# NINE MILE POINT NUCLEAR STATION - UNIT 1

# SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

# JULY - DECEMBER 1993

## SUPPLEMENTAL INFORMATION

**Facility:** Nine Mile Point Unit #1 **Licensee:** Niagara Mohawk Power Corporation

1. TECHNICAL SPECIFICATION LIMITS

A) FISSION AND ACTIVATION GASES

1. The dose rate limit of noble gases from the site to areas at and beyond the site boundary shall be less than or equal to 500 mrems/year to the total body and less than or equal to 3000 mrems/year to the skin.

2. The air dose due to noble gases released in gaseous effluents from the Nine Mile Point 1 Station to areas at and beyond the site boundary shall be limited during any calendar quarter to less than or equal to 5 milliroentgen for gamma radiation and less than or equal to 10 mrads for beta radiation, and during any calendar year to less than or equal to 10 milliroentgen for gamma radiation and less than or equal to 20 mrads for beta radiation.

B&C) TRITIUM, IODINES AND PARTICULATES, HALF LIVES > 8 DAYS

1. The dose rate limit of Iodine-131, Iodine-133, Tritium and all radionuclides in particulate form with half-lives greater than eight days, released to the environs as part of the gaseous wastes from the site, shall be less than or equal to 1500 mrems/year to any organ.

2. The dose to a member of the public from Iodine-131, Iodine-133, Tritium and all radionuclides in particulate form with half lives greater than eight days as part of gaseous effluents released from the Nine Mile Point 1 Station to areas at and beyond the site boundary shall be limited during any calendar quarter to less than or equal to 7.5 mrems to any organ and, during any calendar year to less than or equal to 15 mrems to any organ.

D) LIQUID EFFLUENTS

1. The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gas, the concentration shall be limited to 2E-04 microcuries/ml total activity.

2. The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released from Nine Mile Point Unit 1 to unrestricted areas shall be limited during any calendar quarter to less than or equal to 1.5 mrems to the total body and to less than or equal to 5 mrems to any organ, and during any calendar year to less than or equal to 3 mrems to the total body and to less than or equal to 10 mrems to any organ.

2. MEASUREMENTS AND APPROXIMATIONS OF TOTAL RADIOACTIVITY

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

A) FISSION AND ACTIVATION GASES

Noble gas effluent activity is determined by on-line gamma spectroscopic monitoring (intrinsic germanium crystal) or gross activity monitoring (calibrated against gamma isotopic analysis of a 4.0L Marinelli grab sample) of an isokinetic stack sample stream.

B) IODINES

Iodine effluent activity is determined by gamma spectroscopic analysis (at least weekly) of charcoal cartridges sampled from an isokinetic stack sample stream.

C) PARTICULATES

Activity released from main stack is determined by gamma spectroscopic analysis (at least weekly) of particulate filters sampled from an isokinetic sample stream.

For emergency condenser vent batch releases, effluent curie quantities are estimated by subtracting activity remaining in the shell side of the emergency condenser after batch release from activity delivered to the shell from Make-up sources. Actual isotopic concentrations are found via gamma spectroscopy. Batch release activities of Sr-89, Sr-90 and Fe-55 are estimated by applying scaling factors to activity concentrations of gamma emitters. The activity of Tritium released during normal operation or during batch releases is conservatively estimated by multiplying recent condensate storage tank H-3 activity by assumed steaming rates out the vents.

D) TRITIUM

Tritium effluent activity is estimated by liquid scintillation or gas proportional counting of monthly samples taken with an air sparging/water trap apparatus.

E) LIQUID EFFLUENTS

Isotopic analysis of a representative sample of each batch and composite analysis of non-gamma emitters.

F) SOLID EFFLUENTS

Isotopic contents of waste shipments are determined by gamma spectroscopy, gross alpha and water content analyses of a representative sample of each batch. Scaling factors established from primary composite sample analyses conducted off-site are applied, where appropriate, to find estimated concentration of non-gamma emitters. For low activity trash shipments, curie content is estimated by dose rate measurement and application of appropriate scaling factors.

# ATTACHMENT 1
## Summary Data

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**Liquid Effluents:**

10CFR20, Appendix B, Table II, Column 2

Average MPC (Qtr. 3 ) = N/A
Average MPC (Qtr. 4 ) = N/A

Average Energy (Fission and Activation gases - Mev):

| | | | |
|---|---|---|---|
| Qtr. 3 | : $\bar{E}_\gamma$ = 5.07E-02 | $\bar{E}_\beta$ = | 1.41E-01 |
| Qtr. 4 | : $\bar{E}_\gamma$ = 8.12E-02 | $\bar{E}_\beta$ = | 1.72E-01 |

**Liquid: There were no liquid releases during the reporting period.**

| | |
|---|---|
| Number of batch releases | : 0 |
| Total time period for batch releases (hrs) | : N/A |
| Maximum time period for a batch release (hrs) | : N/A |
| Average time period for a batch release (hrs) | : N/A |
| Minimum time period for a batch release (hrs) | : N/A |
| Total volume of water used to dilute the liquid effluent during release period (L) | : N/A |
| Total volume of water available to dilute the liquid effluent during reporting period (L) | : 2.63E+11 |

*UNIT 1 (ONLY)*

**Gaseous (Emergency Condenser Vent): There were no releases from the operation of the emergency condenser vent.**

| | |
|---|---|
| Number of batch releases | : 0 |
| Total time period for batch releases (hrs) | : N/A |
| Maximum time period for a batch release (hrs) | : N/A |
| Average time period for a batch release (hrs) | : N/A |
| Minimum time period for a batch release (hrs) | : N/A |

**Gaseous (Primary Containment Purge):**

| | |
|---|---|
| Number of batch releases | : 0 |
| Total time period for batch releases (hrs) | : N/A |
| Maximum time period for a batch release (hrs) | : N/A |
| Average time period for a batch release (hrs) | : N/A |
| Minimum time period for a batch release (hrs) | : N/A |

# ATTACHMENT 1
## Summary Data

| | |
|---|---|
| Unit 1 X Unit 2 ___ | Reporting Period July - December 1993 |
| Abnormal Releases: There were no abnormal releases during the reporting period. | |
| A. Liquids: | |
| Number of releases 0 | |
| Total activity released N/A Ci | |
| B. Gaseous: | |
| Number of releases 0 | |
| Total activity released N/A Ci | |

# ATTACHMENT 2[1]

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES ELEVATED AND GROUND LEVEL**

| | | | 3rd QUARTER | 4th QUARTER | EST. TOTAL ERROR, % |
|---|---|---|---|---|---|
| A. | Fission & Activation Gases | | | | |
| | 1. Total release | Ci | 3.63E+01 | 2.91E+00 | 5.00E+01 |
| | 2. Average release rate | µCi/sec | 4.57E+00 | 3.66E-01 | |
| B. | Iodines[2] | | | | |
| | 1. Total Iodine-131 | Ci | ** | ** | 3.00E+01 |
| | 2. Average release rate for period | µCi/sec | ** | ** | |
| C. | Particulates[3] | | | | |
| | 1. Particulates with half-lives >8 days | Ci | 6.39E-05 | 4.25E-04 | 3.00E+01 |
| | 2. Average release rate for period | µCi/sec | 7.62E-06 | 5.41E-05 | |
| | 3. Gross alpha radioactivity | Ci | 5.42E-05 | 3.80E-05 | 2.50E+01 |
| D. | Tritium[3] | | | | |
| | 1. Total release | Ci | 7.19E+00 | 1.74E+01 | 5.00E+01 |
| | 2. Average release rate for period | µCi/sec | 8.57E-01 | 2.21E+00 | |
| E. | Percent of Tech Spec Limits | | | | |
| | Fission and Activation Gases | | | | |
| | Percent of Quarterly Gamma Air Dose Limit (5 mrem) | % | 2.98E-02 | 4.16E-03 | |
| | Percent of Quarterly Beta Air Dose Limit (10 mrem) | % | 3.01E-02 | 2.97E-03 | |
| | Percent of Annual Gamma Air Dose Limit to Date (10 mrem) | % | 7.31E-02 | 7.52E-02 | |
| | Percent of Annual Beta Air Dose Limit to Date (20 mrem) | % | 1.22E-01 | 1.23E-01 | |
| | Percent of Whole Body Dose Rate Limit (500 mrem/yr) | % | 7.09E-04 | 1.05E-04 | |
| | Percent of Skin Dose Rate Limit (3000 mrem/yr) | % | 2.84E-04 | 4.11E-05 | |
| | Tritium, Iodines, and Particulates (with half-lives greater than 8 days) | | | | |
| | Percent of Quarterly Dose Limit (7.5 mrem) | % | 1.20E-02 | 7.63E-02 | |
| | Percent of Annual Dose Limit (15 mrem) | % | 9.92E-01 | 9.98E-01 | |
| | Percent of Organ Dose Rate Limit (1500 mrem/yr) | % | 2.26E-04 | 1.53E-03 | |

[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-Annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

[2] Concentrations less than the lower limit of detection of 1.00E-04 µCi/ml for noble gases, 1.00E-11 µCi/ml for particulates, 1.00E-12 µCi/ml for Iodines, and 1.00E-06 µCi/ml for Tritium as required by Technical Specifications, are indicated with a double asterisk.

[3] Tritium, Iron-55, and Strontium results were not received from the off-site vendor at the time of this report. These numbers include estimates, and actual numbers will be provided in the next Semi-Annual Report.

# ATTACHMENT 3[1]

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

## GASEOUS EFFLUENTS - ELEVATED RELEASE

| | Nuclides Released | | CONTINUOUS MODE[4] 3rd QUARTER | CONTINUOUS MODE[4] 4th QUARTER |
|---|---|---|---|---|
| 1. | Fission Gases[2] | | | |
| | Argon-41 | Ci | ** | ** |
| | Krypton-85 | Ci | ** | ** |
| | Krypton-85m | Ci | 1.70E+00 | 9.16E-01 |
| | Krypton-87 | Ci | ** | ** |
| | Krypton-88 | Ci | ** | ** |
| | Xenon-127 | Ci | ** | ** |
| | Xenon-133 | Ci | 3.46E+01 | 1.99E+00 |
| | Xenon-133m | Ci | ** | ** |
| | Xenon-135 | Ci | ** | ** |
| | Xenon-135m | Ci | ** | ** |
| | Xenon-137 | Ci | ** | ** |
| | Xenon-138 | Ci | ** | ** |
| 2. | Iodines[2] | | | |
| | Iodine-131 | Ci | ** | ** |
| | Iodine-133 | Ci | 1.37E-04 | ** |
| | Iodine-135 | Ci | ** | ** |
| 3. | Particulates[2,3] | | | |
| | Strontium-89 | Ci | 4.20E-05 | 2.55E-04 |
| | Strontium-90 | Ci | ** | 3.05E-05 |
| | Cesium-134 | Ci | ** | ** |
| | Cesium-137 | Ci | ** | ** |
| | Cobalt-60 | Ci | 2.19E-05 | ** |
| | Cobalt-58 | Ci | ** | ** |
| | Manganese-54 | Ci | ** | ** |
| | Barium-Lanthanum-140 | Ci | ** | ** |
| | Antimony-125 | Ci | ** | ** |
| | Niobium-95 | Ci | ** | ** |
| | Cerium-141 | Ci | ** | ** |
| | Cerium-144 | Ci | ** | ** |
| | Iron-59 | Ci | ** | ** |
| | Cesium-136 | Ci | ** | ** |
| | Chromium-51 | Ci | ** | ** |
| | Zinc-65 | Ci | ** | ** |
| | Iron-55 | Ci | ** | 1.39E-04 |
| | Molybdenum-99 | Ci | ** | ** |
| 4. | Tritium[3] | Ci | 1.58E+00 | 1.28E+01 |

[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-Annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

[2] Concentrations less than the lower limit of detection of 1.00E-04 μCi/ml for noble gases, 1.00E-11 μCi/ml for particulates, 1.00E-12 μCi/ml for Iodines, and 1.00E-06 μCi/ml for Tritium as required by Technical Specifications are indicated with a double asterisk.

[3] Tritium, Iron-55, and Strontium results were not received from the off-site vendor at the time of this report. These numbers include estimates, and actual numbers will be included in the next Semi-Annual Report.

[4] No batch mode release occurred during the reporting period.

# ATTACHMENT 4[1]

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

## GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

There were no releases via the emergency condenser vent operation. Only leakage from the vents results in an assumed H-3 release based on the concentration in the condensate storage tanks.

| Nuclides Released | | CONTINUOUS MODE 3rd QUARTER | CONTINUOUS MODE 4th QUARTER | BATCH MODE 3rd QUARTER | BATCH MODE 4th QUARTER |
|---|---|---|---|---|---|
| 1. Fission Gases[2] | | | | | |
| Argon-41 | Ci | ** | ** | No Releases | No Releases |
| Krypton-85 | Ci | ** | ** | No Releases | No Releases |
| Krypton-85m | Ci | ** | ** | No Releases | No Releases |
| Krypton-87 | Ci | ** | ** | No Releases | No Releases |
| Krypton-88 | Ci | ** | ** | No Releases | No Releases |
| Xenon-133 | Ci | ** | ** | No Releases | No Releases |
| Xenon-133m | Ci | ** | ** | No Releases | No Releases |
| Xenon-135 | Ci | ** | ** | No Releases | No Releases |
| Xenon-135m | Ci | ** | ** | No Releases | No Releases |
| Xenon-137 | Ci | ** | ** | No Releases | No Releases |
| Xenon-138 | Ci | ** | ** | No Releases | No Releases |
| Xenon-127 | Ci | ** | ** | No Releases | No Releases |
| 2. Iodines[2] | | | | | |
| Iodine-131 | Ci | ** | ** | No Releases | No Releases |
| Iodine-133 | Ci | ** | ** | No Releases | No Releases |
| Iodine-135 | Ci | ** | ** | No Releases | No Releases |
| 3. Particulates[2] | | | | | |
| Strontium-89 | Ci | ** | ** | No Releases | No Releases |
| Strontium-90 | Ci | ** | ** | No Releases | No Releases |
| Cesium-134 | Ci | ** | ** | No Releases | No Releases |
| Cesium-137 | Ci | ** | ** | No Releases | No Releases |
| Cobalt-60 | Ci | ** | ** | No Releases | No Releases |
| Cobalt-59 | Ci | ** | ** | No Releases | No Releases |
| Manganese-54 | Ci | ** | ** | No Releases | No Releases |
| Barium-Lanthanum-140 | Ci | ** | ** | No Releases | No Releases |
| Antimony-125 | Ci | ** | ** | No Releases | No Releases |
| Niobium-95 | Ci | ** | ** | No Releases | No Releases |
| Cerium-141 | Ci | ** | ** | No Releases | No Releases |
| Cerium-144 | Ci | ** | ** | No Releases | No Releases |
| Iron-59 | Ci | ** | ** | No Releases | No Releases |
| Cesium-136 | Ci | ** | ** | No Releases | No Releases |
| Chromium-51 | Ci | ** | ** | No Releases | No Releases |
| Zinc-65 | Ci | ** | ** | No Releases | No Releases |
| Iron-55 | Ci | ** | ** | No Releases | No Releases |
| Molybedenum-99 | Ci | ** | ** | No Releases | No Releases |
| 4. Tritium | Ci | 5.61E+00 | 4.58E+00 | No Releases | No Releases |

[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-Annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

[2] Concentrations less than the lower limit of detection of 1.00E-04 μCi/ml for noble gases, 1.00E-11 μCi/ml for particulates, 1.00E-12 μCi/ml for Iodines, and 1.00E-06 μCi/ml for Tritium as required by Technical Specifications are indicated with a double asterisk.

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES**

| | | 3rd QUARTER | 4th QUARTER | EST. TOTAL ERROR, % |
|---|---|---|---|---|
| A. Fission & Activation Products | | | | |
| 1. Total release (not including Tritium, gases, alpha) | Ci | No Releases | No Releases | 5.00E+01 |
| 2. Average diluted concentration during reporting period | µCi/ml | No Releases | No Releases | |
| B. Tritium | | | | |
| 1. Total release | Ci | No Releases | No Releases | 5.00E+01 |
| 2. Average diluted concentration during reporting period | µCi/ml | No Releases | No Releases | |
| C. Dissolved and Entrained Gases | | | | |
| 1. Total release | Ci | No Releases | No Releases | 5.00E+01 |
| 2. Average diluted concentration during reporting period | µCi/ml | No Releases | No Releases | |
| D. Gross Alpha Radioactivity | | | | |
| 1. Total release | Ci | No Releases | No Releases | 5.00E+01 |
| E. Volumes | | | | |
| 1. Prior to dilution | Liters | No Releases | No Releases | 5.00E+01 |
| 2. Volume of dilution water used during release period | Liters | No Releases | No Releases | 5.00E+01 |
| 3. Volume of dilution water available during reporting period | Liters | 1.28E+11 | 1.35E+11 | 5.00E+01 |
| F. Percent of Technical Specification Limits | | | | |
| Percent of Quarterly Whole Body Dose Limit (1.5 mrem) | % | No Releases | No Releases | |
| Percent of Quarterly Organ Dose Limit (5 mrem) | % | No Releases | No Releases | |
| Percent of Annual Whole Body Dose Limit to Date (3 mrem) | % | No Releases | No Releases | |
| Percent of Annual Organ Dose Limit to Date (10 mrem) | % | No Releases | No Releases | |
| Percent of 10CFR20 Concentration Limit | % | No Releases | No Releases | |
| Percent of Dissolved or Entrained Noble Gas Limit (1.00E-5 µCi/ml) | % | No Releases | No Releases | |

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**LIQUID EFFLUENTS RELEASED**

| Nuclides Released | | BATCH MODE 3rd QUARTER | 4th QUARTER |
|---|---|---|---|
| Strontium-89 | Ci | No Releases | No Releases |
| Strontium-90 | Ci | No Releases | No Releases |
| Cesium-134 | Ci | No Releases | No Releases |
| Cesium-137 | Ci | No Releases | No Releases |
| Iodine-131 | Ci | No Releases | No Releases |
| Cobalt-58 | Ci | No Releases | No Releases |
| Cobalt-60 | Ci | No Releases | No Releases |
| Iron-59 | Ci | No Releases | No Releases |
| Zinc-65 | Ci | No Releases | No Releases |
| Manganese-54 | Ci | No Releases | No Releases |
| Chromium-51 | Ci | No Releases | No Releases |
| Zirconium-Niobium-95 | Ci | No Releases | No Releases |
| Molybdenum-99 | Ci | No Releases | No Releases |
| Technetium-99m | Ci | No Releases | No Releases |
| Barium-Lanthanum-140 | Ci | No Releases | No Releases |
| Cerium-141 | Ci | No Releases | No Releases |
| Tungsten-187 | Ci | No Releases | No Releases |
| Arsenic-76 | Ci | No Releases | No Releases |
| Iodine-133 | Ci | No Releases | No Releases |
| Iron-55 | Ci | No Releases | No Releases |
| Neptunium-239 | Ci | No Releases | No Releases |
| Praseodymium-144 | Ci | No Releases | No Releases |
| Iodine-135 | Ci | No Releases | No Releases |
| Dissolved or Entrained Gases | Ci | No Releases | No Releases |
| Tritium | Ci | No Releases | No Releases |

Unit 1 X Unit 2 __ Reporting Period July - December 1993

**SOLID WASTE AND IRRADIATED FUEL SHIPMENTS**

| A.1 TYPE | Volume ($m^3$) Class | | | Activity[2] (Ci) Class | | |
|---|---|---|---|---|---|---|
| | A | B | C | A | B | C |
| 1. Spent Resin | 5.83E+00 | 0 | 0 | 6.06E+00 | 0 | 0 |
| Filter Sludge | 5.50E+00 | 0 | 0 | 1.27E+01 | 0 | 0 |
| Concentrated Waste Evaporator Bottoms | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1.13E+01 | 0 | 0 | 1.88E+01 | 0 | 0 |
| 2. Dry Compressible Waste, Dry Non-Compressible Waste (Contaminated Equipment) | 0 | 0 | 0 | 0 | 0 | 0 |
| 3. Irradiated Components | There were no irridated components shipped for burial during the reporting period. | | | | | |
| | | | | | | |

[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-Annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

[2] The estimated total error is 5.00E+01%.

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**SOLID WASTE AND IRRADIATED FUEL SHIPMENTS**

| A.1 TYPE | Container | Package | Solidification Agent |
|---|---|---|---|
| 1. Spent Resin | HIC | TYPE A | NONE |
| Filter Sludge | HIC | TYPE A | CEMENT |
| Concentrated Waste | N/A | N/A | N/A |
| 2. Dry Compressible Waste, Dry Non-Compressible Waste (Contaminated Equipment) | N/A | N/A | N/A |
| 3. Irradiated Components | N/A | N/A | N/A |

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**SOLID WASTE AND IRRADIATED FUEL SHIPMENTS**

A.2 ESTIMATE OF MAJOR NUCLIDE COMPOSITION (BY TYPE OF WASTE)

**a. Spent Resins, Filter Sludges, Concentrated Waste:**

| | Nuclide | Percent |
|---|---|---|
| (1) | Co-60 | 3.80E+01 |
| (2) | Cs-137 | 3.29E+01 |
| (3) | Fe-55 | 1.74E+01 |
| (4) | Mn-54 | 6.98E+00 |
| (5) | Cs-134 | 3.10E+00 |
| (6) | Other | 1.56E+00 |

**b. Dry Compressible Waste, Dry Non-Compressible Waste (Contaminated Equipment): There were no shipments.**

| Nuclide | Percent |
|---|---|
| | |

**c. Irradiated Components: There were no shipments.**

| Nuclide | Percent |
|---|---|
| | |

**d. Other: There were no shipments.**

| Nuclide | Percent |
|---|---|
| | |

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**SOLID WASTE AND IRRADIATED FUEL SHIPMENTS**

A.3. SOLID WASTE DISPOSITION

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 2 | Truck | Barnwell, SC |

B. IRRADIATED FUEL SHIPMENTS (DISPOSITION)
**There were no shipments.**

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 0 | N/A | N/A |

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

## SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

### C. SOLID WASTE SHIPPED OFF-SITE TO VENDORS FOR PROCESSING AND SUBSEQUENT BURIAL

Below is a summary of Dry Active Waste that was shipped off-site for processing and burial by vendor facilities (i.e., ALARON, QUADREX, and/or SCIENTIFIC ECOLOGY GROUP) during July - December 1993. These totals were reported separately from "10CFR61 Solid Waste Shipped for Burial" since (a) waste classification and burial was performed by the vendors, and (b) Technical Specification 6.9.1 requires reporting of "information for each class of solid waste (as defined by 10CFR61) shipped off-site during the reporting period". The information provided in this section, therefore, is in addition to that required by the Technical Specifications. The following data represents the actual shipments made from the off-site vendors of our non-compacted commingled trash that was processed prior to burial.

C.1. TYPE OF WASTE - noncompacted commingled trash and contaminated fuel pool equipment shipped to Oak Ridge, TN for processing prior to burial at Barnwell, SC

| Burial Volume ($m^3$) | Activity (Ci) | Est. Total Error, % |
|---|---|---|
| 1.77E+01 | 5.32E-01 | 5.00+01 |

C.2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION

| | Nuclide | Percent |
|---|---|---|
| (1) | Co-60 | 6.17E+01 |
| (2) | Cs-137 | 2.09E+01 |
| (3) | Mn-54 | 8.09E+00 |
| (4) | Co-58 | 4.20E+00 |
| (5) | Fe-55 | 1.83E+00 |
| (6) | Fe-59 | 1.58E+00 |
| (7) | Other | 1.65E+00 |

C.3. SOLID WASTE DISPOSITION[2]

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 25 | Truck | Barnwell, SC |

[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-Annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

[2] The number of shipments reported here represents the total number that was shipped from the off-site vendor for burial. This does not represent the number of shipments Niagara Mohawk sent to be processed.

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

D. SEWAGE SLUDGE SHIPPED TO A TREATMENT FACILITY CENTER FOR PROCESSING AND BURIAL

**There were no shipments of sewage sludge with detectable quantities of plant-related nuclides from NMP to the treatment facility during the reporting period.**

# ATTACHMENT 7

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

## SUMMARY OF CHANGES TO THE OFF-SITE DOSE CALCULATION MANUAL

There was one revision to the Unit 1 ODCM during the reporting period. Revision 13 is attached along with a summary of changes presented to and approved by the Station Operations Review Committee in December 1993. The summary also includes a justification for each change.

# Summary of Unit 1 ODCM Changes

**Document:** Unit 1 Offsite Dose Calculation Manual

**Title:** Revision 13 to the Offsite Dose Calculation Manual

**Executive Summary:** Revision 13 to the Unit 1 ODCM was completed to comply with a milk location addition to the environmental program.

**Background:** The Unit 1 ODCM contains the methodology and parameters to determine gaseous and liquid setpoints for effluent streams. In addition, the Unit 1 ODCM contains dose and dose rate equations and parameters for determining compliance with 10CFR20, 10CFR50 and 40CFR190, in accordance with the requirements of the Unit 1 Technical Specifications.

**Description Change/: Key Points:**

*1)* *Page 66* - Table 5.1 is being updated to reflect an addition of a milk location to the environmental program (memo from B. Zacharek to B. Thomas, dated August 20, 1993).

*2)* *Page 69* - Map location #73 for the additional milk location is being added to Figure 5.1-2.

**Attachments:** The Unit 1 ODCM.

**Technical Review:** A Technical Review was completed by B. Zacharek and H. Flanagan, Environmental Group.

Unit 1 X Unit 2 ___ Reporting Period July - December 1993

**SUMMARY OF CHANGES TO THE PROCESS CONTROL PROGRAM**

**The Unit 1 PCP Revision 01 was implemented in December 1993. Copies of Revisions 00 and 01 are attached. The following changes were approved by the Station Operations Review Committee (SORC) in November 1993 and do not affect or impact the safety of radwaste operations. These changes were done to improve and/or reflect current radwaste operations.**

| Old Page # | New Page # | Section # | Change | Reason for Change |
|---|---|---|---|---|
| ii | ii | Table of Contents | Deleted reference to commitments as a section. | No commitments. |
| 1 | 1 | 1.0 | • Added reference to D.O.T. regulations and guidelines.<br>• Deleted reference to wet waste. | Clarification. |
| 1 | 1 | 2.1.2 | Removed reference to specific Tech Specs section 6.5.2.11, and state, "In accordance with the applicable Tech Spec." | Administrative change. |
| 1 | 1 | 3.1 | • Removed all reference and specific procedural requirements for types of waste (wet radioactive waste, dewatered spent bead resins, activated carbon and dewatered filter sludge) and replaced with general waste processing procedural requirements for any type of radioactive waste including the capability to use vendor equipment and vendor procedures.<br>• Deleted reference to CNSI procedures. | Deletes specific procedures and allows processing using approved vendor equipment and procedures including the capability of dehydrating liquid waste as a method of processing waste to meet shipping and burial requirements.<br>Allows use of more than one vendor. |
| 2 | 2 | 3.2.4 | Deleted reference to specific procedures N1-LWPP-4, "Waste Transfer to a Shipping Cask," and N1-WHP-4, "Cask Loading" procedure. | Administrative to take specific procedure numbers out of the manual and broaden with a more generic statement. |
| 3 | 2 | 3.3.2 | Changed the requirement that, "The Manager of Chemistry shall ensure the chemical and radionuclide content of each sample is determined in accordance with N1-CSP-14V, 'Collection and Analysis of Waste Samples'" to "The Manager of Chemistry shall ensure the chemical and radionuclide content of waste is determined in accordance with the applicable chemistry procedures." | Administrative to take specific procedure numbers out of the manual and broaden with a more generic statement. |

| Old Page # | New Page # | Section # | Change | Reason for Change |
|---|---|---|---|---|
| 2 | 2 | 3.3.3 | Deleted the reference to "applicable S-RPIP's" and state "applicable radiation protection procedures." | Administrative to take specific procedure numbers out of the manual and broaden with a more generic statement. |
| 3 | 3 | 3.4.1.a | Deleted reference to the specific Tech Spec section, 6.9.1, Routine Reports. | Administrative. |
| 3 | 3 | 3.4.1.c | Deleted section. | Addressed in 3.4.1.b. |
| 3 | 3 | 3.4.1.d | Deleted reference to the reference GAP-INV-02, "Control of Material Storage Areas." | Administrative to take specific procedure numbers out of the manual and broaden with a more generic statement. |
| 4 | 3 | 3.4.2.a | Deleted reference to specific Technical Specification section. | Administrative. |
| 4 | 3 | 3.4.2.b | There is a typing error that was inadvertently approved; this will be corrected in next revision of PCP. | Clerical. |
| 4 | 4 | 3.4.3 | Added the statement that personnel are effectively trained in accordance with the "applicable training procedures"... | Clarification to encompass all procedures. |
| 4 | 4 | 3.4.3.a | Changed statement of Radwaste Operator initial qualification requirement from "satisfactory completion of the Radwaste Operations Unit 1 Plant Training Program" to state "satisfactory completion of the Radwaste Operations Unit 1 Initial Training Program". | Clarification. |
| 4 | 4 | 3.4.3.a.1-4 | • Switched and renumbered 3.4.3.a.1 with 3.4.3.a.2 and rewrote 3.4.3.a.2 to delete the reference to classroom instruction and to specific intent of on-the-job training objectives. Added the statement "in accordance with applicable training procedures." | Clarification to take specific training out of the manual and broaden with a more generic statement to ensure compliance with all procedure requirements. |
| 5 | 4 | 3.4.3.b and c | • Deleted sections and incorporated 3.4.3.b.1 and 3.4.3.b.2 into sections 3.4.3.a.3 and 3.4.3.a.4 respectively. Continued training on an annual basis is changed to a cyclical basis and deleted reference to requalification training.<br><br>In addition, remedial training will now be as directed by NTP-TQS-503 instead of by the General Supervisor Radwaste. | Clarification.<br><br>Clarification. |

| Old Page # | New Page # | Section # | Change | Reason for Change |
|---|---|---|---|---|
| 5 | 4 | 3.4.4 | Deleted reference to specific quality assurance procedures and reports and stated that, "Training records and waste management records are maintained in accordance with the applicable quality assurance procedures." | Clarification to take specific procedures out of the manual and broaden with a more generic statement to ensure compliance with all procedural requirements. |
| 5 | 4 | 4.1-4.3 | Deleted specific definitions and stated, "The applicable Radwaste packaging, processing and transportation definitions will be used in accordance with 49CFR171.8 and 49CFR173.403." | Deleted specific definitions and included references to 49CFR171.8 and 49CFR173.403. |
| 6 | 4 | 5.1.1 | Listed the LCO and surveillance requirements separately as Tech Spec sections 3.6.16.c and 4.6.16.c, respectively. | Clarification. |
| 7 | 6 | 5.3 | Deleted reference to AP-3.3, "Radiation Protection Program," AP-3.3.2, "Radiation Work Permit," AP-3.3.3, "Radiation Worker Conduct", and added GAP-RAP-01, "Radiation Protection Program," and GAP-RAP-02, "Radiation Work Permit." | Updated to incorporate current references. |
| 8, 9 | 7, 8 | Attachment 1 | • Deleted reference to N1-WHP-05, "On-Site Drum Handling."<br>• Updated the title to N1-LWPP-14, "Sump and Tank Cleaning" procedure.<br>• Deleted reference to S-RPIP-7.5, "Van and Flatbed Shipments."<br>• Added chemistry procedure, "N1-CTP-V402, "Radioactive Solid Waste Composites."<br>• Updated the quality assurance procedures with revised title and numbers.<br>• Deleted training procedure NTP-13, "Training and Continued Training of Radwaste Operators." | Updated to reflect current references. |

# ATTACHMENT 9

Unit 1 _X_ Unit 2 ___ Reporting Period July - December 1993

**SUMMARY OF INOPERABLE MONITORS**

| Monitor | Dates of Inoperability | Cause and Corrective Actions |
|---|---|---|

**There were no inoperable monitors for a period greater than 30 days during the reporting period.**

# SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (1993)
# NINE MILE POINT NUCLEAR STATION UNIT 1
# DOSES TO MEMBERS OF THE PUBLIC DUE TO THEIR ACTIVITIES INSIDE THE SITE BOUNDARY

## JANUARY - DECEMBER 1993

Doses to members of the public (as defined by the Technical Specifications) from the operation of the NMP1 facility as a result of activity inside the site boundary are controlled by activities at the Energy Center. This facility is open to the public and offers educational information, summer picnicking activities and fishing. Any possible doses received by a member of the public by utilizing the private road that transverses the east and west site boundaries are not considered here since it takes a matter of minutes to travel the distance.

The activity at the Energy Center that is used for the dose analysis is fishing because it is the most time consuming. Although there is no specific survey information available, many of the same individuals have been observed to return again and again because of the access to salmonid and lake trout populations. Dose pathways considered for this activity include direct radiation, inhalation and external ground (shoreline sediment or soil) doses. Other pathways, such as ingestion pathways, are not considered because they are either not applicable, insignificant, or are considered as part of the evaluation of the total dose to a member of the public located off-site. In addition, only releases from the NMP1 stack were evaluated for the inhalation pathway. The emergency condensers were not operated during 1993.

The direct radiation pathway is evaluated in accordance with the methodology found in the Off-site Dose Calculation Manual (ODCM). This pathway considers three components: direct radiation from the generating facilities, direct radiation from any possible overhead plume and direct radiation from plume submersion. The direct radiation pathway is evaluated by the use of high sensitivity environmental TLD's. Since any significant fishing activity near the Energy Center occurs between April through December, environmental TLD data for the approximate period of April 1 - December 31, 1993 were considered. Data from two environmental TLD's from the approximate area where the fishing occurs were compared to control environmental TLD locations for the same time period. The average fishing area TLD dose rate was 7.0E−03 mRem per hour for the period. The average control TLD dose rate was 5.7E−03 mRem per hour for the period (approximate second, third and fourth calendar quarters of the year). The average increase in dose as a result of fishing in this area at a conservative frequency of eight hours per week for thirty-nine weeks is 4.1E−01 mRem from direct radiation for the period in question. The majority of the dose from this pathway is from the NMP1 facility because of its proximity to the fishing area. A small portion may be due to the NMP2 facility.

The inhalation dose pathway is evaluated by utilizing the inhalation equation in the ODCM, as adapted from the Regulatory Guide 1.109. The equation basically gives a total inhalation dose in mRem for the time period in question (April - December). The total dose equals the sum, for all applicable radionuclides, of the NMP1 stack release concentration, times the average NMP1 stack flowrate, times the applicable five-year average calculated X/Q, times the inhalation dose factors from Regulatory Guide 1.109, Table E-7, times the Regulatory Guide 1.109 annual air intake, times the fractional portion of the year in question. In order to be slightly conservative, no radiological decay is assumed.

[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (1993)
NINE MILE POINT NUCLEAR STATION UNIT 1
DOSES TO MEMBERS OF THE PUBLIC DUE TO THEIR ACTIVITIES
INSIDE THE SITE BOUNDARY

JANUARY - DECEMBER 1993

The 1993 calculation utilized the following information:

NMP1 Stack:

- Unit 1 average stack flowrate = 1.04+02 $m^3$/sec
- X/Q value = 8.9 E−06 (annual NWN sector, historical average)
- Inhalation dose factor = Table E-7 of Regulatory Guide 1.109
- Annual air intake = 8000 $m^3$ per year (adult)
- Fractional portion of the year = 0.0356 (312 hours)
- Co-60 = 2.91E−01 pCi/$m^3$
- Fe-55 = 1.16E−01 pCi/$m^3$
- Sr-89 = 1.97E−01 pCi/$m^3$
- Sr-90 = 2.33E−02 pCi/$m^3$
- H-3 = 1.03E+04 pCi/$m^3$
- I-131 = 7.90E−02 pCi/$m^3$
- I-133 = 7.90E−02 pCi/$m^3$
- I-135 = 1.42E−02 pCi/$m^3$

The inhalation dose to a member of the public as a result of activities inside the site boundary is 5.03E−04 mRem to the lung (maximum organ dose) and 4.34E−04 mRem to the whole body.

The dose from standing on the shoreline to fish is based on the methodology in the ODCM, as adapted from Regulatory Guide 1.109. During 1993, it was noted that fishing was performed from the shoreline on many occasions although waders were also utilized. In order to be conservative, it is assumed that the maximum exposed individual fished from the shoreline at all times. The use of waders, of course, would result in a dose of zero from this pathway. The shoreline sediment doses are not taken into consideration by environmental TLD data.

The ODCM equation basically gives the total dose to the whole body and skin from the sum of all plant-related radionuclides detected in shoreline sediment samples. The plant-related radionuclide concentration is adjusted for background sample results, as applicable. The equation, therefore, yields the whole body and skin dose by multiplying the radionuclide concentration adjusted for any background data (as applicable), times a usage factor, times the sediment or soil density in grams per square meter (to a depth of one centimeter), times the applicable shore width factor, times the regulatory guide dose factor, times the fractional portion of the year over which the dose is applicable. In order to be conservative and to simplify the equation, no radiological decay is assumed since the applicable radionuclides are usually long lived.

SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (1993)
NINE MILE POINT NUCLEAR STATION UNIT 1
DOSES TO MEMBERS OF THE PUBLIC DUE TO THEIR ACTIVITIES
INSIDE THE SITE BOUNDARY

JANUARY - DECEMBER 1993

The calculation utilized the following information:

- Usage factor = 312 hours
- Density in grams per meter = 40,000
- Shore width factor = 0.3
- Whole body and skin dose factor for each radionuclide = Regulatory Guide 1.109, Table E-6
- Fractional portion of the year = 1 (used average radionuclide concentration over total time period)
- Average Cs-137 concentration = 0.295 pCi/g
- Average Co-60 concentration = 0.031 pCi/g

The total whole body and skin dose from standing on the shoreline to fish is 6.61E−03 mRem whole body and 7.73E−03 mRem skin dose for the period.

Doses to members of the public relative to activities inside the site boundary from aquatic pathways other than ground dose from shoreline sediment/soil are not applicable.

In summary, the total dose to a member of the public as a result of activities inside the site boundary from the direct radiation, inhalation and shoreline dose pathways is 4.2E−01 mRem to the whole body and 5.03−04 mRem to the maximum exposed internal organ (lung). The dose to the skin of an adult is 7.73E−03 mRem. These doses are generally a result of the operation of NMP1. However, a portion of these doses for the direct radiation pathway may be attributable to the NMP2 facility.

# SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (1993)
# NINE MILE POINT NUCLEAR STATION UNIT 1
# RADIATION DOSES TO THE LIKELY MOST EXPOSED MEMBER OF THE PUBLIC OUTSIDE THE SITE BOUNDARY

## JANUARY - DECEMBER 1993

Radiation doses to the likely most exposed member of the public outside of the site boundary are evaluated relative to 40CFR190 requirements. The dose limits of 40CFR190 are 25 mRem (whole body or organ) per calendar year and 75 mRem (thyroid) per calendar year. The intent of 40CFR190 also requires that the effluents of NMP2 as well as other nearby uranium fuel cycle facilities be considered. In this case, the effluents of NMP1, NMP2 and the James A. FitzPatrick (JAF) facilities must be considered.

Doses to the likely most exposed member of the public as a result of effluents from the site can be evaluated by using calculated dose modeling based on the accepted methodologies of the facilities' Off-site Dose Calculation Manuals (ODCM's) or may, in some cases, be calculated from the analysis results of actual environmental samples. Acceptable methods for calculating doses from environmental samples are also found in the facilities' ODCM's. These methods are based on Regulatory Guide 1.109 methodology.

Dose calculations from actual environmental samples are, at times, difficult to perform for some pathways. Some pathway doses should be estimated using calculational dose modeling. These pathways include noble gas air dose, inhalation dose, etc. Other pathway doses may be calculated directly from environmental sample concentrations using Regulatory Guide 1.109 methodology.

Since the effluents from the generating facilities are low, the resultant gaseous and liquid effluent doses are anticipated to be low. In view of this, doses can be based on calculated data. Doses are not based on actual environmental data for 1993 with the exception of doses from direct radiation, fish consumption and shoreline sediment. In addition, in order to be conservative and for the sake of simplicity, it is assumed in the dose calculations that the likely most exposed member of the public is positioned in the maximum receptor location for each pathway at the same time. This approach is utilized because the doses are very low and the computations are greatly simplified.

The following pathways are considered:

1. The inhalation dose is calculated at the critical residence because of the high occupancy factor. In order to be conservative, the maximum whole body and organ dose assumes no correction for residing inside a residence.

2. The milk ingestion dose is calculated utilizing the maximum milk cow location. As noted previously, in order to be conservative and for the sake of simplicity, the likely most exposed member of the public is assumed to be at all critical receptors at one time. In this case, the member of the public at the critical residence is assumed to consume milk from the critical milk location.

3. The maximum dose from the milk ingestion pathway as a result of consuming goat's milk is based on the same criteria established for item "2", above (ingestion of cow's milk).

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[1] An independent technical evaluation of the off-site vendor analyses performed by Niagara Mohawk Power Corporation has indicated a potential for a discrepancy in the data results. The resident inspectors at Nine Mile Point have been informed and corrective actions initiated. Future Semi-annual Radioactive Effluent Release Reports will reflect any changes as a result of this technical evaluation.

SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (1993)
NINE MILE POINT NUCLEAR STATION UNIT 1
RADIATION DOSES TO THE LIKELY MOST EXPOSED MEMBER OF THE PUBLIC
OUTSIDE THE SITE BOUNDARY

JANUARY - DECEMBER 1993

4. The maximum dose associated from consuming meat is based on the critical meat animal. The likely most exposed member at the critical residence is assumed to consume meat from the critical meat animal location.

5. The maximum site dose associated with the consumption of vegetables is calculated from the critical vegetable garden location. As noted previously, the likely most exposed member of the public is assumed to be located at the critical residence and is assumed to consume vegetables from the critical garden location.

6. The dose, as a result of direct gamma radiation from the site, encompasses doses from direct "shine" from the generating facilities, direct radiation from any overhead gaseous plumes, plume submersion and from ground deposition. This total dose is measured by environmental TLD. The critical location is based on the closest year-round residence from the generating facilities as well as the closest residence in the critical downwind sector in order to evaluate both direct radiation from the generating facilities and gaseous plumes as determined by the local meteorology. During 1993, the closest residence and the critical downwind residence are at the same location.

   The measured average dose for 1993 at the critical residence was 54.2 mRem. The average control dose was 50.0 mRem. The average dose at the critical residence is slightly greater than the average control location dose. The net increase in dose is due to the differences between doses from naturally occurring radionuclides in the soil and rock at the different locations and due to the standard deviation in TLD measurements. This difference in dose rate can be demonstrated by observing the 1993 average dose for an environmental TLD located near the critical residence TLD, but approximately 700 feet closer to the generating facilities. The annual average dose for this TLD location was 51.3 mRem. The dose for this location is lower than the critical residence location even though they are close to one another and even though the TLD location with the lowest dose is closer to the generating facilities.

7. The dose, as a result of fish consumption, is considered as part of the aquatic pathway. The dose for 1993 is calculated from actual results of the analysis of environmental fish samples. For the sake of being conservative, the average plant-related radionuclide concentrations were utilized from fish samples taken near the site discharge points. Only Cs-137 was detected during 1993. Adjusting the average concentration of Cs-137 in indicator samples by subtracting the average concentration of Cs-137 in control sampes resulted in a net negative concentration. Therefore, no dose was calculated and assumed to be zero for this pathway.

8. The shoreline sediment pathway is considered relative to recreational activities. The dose due to recreational activities from shoreline sediment is based on the methodology in the ODCM as adapted from Regulatory Guide 1.109. The ODCM gives the total dose to the whole body and skin from the sum of plant-related radionuclides detected in actual shoreline sediment samples. The plant-related radionuclide concentration is adjusted for background sample results, as applicable. The total whole body and skin dose from shoreline recreational activities is 1.02E−03 mRem whole body and 1.19E−03 mRem skin dose for the period.

SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT (1993)
NINE MILE POINT NUCLEAR STATION UNIT 1
RADIATION DOSES TO THE LIKELY MOST EXPOSED MEMBER OF THE PUBLIC
OUTSIDE THE SITE BOUNDARY

JANUARY - DECEMBER 1993

9. In summary, the maximum dose to the most likely exposed member of the public is 1.67E−01 mRem to the thyroid (maximum organ dose) and 3.97E−02 mRem to the whole body. It should be noted that the maximum organ dose and maximum whole body doses are based on the sum of the maximum doses observed for all three facilities regardless of age group. This results in some conservatism. The maximum organ and whole body doses were a result of gaseous effluents. Doses as a result of liquid effluents were secondary. The total whole body and skin dose from shoreline recreational activities are 1.02E−03 mRem whole body and 1.19E−03 mRem skin dose for the period. The direct radiation dose to the critical residence from the generating facilities was insignificant or zero. The dose to an individual as a result of fish consumption was also zero. These maximum total doses are a result of operations at the Nine Mile Point Unit 1, Nine Mile Point Unit 2 and the James A. Fitzpatrick facilities. The maximum organ dose and whole body dose are below the 40CRF190 criteria of 25 mRem per calendar year to the maximum exposed organ or the whole body, andbelow 75 mRem per calendar year to the thyroid.

# UPDATE TO THE PREVIOUS REPORTS

Unit 1 X Unit 2 ___ Reporting Period January - June 1993

**UPDATE OF RELEASE AND DOSE DATA FOR GASEOUS EFFLUENTS - ELEVATED AND GROUND LEVEL LIQUID EFFLUENTS**

Update of data using actual results from the off-site vendors for Strontium, Tritium, and Iron-55 for the second quarter of 1993.

| Nuclide[1] | GASEOUS 2nd QUARTER Activity (Ci) | LIQUID 2nd QUARTER Activity (Ci) |
|---|---|---|
| Sr-89 | 4.48E-05 | No Releases |
| Sr-90 | ** | No Releases |
| H-3 | 6.31E+00 | No Releases |
| Fe-55 | 2.08E-05 | No Releases |

| | | | GASEOUS | LIQUID |
|---|---|---|---|---|
| Particulates | | | | |
| | 1. Particulates with half-lives >8 days | Ci | 3.98E-04 | N/A |
| | 2. Average release rate for period | µCi/sec | 5.42E-05 | N/A |
| Tritium | | | | |
| | 1. Total release | Ci | 6.31E+00 | N/A |
| | 2. Average release rate for period | µCi/sec | 8.60E-01 | N/A |

| Tritium, Iodines, and Particulates (with half-lives greater than 8 days) | | GASEOUS | LIQUID |
|---|---|---|---|
| 1. Percent of Quarterly Dose Limit[2] | % | 1.06E-01 (Quarterly) | N/A (Quarterly) |
| 2. Percent of Annual Dose Limit to Date[2] | % | 9.85E-01 (Annual) | N/A (Annual) |
| 3. Percent of Organ - Dose Rate Limit (Gaseous)(Quarterly) - Dose Limit (Liquid) (Annual & Quarterly) | % | 2.27E-03 (Quarterly) N/A (Annual) | N/A (Quarterly) N/A (Annual) |
| 4. Percent of 10CFR20 Concentration Limit (Liquid) | % | N/A | N/A |
| 5. Percent of Dissolved or Entrained Noble Gas (Liquid) | % | N/A | N/A |

[1] Concentrations less than the lower limit of detection, as required by Technical Specifications are indicated with a double asterisk.

[2] The dose is to the maximally exposed organ for gaseous effluents.

Unit 1 X Unit 2 ___ Reporting Period January - June 1993

## SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

### C. SOLID WASTE SHIPPED OFF-SITE TO VENDORS FOR PROCESSING AND SUBSEQUENT BURIAL

Below is a summary of Dry Active Waste that was shipped off-site for processing and burial by vendor facilities (i.e., ALARON, QUADREX, and/or SCIENTIFIC ECOLOGY GROUP) during January - June 1993. These totals were reported separately from "10CFR61 Solid Waste Shipped for Burial" (i.e., Section A of Table 3A) since (a) waste classification and burial was performed by the vendors, and (b) Technical Specification 6.9.1 requires reporting of "information for each class of solid waste (as defined by 10CFR61) shipped off-site during the reporting period". The information provided in this section, therefore, is in addition to that required by the Technical Specifications. The following data represents the actual shipments made from the off-site vendors of our non-compacted commingled trash that was processed prior to burial.

C.1. TYPE OF WASTE - noncompacted commingled trash and contaminated fuel pool equipment shipped to Oak Ridge, TN for processing prior to burial at Barnwell, SC

| Burial Volume ($m^3$) | Activity (Ci) | Est. Total Error, % |
|---|---|---|
| 1.92E+01 | 2.71E−01 | 5.00+01 |

C.2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION

| | Nuclide | Percent |
|---|---|---|
| (1) | Co-60 | 5.98E+01 |
| (2) | Cs-137 | 2.27E+01 |
| (3) | Mn-54 | 9.54E+00 |
| (4) | Co-58 | 5.10E+00 |
| (5) | Fe-59 | 1.88E+00 |
| (6) | Other | 9.34E−01 |

C.3. SOLID WASTE DISPOSITION[2]

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 4 | Truck | Barnwell, SC |
| 6 | Truck | Richland, WA |

[1] This Attachment 6 supersedes the information provided in the January-June 1993 Semi-Annual Radioactive Effluent Release Report for Nine Mile Point Nuclear Station Unit 1.

[2] The number of shipments reported here represents the total number that was shipped from the off-site vendor for burial. This does not represent the number of shipments Niagara Mohawk sent to be processed.

NINE MILE POINT NUCLEAR STATION

NINE MILE POINT UNIT 1

OFF-SITE DOSE CALCULATION MANUAL (ODCM)

| APPROVALS | SIGNATURES | DATE AND INITIALS REVISION 13 |
|---|---|---|
| K. A. Dahlberg<br>Plant Manager Unit 1 | Robert L Treskin for ICAD | 12/15/93 |
| C. D. Terry<br>V.P. Nuclear Engineering | | 12/17/93 |

INFORMATION ONLY

NIAGARA MOHAWK POWER CORPORATION

INFORMATION ONLY

## SUMMARY OF REVISIONS

### Revision 13 (Effective 12/31/93 )

| PAGE | DATE |
|---|---|
| 1, 2, 5, 6, 8, 9, 11-13/15-18, 21, 24, 25, 36-44, 47-49, 52-81, 86-116 | February 1987 |
| 3, 4, 7, 10, 14, 19, 20, 22, 23, 26-35 | December 1987 |
| 45, 46, 50, 51, 82-85 | January 1988 |
| *29 | May 1988 (Reissue) |
| *64, 77, 78 | May 27, 1988 (Reissue) |
| i, 19, 21, 22A, 22B, 124, 25, 26, 112 | February 1990 |
| i, ii, iii, 12-16, 18, 28-40, 45-47, | |
| 52, 55, 59-89, 92, 93, 97-129, | June 1990 |
| 91-93, 95 | June 1992 |
| 3, 4, 21, 92, 95a-c | February 1993 |
| 10, 16-20 | March 1993 |
| 5, 13, 18, 20, 25-30, 65, 79 | June 1993 |
| 66, 69 | December 1993 |

ODCM - NINE MILE POINT UNIT 1

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## 1.0 INTRODUCTION

The Offsite Dose Calculation Manual (ODCM) provides the methodology to be used for demonstrating compliance with the Radiological Effluent Technical Specifications (RETS), 10 CFR 20, 10 CFR 50, and 40 CFR 190. The contents of the ODCM are based on Draft NUREG-0472, Revision 3, "Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors," September 1982; Draft NUREG-0473, Revision 2, "Radiological Effluent Technical Specifications for BWR's", "July 1979; NUREG 0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978; the several Regulatory Guides referenced in these documents; and, communication with the NRC staff.

Section 5 contains a detailed description of the Radiological Environmental Monitoring (REM) sampling locations.

Should it be necessary to revise the ODCM, these revisions will be made in accordance with Technical Specifications.

## 2.0 LIQUID EFFLUENTS

### 2.1 Setpoint Determinations

#### 2.1.1 Basis

Monitor setpoints will be established such that the concentration of radionuclides in the liquid effluent releases in the discharge canal will not exceed those concentrations as specified in 10 CFR 20, Appendix B, Table II, Column 2. Setpoints for the Service Water System Effluent Line will be calculated quarterly based on the radionuclides identified during the previous year's releases from the liquid radwaste system or the isotopes identified in the most recent radwaste release or other identified probable source. Setpoints for the Liquid Radwaste Effluent Line will be based on the radionuclides identified in each batch of liquid waste prior to its release.

After release, the Liquid Radwaste monitor setpoint may remain as set, or revert back to a setpoint based on a previous Semi-Annual Radioactive Effluent Release Report, or install blank flange in the discharge line and declare inoperable in accordance with the technical specification.

Since the Service Water System effluent monitor and Liquid Radwaste effluent monitor can only detect gamma radiation, the alarm setpoints are calculated by using the concentration of gamma emitting isotopes only (or the corresponding MPC values for the same isotopes, whichever are higher) in the $\Sigma_i(\mu Ci/ml)_{i\gamma}$ expression (Section 2.1.2, 2.1.3).

The Required Dilution Factor is calculated using concentrations of all isotopes present (or the corresponding MPC values for the same isotopes, whichever are higher) including tritium and other non-gamma emitters to ensure that all radionuclides in the discharge canal do not exceed 10 CFR 20 limits.

#### 2.1.2 Service Water System Effluent Line Alarm Setpoint

The detailed methods for establishing setpoints for the Service Water System Effluent Line Monitor shall be contained in the Nine Mile Point Station Procedures. These methods shall be in accordance with the following:

$$\text{Setpoint (Hi alarm)} \frac{< 0.9 \; \Sigma_i(\mu Ci/ml)_{i\gamma} \; (CF) \; TDF/F_{sw}}{\sum_i [(\mu Ci/ml)_{i\pi}/MPC_i]} + \text{background}$$

$$\text{Setpoint (Alert alarm)} \frac{< 0.7 \; \Sigma_i(\mu Ci/ml)_{i\gamma} \; (CF) \; TDF/F_{sw}}{\sum_i [(\mu Ci/ml)_{i\pi}/MPC_i]} + \text{background}$$

$(\mu Ci/ml)_{i\gamma}$ = concentration of gamma emitting isotope i in the sample, or the corresponding MPC of gamma emitting isotope i $(MPC)_i$, whichever is higher (units = $\mu Ci/ml$).

$(\mu Ci/ml)_{i\pi}$ = concentration of any radioactive isotope i in the sample including tritium and other non-gamma emitters or corresponding MPC of isotope i, $MPC_i$, whichever is higher (units = $\mu Ci/ml$).

TDF = Total Dilution Flow (units = gallons/minutes).

$F_{sw}$ = Service Water Flow (units = gallons/minutes).

2.1.2 **Service Water System Effluent Line Alarm Setpoint (Cont'd)**

CF = monitor calibration factor (units = net cpm/$\mu$Ci/ml).

$MPC_i$ = liquid effluent radioactivity concentrations limit for radionuclide i as specified in 10 CFR 20, Appendix B, Table II, Column 2.

Sample = Those nuclides present in the previous batch release from the liquid radwaste effluent system or those nuclides present in the last Semi-annual Radioactive Effluent Release Report (units = $\mu$Ci/ml) or those nuclides present in the service water system.**

$(MPC)_{i\gamma}$ = same as $MPC_i$ but for gamma emitting nuclides only.

0.9 and 0.7 = factors of conservatism to account for inaccuracies.

$\Sigma_i[(\mu Ci/ml)_{i\pi}/MPC_i]$ = Required Dilution Factor. If MPC values are used in the $(\mu Ci/ml)_{i\gamma}$, they must also be used in calculating RDF (numerator).

$TDF/F_{rw}$ = Actual Dilution Factor

2.1.3 **Liquid Radwaste Effluent Line Alarm Setpoint**

The detailed methods for establishing setpoints for the Liquid Radwaste Effluent Line Monitor shall be contained in the Nine Mile Point Station Procedures. These methods shall be in accordance with the following:

Setpoint (Hi-Hi alarm) $\leq 0.9 \dfrac{\Sigma_i(\mu Ci/ml)_{i\gamma}\,(CF)TDF/F_{rw}}{\Sigma_i[(\mu Ci/ml)_{i\pi}/MPC_i]}$ + background

Setpoint (Hi alarm) $\leq 0.7 \dfrac{\Sigma_i(\mu Ci/ml)_{i\gamma}\,(CF)\,TDF/F_{rw}}{\Sigma_i[(\mu Ci/ml)_{i\pi}/MPC_i]}$ + background

$(\mu Ci/ml)_{i\gamma}$ = concentration of gamma emitting isotope i in the sample or the corresponding MPC of gamma emitting isotope i, $(MPC)_i$ whichever is higher.

$(\mu Ci/ml)_{i\pi}$ = concentration of any radioactive isotope i in the sample including tritium and other non-gamma emitters or the corresponding MPC of isotope i $MPC_i$ whichever is higher. (units = $\mu$Ci/ml).

TDF = Total Dilution Flow (units = gallons/minutes).

$F_{rw}$ = Radwaste Effluent Flow (units = gallons/minutes).

CF = monitor calibration factor (units = net cps/$\mu$Ci/ml).

** For periods with known reactor water to RCLC system leakage, RCLC maximum permissible concentration may be prudently substituted for the above.

2.1.3 **Liquid Radwaste Effluent Line Alarm Setpoint (Cont'd)**

$MPC_i$ = liquid effluent radioactivity concentration limit for radionuclide i as specified in 10 CFR 20, Appendix B, Table II, Column 2, for those nuclides detected by spectral analysis of the contents of the radwaste tanks to be released. (units = $\mu$Ci/ml)

$(MPC)_{Hr}$ = same as $MPC_i$ but for gamma emitting nuclide only.

0.9 and 0.7 = factors of conservatism to account for inaccuracies.

$\Sigma[(\mu Ci/ml)_{\pi}/MPC_i]$ = Required Dilution Factor. If MPC values are used in the $(\mu Ci/ml)_{Hr}$, they must also be used in calculating RDF (numerator).

Notes: (a) If $TDF/F_{\pi} = \Sigma_i[(\mu Ci/ml)_{\pi}/MPC_i]$

the discharge could not be made, since the monitor would be continuously in alarm. To avoid this situation, $F_{\pi}$ will be reduced (normally by a factor of 2) to allow setting the alarm point at a concentration higher than tank concentration. This will also result in a discharge canal concentration at approximately 50% maximum permissible concentration.

(b) The value used for TDF will be reduced by the fractional quantity (1-FT), where FT is tempering fraction (i.e., diversion of some fraction of discharge flow to the intake canal for the purpose of temperature control).

2.1.4 **Discussion**

2.1.4.1 **Control of Liquid Effluent Batch Discharges**

At Nine Mile Point Unit 1 Liquid Radwaste Effluents are released only on a batch mode. To prevent the inadvertent release of any liquid radwaste effluents, radwaste discharge is mechanically isolated (blank flange installed or discharge valve chain-locked closed) following the completion of a batch release or series of batch releases.

This mechanical isolation remains in place and will only be removed prior to the next series of liquid radwaste discharges after all analyses required in station procedures and Technical Specification Table 4.6.15-1A are performed and monitor setpoints have been properly adjusted.

2.1.4.2 **Simultaneous Discharges of Radioactive Liquids.**

If during the discharge of any liquid radwaste batch, there is an indication that the service water canal has become contaminated (through a service water monitor alarm or through a grab sample analysis in the event that the service water monitor is inoperable) the discharge shall be terminated immediately. The liquid radwaste discharge shall not be continued until the cause of the service water alarm (or high grab sample analysis result) has been determined and the appropriate corrective measures taken to ensure 10CFR20, Appendix B, Table II, Column 2 (Technical Specification Section 3.6.15.a(1)) limits are not exceeded.

2.1.4.2 **Simultaneous Discharges of Radioactive Liquids (Cont'd)**

In accordance with Site Chemistry procedures, controls are in place to preclude a simultaneous release of liquid radwaste batch tanks. In addition, an independent verification of the discharge valve line-up is performed prior to discharge to ensure that simultaneous discharges are prevented.

2.1.4.3 **Sampling Representativeness**

This section covers Technical Specification Table 4.6.15-1 Note b concerning thoroughly mixing of each batch of liquid radwaste prior to sampling.

Liquid Radwaste Tanks scheduled for discharge at Nine Mile Point Unit 1 are isolated (i.e. inlet valves marked up) and at least two tank volumes of entrained fluids are recirculated prior to sampling. Minimum recirculation time is calculated as follows:

Minimum Recirculation Time = 2.0(T/R)

Where:

2.0 = Plant established mixing factor, unitless
T = Tank volume, gal
R = Recirculation flow rate, gpm

Additionally, the Hi Alarm setpoint of the Liquid Radwaste Effluent Radiation Monitor is set at a value corresponding to not more than 70% of its calculated response to the grab sample or corresponding MPC values. Thus, this radiation monitor will alarm if the grab sample, or corresponding MPC value, is significantly lower in activity than any part of the tank contents being discharged.

2.1.4.4 **Liquid Radwaste Systems Operation**

Technical Specification 3.6.16.a requires that the liquid radwaste system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge, as necessary, to meet the concentration and dose requirements of Technical Specification 3.6.15.

Utilization of the radwaste system will be based on the capability of the indicated components of each process system to process contents of the respective low conductivity and high conductivity collection tanks:

1) Low Conductivity (Equipment Drains): Radwaste Filter and Radwaste Demin. (See Fig. B-1)

2) High Conductivity (Floor Drains): Waste Evaporator (See Fig. B-1)

Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined as described in Section 2.3 of this manual prior to the release of each batch of liquid waste. This same dose projection of Section 2.3 will also be performed in the event that untreated liquid waste is discharged, to ensure that the dose limits of Technical Specification 3.6.15.a(2) are not exceeded. (Thereby implementing the requirements of 10CFR50.36a, General Design Criteria 60 of Appendix A and the Design Objective given in Section II-D of Appendix I to 10 CFR50).

2.1.4.4 **Liquid Radwaste Systems Operation (Cont'd)**

For the purpose of dose projection, the following assumptions shall be made with regard to concentrations of non-gamma emitting radionuclides subsequently analyzed off-site:

a) [H-3] ≤ H-3 Concentration found recent condensate storage tank analysis

b) [Sr-89] ≤ 4 x Cs-137 Concentration

c) [Sr-90] ≤ 0.5 x Cs-137 Concentration

d) [Fe-55] ≤ 1 x Co-60 Concentration

Assumed Scaling Factors used in b, c, and d above represent conservative estimates derived from analysis of historical data from process waste streams. Following receipt of off-site H-3, Sr-89, Sr-90 and Fe-55 analysis information, dose estimates shall be revised using actual radionuclide concentrations and actual tank volumes discharged.

2.1.4.5 **Service Water System Contamination**

Service water is normally non-radioactive. If contamination is suspected, as indicated by a significant increase in service water effluent monitor response, grab samples will be obtained from the service water discharge lines and a gamma isotopic analysis meeting the LLD requirements of Technical Specification Table 4.6.15-1 completed. If it is determined that an inadvertent radioactive discharge is occurring from the service water system, then:

a) A 50.59 safety evaluation shall be performed (ref. I&E Bulletin 80-10),

b) daily service water effluent samples shall be taken and analyzed for principal gamma emitters until the release is terminated,

c) an incident composite shall be prepared for H-3, gross alpha, Sr-89, Sr-90 and Fe-55 analyses and,

d) dose projections shall be performed in accordance with Section 2.3 of this manual (using estimated concentrations for H-3, Sr-89, Sr-90 and Fe-55 to be conservatively determined by supervision at the time of the incident).

Additionally, service water effluent monitor setpoints may be recalculated using the actual distribution of isotopes found from sample analysis.

2.2 **Liquid Effluent Concentration Calculation**

This calculation documents compliance with Technical Specification Section 3.6.1.5.a (1).

The concentration of radioactive material released in liquid effluents to unrestricted areas (see Figure B-7) shall be limited to the concentrations specified in 10CFR20, Appendix B, Table II, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2 E-4 microcurie/milliliter (μCi/ml) total activity.

## 2.2 Liquid Effluent Concentration Calculation (Cont'd)

The concentration of radioactivity from Liquid Radwaste batch releases and, if applicable, Service Water System and emergency condenser start-up vent discharges are included in the calculation. The calculation is performed for a specific period of time. No credit taken for averaging over the calendar year as permitted by 10CFR20.106. The limiting concentration is calculated as follows:

$$\text{MPC Fraction} = \Sigma_i [ (\Sigma_s C_{is} F_s) / (MPC_i \Sigma_s F_s) ]$$

Where:

MPC Fraction = The limiting concentration of 10 CFR 20, Appendix B, Table II, for radionuclides other than dissolved or entrained noble gases. For noble gases, the concentration shall be limited to 2 E-4 microcurie/ml total activity.

$C_{is}=(\mu Ci/ml)_{is}$ = The concentration of nuclide i in particular effluent stream s, $\mu$Ci/ml.

$F_s$ = The flow rate of a particular effluent stream s, gpm.

$MPC_i$ = The limiting concentration of a specific nuclide i from 10CFR20, Appendix B, Table II, Column 2 (noble gas limit is 2E-4 $\mu$Ci/ml).

$\Sigma_s(\mu Ci/ml)_{is}F_s)$ = The total activity rate of nuclide i, in all effluent streams s.

$\Sigma_s(F_s)$ = The total flow rate of all effluent streams s, gpm (including those streams which do not contain radioactivity).

A value of less than one for MPC fraction is considered acceptable for compliance with Technical Specification Section 3.6.15.a.(1).

## 2.3 Dose Determination

### 2.3.1 Maximum Dose Equivalent Pathway

A dose assessment report was prepared for the Nine Mile Point Unit 1 facility by Charles T. Main, Inc., of Boston, MA. This report presented the calculated dose equivalent rates to individuals as well as the population within a 50-mile radius of the facility based on the radionuclides released in liquid and gaseous effluents during the time periods of 1 July 1980 through 31 December 1980 and from January 1981 through 31 December 1981. The radwaste liquid releases are based on a canal discharge rate of 590 $ft^3$/sec which affects near field and far field dilution; therefore, this report is specific to this situation. Utilizing the effluent data contained in the Semi-Annual Radioactive Effluent Release Reports as source terms, dose equivalent rates were determined using the environmental pathway models specified in Regulatory Guides 1.109 and 1.111 as incorporated in the NRC computer codes LADTAP for liquid pathways, and XOQDOQ and GASPAR for gaseous effluent pathways. Dose equivalent rates were calculated for the total body as well as seven organs and/or tissues for the adult, teen, child, and infant age groups. From the standpoint of liquid effluents, the pathways evaluated included fish and drinking water ingestion, and external exposure to water and sediment.

2.3.1 **Maximum Dose Equivalent Pathway (Cont'd)**

The majority of the dose for a radwaste liquid batch release was received via the fish pathway. However, to comply with Technical Specifications for dose projections, the drinking water and sediment pathways are included. Therefore, all doses due to liquid effluents are calculated monthly for the fish and drinking water ingestion pathways and the sediment external pathway from all detected nuclides in liquid effluents released to the unrestricted areas to each organ. The dose projection for liquid batch releases will also include discharges from the emergency condenser vent as applicable, for all pathways. Each age group dose factor, $A_{iat}$, is given in Tables 1-1 to 1-8. To expedite time the dose is calculated for a maximum individual instead of each age group. This maximum individual will be a composite of the highest dose factor of each age group for each organ, hence $A_{it}$. The following expression from NUREG 0133, Section 4.3 is used to calculate dose:

$$D_t = \Sigma_i \left[ A_{it} \Sigma_L (\Delta T_L C_{iL} F_L) \right]$$

Where:

$D_t$ = The cumulative dose commitment to the total body or any organ, from the liquid effluents for the total time period ($\Delta T_L$), mrem.

$\Delta T_l$ = The length of the L th time period over which $C_{iL}$ and $F_L$ are averaged for all liquid releases, hours.

$C_{iL}$ = The average concentration of radionuclide, i, in undiluted liquid effluents during time period $\Delta T_L$ from any liquid release, $\mu$Ci/ml.

$A_{it}$ = The site related ingestion dose commitment factor to the total body or any organ t for each identified principal gamma or beta emitter for a maximum individual, mrem/hr per $\mu$Ci/ml.

$F_L$ = The near field average dilution factor for $C_{iL}$ during any liquid effluent release. Defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted receiving waters, unitless.

$A_{iat}$ values for radwaste liquid batch releases at a discharge rate of 295 $ft^3$/sec (one circulating water pump in operation) are presented in tables 1-1 to 1-4. $A_{iat}$ values for an emergency condenser vent release are presented in tables 1-5 to 1-8. The emergency condenser vent releases are assumed to travel to the perimeter drain system and released from the discharge structure at a rate of .33 $ft^3$/sec. See Appendix A for the dose factor $A_{iat}$ derivation. To expedite time the dose is calculated to a maximum individual. This maximum individual is a composite of the highest dose factor $A_{iat}$ of each age group a for each organ t and each nuclide i. If a nuclide is detected for which a factor is not listed, then it will be calculated and included in a revision to the ODCM.

All doses calculated in this manner for each batch of liquid effluent will be summed for comparison with quarterly and annual limits, added to the doses accumulated from other releases in the quarter and year of interest. In all cases, the following relationships will hold:

2.3.1 **Maximum Dose Equivalent Pathway (Cont'd)**

For a calendar quarter:

$D_t \leq 1.5$ mrem total body

$D_t \leq 5$ mrem for any organ

For the calendar year:

$D_t \leq 3.0$ mrem total body

$D_t \leq 10$ mrem for any organ

Where:

$D_t$ = total dose received to the total body or any organ due to liquid effluent releases.

If these limits are exceeded, a special report will be submitted to the NRC identifying the cause and proposed corrective actions. In addition, if these limits are exceeded by a factor of two, calculations shall be made to determine if the dose limits contained in 40 CFR 190 have been exceeded. Dose limits, as contained in 40 CFR 190 are total body and organ doses of 25 mrem per year and a thyroid dose of 75 mrem per year.

These calculations will include doses as a result of liquid and gaseous pathways as well as doses from direct radiation. The liquid pathway analysis will only include the fish and sediment pathways since the drinking water pathway is insignificant. This pathway is only included in the station's effluent dose projections to comply with Technical Specifications. Liquid, gaseous and direct radiation pathway doses will consider the James A. FitzPatrick and Nine Mile Point Unit II facilities as well as Nine Mile Point Unit I Nuclear Station.

In the event the calculations demonstrate that the 40 CFR 190 dose limits, as defined above, have been exceeded, then a report shall be prepared and submitted to the Commission within 30 days as specified in Section 3.6.15.d of the Technical Specifications.

Section 4.0 of the ODCM contains more information concerning calculations for an evaluation of whether 40 CFR 190 limits have been exceeded.

## 3.0 GASEOUS EFFLUENTS

### 3.1 Setpoint Determinations

#### 3.1.1 Basis

Stack gas and off gas monitor setpoints will be established such that the instantaneous release rate of radioactive materials in gaseous effluents does not exceed the 10 CFR 20 limits for annual release rate. The setpoints will be activated if the instantaneous dose rate at or beyond the (land) site boundary would exceed 500 mrem/yr to the whole body or 3000 mrem/yr to the skin from the continuous release of radioactive noble gas in the gaseous effluent.

Emergency condenser vent monitor setpoints will be established such that the release rate for radioactive materials in gaseous effluents do not exceed the 10 CFR 20 limits for annual release rate over the projected longest period of release.

Monitor setpoints from continuous release points will be determined once per quarter under normal release rate conditions and will be based on the isotopic composition of the actual release in progress, or an offgas isotopic distribution or a more conservative default composition specified in the pertinent procedure. If the calculated setpoint is higher than the existing setpoint, it is not mandatory that the setpoint be changed.

Monitor setpoints for emergency condenser vent monitors are conservatively fixed at 5 mr/hr for reasons described in Sections 3.1.4 and therefore do not require periodic recalculations.

Under abnormal site release rate conditions, monitor alarm setpoints from continuous release points will be recalculated and, if necessary, reset at more frequent intervals as deemed necessary by C&RM Supervision. In particular, contributions from both JAF and NMP-2 and the Emergency Condenser Vents shall be assessed.

During outages and until power operation is again realized, the last operating stack and off gas monitor alarm setpoints shall be used.

Since monitors respond to noble gases only, monitor alarm points are set to alarm prior to exceeding the corresponding total body dose rates.

The skin dose rate limit is not used in setpoint calculations because it is never limiting.

#### 3.1.2 Stack Monitor Setpoints

The detailed methods for establishing setpoints shall be contained in the station procedures. These methods shall apply the following general criteria:

(1) Rationale for Stack monitor settings is based on the general equation:

$$\frac{\text{release rate, actual}}{\text{corresp. dose rate, actual}} = \frac{\text{release rate, max. allowable}}{\text{corresp. dose rate, max. allowable}}$$

$$\frac{\Sigma_i Q_i}{\Sigma_i Q_i (V_i + (SF) K_i (X/Q)_i)} = \frac{(Q)max}{500 \text{ mrem/yr}}$$

3.1.2 **Stack Monitor Setpoints (Cont'd)**

Where:

$Q_i$ = release rate for each isotope i, $\mu$Ci/sec.

$V_i$ = gamma whole body dose factor in units of mrem/yr per $\mu$Ci/sec. (See Table 3-2).

$(Q)_{max}$ = instantaneous release rate limit $\mu$Ci/sec.

(2) To ensure that 10 CFR 20 and Technical Specifications dose rate limits are not exceeded, the Hi Hi alarms on the stack monitors shall be set lower than or equal to (0.9) $(Q)_{max}$. Hi alarms shall be set lower than or equal to (0.5) $(Q)_{max}$.

(3) Based on the above conservatism, the dose contribution from JAF and NMP-2 can usually be ignored. During Emergency Classifications at JAF or NMP-2 due to airborne effluent, or after emergency condenser vent releases of significant proportions, the 500 mrem/yr value may be reduced accordingly.

(4) To convert monitor gross count rates to $\mu$Ci/sec release rates, the following general formula shall be applied:

$(C_m-B)\ K_s = Q = \mu$Ci/sec, release rate

Where:

$C_m$ = monitor gross count rate in cps or cpm
B = monitor background count rate
$K_s$ = stack monitor efficiency factor with units of $\mu$Ci/sec-cps or $\mu$Ci/sec-cpm

(5) Monitor $K_s$ factors shall be determined using the general formula:

$K_s = \Sigma_i Q_i / (C_m-B)$

Where:

$Q_i$ = individual radionuclide stack effluent release rate as determined by isotopic analysis.

$K_s$ factors more conservative than those calculated by the above methodology may be assumed.

Alternatively, when stack release rates are near the lower limit of detection, the following general formula may be used to calculate $k_s$:

$$1/K_s = \frac{E}{f} = \frac{(\Sigma_i F_i\ \Sigma_i Y_i E_i)(3.7E4day)}{f \qquad \text{Sec.-}\mu\text{Ci}}$$

Where:

f = stack flow in cc/sec.

E = efficiency in units of cpm-cc/$\mu$Ci or cps-cc/$\mu$Ci (cpm = counts per minute; cps = counts per second).

$E_k$ = cpm-cc/bps or cps-cc/$\gamma$ps.

From energy calibration curve produced during NIST traceable primary gas calibration or transfer source calibration (bps = beta per second; $\gamma$ps = gammas per second).

3.1.2 **Stack Monitor Setpoints (Cont'd)**

$Y_k$ = b/d (betas/disintegration) or γ/d (gammas/disintegration).

$\bar{F}_i$ = Activity fraction of nuclide i in the mixture.

i = nuclide counter.

k = discrete energy beta or gamma emitter per nuclide counter.

s = seconds.

This monitor calibration method assumes a noble gas distribution typical of a recoil release mechanism. To ensure that the calculated efficiency is conservative, beta or gamma emissions whose energy is above the range of calibration of the detector are not included in the calculation.

3.1.3 **Recombiner Discharge (Off Gas) Monitor Setpoints**

(1) The Hi-Hi alarm points shall activate with recombiner discharge rates equal to or less than 500,000 μCi/sec. This alarm point may be set equal to or less than 1 Ci/sec for a period of time not to exceed 60 days provided the offgas treatment system is in operation.

(2) The Hi alarm points shall activate with recombiner discharge rates equal to or less than 500,000 μCi/sec. According to the Unit 1 Technical Specifications, Note (C) to Table 4.6.14-2, the channel functional test of the condenser air ejector radioactivity monitor shall demonstrate that automatic isolation of this pathway occurs if either of the following conditions exist:

i) Instruments indicate two channels above the Hi-Hi alarm setpoint,

ii) Instruments indicate one channel above Hi-Hi alarm setpoint and one channel downscale.

This automatic isolation function is tested once per operating cycle in accordance with station procedures.

(3) To convert monitor mR/hr readings to μCi/sec, the formula below shall be applied:

$(R)(K_R) = Q_R$ μCi/sec recombiner discharge release rate

Where:

R = mR/hr monitor indicator.

$K_R$ = efficiency factor in units of μCi/sec/mR/hr determined prior to setting monitor alarm points.

(4) Monitor $K_R$ factors shall be determined using the general formula:

$$K_R = \Sigma_i Q_i / R$$

Where:

$Q_i$ = individual radionuclide recombiner discharge release rate as determined by isotopic analysis and flow rate monitor.

$K_R$ factors more conservative than those calculated by the above methodology may be assumed.

3.1.3 **Recombiner Discharge (Off Gas) Monitor Setpoints (Cont'd)**

(5) The setpoints chosen provide assurance that the total body exposure to an individual at the exclusion area boundary will not exceed a very small fraction of the limits of 10CFR Part 100 in the event this effluent is inadvertently discharged directly to the environment without treatment (thereby implementing the requirements of General Design Criteria 60 and 64 of Appendix A to 10CFR Part 50). Additionally, these setpoints serve to limit buildup of fission product activity within the station systems which would result if high fuel leakage were to be permitted over extended periods.

3.1.4 **Emergency Condenser Vent Monitor Setpoint**

The monitor setpoint was established by calculation ("Emergency Condenser Vent Monitor Alarm Setpoint", January 13, 1986, NMPC File Code #16199). Assuming a hypothetical case with (1) reactor water iodine concentrations higher than the Technical Specification Limit, (2) reactor water noble gas concentrations higher than would be expected at Technical Specification iodine levels, and (3) leakage of reactor steam into the emergency condenser shell at 300% of rated flow (or 1.3 E6 lbs/hr), the calculation predicts an emergency condenser vent monitor response of 20 mR/hr. Such a release would result in less than 10 CFR 20 dose rate values at the site boundary and beyond for typical emergency condenser cooldown periods.

Since a 20 mR/hr monitor response can, in theory, be achievable only when reactor water iodines are higher than permitted by Technical Specifications, a conservative monitor setpoint of 5 mr/hr has been adopted.

3.1.5 **Discussion**

3.1.5.1 **Stack Effluent Monitoring System Description**

The NMP-1 Stack Effluent Monitoring System consists of two subsystems; the Radioactive Gaseous Effluent Monitoring System (RAGEMS) and the old General Electric Stack Monitoring System (OGESMS). During normal operation, the OGESMS shall be used to monitor station noble gas effluents and collect particulates and iodine samples in compliance with Technical Specification requirements.

The RAGEMS is designed to be promptly activated from the Main Control Room for use in high range monitoring during accident situations in compliance with NUREG 0737 criteria. Overall system schematic for the OGESMS and RAGEMS are shown on Figure B-9. A simplified view of RAGEMS Showing Unit 0, 1, 2, 3 and 4 can be found on Figure B-8.

The RAGEMS can provide continuous accident monitoring and on-line isotopic analysis of NMP-1 stack effluent noble gases at Lower Levels of Detection less than Technical Specification Table 4.6.15-2 limits. Activities as low as 5.0E-8 and as high as 2.0E5 $\mu$Ci/cc for noble gases are detectable by the system.

3.1.5.2 **Stack Sample Flow Path - RAGEMS**

The effluent sample is obtained inside the stack at elevation 530' using an isokinetic probe with four orifices. The sample line then bends radially out and back into the stack; descends down the stack and out of the stack at approximately elevation 257'; runs horizontally (enclosed in heat tracing) some 270' along the off gas tunnel; and enters the RAGEMS located on the Turbine Building 250' (Dilution cabinet - Unit 0) and Off Gas Building 247' (Particulate, Iodine, Noble Gas stations - Units 1-3).

3.1.5.2 **Stack Sample Flow Path - RAGEMS (Cont'd)**

In the Dilution cabinet of the RAGEMS, the stack gas may be diluted during accident situations approximately 100-200X (first stage) or 10000-40000 X (first and second stage) with gaseous nitrogen supplied from an on-site liquid nitrogen storage tank (see Figure B-9).

From Unit 0, the sample gas enters Unit 1-3 of RAGEMS and flows thru in-line particulate and iodine cartridges and then thru either a 6 liter (low range) or 30 cc (high range) noble gas chamber. The sample gas next flows back thru Unit 0 and the off gas tunnel; and back into the stack.

3.1.5.3 **Stack Sample Flow Path - OGESMS**

The OGESMS sample is obtained from the same stack sample probe as the RAGEMS. From the exit of the stack at elevation 257', the sample line runs east approximately 20' and then vertically approximately 8' to the OGESMS skid. In the OGESMS, sample flows thru a particulate/iodine cartridge housing and four noble gas scintillation detectors (i.e., 07 and 08 low range beta detectors and RN-03A and RN-03B high range gamma detectors). From OGESMS, the stack sample flows back into the stack at approximately elevation 257'.

All OGESMS detector outputs are monitored and recorded remotely in the Main Control Room. Alarming capabilities are provided to alert Operators of high release rate conditions prior to exceeding Technical Specification 3.6.15.b (1) a dose rate limits.

Stack particulate and iodine samples are retrieved manually from the OGESMS and analyzed in the laboratory using gamma spectroscopy at frequencies and LLDs specified in Table 4.6.15-2 of the Technical Specifications.

3.1.5.4 **Sampling Frequency/Sample Analysis**

Regardless of which stack monitoring subsystem is utilized, radioactive gaseous wastes shall be sampled and analyzed in accordance with the sampling and analysis program specified in Technical Specification Table 4.6.15-2. Particulate samples are saved and analyzed for principal gamma emitters, gross alpha, Fe-55, Sr-89, Sr-90 at monthly intervals minimally. The latter three analyses are performed off-site from a composite sample. Sample analysis frequencies are increased during elevated release rate conditions, following startup, shutdown and in conjunction with each drywell purge.

Consistent with Technical Specification Table 4.6.15-2, stack effluent tritium is sampled monthly, during each drywell purge, and weekly when fuel is off loaded until stable release rates are demonstrated. Samples are analyzed off-site.

Line loss correction factors are applied to all particulate and iodine results. Correction factors of 2.0 and 1.5 are used for data obtained from RAGEMS and OGESMS respectively. These correction factors are based on empirical data from sampling conducted at NMP-1 in 1985 (memo from J. Blasiak to RAGEMS File, 1/6/86, "Stack Sample Representativeness Study: RAGEMS versus In-Stack Auxiliary Probe Samples").

3.1.5.5 **I-133 Estimates**

Monthly, the stack effluent shall be sampled for iodines over a 24 hour period and the I-135/I-131 and the I-133/I-131 ratios calculated. These ratios shall be used to calculate I-133, I-135 release for longer acquisition samples collected during the month.

3.1.5.5 I-133 Estimates (Cont'd)

Additionally, the I-135/I-131 and I-133/I-131 ratios should also be determined after a significant change in the ratio is suspected (eg, plant status changes from prolonged shutdown to power operation or fuel damage has occurred).

3.1.5.6 Gaseous Radwaste Treatment System Operation

Technical Specification 3.6.16.b requires that the gaseous radwaste treatment system shall be operable and shall be used to reduce radioactive materials in gaseous waste prior to their discharge as necessary to meet the requirements of Technical Specification 3.6.15.b.

To ensure Technical Specification 3.6.15.b limits are not exceeded, and to confirm proper radwaste treatment system operation as applicable, cumulative dose contributions for the current calendar quarter and current calendar year shall be determined monthly in accordance with section 3.2 of this manual. Initial dose calculations shall incorporate the following assumptions with regard to release rates of non-gamma emitting radionuclides subsequently analyzed off-site:

a) H-3 release rate ≤ 4 μCi/sec
b) Sr-89 release rate ≤ 4 x Cs-137 release rate
c) Sr-90 release rate ≤ 0.5 x Cs-137 release rate
d) Fe-55 release rate ≤ 1 x Co-60 release rate

Assumed release rates represent conservative estimates derived from analysis of historical data from effluent releases and process waste streams (See NMP 34023, C. Ware to J. Blasiak, April 29, 1988, "Dose Estimates for Beta-Emitting Isotopes"). Following receipt of off-site H-3, Sr-89, Sr-90, Fe-55 analysis information, dose estimates shall be revised using actual radionuclide concentrations.

3.2 Dose and Dose Rate Determinations

In accordance with specifications 4.6.15.b.(1), 4.6.15.b.(2), and 4.6.15.b.(3) dose and dose rate determinations will be made monthly to determine:

(1) Total body dose rates and gamma air doses at the maximum X/Q land sector site boundary interface and beyond.

(2) Skin dose rates and beta air doses at the maximum X/Q land sector site boundary interface and beyond.

(3) The critical organ dose and dose rate at the maximum X/Q land sector site boundary interface and at a critical receptor location beyond the site boundary.

Average meteorological data (ie, maximum five year annual average X/Q and D/Q values in the case of elevated releases or 1985 annual average X/Q and D/Q values, in the case of ground level releases) shall be utilized for dose and dose rate calculations. Where average meteorological data is assumed, dose and dose rates due to noble gases at locations beyond the site boundary will be lower than equivalent site boundary dose and dose rates. Therefore, under these conditions, calculations of noble gas dose and dose rates beyond the maximum X/Q land sector site boundary locations can be neglected.

The frequency of dose rate calculations will be upgraded when elevated release rate conditions specified in subsequent sections 3.2.1.1 and 3.2.1.2 are realized.

## 3.2 Dose and Dose Rate Determinations (Cont'd)

Emergency condenser vent release contributions to the monthly dose and dose rate determinations will be considered only when the emergency condenser return isolation valves have been opened for reactor cooldown or if Emergency Condenser tube leaks develop with or without the system's return isolation valve opened.

Without tube leakage or opening of the return isolation valves, releases from this system are negligible and the corresponding dose contributions do not have to be included.

When releases from the emergency condenser have occurred, dose rate and dose determinations shall be performed using methodology in 3.2.1 and 3.2.2. Furthermore, environmental sampling may also be initiated to refine any actual contribution to doses. See Section 3.4.

Critical organ doses and dose rates may be conservatively calculated by assuming the existence of a maximum individual. This individual is a composite of the highest dose factor of each age group, for each organ and total body, and each nuclide. It is assumed that all pathways are applicable and the highest X/Q and/or D/Q value for actual pathways as noted in Table 3-1 are in effect. The maximum individual's dose is equal to the same dose that person would receive if they were simultaneously subjected to the highest pathway dose at each critical receptor identified for each pathway. The pathways include grass-(cow and goat)-milk, grass-cow-meat, vegetation, ground plane and inhalation. To comply with Technical Specifications we will calculate the maximum individual dose rate at the site boundary and beyond at the critical residence.

If dose or dose rates calculated, using the assumptions noted above, reach Technical Specification limits, actual pathways will be evaluated, and dose/dose rates shall be calculated at separate critical receptor locations and compared with applicable limits.

### 3.2.1 Dose Rate

Dose rates will be calculated monthly, at a minimum, or when the Hi-Hi stack monitor alarm setpoint is reached, to demonstrate that dose rates resulting from the release of noble gases, tritium, iodines, and particulates with half lives greater than 8 days are within the limits specified in 10CFR.20. These limits are:

Noble Gases

Whole Body Dose Rate: 500 mrem/yr
Skin Dose Rate: 3000 mrem/yr

Tritium, Iodines and Particulates

Organ Dose Rate: 1500 mrem/yr

### 3.2.1.1 Noble Gases

The following noble gas dose rate equation includes the contribution from the stack (s) elevated release and the emergency condenser vent (v) ground level release when applicable (See section 3.2).

To ensure that the site noble gas dose rate limits are not exceeded, the following procedural actions are taken if the offsite dose rates from Unit 1 exceed 10% of the limits:

1) Notify the Unit 1 SSS (Station Shift Supervisor) and Unit 1 Supervisor Chemistry.

3.2.1.1 **Noble Gases (Cont'd)**

2) Notify the Unit 2 SSS and Unit 2 Supervisor Chemistry and request the Unit 2 contribution to offsite dose.

3) Notify the SSS of the James A. Fitzpatrick Nuclear Plant and request the Fitzpatrick contribution to offsite dose.

4) Increase the frequency of performing noble gas dose calculations, if necessary, to ensure Site (Nine Mile Point Units 1 and 2 and Fitzpatrick) limits are not exceeded.

Additionally, alarm setpoints are set at 50% of the dose rate limit to ensure that site limits are not exceeded. This alarm setpoint is adjusted if the noble gas dose rate from Unit 1 is greater than 10% of the limit.

For total body dose rates (mrem/sec):

$$DR_\gamma \text{ (mrem/sec)} = 3.17E\text{-}8\Sigma_i[(V_i + (SF)K_i(X/Q)_s)Q_{is} + (SF)K_i\ (X/Q)_v Q_{iv}]$$

For skin dose rates (mrem/sec):

$$DR_{\gamma+\beta}(\text{mrem/sec}) = 3.17E\text{-}8\Sigma_i[(L_i(X/Q)_s + 1.11(SF)(B_i + M_i(X/Q)_s))Q_{is} + \ldots \ldots(L_i + 1.11(SF)M_i)(X/Q)_v Q_{iv}]$$

Where:

$DR_\gamma$ = total body gamma dose rate (mrem/sec).

$DR_{\gamma+\beta}$ = skin dose rate from gamma and beta radiation (mrem/sec).

$V_i$ = the constant accounting for the gamma whole body dose rate from stack radiation for an elevated finite plume releases for each identified noble gas nuclide, i. Listed on Table 3-2 in mrem/yr per $\mu$Ci/sec.

$K_i$ = the constant accounting for the gamma whole body dose rate from immersion in the semi-infinite cloud for each identified noble gas nuclide, i. Listed in Table 3-3 in mrem/yr per $\mu Ci/m^3$ (from Reg. Guide 1.109)

$Q_{is}, Q_{iv}$ = the release rate of isotope i from the stack(s) or vent(v); ($\mu$Ci/sec)

SF = structural shielding factor.

X/Q = the relative plume concentration (in units of sec/$m^3$) at the land sector site boundary or beyond. Average meteorological data (Table 3-1) is used. "Elevated" X/Q values are used for stack releases (s = stack); "Ground" X/Q values are used for Emergency Condenser Vent releases (v = vent).

$L_i$ = the constant accounting for the beta skin dose rate from immersion in the semi-infinite cloud for each identified noble gas nuclide, i. Listed in Table 3-3 in mrem/yr per $\mu Ci/m^3$ (from Reg. Guide 1.109)

$B_i$ = the constant accounting for the air gamma radiation from the elevated Finite plume resulting from stack releases for each identified noble gas nuclide, i. Listed in Table 3-2 in mrad/yr per $\mu$Ci/sec.

3.2.1.1 **Noble Gases (Cont'd)**

$M_i$ = the constant accounting for the gamma air dose rate from immersion in the semi-infinite cloud for each identified noble gas nuclide, i. Listed in Table 3-3 in mrem/yr per $\mu Ci/m^3$ (from Reg. Guide 1.109)

See Appendix B for derivation of $B_i$ and $V_i$.

3.2.1.2 **Tritium, Iodines and Particulates**

To ensure that the 1500 mrem/year site dose rate limit is not exceeded, offsite dose rates for tritium, iodine and particulates with half lives greater than 8 days shall be calculated monthly and when release rates (Q) exceed 0.34 $\mu Ci/sec$ using the following equation.

$$D_{ak} \text{ (mrem/sec)} = 3.17E\text{-}8 \Sigma_j [\Sigma_i R_{ijak} [W_s Q_{is} + W_v Q_{iv}]]$$

Where:

$D_{ak}$ = Total dose rate to each organ k of an individual in age group a (mrem/sec).

$W_j$ = dispersion parameter either X/Q ($sec/m^3$) or D/Q ($1/m^2$) depending on pathway and receptor location assumed. Average meteorological data is used (Table 3-1). "Elevated" $W_j$ values are used for stack releases (s = stack); "Ground" $W_j$ values are used for Emergency Condenser Vent releases (v = vent).

$Q_i$ = the release rate of isotope i, from the stack (s) or vent(v); ($\mu Ci/sec$).

$R_{ijak}$ = the dose factor for each isotope i, pathway j, age group a, and organ k (Table 3-4, through 3-22; $m^2$-mrem/yr per $\mu Ci/sec$ for all pathways except inhalation, mrem/yr per $\mu Ci/m^3$. The R values contained in Tables 3-4 through 3-22 were calculated using the methodology defined in NUREG-0133 and parameters from Regulatory Guide 1.109, Revision 1; as presented in Appendix C.

3.17E-8 = the inverse of the number of seconds in a year.

When the release rate exceeds 0.34 $\mu Ci/sec$, the dose rate assessment shall also include JAF and NMP-2 contribution.

The use of the 0.34 $\mu Ci/sec$ release rate threshold to perform dose rate calculations is justified as follows:

(a) The 1500 mrem/yr organ dose rate limit corresponds to a minimum release rate limit of 0.34 $\mu Ci/sec$ calculated using the equation:

$$1500 = (Q, \mu Ci/sec) \times (R_{ij}W_j)_{max}$$

Where:

1500 = site boundary dose rate limit (mrem/year).

$(R_{ij}W_j)_{max}$ = the maximum curie-to-dose conversion factor equal to 4.45E3 mrem-sec/$\mu Ci$-yr for Sr-90, child bone at the critical residence receptor location beyond the site boundary.

3.2.1.2 **Tritium, Iodines and Particulates (Cont'd)**

(b) The use of 0.34 $\mu$Ci/sec release rate threshold and the 4.45E3 mrem-sec/$\mu$Ci-yr curie-to-dose conversion factor is conservative since curie-to-dose conversion factors for other isotopes likely to be present are significantly lower.

In addition, if the organ dose rate exceeds 5% of the annual limit, the following procedural actions will be taken:

1) Notify the Unit 1 SSS (Station Shift Supervisor) and Unit 1 Supervisor Chemistry.

2) Notify the Unit 2 SSS and Unit 2 Supervisor Chemistry and request the Unit 2 contribution to offsite dose.

3) Notify the SSS of the James A. Fitzpatrick contribution to offsite dose.

4) Increase the frequency of performing dose calculations if necessary to ensure site (Nine Mile Point Units 1 and 2 and Fitzpatrick) limits are not exceeded.

3.2.2 **Dose**

Calculations will be performed monthly at a minimum, to demonstrate that doses resulting from the release of noble gases, tritium, iodines, and particulates with half lives greater than 8 days are within the limits specified in 10 CFR 50, Appendix I. These limits are:

Noble Gases

5 mR gamma/calendar quarter
10 mrad beta/calendar quarter
10 mR gamma/calendar year
20 mrad beta/calendar year

Tritium, Iodines and Particulates

7.5 mrem to any organ/calendar quarter
15 mrem to any organ/calendar year

3.2.2.1 **Noble Gas Air Dose**

The following Noble Gas air dose equation includes contributions from the stack (s) elevated release and the emergency condenser vent (v) ground level release when applicable (see section 3.2):

For gamma radiation[1] (mrad):

$$D_\gamma \text{ (mrad)} = 3.17E\text{-}8\Sigma_i[M_i(X/Q)_v\ Q_{iv} + (B_i + M_i(X/Q)_s)\ Q_{is}] \cdot t$$

For beta radiation (mrad):

$$D_\beta\text{(mrad)} = 3.17E\text{-}8\Sigma_i N_i[(X/Q)_v\ Q_{iv} + (X/Q)_s\ Q_{is}] \cdot t$$

Where:

$D_\gamma$ = gamma air dose (mrad).

$D_\beta$ = beta air dose (mrad).

[1] Note that the units for the gamma air dose are in mrad compared to the units for the limits are in mR. The NRC recognizes that 1 mR=1 mrad, for gamma radiation.

3.2.2.1 **Noble Gas Air Dose (Cont'd)**

$B_i$ = the constant accounting for the air gamma radiation from the elevated finite plume resulting from stack releases for each identified noble gas nuclide, i. Listed in Table 3-2 in mrad/yr per $\mu$Ci/sec.

$N_i$ = The constant accounting for the air beta dose from immersion in the semi-infinite cloud for each identified noble gas nuclide, i. Listed on Table 3-3 in mrad/yr per $\mu Ci/m^3$ (from Reg. Guide 1.109).

$Q_{is}$, $Q_{iv}$ = the release rate of isotope i, from the stack (s) or vent (v); ($\mu$Ci/sec).

3.17E-8 = the inverse of the number of seconds in a year.

$M_i$ = the constant accounting for the air gamma dose from immersion in the semi-infinite cloud for each identified noble gas nuclide, i. Listed on Table 3-3 in mrad/yr per $\mu Ci/m^3$ (from Reg. Guide 1.109).

t = total time during release period, sec.

All other parameters are as defined in section 3.2.1.1.

3.2.2.2 **Tritium, Iodines and Particulates**

To ensure that the 15 mrem/yr facility dose limit is not exceeded, offsite doses for tritium, iodines, and particulates with half lives greater than 8 days shall be calculated monthly using the following equation:

$$D_{ak} \text{ (mrem)} = 3.17E\text{-}8 \Sigma_j [\Sigma_i R_{ijak} [W_s Q_{is} + W_v Q_{iv}]] \cdot t$$

Where:

$D_{ak}$ = total dose to each organ k of an individual in age group a(mrem).

$W_j$ = dispersion parameter either X/Q (sec/$m^3$) or D/Q ($1/m^2$) depending on pathway and receptor location assumed. Average meteorological data is used (Table 3-1). "Elevated" $W_j$ values are used for stack releases (s = stack); "Ground" $W_j$ values are used for Emergency Condenser Vent releases (v = vent).

$Q_{is}$, $Q_{iv}$ = the release rate of isotope i from stack(s) or vent (v); ($\mu$Ci/sec).

$R_{ijak}$ = the dose factor for each isotope i, pathway j, age group a, and organ k (Tables 3-4, through 3-22; $m^2$-mrem/yr per $\mu$Ci/sec). R values contained in Tables 3-4 through 3-22 were calculated using the methodology defined in NUREG-0133 and parameters from Regulatory Guide 1.109, Revision 1; as presented in Appendix C.

3.17E-8 = the inverse of the number of seconds in a year.

t = total time during the release period, sec.

### 3.2.2.3 Accumulating Doses

Doses will be calculated monthly, at a minimum, for gamma air, beta air, and the critical organ for each age group. Dose estimates will, also, be calculated monthly prior to receipt of any offsite analysis data i.e., strontium, tritium, and iron-55. Results will be summed for each calendar quarter and year.

The critical doses are based on the following:

- noble gas plume air dose
- direct radiation from ground plane deposition
- inhalation dose
- cow milk ingestion dose
- goat milk ingestion dose
- cow meat ingestion dose
- vegetation (food crops) ingestion dose

The quarterly and annual results shall be compared to the limits listed in paragraph 3.2.2. If the limits are exceeded, special reports, as required by Section 6.9.3 of the Technical Specification, shall be submitted.

## 3.3 Critical Receptors

In accordance with the provisions of 10 CFR 20 and 10 CFR 50, Appendix I, the critical receptors have been identified and are contained in Table 3-1.

For elevated noble gas releases the critical receptor is the site boundary.

When 1985 average annual X/Q values are used for ground level noble gas releases, the critical receptor is the maximum X/Q land sector site boundary interface.

For tritium, iodines, and particulates with half lives greater than eight days, the critical pathways are grass-(cow and goat)-milk, grass-cow meat, vegetation, inhalation and direct radiation (ground plane) as a result of ground deposition.

The grass-(cow and goat)-milk, and grass-cow-meat pathways will be based on the greatest D/Q location. This location has been determined in conjunction with the land use census (technical specification 3.6.22) and is subject to change. The vegetation (food crop) pathway is based on the greatest D/Q garden location from which samples are taken. This location may also be modified as a result of vegetation sampling surveys.

The inhalation and ground plane dose pathways will be calculated at the critical residence.

Because the Technical Specifications state to calculate "at the site boundary and beyond", the doses and/or dose rates must be calculated for a maximum individual who is exposed to all pathways at the site boundary and at the critical residence. The maximum individual is a composite of the highest dose factor of each age group, for each organ and total body, and each nuclide. Since the critical residence location has the greatest occupancy time, the resultant dose at the residence including all pathways is limiting. However, due to the Technical Specification wording, the inhalation and ground plane dose at the site boundary along with all other pathways, will be calculated assuming a continuous occupancy time.

3.3 **Critical Receptors (Cont'd)**

In lieu of correcting land site boundary ground plane and inhalation dose factors for occupancy time, a Technical Specification change will be submitted to change the requirement from calculating "at the site boundary and beyond" to "at the site boundary or beyond". Unit 1 will then calculate at the critical residence since this should be the limiting dose. Until this change is effective, the dose and/or dose rate calculations for tritium, iodines, and particulates with half lives greater than 8 days will conservatively assume that the ground plane and inhalation pathway critical receptors are at the site boundary, i.e., X/Q and D/Q, respectively, are calculated at the site boundary.

3.4 **Refinement of Offsite Doses Resulting from Emergency Condenser Vent Releases**

The doses resulting from the operation of the emergency condensers and calculated in accordance with 3.2.2 may be refined using data from actual environmental samples. Ground deposition samples will be obtained from an area or areas of maximum projected deposition. These areas are anticipated to be at or near the site boundary and near projected plume centerline. Using the methodology found in Regulatory Guide 1.109, the dose will be calculated to the maximum exposed individual. This dose will then be compared to the dose calculated in accordance with 3.2.2. The comparison will result in an adjustment factor of less than or greater than one which will be used to adjust the other doses from other pathways. Other environmental samples may also be collected and the resultant calculated doses to the maximum exposed individual compared to the dose calculated per 3.2.2. Other environmental sample media may include milk, vegetation (such as garden broadleaf vegetables), etc. The adjustment factors from these pathways may be applied to the doses calculated per 3.2.2 on a pathway by pathway basis or several pathway adjustment factors may be averaged and used to adjust calculated doses.

Doses calculated from actual environmental sample media will be based on the methodology presented in Regulatory Guide 1.109. The regulatory guide equations may be slightly modified to account for short intervals of time (less than one year) or modified for simplicity purposes by deleting decay factors. Deletion of decay factors would yield more conservative results.

## 4.0 40 CFR 190 REQUIREMENTS

The "Uranium Fuel Cycle" is defined in 40 CFR Part 190.02 (b) as follows:

"Uranium fuel cycle means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and by-product materials from the cycle."

Section 3.6.15.d of the Technical Specifications requires that when the calculated doses associated with the effluent releases exceed twice the applicable quarter or annual limits, the licensee shall evaluate the calendar year doses and, if required, submit a Special Report to the NRC and limit subsequent releases such that the dose commitment to a real individual from all uranium fuel cycle sources is limited to 25 mrem to the total body or any organ (except the thyroid, which is limited to 75 mrem). This report is to demonstrate that radiation exposures to all real individuals from all uranium fuel cycle sources (including all liquid and gaseous effluent pathways and direct radiation) are less than the limits in 40 CFR Part 190. If releases that result in doses exceeding the 40 CFR 190 limits have occurred, then a variance from the NRC to permit such releases will be requested and if possible, action will be taken to reduce subsequent releases.

The report to the NRC shall contain:

1) Identification of all uranium fuel cycle facilities or operations within 5 miles of the nuclear power reactor units at the site that contribute to the annual dose of the maximum exposed member of the public.

2) Identification of the maximum exposed member of the public and a determination of the total annual dose to this person from existing pathways and sources of radioactive effluents and direct radiation.

The total body and organ doses resulting from radioactive material in liquid effluents from Nine Mile Point Unit 1 will be summed with the maximum doses resulting from the releases of noble gases, radioiodines, and particulates for the other calendar quarters (as applicable) and from the calendar quarter in which twice the limit was exceeded. The direct dose components will be determined by either calculation or actual measurement. Actual measurements will utilize environmental TLD dosimetry. Calculated measurements will utilize engineering calculations to determine a projected direct dose component. In the event calculations are used, the methodology will be detailed as required in Section 6.9.1.e of the Technical Specifications.

The doses from Nine Mile Point Unit 1 will be added to the doses to the maximum exposed individual that are contributed from other uranium fuel cycle operations within 5 miles of the site. Other uranium fuel cycle facilities within 5 miles of the Site include Nine Mile Point Nuclear Station Unit 2 and the James A. Fitzpatrick Nuclear Power Plant. Doses from other facilities will be calculated in accordance with each facilities' ODCM.

For the purpose of calculating doses, the results of the Radiological Environmental Monitoring Program may be included for providing more refined estimates of doses to a real maximum exposed individual. Estimated doses, as calculated from station effluents, may be replaced by doses calculated from actual environmental sample results. Reports will include all significant details of the dose determination if radiological sampling and analyses are used to determine if the dose limits of 40CFR190 are exceeded.

## 4.1 Evaluation of Doses From Liquid Effluents

For the evaluation of doses to real members of the public from liquid effluents, the fish consumption and shoreline sediment ground dose will be considered. Since the doses from other aquatic pathways are insignificant, fish consumption and shoreline sediment are the only two pathways that will be considered. The dose associated with fish consumption may be calculated using effluent data and Regulatory Guide 1.109 methodology or by calculating a dose to man based on actual fish sample analysis data. Because of the nature of the receptor location and the extensive fishing in the area, the critical individual may be a teenager or an adult. The dose associated with shoreline sediment is based on the assumption that the shoreline would be utilized as a recreational area. This dose may be derived from liquid effluent data and Regulatory Guide 1.109 methodology or from actual shoreline sediment sample analysis data.

Equations used to evaluate doses from actual fish and shoreline sediment samples are based on Regulatory Guide 1.109 methodology. Because of the sample medium type and the half-lives of the radionuclides historically observed, the decay corrected portions of the equations are deleted. This does not reduce the conservatism of the calculated doses but increases the simplicity from an evaluation point of view. Table 3-23 presents the parameters used for calculating doses from liquid effluents.

The dose from fish sample media is calculated as:

$$R_{apj} = \Sigma_i \left[ C_{if} \, (U)(D_{aipj}) \, f \right] (1E+3)$$

Where:

$R_{apj}$ = The total annual dose to organ j, of an individual of age group a, from nuclide i, via fish pathway p, in mrem per year.

$C_{if}$ = The concentration of radionuclide i in fish samples in pCi/gram.

U = The consumption rate of fish in kg/yr.

1E+3 = Grams per kilogram.

4.1 Evaluation of Doses From Liquid Effluents (Cont'd)

$(D_{aipj})$ = The ingestion dose factor for age group a, nuclide i, fish pathway p, and organ j, (Reg. Guide 1.109, Table E-11) (mrem/pCi).

f = The fractional portion of the year over which the dose is applicable.

The dose from shoreline sediment sample media is calculated as:

$$R_{apj} = \Sigma_i [C_{is} (U)(4E+4)(0.3)(D_{aipj}) f]$$

Where:

$R_{apj}$ = The total annual dose to organ j, of an individual of age group a, from nuclide i, via the sediment pathway p, in mrem per year.

$C_{is}$ = The concentration of radionuclide i in shoreline sediment in pCi/gram.

U = The usage factor, (hr/yr) (Reg. Guide 1.109).

4E+4 = The product of the assumed density of shoreline sediment (40 kilogram per square meter to a depth of 2.5 cm) times the number of grams per kilogram.

0.3 = The shore width factor for a lake.

$D_{aipj}$ = The dose factor for age group a, nuclide i, sediment pathway s, and organ j. (Reg. Guide 1.109, Table E-6)(mrem/hr per pCi/$m^2$).

f = The fractional portion of the year over which the dose is applicable.

4.2 Evaluation of Doses From Gaseous Effluents

For the evaluation of doses to real members of the public from gaseous effluents, the pathways contained in section 3.2.2.3 of the ODCM will be considered. These include the deposition, inhalation cows milk, goats milk, meat, and food products (vegetation). However, any updated field data may be utilized that concerns locations of real individuals, real time meteorological data, location of critical receptors, etc. Data from the most recent census and sample location surveys should be utilized. Doses may also be calculated from actual environmental sample media, as available. Environmental sample media data such as TLD, air sample, milk sample and vegetable (food crop) sample data may be utilized in lieu of effluent calculational data.

Doses to member of the public from the pathways contained in ODCM section 3.2.2.3 as a result of gaseous effluents will be calculated using the dose factors of Regulatory Guide 1.109 or the methodology of the ODCM, as applicable. Doses calculated from environmental sample media will be based on the methodologies found in Regulatory Guide 1.109.

## 4.3 Evaluation of Doses From Direct Radiation

The dose contribution as a result of direct radiation shall be considered when evaluating whether the dose limitations of 40 CFR 190 have been exceeded.

Direct radiation doses as a result of the reactor, turbine and radwaste buildings and outside radioactive storage tanks (as applicable) may be evaluated by engineering calculations or by evaluating environmental TLD results at critical receptor locations, site boundary or other special interest locations. For the evaluation of direct radiation doses utilizing environmental TLDs, the critical receptor in question, such as the critical residence, etc., will be compared to the control locations. The comparison involves the difference in environmental TLD results between the receptor location and the average control location result.

## 4.4 Doses to Members of the Public Within the Site Boundary

The Semi-Annual Radioactive Effluent Release Report shall include an assessment of the radiation doses from radioactive liquid and gaseous effluents to members of the public due to their activities inside the site boundary as defined by Figure 5.1-1 of the specifications. A member of the public, as defined by the Technical Specifications, would be represented by an individual who visits the sites' Energy Center for the purpose of observing the educational displays or for picnicking and associated activities.

Fishing is a major recreational activity in the area and on the Site as a result of the salmonoid and trout populations in Lake Ontario. Fishermen have been observed fishing at the shoreline near the Energy Center from April through December in all weather conditions. Thus, fishing is the major activity performed by members of the public within the site boundary. Based on the nature of the fishermen and undocumented observations, it is conservatively assumed that the maximum exposed individual spends an average of 8 hours per week fishing from the shoreline at a location between the Energy Center and the Unit 1 facility. This estimate is considered conservative but not necessarily excessive and accounts for occasions where individuals may fish more on weekends or on a few days in March of the year.

The pathways considered for the evaluation include the inhalation pathway, the ground dose pathway with the resultant whole body and skin dose and the direct radiation dose pathway with the associated whole body dose. The direct radiation dose pathway, in actuality, includes several pathways. These include: the direct radiation gamma dose to an individual from an overhead plume, a gamma submersion plume dose (as applicable), possible direct radiation dose from the facility and a ground plane dose (deposition). Because the location is in close proximity to the site, any beta plume submersion dose is felt to be insignificant.

Other pathways, such as the ingestion pathway, are not applicable since these doses are included under calculations for doses to members of the public outside of the site boundary. In addition, pathways associated with water related recreational activities, other than fishing, are not applicable here. These include swimming, boating and wading which are prohibited at the facility.

## 4.4 Doses to Members of the Public Within the Site Boundary (Cont'd)

The inhalation pathway is evaluated by identifying the applicable radionuclides (radioiodine, tritium and particulates) in the effluent for the appropriate time period. The radionuclide concentrations are then multiplied by the appropriate X/Q value, inhalation dose factor, air intake rate, and the fractional portion of the year in question. Thus, the inhalation pathway is evaluated using the following equation adapted from Regulatory Guide 1.109. Table 3-23 presents the reference for the parameters used in the following equation.

NOTE: The following equation is adapted from equations C-3 and C-4 of Regulatory Guide 1.109. Since many of the factors are in units of $pCi/m^3$, $m^3/sec.$, etc., and since the radionuclide decay expressions have been deleted because of the short distance to the receptor location, the equation presented here is not identical to the Regulatory Guide equations.

$$D_{ja} = \Sigma_i \left[ (C_i) F \, (X/Q) (DFA)_{ija} (BR)_a t \right]$$

Where:

$D_{ja}$ = The maximum dose from all nuclides to the organ j and age group (a) in mrem/yr.

$C_i$ = The average concentration in the stack release of nuclide i for the period in $pCi/m^3$.

$F$ = Unit 1 average stack flowrate in $m^3/sec$.

$X/Q$ = The plume dispersion parameter for a location approximately 0.50 miles west of NMP-1; the plume dispersion parameter is 8.9E-06 (stack) and was obtained from the C.T. Main five year average annual X/Q tables. The stack (elevated) X/Q is conservative when based on 0.50 miles because of the close proximity of the stack and the receptor location.

$(DFA)_{ija}$ = The dose factor for nuclide i, organ j, and age group a in mrem per pCi (Reg. Guide 1.109, Table E-7).

$(BR)_a$ = Annual air intake for individuals in age group a in $m^3$ per year (obtained from Table E-5 of Regulatory Guide 1.109).

$t$ = Fractional portion of the year for which radionuclide i was detected and for which a dose is to be calculated (in years).

## 4.4 Doses to Members of the Public Within the Site Boundary (Cont'd)

The ground dose pathway (deposition) will be evaluated by obtaining at least one soil or shoreline sediment sample in the area where fishing occurs. The dose will then be calculated using the sample results, the time period in question, and the methodology based on Regulatory Guide 1.109 as presented in Section 4.1. The resultant dose may be adjusted for a background dose by subtracting the applicable off-site control soil or shoreline sediment sample radionuclide activities. In the event it is noted that fishing is not performed from the shoreline, but is instead performed in the water (i.e., the use of waders), then the ground dose pathway (deposition) may not be evaluated.

The direct radiation gamma dose pathway includes any gamma doses from an overhead plume, potential submersion in the plume, possible direct radiation from the facility and ground plane dose (deposition). This general pathway will be evaluated by average environmental TLD readings. At least two environmental TLDs will be utilized at one location in the approximate area where fishing occurs. The TLDs will be placed in the field on approximately the beginning of a calendar quarter and removed on approximately the end of the calendar quarter. For the purposes of this evaluation, TLD data from quarters 2, 3, and 4 will be utilized.

The average TLD readings will be adjusted by the average control TLD readings. This is accomplished by subtracting the average quarterly control TLD value from the average fishing location TLD value. The applicable quarterly control TLD values will be utilized after adjusting for the appropriate time period (as applicable). In the event of loss or theft of the TLDs, results from a TLD or TLDs in a nearby area may be utilized.

## 5.0 ENVIRONMENTAL MONITORING PROGRAM

### 5.1 Sampling Stations

The current sampling locations are specified in Table 5-1 and Figures 5.1-1, 5.1-2. The meteorological tower is shown in Figure 5.1-1. The location is shown as TLD location 17. The Radiological Environmental Monitoring Program is a joint effort between the Niagara Mohawk Power Corporation and the New York Power Authority, the owners and operators of the Nine Mile Point Unit 1 and the James A. FitzPatrick Nuclear Power Plant, respectively. Sampling locations are chosen on the basis of historical average dispersion or deposition parameters from both units. The environmental sampling location coordinates shown on Table 5-1 are based on the NMP-2 reactor centerline.

The average dispersion and deposition parameters have been calculated for a 5 year period, 1978 through 1982. These dispersion calculations are attached as Appendix E.

The calculated dispersion or deposition parameters will be compared to the results of the annual land use census. If it is determined that a milk sampling location exists at a location that yields a significantly higher (e.g. 50%) calculated D/Q rate, the new milk sampling location will be added to the monitoring program within 30 days.

If a new location is added, the old location that yields the lowest calculated D/Q may be dropped from the program after October 31 of that year.

### 5.2 Interlaboratory Comparison Program

Analyses shall be performed on samples containing known quantities of radioactive materials that are supplied as part of a Commission approved or sponsored Interlaboratory Comparison Program, such as the EPA Crosscheck Program. Participation shall be only for those media, e.g., air, milk, water, etc., that are included in the Nine Mile Point Environmental Monitoring Program and for which crosscheck samples are available. An attempt will be made to obtain a QC sample to program sample ratio of 5% or better. The site identification symbol or the actual Quality Control sample results shall be reported in the Annual Radiological Environmental Operating Report so that the Commission staff may evaluate the results.

Specific sample media for which EPA Cross Check Program samples are available include the following:

- gross beta in air particulate filters
- gamma emitters in air particulate filters
- gamma emitters in milk
- gamma emitters in water
- tritium in water
- I-131 in water

## 5.3 Capabilities for Thermoluninescent Dosimeters Used for Environmental Measurements

Required detection capabilities for thermoluminescent dosimeters used for environmental measurements required by Table 4.6.20-1, footnote b of the Technical Specifications are based on ANSI Standard N545, section 4.3. TLDs are defined as phosphors packaged for field use. In regard to the detection capabilities for thermoluminescent dosimeters, only one determination is required to evaluate the above capabilities per type of TLD. Furthermore, the above capabilities may be determined by the vendor who supplies the TLDs. Required detection capabilities are as follows:

5.3.1 Uniformity shall be determined by giving TLDs from the same batch an exposure equal to that resulting from an exposure rate of 10 mR/hr during the field cycle. The responses obtained shall have a relative standard deviation of less than 7.5%. A total of at least 5 TLDs shall be evaluated.

5.3.2 Reproducibility shall be determined by giving TLDs repeated exposures equal to that resulting from an exposure rate of 10 uR/hr during the field cycle. The average of the relative standard deviations of the responses shall be less than 3.0%. A total of at least 4 TLDs shall be evaluated.

5.3.3 Dependence of exposure interpretation on the length of a field cycle shall be examined by placing TLDs for a period equal to at least a field cycle and a period equal to half the same field cycle in an area where the exposure rate is known to be constant. This test shall be conducted under approximate average winter temperatures and approximate average summer temperatures. For these tests, the ratio of the response obtained in the field cycle to twice that obtained for half the field cycle shall not be less than 0.85. At least 6 TLDs shall be evaluated.

5.3.4 Energy dependence shall be evaluated by the response of TLDs to photons for several energies between approximately 30 keV and 3 MeV. The response shall not differ from that obtained with the calibration source by more than 25% for photons with energies greater than 80 keV and shall not be enhanced by more than a factor of two for photons with energies less than 80 keV. A total of at least 8 TLDs shall be evaluated.

5.3.5 The directional dependence of the TLD response shall be determined by comparing the response of the TLD exposed in the routine orientation with respect to the calibration source with the response obtained for different orientations. To accomplish this, the TLD shall be rotated through at least two perpendicular planes. The response averaged over all directions shall not differ from the response obtained in the standard calibration position by more than 10%. A total of at least 4 TLDs shall be evaluated.

5.3.6 Light dependence shall be determined by placing TLDs in the field for a period equal to the field cycle under the four conditions found in ANSI N545, section 4.3.6. The results obtained for the unwrapped TLDs shall not differ from those obtained for the TLDs wrapped in aluminum foil by more than 10%. A total of at least 4 TLDs shall be evaluated for each of the four conditions.

5.3.7 Moisture dependence shall be determined by placing TLDs (that is, the phosphors packaged for field use) for a period equal to the field cycle in an area where the exposure rate is known to be constant. The TLDs shall be exposed under two conditions: (1) packaged in a thin, sealed plastic bag, and (2) packaged in a thin, sealed plastic bag with sufficient water to yield observable moisture throughout the field cycle. The TLD or phosphor, as appropriate, shall be dried before readout. The response of the TLD exposed in the plastic bag containing water shall not differ from that exposed in the regular plastic bag by more than 10%. A total of at least 4 TLDs shall be evaluated for each condition.

5.3.8 Self irradiation shall be determined by placing TLDs for a period equal to the field cycle in an area where the exposure rate is less than 10 uR/hr and the exposure during the field cycle is known. If necessary, corrections shall be applied for the dependence of exposure interpretation on the length of the field cycle (ANSI N545, section 4.3.3). The average exposure inferred from the responses of the TLDs shall not differ from the known exposure by more than an exposure equal to that resulting from an exposure rate of 10 uR/hr during the field cycle. A total of at least 3 TLDs shall be evaluated.

TABLE 1-1

Average Energy Per Disintegration

| ISOTOPE | $\bar{E}\gamma$ mev/dis | (Ref) | $\bar{E}_\beta$mev/dis[4] | (Ref) |
|---|---|---|---|---|
| Ar-41 | 1.294 | (3) | 0.464 | (3) |
| Kr-83m | 0.00248 | (1) | 0.0371 | (1) |
| Kr-85 | 0.0022 | (1) | 0.250 | (1) |
| Kr-85m | 0.159 | (1) | 0.253 | (1) |
| Kr-87 | 0.793 | (1) | 1.32 | (1) |
| Kr-88 | 1.95 | (1) | 0.377 | (1) |
| Kr-89 | 2.22 | (2) | 1.37 | (2) |
| Kr-90 | 2.10 | (2) | 1.01 | (2) |
| Xe-131M | 0.0201 | (1) | 0.143 | (1) |
| Xe-133 | 0.0454 | (1) | 0.135 | (1) |
| Xe-133m | 0.042 | (1) | 0.19 | (1) |
| Xe-135 | 0.247 | (1) | 0.317 | (1) |
| Xe-135m | 0.432 | (1) | 0.095 | (1) |
| Xe-137 | 0.194 | (1) | 1.64 | (1) |
| Xe-138 | 1.18 | (1) | 0.611 | (1) |

(1) ORNL-4923, Radioactive Atoms - Supplement I, M.S. Martin, November 1973.

(2) NEDO-12037, "Summary of Gamma and Beta Emitters and Intensity Data"; M.E. Meek, R.S. Gilbert, January 1970. (The average energy was computed from the maximum energy using the ICRP II equation, not the 1/3 value assumption used in this reference).

(3) NCRP Report No. 58, "A Handbook of Radioactivity Measurements Procedures"; 1978

(4) The average energy includes conversion electrons.

TABLE 2-1
$A_{ia}$ VALUES - LIQUID*
RADWASTE TANK
INFANT
$\frac{\text{mrem} - \text{ml}}{\text{hr} - \mu\text{Ci}}$

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 2.90E-1 | 2.90E-1 | 2.90E-1 | 2.90E-1 | 2.90E-1 | 2.90E-1 |
| Cr 51 | -- | -- | 1.29E-2 | 8.39E-3 | 1.83E-3 | 1.63E-2 | 3.75E-1 |
| Cu 64 | -- | 1.13E-1 | 5.23E-2 | -- | 1.91E-1 | -- | 2.32 |
| Mn 54 | -- | 1.87E+1 | 4.23 | -- | 4.14 | -- | 6.86 |
| FE 55 | 1.31E+1 | 8.44 | 2.26 | -- | -- | 4.13 | 1.07 |
| Fe 59 | 2.84E+1 | 4.96E+1 | 1.96E+1 | -- | -- | 1.47E+1 | 2.37E+1 |
| Co 58 | -- | 3.34 | 8.34 | -- | -- | -- | 8.33 |
| Co 60 | -- | 1.02E+1 | 2.40E+1 | -- | -- | -- | 2.42E+1 |
| Zn 65 | 1.72E+1 | 5.91E+1 | 2.73E+1 | -- | 2.87E+1 | -- | 5.00E+1 |
| Sr 89 | 2.32E+3 | -- | 6.66E+1 | -- | -- | -- | 4.77E+1 |
| Sr 90 | 1.74E+4 | -- | 4.43E+3 | -- | -- | -- | 2.17E+2 |
| Zr 95 | 1.91E-1 | 4.66E-2 | 3.30E-2 | -- | 5.02E-2 | -- | 2.32E+1 |
| Mn 56 | -- | 2.40E-4 | 4.15E-5 | -- | 2.07E-4 | -- | 2.18E-2 |
| Mo 99 | -- | 2.34E+1 | 4.57 | -- | 3.50E+1 | -- | 7.71 |
| Na 24 | 2.37 | 2.37 | 2.37 | 2.37 | 2.37 | 2.37 | 2.37 |
| I 131 | 3.03E+1 | 3.54E+1 | 1.57E+1 | 1.17E+4 | 4.17E+1 | -- | 1.28 |
| I 133 | 4.22 | 6.15 | 1.80 | 1.12E+3 | 7.23 | -- | 1.04 |
| Ni 65 | 1.33E-3 | 1.51E-4 | 6.85E-5 | -- | -- | -- | 1.15E-2 |
| I 132 | 1.58E-4 | 3.21E-4 | 1.14E-4 | 1.50E-2 | 3.58E-4 | -- | 2.60E-4 |
| Cs 134 | 3.54E+2 | 6.60E+2 | 6.67E+1 | -- | 1.70E+2 | 6.97E+1 | 1.79 |
| Cs 136 | 4.05E+1 | 1.19E+2 | 4.45E+1 | -- | 4.75E+1 | 9.71E+1 | 1.81 |
| Cs 137 | 4.91E+2 | 5.75E+2 | 4.07E+1 | -- | 1.54E+2 | 6.24E+1 | 1.80 |
| Ba 140 | 1.50E+2 | 1.50E-1 | 7.74 | -- | 3.57E-2 | 9.23E-2 | 3.69E+1 |
| Ce 141 | 7.21E-2 | 4.40E-2 | 5.17E-3 | -- | 1.36E-2 | -- | 2.27E+1 |
| Nb 95 | 3.85E-2 | 1.59E-2 | 9.18E-3 | -- | 1.14E-2 | -- | 1.34E+1 |
| La 140 | 1.18E-2 | 4.67E-3 | 1.20E-3 | -- | -- | -- | 5.48E+1 |
| Ce 144 | 2.79 | 1.14 | 1.57E-1 | -- | 4.62E-1 | -- | 1.60E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-2
$A_{iat}$ VALUES - LIQUID*
RADWASTE TANK
CHILD
$\frac{\text{mrem} - \text{ml}}{\text{hr} - \mu\text{Ci}}$

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 4.39E-1 | 4.39E-1 | 4.39E-1 | 4.39E-1 | 4.39E-1 | 4.39E-1 |
| Cr 51 | 2.13E-2 | 2.13E-2 | 1.40 | 7.86E-1 | 2.30E-1 | 1.42 | 7.31E+1 |
| Cu 64 | 2.51E-6 | 2.70 | 1.63 | 2.51E-6 | 6.52 | 2.51E-6 | 1.27E+2 |
| Mn 54 | 6.92 | 3.38E+3 | 9.06E+2 | 6.92 | 9.53E+2 | 6.92 | 2.84E+3 |
| Fe 55 | 9.21E+2 | 4.88E+2 | 1.51E+2 | -- | -- | 2.76E+2 | 9.05E+1 |
| Fe 59 | 1.30E+3 | 2.11E+3 | 1.05E+3 | 1.34 | 1.34 | 6.12E+2 | 2.19E+3 |
| Co 58 | 1.89 | 7.46E+1 | 2.24E+2 | 1.89 | 1.89 | 1.89 | 4.26E+2 |
| Co 60 | 1.12E+2 | 3.28E+2 | 7.48E+2 | 1.12E+2 | 1.12E+2 | 1.12E+2 | 1.31E+3 |
| Zn 65 | 2.15E+4 | 5.73E+4 | 3.56E+4 | 3.85 | 3.61E+4 | 3.85 | 1.01E+4 |
| Sr 89 | 3.26E+4 | 1.10E-4 | 9.32E+2 | 1.10E-4 | 1.10E-4 | 1.10E-4 | 1.26E+3 |
| Sr 90 | 4.26E+5 | -- | 1.08E+5 | -- | -- | -- | 5.74E+3 |
| Zr 95 | 1.70 | 1.33 | 1.32 | 1.23 | 1.38 | 1.23 | 1.08E+2 |
| Mn 56 | -- | 1.65E-1 | 3.73E-2 | -- | 2.00E-1 | -- | 2.39E+1 |
| Mo 99 | 5.35E-3 | 9.57E+1 | 2.37E+1 | 5.35E-3 | 2.04E+2 | 5.35E-3 | 7.91E+1 |
| Na 24 | 1.52E+2 | 1.52E+2 | 1.52E+2 | 1.52E+2 | 1.52E+2 | 1.52E+2 | 1.52E+2 |
| I 131 | 2.09E+2 | 2.10E+2 | 1.19E+2 | 6.94E+4 | 3.45E+2 | 5.60E-2. | 1.87E+1 |
| I 133 | 3.39E+1 | 4.19E+1 | 1.59E+1 | 7.78E+3 | 6.98E+1 | 1.38E-4 | 1.69E+1 |
| Ni 65 | 2.67E-1 | 2.51E-2 | 1.47E-2 | -- | -- | -- | 3.08 |
| I 132 | 6.13E-3 | 1.13E-2 | 5.18E-3 | 5.22E-1 | 1.72E-2 | -- | 1.32E-2 |
| Cs 134 | 3.68E+5 | 6.04E+5 | 1.27E+5 | 3.54E+1 | 1.87E+5 | 6.72E+4 | 3.29E+3 |
| Cs 136 | 3.52E+4 | 9.67E+4 | 6.26E+4 | 6.21E-1 | 5.15E+4 | 7.68E+3 | 3.40E+3 |
| Cs 137 | 5.15E+5 | 4.93E+5 | 7.28E+4 | 5.37E+1 | 1.61E+5 | 5.78E+4 | 3.14E+3 |
| Ba 140 | 3.61E+2 | 3.96E-1 | 2.11E+1 | 7.96E-2 | 1.82E-1 | 2.68E-1 | 1.83E+2 |
| Ce 141 | 1.50E-1 | 1.07E-1 | 6.99E-2 | 6.34E-2 | 8.24E-2 | 6.34E-2 | 5.40E+1 |
| Nb 95 | 5.21E+2 | 2.03E+2 | 1.45E+2 | 6.39E-1 | 1.91E+2 | 6.39E-1 | 3.75E+5 |
| La 140 | 1.50E-1 | 5.93E-2 | 2.68E-2 | 1.03E-2 | 1.03E-2 | 1.03E-2 | 1.36E+3 |
| Ce 144 | 5.00 | 1.81 | 6.06E-1 | 3.58E-1 | 1.16 | 3.58E-1 | 3.80E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-3
$A_{iat}$ VALUES - LIQUID*
RADWASTE TANK
TEEN
mrem - ml
hr - $\mu$Ci

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 3.28E-1 | 3.28E-1 | 3.28E-1 | 3.28E-1 | 3.28E-1 | 3.28E-1 |
| Cr 51 | 1.02E-1 | 1.02E-1 | 1.39 | 8.16E-1 | 3.84E-1 | 1.94 | 2.16E+2 |
| Cu 64 | 1.20E-5 | 2.89 | 1.36 | 1.20E-5 | 7.32 | 1.20E-5 | 2.24E+2 |
| Mn 54 | 3.31E+1 | 4.34E+3 | 8.87E+2 | 3.31E+1 | 1.32E+3 | 3.31E+1 | 8.86E+3 |
| Fe 55 | 6.94E+2 | 4.92E+2 | 1.15E+2 | -- | -- | 3.12E+2 | 2.13E+2 |
| Fe 59 | 1.07E+3 | 2.49E+3 | 9.64E+2 | 6.41 | 6.41 | 7.89E+2 | 5.87E+3 |
| Co 58 | 9.03 | 9.82E+1 | 2.15E+2 | 9.03 | 9.03 | 9.03 | 1.24E+3 |
| Co 60 | 5.36E+2 | 7.96E+2 | 1.12E+3 | 5.36E+2 | 5.36E+2 | 5.36E+2 | 3.93E+3 |
| Zn 65 | 2.10E+4 | 7.28E+4 | 3.40E+4 | 1.84E+1 | 4.66E+4 | 1.84E+1 | 3.08E+4 |
| Sr 89 | 2.44E+4 | 5.24E-4 | 6.98E+2 | 5.24E-4 | 5.24E-4 | 5.24E-4 | 2.90E+3 |
| Sr 90 | 4.66E+5 | -- | 1.15E+5 | -- | -- | -- | 1.31E+4 |
| Zr 95 | 6.20 | 6.00 | 5.97 | 5.90 | 6.04 | 5.90 | 2.28E+2 |
| Mn 56 | -- | 1.81E-1 | 3.22E-2 | -- | 2.29E-1 | -- | 1.19E+1 |
| Mo 99 | 2.56E-2 | 9.22E+1 | 1.76E+1 | 2.56E-2 | 2.11E+2 | 2.56E-2 | 1.65E+2 |
| Na 24 | 1.39E+2 | 1.39E+2 | 1.39E+2 | 1.39E+2 | 1.39E+2 | 1.39E+2 | 1.39E+2 |
| I 131 | 1.55E+2 | 2.17E+2 | 1.16E+2 | 6.31E+4 | 3.73E+2 | 2.68E-1 | 4.30E+1 |
| I 133 | 2.53E+1 | 4.29E+1 | 1.31E+1 | 5.99E+3 | 7.52E+1 | 6.60E-4 | 3.25E+1 |
| Ni 65 | 2.08E-1 | 2.66E-2 | 1.21E-2 | -- | -- | -- | 1.44 |
| I 132 | 4.90E-2 | 1.28E-2 | 4.60E-3 | 4.32E-1 | 2.02E-2 | -- | 5.59E-3 |
| Cs 134 | 3.05E+5 | 7.18E+5 | 3.33E+5 | 1.69E+2 | 2.28E+5 | 8.73E+4 | 9.10E+3 |
| Cs 136 | 2.98E+4 | 1.17E+5 | 7.88E+4 | 2.97 | 6.38E+4 | 1.01E+4 | 9.44E+3 |
| Cs 137 | 4.09E+5 | 5.44E+5 | 1.90E+5 | 2.57E+2 | 1.85E+5 | 7.21E+4 | 7.99E+3 |
| Ba 140 | 2.35E+2 | 4.10E-1 | 1.55E+1 | 3.81E-1 | 4.79E-1 | 5.75E-1 | 3.63E+2 |
| Ce 141 | 3.46E-1 | 3.32E-1 | 3.07E-1 | 3.04E-1 | 3.17E-1 | 3.04E-1 | 8.16E+1 |
| Nb 95 | 4.44E+2 | 2.48E+2 | 1.18E+2 | 3.06 | 2.40E+2 | 3.06 | 1.05E+6 |
| La 140 | 1.57E-1 | 1.02E-1 | 6.35E-2 | 4.94E-2 | 4.94E-2 | 4.94E-2 | 3.05E+3 |
| Ce 144 | 3.99 | 2.65 | 1.83 | 1.71 | 2.27 | 1.71 | 5.74E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-4
$A_{im}$ VALUES - LIQUID*
RADWASTE TANK
ADULT
$\frac{\text{mrem - ml}}{\text{hr - } \mu\text{Ci}}$

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 4.45E-1 | 4.45E-1 | 4.45E-1 | 4.45E-1 | 4.45E-1 | 4.45E-1 |
| Cr 51 | 1.82E-2 | 1-82E-2 | 1.27 | 7.64E-1 | 2.93E-1 | 1.67 | 3.14E+2 |
| Cu 64 | -- | 2.75 | 1.29 | -- | 6.94 | -- | 2.35E+2 |
| Mn 54 | 5.94 | 4.38E+3 | 8.41E+2 | 5.94 | 1.31E+3 | 5.94 | 1.34E+4 |
| Fe 55 | 6.64E+2 | 4.58E+2 | 1.07E+2 | -- | -- | 2.56E+2 | 2.63E+2 |
| Fe 59 | 1.03E+3 | 2.43E+3 | 9.31E+2 | 1.15 | 1.15 | 6.79E+2 | 8.09E+3 |
| Co 58 | 1.62 | 9.15E+1 | 2.03E+2 | 1.62 | 1.62 | 1.62 | 1.82E+3 |
| Co 60 | 9.60E+1 | 2.57E+2 | 6.71E+2 | 9.60E+1 | 9.60E+1 | 9.60E+1 | 4.99E+3 |
| Zn 65 | 2.31E4 | 7.36E+4 | 3.32E+4 | 3.30 | 4.92E+4 | 3.30 | 4.63E+4 |
| Sr 89 | 2.25E+4 | 9.39E-5 | 6.45E+2 | 9.39E-5 | 9.39E-5 | 9.39E-5 | 3.60E+3 |
| Sr 90 | 5.60E+5 | -- | 1.37E+5 | -- | -- | -- | 1.62E+4 |
| Zr 95 | 1.36 | 1.15E | 1.12 | 1.06 | 1.21 | 1.06 | 3.06E+2 |
| Mn 56 | -- | 1.73E-1 | 3.07E-2 | -- | 2.20E-1 | -- | 5.52 |
| Mo 99 | 4.58E-3 | 8.70E+1 | 1.66E+1 | 4.58E-3 | 1.97E+2 | 4-58E-3 | 2.02E+2 |
| Na 24 | 1.35E+2 | 1.35E+2 | 1.35E+2 | 1.35E+2 | 1.35E+2 | 1.35E+2 | 1.35E+2 |
| I 131 | 1.45E+2 | 2.07E+2 | 1.19E+2 | 6.79E+4 | 3.55E+2 | 4.80E-2 | 5.47E+1 |
| I 133 | 2.35E+1 | 4.09E+1 | 1.25E+1 | 6.02E+3 | 7.14E+1 | 1.18E-4 | 3.68E+1 |
| Ni 65 | 1.93E-1 | 2.51E-2 | 1.14E-2 | -- | -- | -- | 6.36E-1 |
| I 132 | 4.68E-3 | 1.25E-2 | 4.38E-3 | 4.38E-1 | 2.00E-2 | -- | 2.35E-3 |
| Cs 134 | 2.98E+5 | 7.08E+5 | 5.79E+5 | 3.03E+1 | 2.29E+5 | 7.61E+4 | 1.24E+4 |
| Cs 136 | 2.96E+4 | 1.17E+5 | 8.42E+4 | 5.32E-1 | 6.51E+4 | 8.93E+3 | 1.33E+4 |
| Cs 137 | 3.82E+5 | 5.22E+5 | 3.42E+5 | 4.60E+1 | 1.77E+5 | 5.90E+4 | 1.02E+4 |
| Ba 140 | 2.24E+2 | 3.49E-1 | 1.47E+1 | 6.83E-2 | 1.64E-1 | 2.29E-1 | 4.61E+2 |
| Ce 141 | 9.53E-2 | 8.20E-2 | 5.75E-2 | 5.44E-2 | 6.72E-2 | 5.44E-2 | 1.06E+2 |
| Nb 95 | 4.39E+2 | 2.44E+2 | 1.32E+2 | 5.47E-1 | 2.41E+2 | 5.47E-1 | 1.48E+6 |
| La 140 | 1.11E-1 | 6.03E-2 | 2.24E-2 | 8.84E-3 | 8.84E-3 | 8.84E-3 | 3.78E+3 |
| Ce 144 | 2.48 | 1.22 | 4.24E-1 | 3.07E-1 | 8.47E-1 | 3.07E-1 | 7.37E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-5
$A_{il}$ VALUES - LIQUID*
EMERGENCY CONDENSER VENT
INFANT
$\frac{\text{mrem - ml}}{\text{hr - } \mu\text{Ci}}$

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 7.43E-4 | 7.43E-4 | 7.43E-4 | 7.43E-4 | 7.43E-4 | 7.43E-4 |
| Cr 51 | -- | -- | 3.30E-5 | 2.15E-5 | 4.70E-6 | 4.18E-5 | 9.61E-4 |
| Cu 64 | -- | 2.89E-4 | 1.34E-4 | -- | 4.89E-4 | -- | 5.94E-3 |
| Mn 54 | -- | 4.79E-2 | 1.08E-2 | -- | 1.06E-2 | -- | 1.76E-2 |
| Fe 55 | 3.35E-2 | 2.16E-2 | 5.78E-3 | -- | -- | 1.06E-2 | 2.75E-3 |
| Fe 59 | 7.29E-2 | 1.27E-1 | 5.02E-2 | -- | -- | 3.76E-2 | 6.08E-2 |
| Co 58 | -- | 8.58E-3 | 2.14E-2 | -- | -- | -- | 2.14E-2 |
| Co 60 | -- | 2.60E-2 | 6.15E-2 | -- | -- | -- | 6.19E-2 |
| Zn 65 | 4.42E-2 | 1.52E-1 | 6.99E-2 | -- | 7.35E-2 | -- | 1.28E-1 |
| Sr 89 | 5.95 | -- | 1.71E-1 | -- | -- | -- | 1.22E-1 |
| Sr 90 | 4.46E+1 | -- | 1.14E+1 | -- | -- | -- | 5.57E-1 |
| Zr 95 | 4.90E-4 | 1.19E-4 | 8.47E-5 | -- | 1.29E-4 | -- | 5.95E-2 |
| Mn 56 | -- | 6.17E-7 | 1.06E-7 | -- | 5.30E-7 | -- | 5.60E-5 |
| Mo 99 | -- | 6.00E-2 | 1.17E-2 | -- | 8.97E-2 | -- | 1.98E-2 |
| Na 24 | 6.07E-3 | 6.07E-3 | 6.07E-3 | 6.07E-3 | 6.07E-3 | 6.07E-3 | 6.07E-3 |
| I 131 | 7.77E-2 | 9.16E-2 | 4.03E-2 | 3.01E+1 | 1.07E-1 | -- | 3.27E-3 |
| I 133 | 1.08E-2 | 1.58E-2 | 4.62E-3 | 2.87 | 1.85E-2 | -- | 2.67E-3 |
| Ni 65 | 3.41E-6 | 3.86E-7 | 1.76E-7 | -- | -- | -- | 2.94E-5 |
| I 132 | 4.05E-7 | 8.22E-7 | 2.93E-7 | 3.85E-5 | 9.17E-7 | -- | 6.66E-7 |
| Cs 134 | 9.08E-1 | 1.69 | 1.71E-1 | -- | 4.36E-1 | 1.79E-1 | 4.60E-3 |
| Cs 136 | 1.04E-1 | 3.06E-1 | 1.14E-1 | -- | 1.22E-1 | 2.49E-2 | 4.64E-3 |
| Cs 137 | 1.26 | 1.47 | 1.04E-1 | -- | 3.95E-1 | 1.60E-1 | 4.61E-3 |
| Ba 140 | 3.85E-1 | 3.85E-4 | 1.99E-2 | -- | 9.15E-5 | 2.37E-4 | 9.47E-2 |
| Ce 141 | 1.85E-4 | 1.13E-4 | 1.33E-5 | -- | 3.48E-5 | -- | 5.82E-2 |
| Nb 95 | 9.88E-5 | 4.07E-5 | 2.35E-5 | -- | 2.92E-5 | -- | 3.43E-2 |
| La 140 | 3.03E-5 | 1.20E-5 | 3.08E-6 | -- | -- | -- | 1.41E-1 |
| Ce 144 | 7.16E-3 | 2.93E-3 | 4.02E-4 | -- | 1.19E-3 | -- | 4.11E-1 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-6
$A_{im}$ VALUES - LIQUID*
EMERGENCY CONDENSER VENT
CHILD
mrem - ml
hr - μCi

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 1.44E-1 | 1.44E-1 | 1.44E-1 | 1.44E-1 | 1.44E-1 | 1.44E-1 |
| Cr 51 | 3.78E-5 | 3.78E-5 | 1.37 | 7.58E-1 | 2.07E-1 | 1.38 | 7.24E+1 |
| Cu 64 | -- | 2.63 | 1.59 | -- | 6.35 | -- | 1.23E+2 |
| Mn 54 | 1.23E-2 | 3.36E+3 | 8.95E+2 | 1.23E-2 | 9.42E+2 | 1.23E-2 | 2.82E+3 |
| Fe 55 | 9.04E+2 | 4.79E+2 | 1.49E+2 | -- | -- | 2.71E+2 | 8.88E+1 |
| Fe 59 | 1.28E+3 | 2.07E+3 | 1.03E+3 | 2.38E-3 | 2.38E-3 | 6.00E+2 | 2.15E+3 |
| Co 58 | 3.36E-3 | 7.01E+1 | 2.15E+2 | 3.36E-3 | 3.36E-3 | 3.36E-3 | 4.09E+2 |
| Co 60 | 1.99E-1 | 2.08E+2 | 6.14E+2 | 1.99E-1 | 1.99E-1 | 1.99E-1 | 1.15E+3 |
| Zn 65 | 2.15E+4 | 5.73E+4 | 3.56E+4 | 6.84E-3 | 3.61E+4 | 6.84E-3 | 1.01E+4 |
| Sr 89 | 3.07E+4 | -- | 8.78E+2 | -- | -- | -- | 1.19E+3 |
| Sr 90 | 4.01E+5 | -- | 1.02E+5 | -- | -- | -- | 5.40E+3 |
| Zr 95 | 3.01E-1 | 6.78E-2 | 6.06E-2 | 2.19E-3 | 9.61E-2 | 2.19E-3 | 6.84E+1 |
| Mn 56 | -- | 1.65E-1 | 3.73E-2 | -- | 2.00E-1 | -- | 2.39E+1 |
| Mo 99 | -- | 8.16E+1 | 2.02E+1 | -- | 1.74E+2 | -- | 6.75E+1 |
| Na 24 | 1.50E+2 | 1.50E+2 | 1.50E+2 | 1.50E+2 | 1.50E+2 | 1.50E+2 | 1.50E+2 |
| I 131 | 1.86E+2 | 1.87E+2 | 1.06E+2 | 6.19E+4 | 3.08E+2 | -- | 1.67E+1 |
| I 133 | 3.08E+1 | 3.81E+1 | 1.44E+1 | 7.07E+3 | 6.35E+1 | -- | 1.53E+1 |
| Ni 65 | 2.66E-1 | 2.50E-2 | 1.46E-2 | -- | -- | -- | 3.07 |
| I 132 | 6.01E-3 | 1.10E-2 | 5.08E-3 | 5.12E-1 | 1.69E-2 | -- | 1.30E-2 |
| Cs 134 | 3.68E+5 | 6.04E+5 | 1.27E+5 | 6.29E-2 | 1.87E+5 | 6.71E+4 | 3.25E+3 |
| Cs 136 | 3.51E+4 | 9.66E+4 | 6.25E+4 | 1.10E-3 | 5.14E+4 | 7.67E+3 | 3.40E+3 |
| Cs 137 | 5.14E+5 | 4.92E+5 | 7.27E+4 | 9.55E-2 | 1.60E+5 | 5.77E+4 | 3.08E+3 |
| Ba 140 | 2.48E+2 | 2.17E-1 | 1.45E+1 | 1.42E-4 | 7.09E-2 | 1.30E-1 | 1.26E+2 |
| Ce 141 | 3.08E-2 | 1.54E-2 | 2.39E-3 | 1.13E-4 | 6.83E-3 | 1.13E-4 | 1.91E+1 |
| Nb 95 | 5.21E+2 | 2.03E+2 | 1.45E+2 | 1.14E-3 | 1.90E+2 | 1.14E-3 | 3.75E+5 |
| La 140 | 1.31E-1 | 4.59E-2 | 1.55E-2 | 1.83E-5 | 1.83E-5 | 1.83E-5 | 1.28E+3 |
| Ce 144 | 1.64 | 5.15E-1 | 8.81E-2 | 6.36E-4 | 2.85E-1 | 6.36E-4 | 1.34E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-7
$A_{iat}$ VALUES - LIQUID*
EMERGENCY CONDENSER VENT
TEEN
mrem - ml / hr - μCi

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 1.74E-1 | 1.74E-1 | 1.74E-1 | 1.74E-1 | 1.74E-1 | 1.74E-1 |
| Cr 51 | 1.81E-4 | 1.81E-4 | 1.28 | 7.12E-1 | 2.81E-1 | 1.83 | 2.15E+2 |
| Cu 64 | -- | 2.86 | 1.35 | -- | 7.24 | -- | 2.22E+2 |
| Mn 54 | 5.89E-2 | 4.29E+3 | 8.52E+2 | 5.89E-2 | 1.28E+3 | 5.89E-2 | 8.81E+3 |
| Fe 55 | 6.89E+2 | 4.88E+2 | 1.14E+2 | -- | -- | 3.10E+2 | 2.11E+2 |
| Fe 59 | 1.05E+3 | 2.46E+3 | 9.50E+2 | 1.14E-2 | 1.14E-2 | 7.76E2 | 5.82E+3 |
| Co 58 | 1.61E-2 | 8.78E+1 | 2.02E+2 | 1.61E-2 | 1.61E-2 | 1.61E-2 | 1.21E+3 |
| Co 60 | 9.53E-1 | 2.57E+2 | 5.78E+2 | 9.53E-1 | 9.53E-1 | 9.53E-1 | 3.34E+3 |
| Zn 65 | 2.10E+4 | 7.28E+4 | 3.39E+4 | 3.28E-2 | 4.66E+4 | 3.28E-2 | 3.08E+4 |
| Sr 89 | 2.38E+4 | -- | 6.81E+2 | -- | -- | -- | 2.83E+3 |
| Sr 90 | 4.54E+5 | -- | 1.12E+5 | -- | -- | -- | 1.27E+4 |
| Zr 95 | 2.56E-1 | 8.80E-2 | 6.38E-2 | 1.05E-2 | 1.24E-1 | 1.05E-2 | 1.79E+2 |
| Mn 56 | -- | 1.81E-1 | 3.22E-2 | -- | 2.29E-1 | -- | 1.19E+1 |
| Mo 99 | -- | 8.57E+1 | 1.63E+1 | -- | 1.96E+2 | -- | 1.54E+2 |
| Na 24 | 1.38E+2 | 1.38E+2 | 1.38E+2 | 1.38E+2 | 1.38E+2 | 1.38E+2 | 1.38E+2 |
| I 131 | 1.47E+2 | 2.06E+2 | 1.10E+2 | 6.00E+4 | 3.54E+2 | 4.77E-4 | 4.07E+1 |
| I 133 | 2.42E+1 | 4.11E+1 | 1.25E+1 | 5.74E+3 | 7.21E+1 | -- | 3.11E+1 |
| Ni 65 | 2.08E-1 | 2.66E-2 | 1.21E-2 | -- | -- | -- | 1.44 |
| I 132 | 4.86E-3 | 1.27E-2 | 4.56E-3 | 4.29E-1 | 2.00E-2 | -- | 5.54E-3 |
| Cs 134 | 3.05E+5 | 7.18E+5 | 3.33E+5 | 3.01E-1 | 2.28E+5 | 8.71E+4 | 8.93E+3 |
| Cs 136 | 2.98E+4 | 1.17E+5 | 7.87E+4 | 5.28E-3 | 6.38E+4 | 1.01E+4 | 9.43E+3 |
| Cs 137 | 4.09E+5 | 5.44E+5 | 1.89E+5 | 4.57E-1 | 1.85E+5 | 7.19E+4 | 7.73E+3 |
| Ba 140 | 1.96E+2 | 2.47E-2 | 1.27E+1 | 6.77E-4 | 8.23E-2 | 1.62E-1 | 3.03E+2 |
| Ce 141 | 2.43E-2 | 1.64E-2 | 2.36E-3 | 5.40E-4 | 8.02E-3 | 5.40E-4 | 4.54E+1 |
| Nb 95 | 4.41E+2 | 2.45E+2 | 1.15E+2 | 5.43E-3 | 2.37E+2 | 5.43E-3 | 1.05E+6 |
| La 140 | 1.05E-1 | 5.17E-2 | 1.38E-2 | 8.78E-5 | 8.78E-5 | 8.78E-5 | 2.96E+3 |
| Ce 144 | 1.27 | 5.28E-1 | 7.12E-2 | 3.04E-3 | 3.17E-1 | 3.04E-3 | 3.19E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 2-8
$A_{ai}$ VALUES - LIQUID*
EMERGENCY CONDENSER VENT
ADULT
$\frac{\text{mrem - ml}}{\text{hr - } \mu\text{Ci}}$

| NUCLIDE | BONE | LIVER | T BODY | THYROID | KIDNEY | LUNG | GI-TRACT |
|---|---|---|---|---|---|---|---|
| H3 | -- | 2.27E-1 | 2.27E-1 | 2.27E-1 | 2.27E-1 | 2.27E-1 | 2.27E-1 |
| Cr 51 | 3.24E-5 | 3.24E-5 | 1.24 | 7.43E-1 | 2.74E-1 | 1.65 | 3.12E+2 |
| Cu 64 | -- | 2.72 | 1.28 | -- | 6.86 | -- | 2.32E+2 |
| Mn 54 | 1.06E-2 | 4.37E+3 | 8.33E+2 | 1.06E-2 | 1.30E+3 | 1.06E-2 | 1.34E+4 |
| Fe 55 | 6.58E+2 | 4.55E+2 | 1.06E+2 | -- | -- | 2.54E+2 | 2.61E+2 |
| Fe 59 | 1.02E+3 | 2.41E+3 | 9.22E+2 | 2.04E-3 | 2.04E-3 | 6.72E+2 | 8.02E+3 |
| Co 58 | 2.88E-3 | 8.83E+1 | 1.98E+2 | 2.88E-3 | 2.88E-3 | 2.88E-3 | 1.79E+3 |
| Co 60 | 1.71E-1 | 2.56E+2 | 5.65E+2 | 1.71E-1 | 1.71E-1 | 1.71E-1 | 4.81E+3 |
| Zn 65 | 2.31E+4 | 7.36E+4 | 3.32E+4 | 5.87E-3 | 4.92E+4 | 5.87E-3 | 4.63E+4 |
| Sr 89 | 2.18E+4 | -- | 6.27E+2 | -- | -- | -- | 3.50E+3 |
| Sr 90 | 5.44E+5 | -- | 1.34E+5 | -- | -- | -- | 1.57E+4 |
| Zr 95 | 2.40E-1 | 7.81E-2 | 5.35E-2 | 1.88E-3 | 1.22E-1 | 1.88E-3 | 2.42E+2 |
| Mn 56 | -- | 1.73E-1 | 3.07E-2 | -- | 2.20E-1 | -- | 5.52 |
| Mo 99 | -- | 8.04E+1 | 1.53E+1 | -- | 1.82E+2 | -- | 1.86E+2 |
| Na 24 | 1.34E+2 | 1.34E+2 | 1.34E+2 | 1.34E+2 | 1.34E+2 | 1.34E+2 | 1.34E+2 |
| I 131 | 1.37E+2 | 1.96E+2 | 1.12E+2 | 6.43E+4 | 3.36E+2 | -- | 5.17E+1 |
| I 133 | 2.25E+1 | 3.91E+1 | 1.19E+1 | 5.75E+3 | 6.82E+1 | -- | 3.51E+1 |
| Ni 65 | 1.93E-1 | 2.50E-2 | 1.14E-2 | -- | -- | -- | 6.36E-1 |
| I 132 | 4.64E-3 | 1.24E-2 | 4.34E-3 | 4.34E-1 | 1.98E-2 | -- | 2.33E-3 |
| Cs 134 | 2.98E+5 | 7.08E+5 | 5.79E+5 | 5.39E-2 | 2.29E+5 | 7.61E+4 | 1.24E+4 |
| Cs 136 | 2.96E+4 | 1.17E+5 | 8.42E+4 | 9.46E-4 | 6.51E+4 | 8.92E+3 | 1.33E+4 |
| Cs 137 | 3.82E+5 | 5.22E+5 | 3.42E+5 | 8.19E-2 | 1.77E+5 | 5.89E+4 | 1.01E+4 |
| Ba 140 | 1.84E+2 | 2.32E-1 | 1.21E+1 | 1.21E-4 | 7.88E-2 | 1.33E-1 | 3.79E+2 |
| Ce 141 | 2.21E-2 | 1.50E-2 | 1.78E-3 | 9.67E-5 | 7.00E-3 | 9.67E-5 | 5.68E+1 |
| Nb 95 | 4.38E+2 | 2.44E+2 | 1.31E+2 | 9.73E-4 | 2.41E+2 | 9.73E-4 | 1.48E+6 |
| La 140 | 9.90E-2 | 4.99E-2 | 1.32E-2 | 1.57E-5 | 1.57E-5 | 1.57E-5 | 3.66E+3 |
| Ce 144 | 1.17 | 4.89E-1 | 6.33E-2 | 5.45E-4 | 2.90E-1 | 5.45E-4 | 3.95E+2 |

* Calculated in accordance with NUREG 0133, Section 4.3.1; and Regulatory Guide 1.109, Regulatory position C, Section 1.

TABLE 3-1
Critical Receptor Dispersion Parameters[a]
For Ground Level and Elevated Releases

| LOCATION | DIR | MILES | ELEVATED X/Q (sec/$m^3$) | ELEVATED D/Q ($m^{-2}$) | GROUND[e] X/Q(sec/$m^3$) | GROUND[e] D/Q ($m^{-2}$) |
|---|---|---|---|---|---|---|
| Residences | E (98°) | 1.4 | 1.8 E-07[b] | 5.2 E-09[b] | 4.02 E-07 | 8.58 E-09 |
| Dairy Cows[f] | SE (130°) | 2.6 | 2.2 E-08[c] | 7.0 E-10[c] | 6.00 E-08 | 1.64 E-09 |
| Milk Goats[f] | SE (130°) | 2.6 | 2.2 E-08[c] | 7.0 E-10[c] | 6.00 E-08 | 1.64 E-09 |
| Meat Animals | ESE (115°) | 1.8 | 5.1 E-08[c] | 1.7 E-09[c] | 1.16 E-07 | 3.54 E-09 |
| Gardens | E (97°) | 1.8 | 1.0 E-07[c] | 3.5 E-09[c] | 2.53 E-07 | 5.55 E-09 |
| Site Boundary | ENE (67°) | 0.4 | 2.4 E-06[b,d] | 4.4 E-08[c,d] | 6.63 E-06 | 6.35 E-08 |

a. These values will be used in dose calculations beginning in April 1986 but may be revised periodically to account for changes in locations of farms, gardens or critical residences.

b. Values based on 5 year annual meteorological data (C.T. Main, Rev. 2)

c. Values based on 5 year average grazing season meteorological data (C.T. Main Rev. 2)

d. Value are based on most restrictive X/Q land-based sector (ENE). (C.T. Main, Rev. 2)

e. Values are based on average annual meteorological data for the year 1985.

f. Conservative location based on past dairy cow and goat milk history.

TABLE 3-2

Gamma Air and Whole Body Plume Shine Dose Factors*
For
Noble Gases

| Nuclide | Gamma Air $B_i$ mrad/yr / µCi/sec | Gamma Whole Body $V_i$ mrem/yr / µCi/sec |
|---|---|---|
| Kr-85 | 2.23E-6 | -- |
| Kr-85m | 1.75E-3 | 1.68E-3 |
| Kr-87 | 1.02E-2 | 9.65E-3 |
| Kr-88 | 2.23E-2 | 2.17E-2 |
| Kr-89 | 2.50E-2 | 1.71E-2 |
| Kr-83m | 2.26E-6 | -- |
| Xe-133 | 2.80E-4 | 2.41E-4 |
| Xe-133m | 2.27E-4 | 1.87E-4 |
| Xe-135 | 2.62E-3 | 2.50E-3 |
| Xe-135m | 5.20E-3 | 4.89E-3 |
| Xe-137 | 2.30E-3 | 2.20E-3 |
| Xe-138 | 1.32E-2 | 1.26E-2 |
| Xe-131m | 1.74E-5 | 1.47E-6 |
| Ar-41 | 1.64E-2 | 1.57E-2 |

* Calculated in accordance with Regulatory Guide 1.109. (See Appendix B.)

TABLE 3-3

IMMERSION DOSE FACTORS*

| Nuclide | $K_i$(γ-Body)** | $L_i$(β-Skin)** | $M_i$(γ-Air)*** | $N_i$(β-Air)*** |
|---|---|---|---|---|
| Kr 83m | 7.56E-02 | --- | 1.93E1 | 2.88E2 |
| Kr 85m | 1.17E3 | 1.46E3 | 1.23E3 | 1.97E3 |
| Kr 85 | 1.61E1 | 1.34E3 | 1.72E1 | 1.95E3 |
| Kr 87 | 5.92E3 | 9.73E3 | 6.17E3 | 1.03E4 |
| Kr 88 | 1.47E4 | 2.37E3 | 1.52E4 | 2.93E3 |
| Kr 89 | 1.66E4 | 1.01E4 | 1.73E4 | 1.06E4 |
| Kr 90 | 1.56E4 | 7.29E3 | 1.63E4 | 7.83E3 |
| Xe 131m | 9.15E1 | 4.76E2 | 1.56E2 | 1.11E3 |
| Xe 133m | 2.51E2 | 9.94E2 | 3.27E2 | 1.48E3 |
| Xe 133 | 2.94E2 | 3.06E2 | 3.53E2 | 1.05E3 |
| Xe 135m | 3.12E3 | 7.11E2 | 3.36E3 | 7.39E2 |
| Xe 135 | 1.81E3 | 1.86E3 | 1.92E3 | 2.46E3 |
| Xe 137 | 1.42E3 | 1.22E4 | 1.51E3 | 1.27E4 |
| Xe 138 | 8.83E3 | 4.13E3 | 9.21E3 | 4.75E3 |
| Ar 41 | 8.84E3 | 2.69E3 | 9.30E3 | 3.28E3 |

* From, Table B-1.Regulatory Guide 1.109 Rev. 1

** mrem/yr per $\mu Ci/m^3$.

*** mrad/yr per $\mu Ci/m^3$.

TABLE 3-4
DOSE AND DOSE RATE
$R_i$ VALUES - INHALATION - INFANT[1]
mrem/yr
$\mu Ci/m^3$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 6.47E2 | 6.47E2 | 6.47E2 | 6.47E2 | 6.47E2 | 6.47E2 |
| C 14* | 2.65E4 | 5.31E3 | 5.31E3 | 5.31E3 | 5.31E3 | 5.31E3 | 5.31E3 |
| Cr 51 | -- | -- | 8.95E1 | 5.75E1 | 1.32E1 | 1.28E4 | 3.57E2 |
| Mn 54 | -- | 2.53E4 | 4.98E3 | -- | 4.98E3 | 1.00E6 | 7.06E3 |
| Fe 55 | 1.97E4 | 1.17E4 | 3.33E3 | -- | -- | 8.69E4 | 1.09E3 |
| Fe 59 | 1.36E4 | 2.35E4 | 9.48E3 | -- | -- | 1.02E6 | 2.48E4 |
| Co 58 | -- | 1.22E3 | 1.82E3 | -- | -- | 7.77E5 | 1.11E4 |
| Co 60 | -- | 8.02E3 | 1.18E4 | -- | -- | 4.51E6 | 3.19E4 |
| Zn 65 | 1.93E4 | 6.26E4 | 3.11E4 | -- | 3.25E4 | 6.47E5 | 5.14E4 |
| Sr 89 | 3.98E5 | -- | 1.14E4 | -- | -- | 2.03E6 | 6.40E4 |
| Sr 90 | 4.09E7 | -- | 2.59E6 | -- | -- | 1.12E7 | 1.31E5 |
| Zr 95 | 1.15E5 | 2.79E4 | 2.03E4 | -- | 3.11E4 | 1.75E6 | 2.17E4 |
| Nb 95 | 1.57E4 | 6.43E3 | 3.78E3 | -- | 4.72E3 | 4.79E5 | 1.27E4 |
| Mo 99 | -- | 1.65E2 | 3.23E1 | -- | 2.65E2 | 1.35E5 | 4.87E4 |
| I-131 | 3.79E4 | 4.44E4 | 1.96E4 | 1.48E7 | 5.18E4 | -- | 1.06E3 |
| I 133 | 1.32E4 | 1.92E4 | 5.60E3 | 3.56E6 | 2.24E4 | -- | 2.16E3 |
| Cs 134 | 3.96E5 | 7.03E5 | 7.45E4 | -- | 1.90E5 | 7.97E4 | 1.33E3 |
| Cs 137 | 5.49E5 | 6.12E5 | 4.55E4 | -- | 1.72E5 | 7.13E4 | 1.33E3 |
| Ba 140 | 5.60E4 | 5.60E1 | 2.90E3 | -- | 1.34E1 | 1.60E6 | 3.84E4 |
| La 140 | 5.05E2 | 2.00E2 | 5.15E1 | -- | -- | 1.68E5 | 8.48E4 |
| Ce 141 | 2.77E4 | 1.67E4 | 1.99E3 | -- | 5.25E3 | 5.17E5 | 2.16E4 |
| Ce 144 | 3.19E6 | 1.21E6 | 1.76E5 | -- | 5.38E5 | 9.84E6 | 1.48E5 |
| Nd 147 | 7.94E3 | 8.13E3 | 5.00E2 | | 3.15E3 | 3.22E5 | 3.12E4 |

* mrem/yr per $\mu Ci/m^3$.

[1] This and following $R_i$ Tables Calculated in accordance with NUREG 0133, Section 5.3.1, except C 14 values in accordance with Regulatory Guide 1.109 Equation C-8.

TABLE 3-5
DOSE AND DOSE RATE
$R_i$ VALUES - INHALATION - CHILD
mrem/yr
$\mu Ci/m^3$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 1.12E3 | 1.12E3 | 1.12E3 | 1.12E3 | 1.12E3 | 1.12E3 |
| C 14* | 3.59E4 | 6.73E3 | 6.73E3 | 6.73E3 | 6.73E3 | 6.73E3 | 6.73E3 |
| Cr 51 | -- | -- | 1.54E2 | 8.55E1 | 2.43E1 | 1.70E4 | 1.08E3 |
| Mn 54 | -- | 4.29E4 | 9.51E3 | -- | 1.00E4 | 1.58E6 | 2.29E4 |
| Fe 55 | 4.74E4 | 2.52E4 | 7.77E3 | -- | -- | 1.11E5 | 2.87E3 |
| Fe 59 | 2.07E4 | 3.34E4 | 1.67E4 | -- | -- | 1.27E6 | 7.07E4 |
| Co 58 | -- | 1.77E3 | 3.16E3 | -- | -- | 1.11E6 | 3.44E4 |
| Co 60 | -- | 1.31E4 | 2.26E4 | -- | -- | 7.07E6 | 9.62E4 |
| Zn 65 | 4.26E4 | 1.13E5 | 7.03E4 | -- | 7.14E4 | 9.95E5 | 1.63E4 |
| Sr 89 | 5.99E5 | -- | 1.72E4 | -- | -- | 2.16E6 | 1.67E5 |
| Sr 90 | 1.01E8 | -- | 6.44E6 | -- | -- | 1.48E7 | 3.43E5 |
| Zr 95 | 1.90E5 | 4.18E4 | 3.70E4 | -- | 5.96E4 | 2.23E6 | 6.11E4 |
| Nb 95 | 2.35E4 | 9.18E3 | 6.55E3 | -- | 8.62E3 | 6.14E5 | 3.70E4 |
| Mo 99 | -- | 1.72E2 | 4.26E1 | -- | 3.92E2 | 1.35E5 | 1.27E5 |
| I 131 | 4.81E4 | 4.81E4 | 2.73E4 | 1.62E7 | 7.88E4 | -- | 2.84E3 |
| I 133 | 1.66E4 | 2.03E4 | 7.70E3 | 3.85E6 | 3.38E4 | -- | 5.48E3 |
| Cs 134 | 6.51E5 | 1.01E6 | 2.25E5 | -- | 3.30E5 | 1.21E5 | 3.85E3 |
| Cs 137 | 9.07E5 | 8.25E5 | 1.28E5 | -- | 2.82E5 | 1.04E5 | 3.62E3 |
| Ba 140 | 7.40E4 | 6.48E1 | 4.33E3 | -- | 2.11E1 | 1.74E6 | 1.02E5 |
| La 140 | 6.44E2 | 2.25E2 | 7.55E1 | -- | -- | 1.83E5 | 2.26E5 |
| Ce 141 | 3.92E4 | 1.95E4 | 2.90E3 | -- | 8.55E3 | 5.44E5 | 5.66E4 |
| Ce 144 | 6.77E6 | 2.12E6 | 3.61E5 | -- | 1.17E6 | 1.20E7 | 3.89E5 |
| Nd 147 | 1.08E4 | 8.73E3 | 6.81E2 | | 4.81E3 | 3.28E5 | 8.21E4 |

* mrem/yr per $\mu Ci/m^3$.

TABLE 3-6
DOSE AND DOSE RATE
$R_i$ VALUES - INHALATION - TEEN
mrem/yr
$\mu Ci/m^3$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 1.27E3 | 1.27E3 | 1.27E3 | 1.27E3 | 1.27E3 | 1.27E3 |
| C 14* | 2.60E4 | 4.87E3 | 4.87E3 | 4.87E3 | 4.87E3 | 4.87E3 | 4.87E3 |
| Cr 51 | -- | -- | 1.35E2 | 7.50E1 | 3.07E1 | 2.10E4 | 3.00E3 |
| Mn 54 | -- | 5.11E4 | 8.40E3 | -- | 1.27E4 | 1.98E6 | 6.68E4 |
| Fe 55 | 3.34E4 | 2.38E4 | 5.54E3 | -- | -- | 1.24E5 | 6.39E3 |
| Fe 59 | 1.59E4 | 3.70E4 | 1.43E4 | -- | -- | 1.53E6 | 1.78E5 |
| Co 58 | -- | 2.07E3 | 2.78E3 | -- | -- | 1.34E6 | 9.52E4 |
| Co 60 | -- | 1.51E4 | 1.98E4 | -- | -- | 8.72E6 | 2.59E5 |
| Zn 65 | 3.86E4 | 1.34E5 | 6.24E4 | -- | 8.64E4 | 1.24E6 | 4.66E4 |
| Sr 89 | 4.34E5 | -- | 1.25E4 | -- | -- | 2.42E6 | 3.71E5 |
| Sr 90 | 1.08E8 | -- | 6.68E6 | -- | -- | 1.65E7 | 7.65E5 |
| Zr 95 | 1.46E5 | 4.58E4 | 3.15E4 | -- | 6.74E4 | 2.69E6 | 1.49E5 |
| Nb 95 | 1.86E4 | 1.03E4 | 5.66E3 | -- | 1.00E4 | 7.51E5 | 9.68E4 |
| Mo 99 | -- | 1.69E2 | 3.22E1 | -- | 4.11E2 | 1.54E5 | 2.69E5 |
| I 131 | 3.54E4 | 4.91E4 | 2.64E4 | 1.46E7 | 8.40E4 | -- | 6.49E3 |
| I 133 | 1.22E4 | 2.05E4 | 6.22E3 | 2.92E6 | 3.59E4 | -- | 1.03E4 |
| Cs 134 | 5.02E5 | 1.13E6 | 5.49E5 | -- | 3.75E5 | 1.46E5 | 9.76E3 |
| Cs 137 | 6.70E5 | 8.48E5 | 3.11E5 | -- | 3.04E5 | 1.21E5 | 8.48E3 |
| Ba 140 | 5.47E4 | 6.70E1 | 3.52E3 | -- | 2.28E1 | 2.03E6 | 2.29E5 |
| La 140 | 4.79E2 | 2.36E2 | 6.26E1 | -- | -- | 2.14E5 | 4.87E5 |
| Ce 141 | 2.84E4 | 1.90E4 | 2.17E3 | -- | 8.88E3 | 6.14E5 | 1.26E5 |
| Ce 144 | 4.89E6 | 2.02E6 | 2.62E5 | -- | 1.21E6 | 1.34E7 | 8.64E5 |
| Nd 147 | 7.86E3 | 8.56E3 | 5.13E2 | | 5.02E3 | 3.72E5 | 1.82E5 |

* mrem/yr per $\mu Ci/m^3$.

TABLE 3-7
DOSE AND DOSE RATE
$R_i$ VALUES - INHALATION - ADULT
$\frac{\text{mrem/yr}}{\mu Ci/m^3}$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 1.26E3 | 1.26E3 | 1.26E3 | 1.26E3 | 1.26E3 | 1.26E3 |
| C 14* | 1.82E4 | 3.41E3 | 3.41E3 | 3.41E3 | 3.41E3 | 3.41E3 | 3.41E3 |
| Cr 51 | -- | -- | 1.00E2 | 5.95E1 | 2.28E1 | 1.44E4 | 3.32E3 |
| Mn 54 | -- | 3.96E4 | 6.30E3 | -- | 9.84E3 | 1.40E6 | 7.74E4 |
| Fe 55 | 2.46E4 | 1.70E4 | 3.94E3 | -- | -- | 7.21E4 | 6.03E3 |
| Fe 59 | 1.18E4 | 2.78E4 | 1.06E4 | -- | -- | 1.02E6 | 1.88E5 |
| Co 58 | -- | 1.58E3 | 2.07E3 | -- | -- | 9.28E5 | 1.06E5 |
| Co 60 | -- | 1.15E4 | 1.48E4 | -- | -- | 5.97E6 | 2.85E5 |
| Zn 65 | 3.24E4 | 1.03E5 | 4.66E4 | -- | 6.90E4 | 8.64E5 | 5.34E4 |
| Sr 89 | 3.04E5 | -- | 8.72E3 | -- | -- | 1.40E6 | 3.50E5 |
| Sr 90 | 9.92E7 | -- | 6.10E6 | -- | -- | 9.60E6 | 7.22E5 |
| Zr 95 | 1.07E5 | 3.44E4 | 2.33E4 | -- | 5.42E4 | 1.77E6 | 1.50E5 |
| Nb 95 | 1.41E4 | 7.82E3 | 4.21E3 | -- | 7.74E3 | 5.05E5 | 1.04E5 |
| Mo 99 | -- | 1.21E2 | 2.30E1 | -- | 2.91E2 | 9.12E4 | 2.48E5 |
| I 131 | 2.52E4 | 3.58E4 | 2.05E4 | 1.19E7 | 6.13E4 | -- | 6.28E3 |
| I 133 | 8.64E3 | 1.48E4 | 4.52E3 | 2.15E6 | 2.58E4 | -- | 8.88E3 |
| Cs 134 | 3.73E5 | 8.48E5 | 7.28E5 | -- | 2.87E5 | 9.76E4 | 1.04E4 |
| Cs 137 | 4.78E5 | 6.21E5 | 4.28E5 | -- | 2.22E5 | 7.52E4 | 8.40E3 |
| Ba 140 | 3.90E4 | 4.90E1 | 2.57E3 | -- | 1.67E1 | 1.27E6 | 2.18E5 |
| La 140 | 3.44E2 | 1.74E2 | 4.58E1 | -- | -- | 1.36E5 | 4.58E5 |
| Ce 141 | 1.99E4 | 1.35E4 | 1.53E3 | -- | 6.26E3 | 3.62E5 | 1.20E5 |
| Ce 144 | 3.43E6 | 1.43E6 | 1.84E5 | -- | 8.48E5 | 7.78E6 | 8.16E5 |
| Nd 147 | 5.27E3 | 6.10E3 | 3.65E2 | | 3.56E3 | 2.21E5 | 1.73E5 |

* mrem/yr per $\mu Ci/m^3$.

TABLE 3-8
DOSE AND DOSE RATE
$R_i$ VALUES - GROUND PLANE
ALL AGE GROUPS
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

| NUCLIDE | TOTAL BODY | SKIN |
|---|---|---|
| H 3 | -- | -- |
| C 14 | -- | -- |
| Cr 51 | 4.65E6 | 5.50E6 |
| Mn 54 | 1.40E9 | 1.64E9 |
| Fe 55 | -- | -- |
| Fe 59 | 2.73E8 | 3.20E8 |
| Co 58 | 3.80E8 | 4.45E8 |
| Co 60 | 2.15E10 | 2.53E10 |
| Zn 65 | 7.46E8 | 8.57E8 |
| Sr 89 | 2.16E4 | 2.51E4 |
| Sr 90 | -- | -- |
| Zr 95 | 2.45E8 | 2.85E8 |
| Nb 95 | 1.36E8 | 1.61E8 |
| Mo 99 | 3.99E6 | 4.63E6 |
| I 131 | 1.72E7 | 2.09E7 |
| I 133 | 2.39E6 | 2.91E6 |
| Cs 134 | 6.83E9 | 7.97E9 |
| Cs 137 | 1.03E10 | 1.20E10 |
| Ba 140 | 2.05E7 | 2.35E7 |
| La 140 | 1.92E7 | 2.18E7 |
| Ce 141 | 1.37E7 | 1.54E7 |
| Ce 144 | 6.96E7 | 8.07E7 |
| Nd 147 | 8.46E6 | 1.01E7 |

TABLE 3-9
DOSE AND DOSE RATE
$R_i$ VALUES - COW MILK - INFANT
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 2.38E3 | 2.38E3 | 2.38E3 | 2.38E3 | 2.38E3 | 2.38E3 |
| C 14* | 3.23E6 | 6.89E5 | 6.89E5 | 6.89E5 | 6.89E5 | 6.89E5 | 6.89E5 |
| Cr 51 | -- | -- | 8.35E4 | 5.45E4 | 1.19E4 | 1.06E5 | 2.43E6 |
| Mn 54 | -- | 2.51E7 | 5.68E6 | -- | 5.56E6 | -- | 9.21E6 |
| Fe 55 | 8.43E7 | 5.44E7 | 1.45E7 | -- | -- | 2.66E7 | 6.91E6 |
| Fe 59 | 1.22E8 | 2.13E8 | 8.38E7 | -- | -- | 6.29E7 | 1.02E8 |
| Co 58 | -- | 1.39E7 | 3.46E7 | -- | -- | -- | 3.46E7 |
| Co 60 | -- | 5.90E7 | 1.39E8 | -- | -- | -- | 1.40E8 |
| Zn 65 | 3.53E9 | 1.21E10 | 5.58E9 | -- | 5.87E9 | -- | 1.02E10 |
| Sr 89 | 6.93E9 | -- | 1.99E8 | -- | -- | -- | 1.42E8 |
| Sr 90 | 8.19E10 | -- | 2.09E10 | -- | -- | -- | 1.02E9 |
| Zr 95 | 3.85E3 | 9.39E2 | 6.66E2 | -- | 1.01E3 | -- | 4.68E5 |
| Nb 95 | 4.21E5 | 1.64E5 | 1.17E5 | -- | 1.54E5 | -- | 3.03E8 |
| Mo 99 | -- | 1.04E8 | 2.03E7 | -- | 1.55E8 | -- | 3.43E7 |
| I 131 | 6.81E8 | 8.02E8 | 3.53E8 | 2.64E11 | 9.37E8 | -- | 2.86E7 |
| I 133 | 8.52E6 | 1.24E7 | 3.63E6 | 2.26E9 | 1.46E7 | -- | 2.10E6 |
| Cs 134 | 2.41E10 | 4.49E10 | 4.54E9 | -- | 1.16E10 | 4.74E9 | 1.22E8 |
| Cs 137 | 3.47E10 | 4.06E10 | 2.88E9 | -- | 1.09E10 | 4.41E9 | 1.27E8 |
| Ba 140 | 1.21E8 | 1.21E5 | 6.22E6 | -- | 2.87E4 | 7.42E4 | 2.97E7 |
| La 140 | 2.03E1 | 7.99 | 2.06 | -- | -- | -- | 9.39E4 |
| Ce 141 | 2.28E4 | 1.39E4 | 1.64E3 | -- | 4.28E3 | -- | 7.18E6 |
| Ce 144 | 1.49E6 | 6.10E5 | 8.34E4 | -- | 2.46E5 | -- | 8.54E7 |
| Nd 147 | 4.43E2 | 4.55E2 | 2.79E1 | -- | 1.76E2 | -- | 2.89E5 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-10
DOSE AND DOSE RATE
$R_i$ VALUES - COW MILK - CHILD
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 1.57E3 | 1.57E3 | 1.57E3 | 1.57E3 | 1.57E3 | 1.57E3 |
| C 14* | 1.65E6 | 3.29E5 | 3.29E5 | 3.29E5 | 3.29E5 | 3.29E5 | 3.29E5 |
| Cr 51 | -- | -- | 5.27E4 | 2.93E4 | 7.99E3 | 5.34E4 | 2.80E6 |
| Mn 54 | -- | 1.35E7 | 3.59E6 | -- | 3.78E6 | -- | 1.13E7 |
| Fe 55 | 6.97E7 | 3.07E7 | 1.15E7 | -- | -- | 2.09E7 | 6.85E6 |
| Fe 59 | 6.52E7 | 1.06E8 | 5.26E7 | -- | -- | 3.06E7 | 1.10E8 |
| Co 58 | -- | 6.94E6 | 2.13E7 | -- | -- | -- | 4.05E7 |
| Co 60 | -- | 2.89E7 | 8.52E7 | -- | -- | -- | 1.60E8 |
| Zn 65 | 2.63E9 | 7.00E9 | 4.35E9 | -- | 4.41E9 | -- | 1.23E9 |
| Sr 89 | 3.64E9 | -- | 1.04E8 | -- | -- | -- | 1.41E8 |
| Sr 90 | 7.53E10 | -- | 1.91E10 | -- | -- | -- | 1.01E9 |
| Zr 95 | 2.17E3 | 4.77E2 | 4.25E2 | -- | 6.83E2 | -- | 4.98E5 |
| Nb 95 | 1.86E5 | 1.03E4 | 5.69E4 | -- | 1.00E5 | -- | 4.42E8 |
| Mo 99 | -- | 4.07E7 | 1.01E7 | -- | 8.69E7 | -- | 3.37E7 |
| I 131 | 3.26E8 | 3.28E8 | 1.86E8 | 1.08E11 | 5.39E8 | -- | 2.92E7 |
| I 133 | 4.04E6 | 4.99E6 | 1.89E6 | 9.27E8 | 8.32E6 | -- | 2.01E6 |
| Cs 134 | 1.50E10 | 2.45E10 | 5.18E9 | -- | 7.61E9 | 2.73E9 | 1.32E8 |
| Cs 137 | 2.17E10 | 2.08E10 | 3.07E9 | -- | 6.78E9 | 2.44E9 | 1.30E8 |
| Ba 140 | 5.87E7 | 5.14E4 | 3.43E6 | -- | 1.67E4 | 3.07E4 | 2.97E7 |
| La 140 | 9.70 | 3.39 | 1.14 | -- | -- | -- | 9.45E4 |
| Ce 141 | 1.15E4 | 5.73E3 | 8.51E2 | -- | 2.51E3 | -- | 7.15E6 |
| Ce 144 | 1.04E6 | 3.26E5 | 5.55E4 | -- | 1.80E5 | -- | 8.49E7 |
| Nd 147 | 2.24E2 | 1.81E2 | 1.40E1 | -- | 9.94E1 | -- | 2.87E5 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-11
DOSE AND DOSE RATE
$R_i$ VALUES - COW MILK - TEEN
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 9.94E2 | 9.94E2 | 9.94E2 | 9.94E2 | 9.94E2 | 9.94E2 |
| C 14* | 6.70E5 | 1.34E5 | 1.34E5 | 1.34E5 | 1.34E5 | 1.35E5 | 1.34E5 |
| Cr 51 | -- | -- | 2.58E4 | 1.44E4 | 5.66E3 | 3.69E4 | 4.34E6 |
| Mn 54 | -- | 9.01E6 | 1.79E6 | -- | 2.69E6 | -- | 1.85E7 |
| Fe 55 | 2.78E7 | 1.97E7 | 4.59E6 | -- | -- | 1.25E7 | 8.52E6 |
| Fe 59 | 2.81E7 | 6.57E7 | 2.54E7 | -- | -- | 2.07E7 | 1.55E8 |
| Co 58 | -- | 4.55E6 | 1.05E7 | -- | -- | -- | 6.27E7 |
| Co 60 | -- | 1.86E7 | 4.19E7 | -- | -- | -- | 2.42E8 |
| Zn 65 | 1.34E9 | 4.65E9 | 2.17E9 | -- | 2.97E9 | -- | 1.97E9 |
| Sr 89 | 1.47E9 | -- | 4.21E7 | -- | -- | -- | 1.75E8 |
| Sr 90 | 4.45E10 | -- | 1.10E10 | -- | -- | -- | 1.25E9 |
| Zr 95 | 9.34E2 | 2.95E2 | 2.03E2 | -- | 4.33E2 | -- | 6.80E5 |
| Nb 95 | 1.86E5 | 1.03E5 | 5.69E4 | -- | 1.00E5 | -- | 4.42E8 |
| Mo 99 | -- | 2.24E7 | 4.27E6 | -- | 5.12E7 | -- | 4.01E7 |
| I 131 | 1.34E8 | 1.88E8 | 1.01E8 | 5.49E10 | 3.24E8 | -- | 3.72E7 |
| I 133 | 1.66E6 | 2.82E6 | 8.59E5 | 3.93E8 | 4.94E6 | -- | 2.13E6 |
| Cs 134 | 6.49E9 | 1.53E10 | 7.08E9 | -- | 4.85E9 | 1.85E9 | 1.90E8 |
| Cs 137 | 9.02E9 | 1.20E10 | 4.18E9 | -- | 4.08E9 | 1.59E9 | 1.71E8 |
| Ba 140 | 2.43E7 | 2.98E4 | 1.57E6 | -- | 1.01E4 | 2.00E4 | 3.75E7 |
| La 140 | 4.05 | 1.99 | 5.30E-1 | -- | -- | -- | 1.14E5 |
| Ce 141 | 4.67E3 | 3.12E3 | 3.58E2 | -- | 1.47E3 | -- | 8.91E6 |
| Ce 144 | 4.22E5 | 1.74E5 | 2.27E4 | -- | 1.04E5 | -- | 1.06E8 |
| Nd 147 | 9.12E1 | 9.91E1 | 5.94E0 | -- | 5.82E1 | -- | 3.58E5 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-12
DOSE AND DOSE RATE
$R_i$ VALUES - COW MILK - ADULT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 7.63E2 | 7.63E2 | 7.63E2 | 7.63E2 | 7.63E2 | 7.63E2 |
| C 14* | 3.63E5 | 7.26E4 | 7.26E4 | 7.26E4 | 7.26E4 | 7.26E4 | 7.26E4 |
| Cr 51 | -- | -- | 1.48E4 | 8.85E3 | 3.26E3 | 1.96E4 | 3.72E6 |
| Mn 54 | -- | 5.41E6 | 1.03E6 | -- | 1.61E6 | -- | 1.66E7 |
| Fe 55 | 1.57E7 | 1.08E7 | 2.52E6 | -- | -- | 6.04E6 | 6.21E6 |
| Fe 59 | 1.61E7 | 3.79E7 | 1.45E7 | -- | -- | 1.06E7 | 1.26E8 |
| Co 58 | -- | 2.70E6 | 6.05E6 | -- | -- | -- | 5.47E7 |
| Co 60 | -- | 1.10E7 | 2.42E7 | -- | -- | -- | 2.06E8 |
| Zn 65 | 8.71E8 | 2.77E9 | 1.25E9 | -- | 1.85E9 | -- | 1.75E9 |
| Sr 89 | 7.99E8 | -- | 2.29E7 | -- | -- | -- | 1.28E8 |
| Sr 90 | 3.15E10 | -- | 7.74E9 | -- | -- | -- | 9.11E8 |
| Zr 95 | 5.34E2 | 1.71E2 | 1.16E2 | -- | 2.69E2 | -- | 5.43E5 |
| Nb 95 | 1.09E5 | 6.07E4 | 3.27E4 | -- | 6.00E4 | -- | 3.69E8 |
| Mo 99 | -- | 1.24E7 | 2.36E6 | -- | 2.81E7 | -- | 2.87E7 |
| I 131 | 7.41E7 | 1.06E8 | 6.08E7 | 3.47E10 | 1.82E8 | -- | 2.80E7 |
| I 133 | 9.09E5 | 1.58E6 | 4.82E5 | 2.32E8 | 2.76E6 | -- | 1.42E6 |
| Cs 134 | 3.74E9 | 8.89E9 | 7.27E9 | -- | 2.88E9 | 9.55E8 | 1.56E8 |
| Cs 137 | 4.97E9 | 6.80E9 | 4.46E9 | -- | 2.31E9 | 7.68E8 | 1.32E8 |
| Ba 140 | 1.35E7 | 1.69E4 | 8.83E5 | -- | 5.75E3 | 9.69E3 | 2.77E7 |
| La 140 | 2.26 | 1.14 | 3.01E-1 | -- | -- | -- | 8.35E4 |
| Ce 141 | 2.54E3 | 1.72E3 | 1.95E2 | -- | 7.99E2 | -- | 6.58E6 |
| Ce 144 | 2.29E5 | 9.58E4 | 1.23E4 | -- | 5.68E4 | -- | 7.74E7 |
| Nd 147 | 4.74E1 | 5.48E1 | 3.28E0 | -- | 3.20E1 | -- | 2.63E5 |

*mrem/yr per $\mu Ci/m^3$.

TABLE 3-13
DOSE AND DOSE RATE
$R_i$ VALUES - GOAT MILK - INFANT
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 6.33E3 | 6.33E3 | 6.33E3 | 6.33E3 | 6.33E3 | 6.33E3 |
| C 14* | 3.23E6 | 6.89E5 | 6.89E5 | 6.89E5 | 6.89E5 | 6.89E5 | 6.89E5 |
| Cr 51 | -- | -- | 1.00E4 | 6.56E3 | 1.43E3 | 1.28E4 | 2.93E5 |
| Mn 54 | -- | 3.01E6 | 6.82E5 | -- | 6.67E5 | -- | 1.11E6 |
| Fe 55 | 1.10E6 | 7.08E5 | 1.89E5 | -- | -- | 3.46E5 | 8.98E4 |
| Fe 59 | 1.59E6 | 2.78E6 | 1.09E6 | -- | -- | 8.21E5 | 1.33E6 |
| Co 58 | -- | 1.67E6 | 4.16E6 | -- | -- | -- | 4.16E6 |
| Co 60 | -- | 7.08E6 | 1.67E7 | -- | -- | -- | 1.68E7 |
| Zn 65 | 4.24E8 | 1.45E9 | 6.70E8 | -- | 7.04E8 | -- | 1.23E9 |
| Sr 89 | 1.48E10 | -- | 4.24E8 | -- | -- | -- | 3.04E8 |
| Sr 90 | 1.72E11 | -- | 4.38E10 | -- | -- | -- | 2.15E9 |
| Zr 95 | 4.66E2 | 1.13E2 | 8.04E1 | -- | 1.22E2 | -- | 5.65E4 |
| Nb 95 | 9.42E4 | 3.88E4 | 2.24E4 | -- | 2.78E4 | -- | 3.27E7 |
| Mo 99 | -- | 1.27E7 | 2.47E6 | -- | 1.89E7 | -- | 4.17E6 |
| I 131 | 8.17E8 | 9.63E8 | 4.23E8 | 3.16E11 | 1.12E9 | -- | 3.44E7 |
| I 133 | 1.02E7 | 1.49E7 | 4.36E6 | 2.71E9 | 1.75E7 | -- | 2.52E6 |
| Cs 134 | 7.23E10 | 1.35E11 | 1.36E10 | -- | 3.47E10 | 1.42E10 | 3.66E8 |
| Cs 137 | 1.04E11 | 1.22E11 | 8.63E9 | -- | 3.27E10 | 1.32E10 | 3.81E8 |
| Ba 140 | 1.45E7 | 1.45E4 | 7.48E5 | -- | 3.44E3 | 8.91E3 | 3.56E6 |
| La 140 | 2.430 | 9.59E-1 | 2.47E-1 | -- | -- | -- | 1.13E4 |
| Ce 141 | 2.74E3 | 1.67E3 | 1.96E2 | -- | 5.14E2 | -- | 8.62E5 |
| Ce 144 | 1.79E5 | 7.32E4 | 1.00E4 | -- | 2.96E4 | -- | 1.03E7 |
| Nd 147 | 5.32E1 | 5.47E1 | 3.35E0 | -- | 2.11E1 | -- | 3.46E4 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-14
DOSE AND DOSE RATE
$R_i$ VALUES - GOAT MILK - CHILD
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 4.17E3 | 4.17E3 | 4.17E3 | 4.17E3 | 4.17E3 | 4.17E3 |
| C 14* | 1.65E6 | 3.29E5 | 3.29E5 | 3.29E5 | 3.29E5 | 3.29E5 | 3.29E5 |
| Cr 51 | -- | -- | 6.34E3 | 3.52E3 | 9.62E2 | 6.43E3 | 3.36E5 |
| Mn 54 | -- | 1.62E6 | 4.31E5 | -- | 4.54E5 | -- | 1.36E6 |
| Fe 55 | 9.06E5 | 4.81E5 | 1.49E5 | -- | -- | 2.72E5 | 8.91E4 |
| Fe 59 | 8.52E5 | 1.38E6 | 6.86E5 | -- | -- | 3.99E5 | 1.43E6 |
| Co 58 | -- | 8.35E5 | 2.56E6 | -- | -- | -- | 4.87E6 |
| Co 60 | -- | 3.47E6 | 1.02E7 | -- | -- | -- | 1.92E7 |
| Zn 65 | 3.15E8 | 8.40E8 | 5.23E8 | -- | 5.29E8 | -- | 1.48E8 |
| Sr 89 | 7.77E9 | -- | 2.22E8 | -- | -- | -- | 3.01E8 |
| Sr 90 | 1.58E11 | -- | 4.01E10 | -- | -- | -- | 2.13E9 |
| Zr 95 | 2.62E2 | 5.76E1 | 5.13E1 | -- | 8.25E1 | -- | 6.01E4 |
| Nb 95 | 5.05E4 | 1.96E4 | 1.40E4 | -- | 1.85E4 | -- | 3.63E7 |
| Mo 99 | -- | 4.95E6 | 1.22E6 | -- | 1.06E7 | -- | 4.09E6 |
| I 131 | 3.91E8 | 3.94E8 | 2.24E8 | 1.30E11 | 6.46E8 | -- | 3.50E7 |
| I 133 | 4.84E6 | 5.99E6 | 2.27E6 | 1.11E9 | 9.98E6 | -- | 2.41E6 |
| Cs 134 | 4.49E10 | 7.37E10 | 1.55E10 | -- | 2.28E10 | 8.19E9 | 3.97E8 |
| Cs 137 | 6.52E10 | 6.24E10 | 9.21E9 | -- | 2.03E10 | 7.32E9 | 3.91E8 |
| Ba 140 | 7.05E6 | 6.18E3 | 4.12E5 | -- | 2.01E3 | 3.68E3 | 3.57E6 |
| La 140 | 1.16 | 4.07E-1 | 1.37E-1 | -- | -- | -- | 1.13E4 |
| Ce 141 | 1.38E3 | 6.88E2 | 1.02E2 | -- | 3.02E2 | -- | 8.59E5 |
| Ce 144 | 1.25E5 | 3.91E4 | 6.66E3 | -- | 2.16E4 | -- | 1.02E7 |
| Nd 147 | 2.68E1 | 2.17E1 | 1.68E0 | -- | 1.19E1 | -- | 3.44E4 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-15
DOSE AND DOSE RATE
$R_i$ VALUES - GOAT MILK - TEEN
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 2.64E3 | 2.64E3 | 2.64E3 | 2.64E3 | 2.64E3 | 2.64E3 |
| C 14* | 6.70E5 | 1.34E5 | 1.34E5 | 1.34E5 | 1.34E5 | 1.35E5 | 1.34E5 |
| Cr 51 | -- | -- | 3.11E3 | 1.73E3 | 6.82E2 | 4.44E3 | 5.23E5 |
| Mn 54 | -- | 1.08E6 | 2.15E5 | -- | 3.23E5 | -- | 2.22E6 |
| Fe 55 | 3.61E5 | 2.56E5 | 5.97E4 | -- | -- | 1.62E5 | 1.11E5 |
| Fe 59 | 3.67E5 | 8.57E5 | 3.31E5 | -- | -- | 2.70E5 | 2.03E6 |
| Co 58 | -- | 5.46E5 | 1.26E6 | -- | -- | -- | 7.53E6 |
| Co 60 | -- | 2.23E6 | 5.03E6 | -- | -- | -- | 2.91E7 |
| Zn 65 | 1.61E8 | 5.58E8 | 2.60E8 | -- | 3.57E8 | -- | 2.36E8 |
| Sr 89 | 3.14E9 | -- | 8.99E7 | -- | -- | -- | 3.74E8 |
| Sr 90 | 9.36E10 | -- | 2.31E10 | -- | -- | -- | 2.63E9 |
| Zr 95 | 1.13E2 | 3.56E1 | 2.45E1 | -- | 5.23E1 | -- | 8.22E4 |
| Nb 95 | 2.23E4 | 1.24E4 | 6.82E3 | -- | 1.20E4 | -- | 5.30E7 |
| Mo 99 | -- | 2.72E6 | 5.19E5 | -- | 6.23E6 | -- | 4.87E6 |
| I 131 | 1.61E8 | 2.26E8 | 1.21E8 | 6.59E10 | 3.89E8 | -- | 4.47E7 |
| I 133 | 1.99E6 | 3.38E6 | 1.03E6 | 4.72E8 | 5.93E6 | -- | 2.56E6 |
| Cs 134 | 1.95E10 | 4.58E10 | 2.13E10 | -- | 1.46E10 | 5.56E9 | 5.70E8 |
| Cs 137 | 2.71E10 | 3.60E10 | 1.25E10 | -- | 1.23E10 | 4.76E9 | 5.12E8 |
| Ba 140 | 2.92E6 | 3.58E3 | 1.88E5 | -- | 1.21E3 | 2.41E3 | 4.50E6 |
| La 140 | 4.86E-1 | 2.39E-1 | 6.36E-2 | -- | -- | -- | 1.37E4 |
| Ce 141 | 5.60E2 | 3.74E2 | 4.30E1 | -- | 1.76E2 | -- | 1.07E6 |
| Ce 144 | 5.06E4 | 2.09E4 | 2.72E3 | -- | 1.25E4 | -- | 1.27E7 |
| Nd 147 | 1.09E1 | 1.19E1 | 7.13E-1 | -- | 6.99E0 | -- | 4.29E4 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-16
DOSE AND DOSE RATE
$R_i$ VALUES - GOAT MILK - ADULT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 2.03E3 | 2.03E3 | 2.03E3 | 2.03E3 | 2.03E3 | 2.03E3 |
| C 14* | 3.63E5 | 7.26E4 | 7.26E4 | 7.26E4 | 7.26E4 | 7.26E4 | 7.26E4 |
| Cr 51 | -- | -- | 1.78E3 | 1.06E3 | 3.92E2 | 2.36E3 | 4.48E5 |
| Mn 54 | -- | 6.50E5 | 1.24E5 | -- | 1.93E5 | -- | 1.99E6 |
| Fe 55 | 2.04E5 | 1.41E5 | 3.28E4 | -- | -- | 7.85E4 | 8.07E4 |
| Fe 59 | 2.10E5 | 4.95E5 | 1.90E5 | -- | -- | 1.38E5 | 1.65E6 |
| Co 58 | -- | 3.25E5 | 7.27E5 | -- | -- | -- | 6.58E6 |
| Co 60 | -- | 1.32E6 | 2.91E6 | -- | -- | -- | 2.48E7 |
| Zn 65 | 1.05E8 | 3.33E8 | 1.51E8 | -- | 2.23E8 | -- | 2.10E8 |
| Sr 89 | 1.70E9 | -- | 4.89E7 | -- | -- | -- | 2.73E8 |
| Sr 90 | 6.62E10 | -- | 1.63E10 | -- | -- | -- | 1.91E9 |
| Zr 95 | 6.45E1 | 2.07E1 | 1.40E1 | -- | 3.25E1 | -- | 6.56E4 |
| Nb 95 | 1.31E4 | 7.29E3 | 3.92E3 | -- | 7.21E3 | -- | 4.42E7 |
| Mo 99 | -- | 1.51E6 | 2.87E5 | -- | 3.41E6 | -- | 3.49E6 |
| I 131 | 8.89E7 | 1.27E8 | 7.29E7 | 4.17E10 | 2.18E8 | -- | 3.36E7 |
| I 133 | 1.09E6 | 1.90E6 | 5.79E5 | 2.79E8 | 3.31E6 | -- | 1.71E6 |
| Cs 134 | 1.12E10 | 2.67E10 | 2.18E10 | -- | 8.63E9 | 2.86E9 | 4.67E8 |
| Cs 137 | 1.49E10 | 2.04E10 | 1.34E10 | -- | 6.93E9 | 2.30E9 | 3.95E8 |
| Ba 140 | 1.62E6 | 2.03E3 | 1.06E5 | -- | 6.91E2 | 1.16E3 | 3.33E6 |
| La 140 | 2.71E-1 | 1.36E-1 | 3.61E-2 | -- | -- | -- | 1.00E4 |
| Ce 141 | 3.06E2 | 2.07E2 | 2.34E1 | -- | 9.60E1 | -- | 7.90E5 |
| Ce 144 | 2.75E4 | 1.15E4 | 1.48E3 | -- | 6.82E3 | -- | 9.30E6 |
| Nd 147 | 5.69E0 | 6.57E0 | 3.93E-1 | -- | 3.84E0 | -- | 3.15E4 |

*mrem/yr per $\mu Ci/m^3$.

TABLE 3-17
DOSE AND DOSE RATE
$R_i$ VALUES - COW MEAT - CHILD
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 2.34E2 | 2.34E2 | 2.34E2 | 2.34E2 | 2.34E2 | 2.34E2 |
| C 14* | 5.29E5 | 1.06E5 | 1.06E5 | 1.06E5 | 1.06E5 | 1.06E5 | 1.06E5 |
| Cr 51 | -- | -- | 4.55E3 | 2.52E3 | 6.90E2 | 4.61E3 | 2.41E5 |
| Mn 54 | -- | 5.15E6 | 1.37E6 | -- | 1.44E6 | -- | 4.32E6 |
| Fe 55 | 2.89E8 | 1.53E8 | 4.74E7 | -- | -- | 8.66E7 | 2.84E7 |
| Fe 59 | 2.04E8 | 3.30E8 | 1.65E8 | -- | -- | 9.58E7 | 3.44E8 |
| Co 58 | -- | 9.41E6 | 2.88E7 | -- | -- | -- | 5.49E7 |
| Co 60 | -- | 4.64E7 | 1.37E8 | -- | -- | -- | 2.57E8 |
| Zn 65 | 2.38E8 | 6.35E8 | 3.95E8 | -- | 4.00E8 | -- | 1.12E8 |
| Sr 89 | 2.65E8 | -- | 7.57E6 | -- | -- | -- | 1.03E7 |
| Sr 90 | 7.01E9 | -- | 1.78E9 | -- | -- | -- | 9.44E7 |
| Zr 95 | 1.51E6 | 3.32E5 | 2.95E5 | -- | 4.75E5 | -- | 3.46E8 |
| Nb 95 | 4.10E6 | 1.59E6 | 1.14E6 | -- | 1.50E6 | -- | 2.95E9 |
| Mo 99 | -- | 5.42E4 | 1.34E4 | -- | 1.16E5 | -- | 4.48E4 |
| I 131 | 4.15E6 | 4.18E6 | 2.37E6 | 1.38E9 | 6.86E6 | -- | 3.72E5 |
| I 133 | 9.38E-2 | 1.16E-1 | 4.39E-2 | 2.15E1 | 1.93E-1 | -- | 4.67E-2 |
| Cs 134 | 6.09E8 | 1.00E9 | 2.11E8 | -- | 3.10E8 | 1.11E8 | 5.39E6 |
| Cs 137 | 8.99E8 | 8.60E8 | 1.27E8 | -- | 2.80E8 | 1.01E8 | 5.39E6 |
| Ba 140 | 2.20E7 | 1.93E4 | 1.28E6 | -- | 6.27E3 | 1.15E4 | 1.11E7 |
| La 140 | 2.80E-2 | 9.78E-3 | 3.30E-3 | -- | -- | -- | 2.73E2 |
| Ce 141 | 1.17E4 | 5.82E3 | 8.64E2 | -- | 2.55E3 | -- | 7.26E6 |
| Ce 144 | 1.48E6 | 4.65E5 | 7.91E4 | -- | 2.57E5 | -- | 1.21E8 |
| Nd 147 | 5.93E3 | 4.80E3 | 3.72E2 | -- | 2.64E3 | -- | 7.61E6 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-18
DOSE AND DOSE RATE
$R_i$ VALUES - COW MEAT - TEEN
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 1.94E2 | 1.94E2 | 1.94E2 | 1.94E2 | 1.94E2 | 1.94E2 |
| C 14* | 2.81E5 | 5.62E4 | 5.62E4 | 5.62E4 | 5.62E4 | 5.62E4 | 5.62E4 |
| Cr 51 | -- | -- | 2.93E3 | 1.62E3 | 6.39E2 | 4.16E3 | 4.90E5 |
| Mn 54 | -- | 4.50E6 | 8.93E5 | -- | 1.34E6 | -- | 9.24E6 |
| Fe 55 | 1.50E8 | 1.07E8 | 2.49E7 | -- | -- | 6.77E7 | 4.62E7 |
| Fe 59 | 1.15E8 | 2.69E8 | 1.04E8 | -- | -- | 8.47E7 | 6.36E8 |
| Co 58 | -- | 8.05E6 | 1.86E7 | -- | -- | -- | 1.11E8 |
| Co 60 | -- | 3.90E7 | 8.80E7 | -- | -- | -- | 5.09E8 |
| Zn 65 | 1.59E8 | 5.52E8 | 2.57E8 | -- | 3.53E8 | -- | 2.34E8 |
| Sr 89 | 1.40E8 | -- | 4.01E6 | -- | -- | -- | 1.67E7 |
| Sr 90 | 5.42E9 | -- | 1.34E9 | -- | -- | -- | 1.52E8 |
| Zr 95 | 8.50E5 | 2.68E5 | 1.84E5 | -- | 3.94E5 | -- | 6.19E8 |
| Nb 95 | 2.37E6 | 1.32E6 | 7.24E5 | -- | 1.28E6 | -- | 5.63E9 |
| Mo 99 | -- | 3.90E4 | 7.43E3 | -- | 8.92E4 | -- | 6.98E4 |
| I 131 | 2.24E6 | 3.13E6 | 1.68E6 | 9.15E8 | 5.40E6 | -- | 6.20E5 |
| I 133 | 5.05E-2 | 8.57E-2 | 2.61E-2 | 1.20E1 | 1.50E-1 | -- | 6.48E-2 |
| Cs 134 | 3.46E8 | 8.13E8 | 3.77E8 | -- | 2.58E8 | 9.87E7 | 1.01E7 |
| Cs 137 | 4.88E8 | 6.49E8 | 2.26E8 | -- | 2.21E8 | 8.58E7 | 9.24E6 |
| Ba 140 | 1.19E7 | 1.46E4 | 7.68E5 | -- | 4.95E3 | 9.81E3 | 1.84E7 |
| La 140 | 1.53E-2 | 7.51E-3 | 2.00E-3 | -- | -- | -- | 4.31E2 |
| Ce 141 | 6.19E3 | 4.14E3 | 4.75E2 | -- | 1.95E3 | -- | 1.18E7 |
| Ce 144 | 7.87E5 | 3.26E5 | 4.23E4 | -- | 1.94E5 | -- | 1.98E8 |
| Nd 147 | 3.16E3 | 3.44E3 | 2.06E2 | -- | 2.02E3 | -- | 1.24E7 |

*mrem/yr per $\mu$Ci/$m^3$.

TABLE 3-19
DOSE AND DOSE RATE
$R_i$ VALUES - COW MEAT - ADULT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 3.25E2 | 3.25E2 | 3.25E2 | 3.25E2 | 3.25E2 | 3.25E2 |
| C 14* | 3.33E5 | 6.66E4 | 6.66E4 | 6.66E4 | 6.66E4 | 6.66E4 | 6.66E4 |
| Cr 51 | -- | -- | 3.65E3 | 2.18E3 | 8.03E2 | 4.84E3 | 9.17E5 |
| Mn 54 | -- | 5.90E6 | 1.13E6 | -- | 1.76E6 | -- | 1.81E7 |
| Fe 55 | 1.85E8 | 1.28E8 | 2.98E7 | -- | -- | 7.14E7 | 7.34E7 |
| Fe 59 | 1.44E8 | 3.39E8 | 1.30E8 | -- | -- | 9.46E7 | 1.13E9 |
| Co 58 | -- | 1.04E7 | 2.34E7 | -- | -- | -- | 2.12E8 |
| Co 60 | -- | 5.03E7 | 1.11E8 | -- | -- | -- | 9.45E8 |
| Zn 65 | 2.26E8 | 7.19E8 | 3.25E8 | -- | 4.81E8 | -- | 4.53E8 |
| Sr 89 | 1.66E8 | -- | 4.76E6 | -- | -- | -- | 2.66E7 |
| Sr 90 | 8.38E9 | -- | 2.06E9 | -- | -- | -- | 2.42E8 |
| Zr 95 | 1.06E6 | 3.40E5 | 2.30E5 | -- | 5.34E5 | -- | 1.08E9 |
| Nb 95 | 3.04E6 | 1.69E6 | 9.08E5 | -- | 1.67E6 | -- | 1.03E10 |
| Mo 99 | -- | 4.71E4 | 8.97E3 | -- | 1.07E5 | -- | 1.09E5 |
| I 131 | 2.69E6 | 3.85E6 | 2.21E6 | 1.26E9 | 6.61E6 | -- | 1.02E6 |
| I 133 | 6.04E-2 | 1.05E-1 | 3.20E-2 | 1.54E1 | 1.83E-1 | -- | 9.44E-2 |
| Cs 134 | 4.35E8 | 1.03E9 | 8.45E8 | -- | 3.35E8 | 1.11E8 | 1.81E7 |
| Cs 137 | 5.88E8 | 8.04E8 | 5.26E8 | -- | 2.73E8 | 9.07E7 | 1.56E7 |
| Ba 140 | 1.44E7 | 1.81E4 | 9.44E5 | -- | 6.15E3 | 1.04E4 | 2.97E7 |
| La 140 | 1.86E-2 | 9.37E-3 | 2.48E-3 | -- | -- | -- | 6.88E2 |
| Ce 141 | 7.38E3 | 4.99E3 | 5.66E2 | -- | 2.32E3 | -- | 1.91E7 |
| Ce 144 | 9.33E5 | 3.90E5 | 5.01E4 | -- | 2.31E5 | -- | 3.16E8 |
| Nd 147 | 3.59E3 | 4.15E3 | 2.48E2 | -- | 2.42E3 | -- | 1.99E7 |

*mrem/yr per $\mu Ci/m^3$.

TABLE 3-20
DOSE AND DOSE RATE
$R_i$ VALUES - VEGETATION - CHILD
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 4.01E3 | 4.01E3 | 4.01E3 | 4.01E3 | 4.01E3 | 4.01E3 |
| C 14* | 3.50E6 | 7.01E5 | 7.01E5 | 7.01E5 | 7.01E5 | 7.01E5 | 7.01E5 |
| Cr 51 | -- | -- | 1.17E5 | 6.49E4 | 1.77E4 | 1.18E5 | 6.20E6 |
| Mn 54 | -- | 6.65E8 | 1.77E8 | -- | 1.86E8 | -- | 5.58E8 |
| Fe 55 | 7.63E8 | 4.05E8 | 1.25E8 | -- | -- | 2.29E8 | 7.50E7 |
| Fe 59 | 3.97E8 | 6.42E8 | 3.20E8 | -- | -- | 1.86E8 | 6.69E8 |
| Co 58 | -- | 6.45E7 | 1.97E8 | -- | -- | -- | 3.76E8 |
| Co 60 | -- | 3.78E8 | 1.12E9 | -- | -- | -- | 2.10E9 |
| Zn 65 | 8.12E8 | 2.16E9 | 1.35E9 | -- | 1.36E9 | -- | 3.80E8 |
| Sr 89 | 3.59E10 | -- | 1.03E9 | -- | -- | -- | 1.39E9 |
| Sr 90 | 1.24E12 | -- | 3.15E11 | -- | -- | -- | 1.67E10 |
| Zr 95 | 3.86E6 | 8.50E5 | 7.56E5 | -- | 1.22E6 | -- | 8.86E8 |
| Nb 95 | 1.02E6 | 3.99E5 | 2.85E5 | -- | 3.75E5 | -- | 7.37E8 |
| Mo 99 | -- | 7.70E6 | 1.91E6 | -- | 1.65E7 | -- | 6.37E6 |
| I 131 | 7.16E7 | 7.20E7 | 4.09E7 | 2.38E10 | 1.18E8 | -- | 6.41E6 |
| I 133 | 1.69E6 | 2.09E6 | 7.92E5 | 3.89E8 | 3.49E6 | -- | 8.44E5 |
| Cs 134 | 1.60E10 | 2.63E10 | 5.55E9 | -- | 8.15E9 | 2.93E9 | 1.42E8 |
| Cs 137 | 2.39E10 | 2.29E10 | 3.38E9 | -- | 7.46E9 | 2.68E9 | 1.43E8 |
| Ba 140 | 2.77E8 | 2.43E5 | 1.62E7 | -- | 7.90E4 | 1.45E5 | 1.40E8 |
| La 140 | 3.25E3 | 1.13E3 | 3.83E2 | -- | -- | -- | 3.16E7 |
| Ce 141 | 6.56E5 | 3.27E5 | 4.85E4 | -- | 1.43E5 | -- | 4.08E8 |
| Ce 144 | 1.27E8 | 3.98E7 | 6.78E6 | -- | 2.21E7 | -- | 1.04E10 |
| Nd 147 | 7.23E4 | 5.86E4 | 4.54E3 | -- | 3.22E4 | -- | 9.28E7 |

*mrem/yr per $\mu Ci/m^3$.

TABLE 3-21
DOSE AND DOSE RATE
$R_i$ VALUES - VEGETATION - TEEN
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 2.59E3 | 2.59E3 | 2.59E3 | 2.59E3 | 2.59E3 | 2.59E3 |
| C-14* | 1.45E6 | 2.91E5 | 2.91E5 | 2.91E5 | 2.91E5 | 2.91E5 | 2.91E5 |
| Cr 51 | -- | -- | 6.16E4 | 3.42E4 | 1.35E4 | 8.79E4 | 1.03E7 |
| Mn 54 | -- | 4.54E8 | 9.01E7 | -- | 1.36E8 | -- | 9.32E8 |
| Fe 55 | 3.10E8 | 2.20E8 | 5.13E7 | -- | -- | 1.40E8 | 9.53E7 |
| Fe 59 | 1.79E8 | 4.18E8 | 1.61E8 | -- | -- | 1.32E8 | 9.89E8 |
| Co 58 | -- | 4.37E7 | 1.01E8 | -- | -- | -- | 6.02E8 |
| Co 60 | -- | 2.49E8 | 5.60E8 | -- | -- | -- | 3.24E9 |
| Zn 65 | 4.24E8 | 1.47E9 | 6.86E8 | -- | 9.41E8 | -- | 6.23E8 |
| Sr 89 | 1.51E10 | -- | 4.33E8 | -- | -- | -- | 1.80E9 |
| Sr 90 | 7.51E11 | -- | 1.85E11 | -- | -- | -- | 2.11E10 |
| Zr 95 | 1.72E6 | 5.44E5 | 3.74E5 | -- | 7.99E5 | -- | 1.26E9 |
| Nb 95 | 4.80E5 | 2.66E5 | 1.46E5 | -- | 2.58E5 | -- | 1.14E9 |
| Mo 99 | -- | 5.64E6 | 1.08E6 | -- | 1.29E7 | -- | 1.01E7 |
| I 131 | 3.85E7 | 5.39E7 | 2.89E7 | 1.57E10 | 9.28E7 | -- | 1.07E7 |
| I 133 | 9.29E5 | 1.58E6 | 4.80E5 | 2.20E8 | 2.76E6 | -- | 1.19E6 |
| Cs 134 | 7.10E9 | 1.67E10 | 7.75E9 | -- | 5.31E9 | 2.03E9 | 2.08E8 |
| Cs 137 | 1.01E10 | 1.35E10 | 4.69E9 | -- | 4.59E9 | 1.78E9 | 1.92E8 |
| Ba 140 | 1.38E8 | 1.69E5 | 8.91E6 | -- | 5.74E4 | 1.14E5 | 2.13E8 |
| La 140 | 1.81E3 | 8.88E2 | 2.36E2 | -- | -- | -- | 5.10E7 |
| Ce 141 | 2.83E5 | 1.89E5 | 2.17E4 | -- | 8.89E4 | -- | 5.40E8 |
| Ce 144 | 5.27E7 | 2.18E7 | 2.83E6 | -- | 1.30E7 | -- | 1.33E10 |
| Nd 147 | 3.66E4 | 3.98E4 | 2.3863 | -- | 2.34E4 | -- | 1.44E8 |

*mrem/yr per $\mu$Ci/$m^3$

TABLE 3-22
DOSE AND DOSE RATE
$R_i$ VALUES - VEGETATION - ADULT
$m^2$-mrem/yr
$\mu$Ci/sec

| NUCLIDE | BONE | LIVER | T. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H 3* | -- | 2.26E3 | 2.26E3 | 2.26E3 | 2.26E3 | 2.26E3 | 2.26E3 |
| C 14* | 8.97E5 | 1.79E5 | 1.79E5 | 1.79E5 | 1.79E5 | 1.79E5 | 1.79E5 |
| Cr 51 | -- | -- | 4.64E4 | 2.77E4 | 1.02E4 | 6.15E4 | 1.17E7 |
| Mn 54 | -- | 3.13E8 | 5.97E7 | -- | 9.31E7 | -- | 9.58E8 |
| Fe 55 | 2.00E8 | 1.38E8 | 3.22E7 | -- | -- | 7.69E7 | 7.91E7 |
| Fe 59 | 1.26E8 | 2.96E8 | 1.13E8 | -- | -- | 8.27E7 | 1.02E9 |
| Co 58 | -- | 3.08E7 | 6.90E7 | -- | -- | -- | 6.24E8 |
| Co 60 | -- | 1.67E8 | 3.69E8 | -- | -- | -- | 3.14E9 |
| Zn 65 | 3.17E8 | 1.01E9 | 4.56E8 | -- | 6.75E8 | -- | 6.36E8 |
| Sr 89 | 9.96E9 | -- | 2.86E8 | -- | -- | -- | 1.60E9 |
| Sr 90 | 6.05E11 | -- | 1.48E11 | -- | -- | -- | 1.75E10 |
| Zr 95 | 1.18E6 | 3.77E5 | 2.55E5 | -- | 5.92E5 | -- | 1.20E9 |
| Nb 95 | 3.55E5 | 1.98E5 | 1.06E5 | -- | 1.95E5 | -- | 1.20E9 |
| Mo 99 | -- | 6.14E6 | 1.17E6 | -- | 1.39E7 | -- | 1.42E7 |
| I 131 | 4.04E7 | 5.78E7 | 3.31E7 | 1.90E10 | 9.91E7 | -- | 1.53E7 |
| I 133 | 1.00E6 | 1.74E6 | 5.30E5 | 2.56E8 | 3.03E6 | -- | 1.56E6 |
| Cs 134 | 4.67E9 | 1.11E10 | 9.08E9 | -- | 3.59E9 | 1.19E9 | 1.94E8 |
| Cs 137 | 6.36E9 | 8.70E9 | 5.70E9 | -- | 2.95E9 | 9.81E8 | 1.68E8 |
| Ba 140 | 1.29E8 | 1.61E5 | 8.42E6 | -- | 5.49E4 | 9.25E4 | 2.65E8 |
| La 140 | 1.98E3 | 9.97E2 | 2.63E2 | -- | -- | -- | 7.32E7 |
| Ce 141 | 1.97E5 | 1.33E5 | 1.51E4 | -- | 6.19E4 | -- | 5.09E8 |
| Ce 144 | 3.29E7 | 1.38E7 | 1.77E6 | -- | 8.16E6 | -- | 1.11E10 |
| Nd 147 | 3.36E4 | 3.88E4 | 2.32E3 | -- | 2.27E4 | -- | 1.86E8 |

*mrem/yr per $\mu$Ci/$m^3$

TABLE 3-23
PARAMETERS FOR THE EVALUATION OF DOSES TO REAL MEMBERS
OF THE PUBLIC FROM GASEOUS AND LIQUID EFFLUENTS

| Pathway | Parameters | Value | Reference |
|---|---|---|---|
| Fish | U (kg/yr) - adult | 21 | Reg. Guide 1.109 Table E-5 |
| Fish | $D_{aipj}$ (mrem/pCi) | Each Radionuclide | Reg. Guide 1.109 Table E-11 |
| Shoreline | U (hr/yr)<br>- adult<br>- teen | 67<br>67 | Reg. Guide 1.09<br>Assumed to be same as Adult |
| Shoreline | $D_{aipj}$ (mrem/hr per pCi/$m^2$) | Each Radionuclide | Reg. Guide 1.109 Table E-6 |
| Inhalation | $DFA_{ija}$ | Each Radionuclide | Reg. Guide 1.109 Table E-7 |

NINE MILE POINT NUCLEAR STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

TABLE 5.1

| Type of Sample | ★ Map Location | Collection Site (Env. Program No.) | Location |
|---|---|---|---|
| Radioiodine and Particulates (air) | 1 | Nine Mile Point Road North (R-1) | 1.8 mi @ 88° E |
| Radioiodine and Particulates (air) | 2 | Co. Rt. 29 & Lake Road (R-2) | 1.1 mi @ 104° ESE |
| Radioiodine and Particulates (air) | 3 | Co. Rt. 29 (R-3) | 1.5 mi @ 132° SE |
| Radioiodine and Particulates (air) | 4 | Village of Lycoming, NY (R-4) | 1.8 mi @ 143° SE |
| Radioiodine and Particulates (air) | 5 | Montario Point Road (R-5) | 16.4 mi @ 42° NE |
| Direct Radiation (TLD) | 6 | North Shoreline Area (75) | 0.1 mi @ 5° N |
| Direct Radiation (TLD) | 7 | North Shoreline Area (76) | 0.1 mi @ 25° NNE |
| Direct Radiation (TLD) | 8 | North Shoreline Area (77) | 0.2 mi @ 45° NE |
| Direct Radiation (TLD) | 9 | North Shoreline Area (23) | 0.8 mi @ 70° ENE |
| Direct Radiation (TLD) | 10 | JAF East Boundary (78) | 1.0 mi @ 90° E |
| Direct Radiation (TLD) | 11 | Rt. 29 (79) | 1.1 mi @ 115° ESE |
| Direct Radiation (TLD) | 12 | Rt. 29 (80) | 1.4 mi @ 133° SE |
| Direct Radiation (TLD) | 13 | Miner Road (81) | 1.6 mi @ 159° SSE |
| Direct Radiation (TLD) | 14 | Miner Road (82) | 1.6 mi @ 181° S |
| Direct Radiation (TLD) | 15 | Lakeview Road (83) | 1.2 mi @ 200° SSW |
| Direct Radiation (TLD) | 16 | Lakeview Road (84) | 1.1 mi @ 225° SW |
| Direct Radiation (TLD) | 17 | Site Meteorological Tower (7) | 0.7 mi @ 250° WSW |
| Direct Radiation (TLD) | 18 | Energy Information Center (18) | 0.4 mi @ 265° W |

★ Map = See Figures 5.1-1 and 5.1-2

NINE MILE POINT NUCLEAR STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

TABLE 5.1
(Continued)

| Type of Sample | ★ Map Location | Collection Site (Env. Program No.) | Location |
|---|---|---|---|
| Direct Radiation (TLD) | 19 | North Shoreline (85) | 0.2 mi @ 294° WNW |
| Direct Radiation (TLD) | 20 | North Shoreline (86) | 0.1 mi @ 315° NW |
| Direct Radiation (TLD) | 21 | North Shoreline (87) | 0.1 mi @ 341° NNW |
| Direct Radiation (TLD) | 22 | Hickory Grove (88) | 4.5 mi @ 97° E |
| Direct Radiation (TLD) | 23 | Leavitt Road (89) | 4.1 mi @ 111° ESE |
| Direct Radiation (TLD) | 24 | Rt. 104 (90) | 4.2 mi @ 135° SE |
| Direct Radiation (TLD) | 25 | Rt. 51A (91) | 4.8 mi @ 156° SSE |
| Direct Radiation (TLD) | 26 | Maiden Lane Road (92) | 4.4 mi @ 183° S |
| Direct Radiation (TLD) | 27 | Co. Rt. 53 (93) | 4.4 mi @ 205° SSW |
| Direct Radiation (TLD) | 28 | Co. Rt. 1 (94) | 4.7 mi @ 223° SW |
| Direct Radiation (TLD) | 29 | Lake Shoreline (95) | 4.1 mi @ 237° WSW |
| Direct Radiation (TLD) | 30 | Phoenix, NY Control (49) | 19.8 mi @ 163° S |
| Direct Radiation (TLD) | 31 | S. W. Oswego, Control (14) | 12.6 mi @ 226° SW |
| Direct Radiation (TLD) | 32 | Scriba, NY (96) | 3.6 mi @ 199° SSW |
| Direct Radiation (TLD) | 33 | Alcan Aluminum, Rt. 1A (58) | 3.1 mi @ 220° SW |
| Direct Radiation (TLD) | 34 | Lycoming, NY (97) | 1.8 mi @ 143° SE |
| Direct Radiation (TLD) | 35 | New Haven, NY (56) | 5.3 mi @ 123° ESE |
| Direct Radiation (TLD) | 36 | W. Boundary, Bible Camp (15) | 0.9 mi @ 237° WSW |
| Direct Radiation (TLD) | 37 | Lake Road (98) | 1.2 mi @ 101° E |
| Surface Water | 38 | OSS Inlet Canal (NA) | 7.6 mi @ 235° SW |
| Surface Water | 39 | JAFNPP Inlet Canal (NA) | 0.5 mi @ 70° ENE |

(NA) = Not applicable
★ Map = See Figures 5.1-1 and 5.1-2

NINE MILE POINT NUCLEAR STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

TABLE 5.1
(Continued)

| Type of Sample | ★ Map Location | Collection Site (Env. Program No.) | Location |
|---|---|---|---|
| Shoreline Sediment | 40 | Sunset Bay Shoreline (NA) | 1.5 mi @ 80° E |
| Fish | 41 | NMP Site Discharge Area (NA) | 0.3 mi @ 315° NW (and/or) |
| Fish | 42 | NMP Site Discharge Area (NA) | 0.6 mi @ 55° NE |
| Fish | 43 | Oswego Harbor Area (NA) | 6.2 mi @ 235° SW |
| Milk | 44 | Milk Location #50 | 8.2 mi @ 93° E |
| Milk | 45 * | Milk Location #7 | 5.5 mi @ 107° ESE |
| Milk | 47 | Milk Location #65 | 17.0 mi @ 220° SW |
| Milk | 64 | Milk Location #55 | 9.0 mi @ 95° E |
| Milk | 65 | Milk Location #60 | 9.5 mi @ 90° E |
| Milk | 66 | Milk Location #4 | 7.8 mi @ 113° ESE |
| Milk (CR) | 73 | Milk Location (Woodworth) | 13.9 mi @ 234° SW |
| Food Product | 48 | Produce Location #6★★ (Bergenstock) (NA) | 1.9 mi @ 141° SE |
| Food Product | 49 | Produce Location #1★★ (Culeton) (NA) | 1.7 mi @ 96° E |
| Food Product | 50 | Produce Location #2★★ (Vitullo) (NA) | 1.9 mi @ 101° E |
| Food Product | 51 | Produce Location #5★★ (C.S. Parkhurst) (NA) | 1.5 mi @ 114° ESE |
| Food Product | 52 | Produce Location #3★★ (C. Narewski) (NA) | 1.6 mi @ 84° E |

* = The Jones milk location has been deleted due to the herd being sold. (Map location #46.)
★ Map = See Figures 5.1-1 and 5.1-2
★★ = Food Product Samples need not necessarily be collected from all listed locations. Collected samples will be of the highest calculated site average D/Q.
(NA) = Not applicable
CR = Control Result (location)

NINE MILE POINT NUCLEAR STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

TABLE 5.1
(Continued)

| Type of Sample | ★ Map Location | Collection Site (Env. Program No.) | Location |
|---|---|---|---|
| Food Product | 53 | Produce Location #4★★ (P. Parkhurst) (NA) | 2.1 mi @ 110° ESE |
| Food Product (CR) | 54 | Produce Location #7★★ (Mc Millen) (NA) | 15.0 mi @ 223° SW |
| Food Product (CR) | 55 | Produce Location #8** (Denman) (NA) | 12.6 mi @ 225° SW |
| Food Product | 56 | Produce Location #9** (O'Connor) (NA) | 1.6 mi @ 171° S |
| Food Product | 57 | Produce Location #10** (C. Lawton) (NA) | 2.2 mi @ 123° ESE |
| Food Product | 58 | Produce Location #11** (C. R. Parkhurst) (NA) | 2.0 mi @ 112° ESE |
| Food Product | 59 | Produce Location #12** (Barton) (NA) | 1.9 mi @ 115° ESE |
| Food Product (CR) | 60 | Produce Location #13** (Flack) (NA) | 15.6 mi @ 225° SW |
| Food Product | 61 | Produce Location #14** (Koeneke) (NA) | 1.9 mi @ 95° E |
| Food Product | 62 | Produce Location #15** (Whaley) (NA) | 1.7 mi @ 136° SE |
| Food Product | 63 | Produce Location #16** (Murray) (NA) | 1.2 mi @ 207° SSW |

★ Map = See Figures 5.1-1 and 5.1-2
★★ = Food Product Samples need not necessarily be collected from all listed locations. Collected samples will be of the highest calculated site average D/Q.
(NA) = Not applicable
CR = Control Result (location)

FIGURE 5.1-1

FIGURE 5.1-2

odonf:g512.dgn

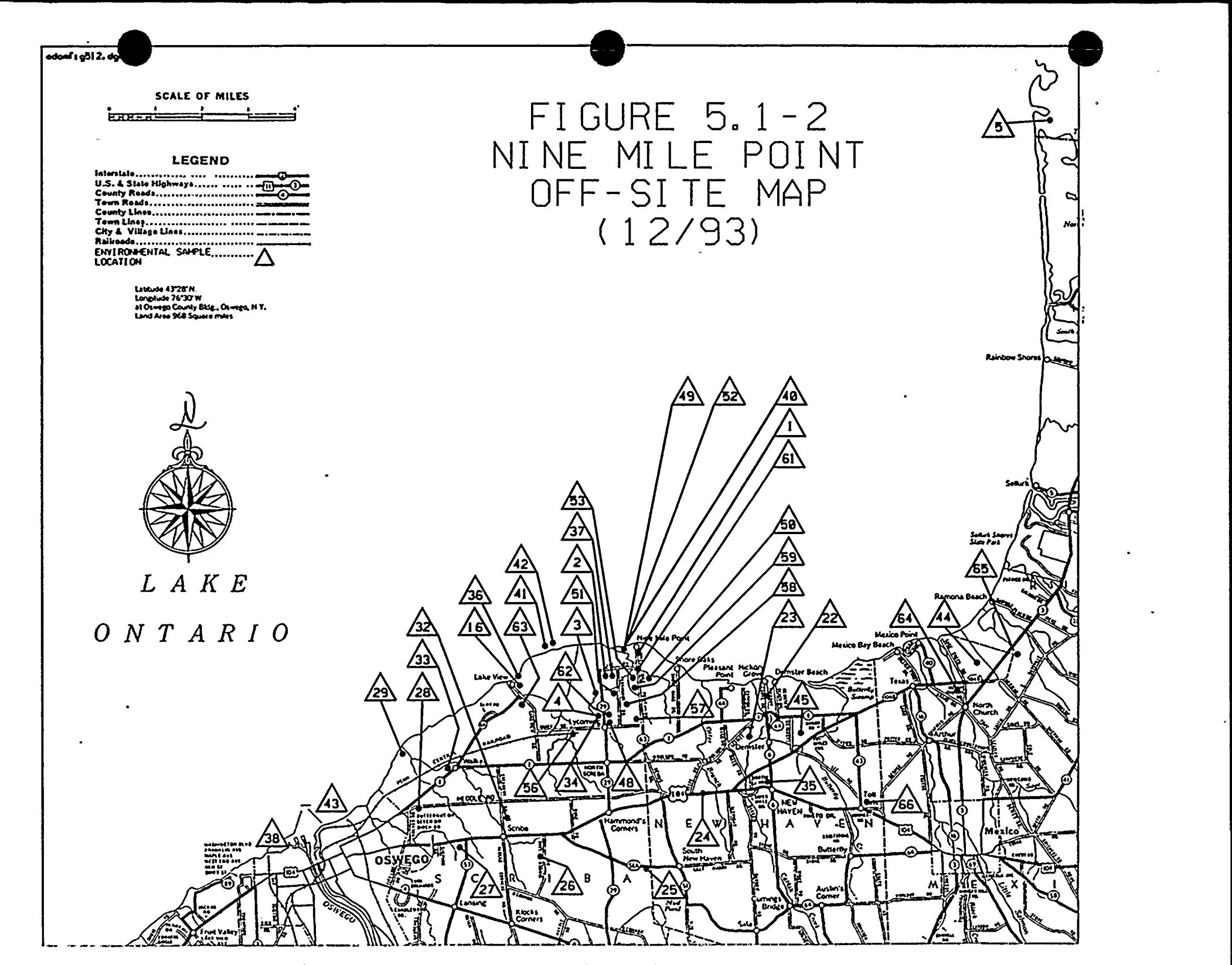
# FIGURE 5.1-2
# NINE MILE POINT
# OFF-SITE MAP
# (12/93)

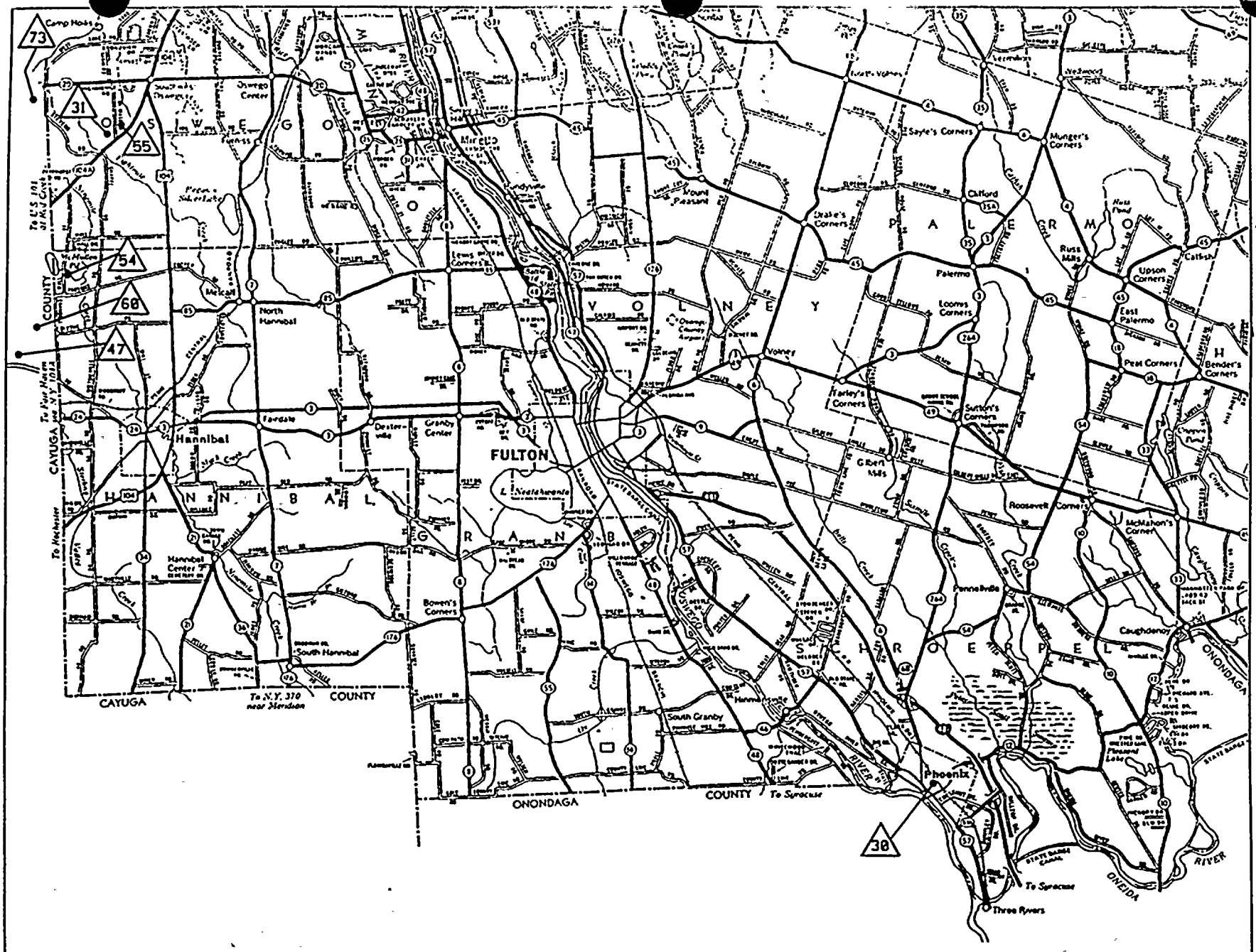
SCALE OF MILES

LEGEND

- Interstate
- U.S. & State Highways
- County Roads
- Town Roads
- County Lines
- Town Lines
- City & Village Lines
- Railroads
- ENVIRONMENTAL SAMPLE LOCATION

Latitude 43°28' N.
Longitude 76°30' W
at Oswego County Bldg., Oswego, N.Y.
Land Area 968 Square miles




Camp Hollis
73
31
55
54
60
47
Mineola
Lewis Corners
North Hannibal
Hannibal
Granby Center
FULTON
Oswego River
Oneida Lake
Bowen's Corners
South Hannibal
Hannibal Center
South Granby
Phoenix
Three Rivers
To Syracuse
To N.Y. 370 near Sheridan
To Port Ontario via N.Y. 104
To Rte 104 at Mexico
To Rte 104 at Red Creek
To Rte 104 at Wolcott
To Rte 104 at Sterling
To Rte 104 at Fair Haven
To Rte 104 at Cato
To Rte 104 at Meridian
To Rte 104 at Auburn
To Rte 104 at Weedsport
To Rte 104 at Port Byron
To Rte 104 at Montezuma
To Rte 104 at Seneca Falls
To Rte 104 at Waterloo
To Rte 104 at Geneva
To Rte 104 at Penn Yan
To Rte 104 at Dundee
To Rte 104 at Watkins Glen
To Rte 104 at Elmira
To Rte 104 at Corning
To Rte 104 at Hornell
To Rte 104 at Wellsville
To Rte 104 at Olean
To Rte 104 at Salamanca
To Rte 104 at Jamestown
To Rte 104 at Dunkirk
To Rte 104 at Fredonia
To Rte 104 at Buffalo
To Rte 104 at Niagara Falls
To Rte 104 at Lockport
To Rte 104 at Medina
To Rte 104 at Albion
To Rte 104 at Brockport
To Rte 104 at Rochester
To Rte 104 at Webster
To Rte 104 at Sodus
To Rte 104 at Wolcott
To Rte 104 at Oswego
To Rte 104 at Fulton
To Rte 104 at Mexico
To Rte 104 at Pulaski
To Rte 104 at Sandy Creek
To Rte 104 at Adams
To Rte 104 at Watertown
To Rte 104 at Carthage
To Rte 104 at Lowville
To Rte 104 at Boonville
To Rte 104 at Rome
To Rte 104 at Utica
To Rte 104 at Herkimer
To Rte 104 at Little Falls
To Rte 104 at Amsterdam
To Rte 104 at Schenectady
To Rte 104 at Albany
To Rte 104 at Troy
To Rte 104 at Saratoga Springs
To Rte 104 at Glens Falls
To Rte 104 at Whitehall
To Rte 104 at Fort Ann
To Rte 104 at Hudson Falls
To Rte 104 at Fort Edward
To Rte 104 at Saratoga
To Rte 104 at Schuylerville
To Rte 104 at Stillwater
To Rte 104 at Troy
To Rte 104 at Albany
To Rte 104 at Schenectady
To Rte 104 at Amsterdam
To Rte 104 at Little Falls
To Rte 104 at Herkimer
To Rte 104 at Utica
To Rte 104 at Rome
To Rte 104 at Boonville
To Rte 104 at Lowville
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To Rte 104 at Mexico
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To Rte 104 at Wolcott
To Rte 104 at Sodus
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To Rte 104 at Fredonia
To Rte 104 at Dunkirk
To Rte 104 at Jamestown
To Rte 104 at Salamanca
To Rte 104 at Olean
To Rte 104 at Hornell
To Rte 104 at Wellsville
To Rte 104 at Corning
To Rte 104 at Elmira
To Rte 104 at Watkins Glen
To Rte 104 at Dundee
To Rte 104 at Penn Yan
To Rte 104 at Geneva
To Rte 104 at Waterloo
To Rte 104 at Seneca Falls
To Rte 104 at Montezuma
To Rte 104 at Port Byron
To Rte 104 at Weedsport
To Rte 104 at Auburn
To Rte 104 at Meridian
To Rte 104 at Cato
To Rte 104 at Fair Haven
To Rte 104 at Sterling
To Rte 104 at Wolcott
To Rte 104 at Red Creek
To Rte 104 at Mexico

FIGURE 5.1.3-1

# APPENDIX A

# LIQUID DOSE FACTOR DERIVATION

Liquid Effluent Dose Factor Derivation, $A_{iat}$

$A_{iat}$ (mrem/hr per $\mu$Ci/ml) which embodies the dose conversion factors, pathway transfer factors (e.g., bioaccumulation factors), pathway usage factors, and dilution factors for the points of pathway origin takes into account the dose from ingestion of fish and drinking water and the sediment. The total body and organ dose conversion factors for each radionuclide will be used from Table E-11 of Regulatory Guide 1.109. To expedite time, the dose is calculated for a maximum individual instead of each age group. The maximum individual dose factor is a composite of the highest dose factor $A_{iat}$ of each nuclide i age group a, and organ t, hence $A_{iat}$. It should be noted that the fish ingestion pathway is the most significant pathway for dose from liquid effluents. The water consumption pathway is included for consistency with NUREG 0133.

The equation for calculating dose contributions given in section 1.3 requires the use of the composite dose factor $A_{it}$ for each nuclide, i. The dose factor equation for a fresh water site is:

$$A_{iat} = Ko \left[ \frac{U_w (e^{-\lambda_i t_{pw}})}{D_w} + U_f (BF)_i (e^{-\lambda_i t_{pf}}) \right] (DFL)_{iat} + \ldots$$

$$\ldots + \frac{69.3\ U_s W}{(D_s)(\lambda_i)} e^{-\lambda_i t_{ps}} (1 - e^{-\lambda_i t_b}) (DFS)_i)$$

Where:

$A_{iat}$ = Is the dose factor for nuclide i, age group a, total body or organ t, for all appropriate pathways, (mrem/hr per $\mu$Ci/ml).

Ko = Is the unit conversion factor, 1.14E5=1E6pCi/$\mu$Ci x 1E3 ml/kg -:- 8760 hr/yr.

$U_w$ = Water consumption (l/yr); from Table E-5 of Reg. Guide 1.109.

$U_f$ = Fish consumption (Kg/yr); from Table E-5 of Reg. Guide 1.109.

$U_s$ = Sediment Shoreline Usage (hr/yr); from Table E-5 of Reg. Guide 1.109.

$(BF)_i$ = Bioaccumulation factor for nuclide, i, in fish, (pCi/kg. per pCi/l), from Table A-1 of Reg. Guide 1.109.

$(DFL)_{iat}$ = Dose conversion factor for age, nuclide, i, group a, total body or organ t, (mrem/pCi); from Table E-11 of Reg. Guide 1.109.

$(DFS)_i$ = Dose conversion factor for nuclide i and total body, from standing on contaminated ground (mem/hr per pCi/$m^2$); from Table E-6 of Reg. Guide 1.109.

$D_w$ = Dilution factor from the near field area within one-quarter mile of the release point to the potable water intake for the adult water consumption. This is the Metropolitan Water Board, Onondaga County intake structure located west of the City of Oswego; (unitless).

$D_s$ = Dilution factor from the near field area within one quarter mile of the release point to the shoreline deposit (taken at the same point where we take environmental samples 1.5 miles; unitless).

69.3 = conversion factor .693 x 100, 100 = $K_c$ (L/kg-hr) *40*24 hr/day/.693 in L/$m^2$-d, and $K_c$ = transfer coefficient from water to sediment in L/kg per hour.

$t_{pw}$, $t_{pf}$, $t_{ps}$ = Average transit time required for each nuclide to reach the point of exposure for internal dose, it is the total time elapsed from release of the nuclides to either ingestion for water (w) and fish (f) or shoreline deposit (s), (hr).

$t_b$ = Length of time the sediment is exposed to the contaminated water, nominally 15 yrs (approximate midpoint of facility operating life), (hrs).

$\lambda_i$ = decay constant for nuclide i ($hr^{-1}$).

W = Shore width factor (unitless) from Table A-2 of Reg. Guide 1.109.

Example Calculation

For I-131 Thyroid Dose Factor for an Adult from a Radwaste liquid effluents release:

| | | | | | | |
|---|---|---|---|---|---|---|
| $(DFS)_i$ | = | 2.80E-9 | mrem/hr per pCi/$m^2$ | | | |
| $(DFL)_{iat}$ | = | 1.95E-3 | mrem/pCi | $t_{pw}$ | = | 30 hrs. (w = water) |
| $BF_i$ | = | 15 | pCi/Kg per pCi/L | $t_{pf}$ | = | 24 hrs. (f = fish) |
| $U_f$ | = | 21 | Kg/yr | $t_b$ | = | 1.314E5 hrs. (5.48E3 days) |
| $D_w$ | = | 40 | unitless | $U_w$ | = | 730 L/yr |
| $D_s$ | = | 12 | unitless | Ko | = | 1.14E5 $\frac{(pCi/\mu Ci)(ml/kg)}{(hr/yr)}$ |
| $U_s$ | = | 12 | hr/yr | | | |
| W | = | 0.3 | | $\lambda_i$ | = | 3.61E-3$hr^{-1}$ |
| $t_{ps}$ | = | 5.5 | hrs (s = Shoreline Sediment) | | | |

These values will yield an $A_{iat}$ Factor of 6.79E4 mrem-ml per $\mu$Ci-hr as listed in Table 2-4. It should be noted that only a limited number of nuclides are listed on Tables 2-1 to 2-8. These are the most common nuclides encountered in effluents. If a nuclide is detected for which a factor is not listed, then it will be calculated and included in a revision to the ODCM.

In addition, not all dose factors are used for the dose calculations. A maximum individual is used, which is a composite of the maximum dose factor of each age group for each organ as reflected in the applicable chemistry procedures.

# APPENDIX B

# PLUME SHINE DOSE FACTOR DERIVATION

For elevated releases the plume shine dose factors for gamma air ($B_i$) and whole body ($V_i$), are calculated using the finite plume model with an elevation above ground equal to the stack height. To calculate the plume shine factor for gamma whole body doses, the gamma air dose factor is adjusted for the attenuation of tissue, and the ratio of mass absorption coefficients between tissue and air. The equations are as follows:

Gamma Air

$$B_i = \Sigma_s \frac{K \mu_a E I_s}{R \Theta V_s}$$

Where:

| | | |
|---|---|---|
| $K^1$ | = | conversion factor (see below for actual value). |
| $\mu_a$ | = | mass absorption coefficient ($cm^2/g$; air for $B_i$, tissue for $V_i$) |
| E | = | Energy of gamma ray per disintegration (Mev) |
| $V_s$ | = | average wind speed for each stability class (s), m/s |
| R | = | downwind distance (site boundary, m) |
| $\Theta$ | = | sector width (radians) |
| s | = | subscript for stability class |
| $I_s$ | = | I function = $I_1 + kI_2$ for each stability class. (unitless, see Regulatory Guide 1.109) |
| $k^2$ | = | Fraction of the attenuated energy that is actually absorbed in air (see Regulatory Guide 1.109, see below for equation) |

Whole Body

$$V_i = 1.11 S_F B_i e^{-\mu_a t_d}$$

Where:

| | | |
|---|---|---|
| $t_d$ | = | tissue depth ($g/cm^2$) |
| $S_F$ | = | shielding factor from structures (unitless) |
| 1.11 | = | Ratio of mass absorption coefficients between tissue and air. |

Where all other parameters are defined above.

$$^1K = \text{conversion factor} = \frac{\left[3.7\ E10\ \frac{dis}{Ci\text{-}sec}\right]\ \left[1.6\ E\text{-}6\ \frac{erg}{Mev}\right]}{\left[1293\ \frac{g}{m^3}\right]\ \left[100\ \frac{erg}{g\text{-}rad}\right]} = .46$$

$$^2k = \frac{\mu - \mu_a}{\mu_a}$$

Where:

| | | |
|---|---|---|
| $\mu$ | = | mass attenuation coefficient ($cm^2/g$; air for $B_i$, tissue for $V_i$) |
| $\mu_a$ | = | defined above |

There are seven stability classes, A thru F. The percentage of the year that each stability class occurs is taken from the U-2 FSAR. From this data, a plume shine dose factor is calculated for each stability class and each nuclide, multiplied by its respective fraction and then summed.

The wind speeds corresponding to each stability class are, also, taken from the U-2 FSAR. To confirm the accuracy of these values, an average of the 12 month wind speeds for 1985, 1986, 1987 and 1988 was compared to the average of the FSAR values. The average wind speed of the actual data is equal to 6.78 m/s, which compared favorably to the FSAR average wind speed equal to 6.77 m/s.

The average gamma energies were calculated using a weighted average of all gamma energies emitted from the nuclide. These energies were taken from the handbook "Radioactive Decay Data Tables", David C. Kocher.

The mass absorption ($\mu_a$) and attenuation ($\mu$) coefficients were calculated by multiplying the mass absorption ($\mu_a/\rho$) and mass attenuation ($\mu/\rho$) coefficients given in the Radiation Health Handbook by the air density equal to 1.293 E-3 g/cc or the tissue density of 1 g/cc where applicable. The tissue depth is $5 g/cm^2$ for the whole body.

The downwind distance is the site boundary.

SAMPLE CALCULATION

Ex. Kr-89 F STABILITY CLASS ONLY - Gamma Air

-DATA

$E = 2.22MeV$ $k = \frac{\mu-\mu_a}{\mu} = .871$ $K = .46$

$\mu_a = 2.943\ E\text{-}3m^{-1}$ $V_F = 5.55$ m/sec

$\mu = 5.5064E\text{-}3m^{-1}$ $R = 644m$

$\theta = .39$

$\sigma_z = 19m$.....vertical plume spread taken from "Introduction to Nuclear Engineering", John R. LaMarsh

-I Function

$U\sigma_z = .06$

$I_1 = .33$

$I_2 = .45$

$I = I_1 + kI_2 = .33 + (.871)(.45) = .72$

$$B_i = \frac{0.46 \left[\frac{\text{dis.}}{\text{Ci-sec}}\right] \left[\frac{\text{Mev/ergs}}{\text{(ergs/g-rad)}}\right] (2.943E\text{-}3m^{-1})(2.22Mev)(.72)}{(\pi^{1/2})\ (g/m^3)\ (5.55\ m/s)\ (.39)\ (644m)}$$

$$= 1.55(-6)\ \frac{\text{rad/s}}{\text{Ci/s}}\ \frac{(3600\ s/hr)(24\ h/d)(365\ d/y)(1E3mrad/rad)}{\frac{(1E6\mu Ci)}{Ci}}$$

$$= 2.76(-2)\ \frac{\text{mrad/yr}}{\mu Ci/sec}$$

$$V_i = 1.11\ (.7)\left[2.76(-2)\ \frac{\text{mrad/yr}}{\mu Ci/sec}\right]\left[e^{-(.0253\ cm^2/g)(5g/cm^2)}\right]$$

$$= 1.89(-2)\ \frac{\text{mrad/yr}}{\mu Ci/sec}$$

NOTE: The above calculation is for the F stability class only. For Table 3-2 and procedure values, a weighted fraction of each stability class was used to determine the $B_i$ and $V_i$ values.

# APPENDIX C

# DOSE PARAMETERS FOR IODINE 131 and 133, PARTICULATES AND TRITIUM

## APPENDIX C

## DOSE PARAMETERS FOR IODINE - 131 AND - 133, PARTICULATES AND TRITIUM

This appendix contains the methodology which was used to calculate the organ dose factors for I-131, I-133, particulates, and tritium. The dose factor, $R_i$, was calculated using the methodology outlined in NUREG-0133. The radioiodine and particulate Technical Specification (Section 3.6.15) is applicable to the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the maximum potential exposure occurs, i.e., the critical receptor. Washout was calculated and determined to be negligible. $R_i$ values have been calculated for the adult, teen, child and infant age groups for all pathways. However, for dose compliance calculations, a maximum individual is assumed that is a composite of highest dose factor of each age group for each organ and pathway. The methodology used to calculate these values follows:

### C.1 Inhalation Pathway

$$R_i(I) = K'(BR)_a(DFA)_{ija}$$

where:

$R_i(I)$ = dose factor for each identified radionuclide i of the organ of interest (units = mrem/yr per $\mu Ci/m^3$);

$K'$ = a constant of unit conversion, 1E6 $pCi/\mu Ci$

$(BR)_a$ = Breathing rate of the receptor of age group a, (units = $m^3/yr$);

$(DFA)_{ija}$ = The inhalation dose factor for nuclide i, organ j and age group a, and organ t (units = mrem/pCi).

The breathing rates $(BR)_a$ for the various age groups, as given in Table E-5 of Regulatory Guide 1.109 Revision 1, are tabulated below.

| Age Group (a) | Breathing Rate ($m^3/yr$) |
|---|---|
| Infant | 1400 |
| Child | 3700 |
| Teen | 8000 |
| Adult | 8000 |

Inhalation dose factors $(DFA)_{ija}$ for the various age groups are given in Tables E-7 through E-10 of Regulatory Guide 1.109 Revision 1.

C.2 Ground Plane Pathway

$$R_i(G) = \frac{K'K''(SF)(DFG)_i \quad (1-e^{-\lambda_i t})}{\lambda_i}$$

Where:

$R_i(G)$ = Dose factor for the ground plane pathway for each identified radionuclide i for the organ of interest (units = $m^2$-mrem/yr per $\mu$Ci/sec)

$K'$ = A constant of unit conversion, 1E6 pCi/$\mu$Ci

$K''$ = A constant of unit conversion, 8760 hr/year

$\lambda_i$ = The radiological decay constant for radionuclide i, (units = $sec^{-1}$)

$t$ = The exposure time, sec, 4.73E8 sec (15 years)

$(DFG)_i$ = The ground plane dose conversion factor for radionuclide i; (units = mrem/hr per pCi/$m^2$)

SF = The shielding factor (dimensionless)

A shielding factor of 0.7 is discussed in Table E-15 of Regulatory Guide 1.109 Revision 1. A tabulation of $DFG_i$ values is presented in Table E-6 of Regulatory Guide 1.109 Revision 1.

C.3 Grass-(Cow or Goat)-Milk Pathway

$$R_i(C) = \frac{K' Q_f (U_{ap}) \; F_m (r) (DFL)_{lat}}{(\lambda_i + \lambda_w)} \left[ \frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)}{Y_s} \left( e^{-\lambda_i t_h} \right) \right] e^{-\lambda_i t_f} \quad \text{--}$$

Where:

$R_i(C)$ = Dose factor for the cow milk or goat milk pathway, for each identified radionuclide i for the organ of interest, (units = m2-mrem/yr per $\mu$Ci/sec)

$K'$ = A constant of unit conversion, 1E6 pCi/$\mu$Ci

$Q_f$ = The cow's or goat's feed consumption rate, (units = Kg/day-wet weight).

$U_{ap}$ = The receptor's milk consumption rate for age group a, (units = liters/yr)

$Y_p$ = The agricultural productivity by unit area of pasture feed grass, (units = kg/m2)

$Y_s$ = The agricultural productivity by unit area of stored feed, (units = kg/m2)

$F_m$ = The stable element transfer coefficients, (units = pCi/liter per pCi/day)

$r$ = Fraction of deposited activity retained on cow's feed grass

$(DFL)_{lat}$ = The ingestion dose factor for nuclide i, age group a, and total body or organ t (units = mrem/pCi)

$\lambda_i$ = The radiological decay constant for radionuclide i, (units=sec -1)

$\lambda_w$ = The decay constant for removal of activity on leaf and plant surfaces by weathering equal to 5.73E-7 sec -1 (corresponding to a 14 day half-life)

$t_f$ = The transport time from pasture to cow or goat, to milk, to receptor, (units = sec)

$t_h$ = The transport time from pasture, to harvest, to cow or goat, to milk, to receptor (units = sec)

$f_p$ = Fraction of the year that the cow or goat is on pasture (dimensionless)

$f_s$ = Fraction of the cow feed that is pasture grass while the cow is on pasture (dimensionless)

Milk cattle and goats are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109 Revision 1, the value of $f_s$ is considered unity in lieu of site specific information. The value of $f_p$ is 0.5 based on 6 month grazing period. This value for $f_p$ was obtained from the environmental group.

Table C-1 contains the appropriate values and their source in Regulatory Guide 1.109 Revision 1.

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the $R_T(C)$ is based on X/Q:

$$R_T(C) = K'K''' F_m Q_f U_{ap} (DFL)_{lat} \quad 0.75(0.5/H)$$

Where:

$R_T(C)$ = Dose factor for the cow or goat milk pathway for tritium for the organ of interest, (units = mrem/yr per $\mu Ci/m^3$)

$K'''$ = A constant of unit conversion, 1E3 g/kg

H = Absolute humidity of the atmosphere, (units = $g/m^3$)

0.75 = The fraction of total feed that is water

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water

Other values are given previously. A site specific value of H equal to 6.14 $g/m^3$ is used. This value was obtained from the environmental group using actual site data.

C.4 Grass-Cow-Meat Pathway

$$R_i(C) = \frac{K' Q_f (U_{ap})\ F_m(r)(DFL)_{at}}{(\lambda_i + \lambda_w)} \left[ \frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s)(e^{-\lambda_i t_h})}{Y_s} \right] e^{-\lambda_i t_f}$$

$R_i(M)$ = Dose factor for the meat ingestion pathway for radionuclide i for any organ of interest, (units = $m^2$-mrem/yr per $\mu$Ci/sec)

$F_f$ = The stable element transfer coefficients, (units = pCi/kg per pCi/day)

$U_{ap}$ = The receptor's meat consumption rate for age group a, (units = kg/year)

$t_h$ = The transport time from harvest, to cow, to receptor, (units = sec)

$t_f$ = The transport time from pasture, to cow, to receptor, (units = sec)

All other terms remain the same as defined for the milk pathway. Table C-2 contains the values which were used in calculating $R_i(M)$.

The concentration of tritium in meat is based on airborne concentration rather than deposition. Therefore, the $R_T(M)$ is based on X/Q.

$$R_T(M) = K'K'''F_f Q_f U_{ap}(DFL)_{at}\ [0.75(0.5/H)]$$

Where:

$R_T(M)$ = Dose factor for the meat ingestion pathway for tritium for any organ of interest, (units = mrem/yr per $\mu Ci/m^3$)

All other terms are defined above.

C.5 Vegetation Pathway

The integrated concentration in vegetation consumed by man follows the expression developed for milk. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption, therefore:

$$R_i(V) = K' \frac{r}{Y_v(\lambda_i + \lambda_w)} (DFL)_{at} \left[ U^L_a F_L e^{-\lambda_i t_L} + U'_a F_g e^{-\lambda_i t_h} \right]$$

Where:

$R_i(V)$ = Dose factor for vegetable pathway for radionuclide i for the organ of interest, (units = $m^2$-mrem/yr per $\mu$Ci/sec)

$K'$ = A constant of unit conversion, 1E6 pCi/$\mu$Ci

$U^L_a$ = The consumption rate of fresh leafy vegetation by the receptor in age group a, (units = kg/yr)

$U^S_a$ = The consumption rate of stored vegetation by the receptor in age group a (units = kg/yr)

$F_L$ = The fraction of the annual intake of fresh leafy vegetation grown locally

$F_g$ = The fraction of the annual intake of stored vegetation grown locally

$t_L$ = The average time between harvest of leafy vegetation and its consumption, (units = sec)

$t_h$ = The average time between harvest of stored vegetation and its consumption, (units = sec)

$Y_v$ = The vegetation areal P density, (units = $kg/m^2$)

All other factors have been defined previously.

Table C-3 presents the appropriate parameter values and their source in Regulatory Guide 1.109 Revision 1.

In lieu of site-specific data, values for $F_L$ and $F_g$ of, 1.0 and 0.76, respectively, were used in the calculation. These values were obtained from Table E-15 of Regulatory Guide 1.109 Revision 1.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the $R_T(V)$ is based on X/Q:

$$R_T(V) = K'K''' [U^L_a f_L + U^L_a f_g](DFL)_{wi} 0.75(0.5/H)$$

Where:

$R_T(V)$ = dose factor for the vegetable pathway for tritium for any organ of interest, (units = mrem/yr per $\mu Ci/m^3$).

All other terms are defined in preceeding sections.

TABLE C-1

Parameters for Grass-(Cow or Goat)-Milk Pathways

| Parameter | Value | Reference (Reg. Guide 1.109 Rev. 1) |
|---|---|---|
| $Q_f$ (kg/day) | 50 (cow)<br>6 (goat) | Table E-3<br>Table E-3 |
| r | 1.0 (radioiodines)<br>0.2 (particulates) | Table E-15<br>Table E-15 |
| $(DFL)_{ija}$ (mrem/pCi) | Each radionuclide | Tables E-11 to E-14 |
| $F_m$ (pCi/liter per pCi/day) | Each stable element | Table E-1 (cow)<br>Table E-2 (goat) |
| $Y_s$ (kg/m$^2$) | 2.0 | Table E-15 |
| $Y_p$ (kg/m$^2$) | 0.7 | Table E-15 |
| $t_h$ (seconds) | $7.78 \times 10^6$ (90 days) | Table E-15 |
| $t_f$ (seconds) | $1.73 \times 10^5$ (2 days) | Table E-15 |
| $U_{ap}$ (liters/yr) | 330 infant<br>330 child<br>400 teen<br>310 adult | Table E-5<br>Table E-5<br>Table E-5<br>Table E-5 |

TABLE C-2

Parameters for the Grass-Cow-Meat Pathway

| Parameter | Value | Reference (Reg. Guide 1.109 Rev. 1) |
|---|---|---|
| r | 1.0 (radioiodines)<br>0.2 (particulates) | Table E-15<br>Table E-15 |
| $F_f$ (pCi/Kg per pCi/day) | Each stable element | Table E-1 |
| $U_{ap}$ (Kg/yr) | 0 infant<br>41 child<br>65 teen<br>110 adult | Table E-5<br>Table E-5<br>Table E-5<br>Table E-5 |
| $(DFL)_{ija}$ (mrem/pCi) | Each radionuclide | Tables E-11 to E-14 |
| $Y_p$ ($kg/m^2$) | 0.7 | Table E-15 |
| $Y_s$ ($kg/m^2$) | 2.0 | Table E-15 |
| $t_h$ (seconds) | 7.78E6 (90 days) | Table E-15 |
| $t_f$ (seconds) | 1.73E6 (20 days) | Table E-15 |
| $Q_f$ (kg/day) | 50 | Table E-3 |

TABLE C-3

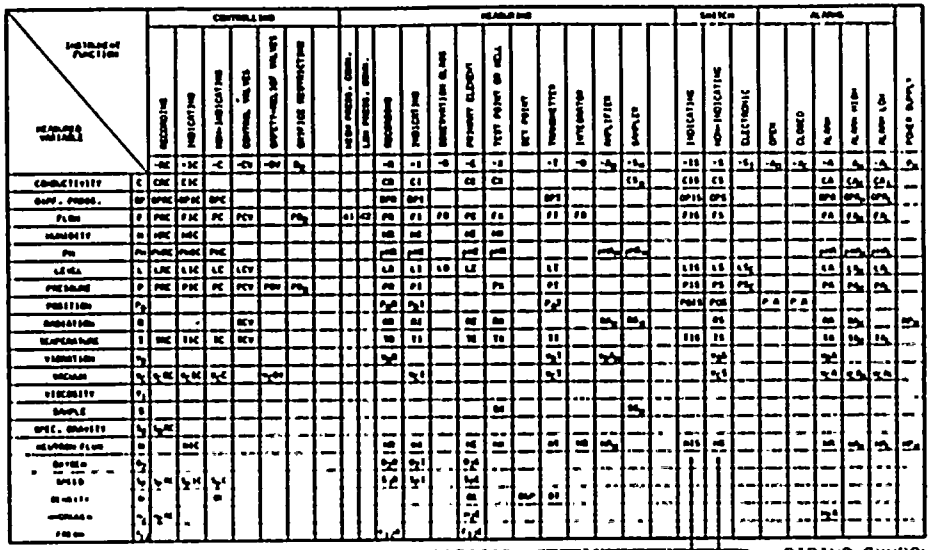
Parameters for the Vegetable Pathway

| Parameter | Value | Reference (Reg. Guide 1.109 Rev. 1) |
|---|---|---|
| r (dimensionless) | 1.0 (radioiodines)<br>0.2 (particulates) | Table E-1<br>Table E-1 |
| $(DFL)_{ija}$ (mrem/pCi) | Each radionuclide | Tables E-11 to E-14 |
| $U^L)_a$ (kg/yr) - infant | 0 | Table E-5 |
| - child | 26 | Table E-5 |
| - teen | 42 | Table E-5 |
| - adult | 64 | Table E-5 |
| $U^a)_a$ (kg/yr) - infant | 0 | Table E-5 |
| - child | 520 | Table E-5 |
| - teen | 630 | Table E-5 |
| - adult | 520 | Table E-5 |
| $t_L$ (seconds) | 8.6E4 (1 day) | Table E-15 |
| $t_h$ (seconds) | 5.18E6 (60 days) | Table E-15 |
| $Y_v$ (kg/m$^2$) | 2.0 | Table E-15 |

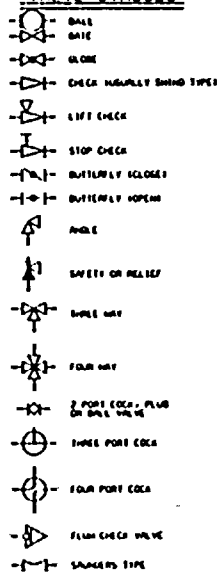
# APPENDIX D

## DIAGRAMS OF LIQUID AND GASEOUS TREATMENT SYSTEMS AND MONITORING SYSTEMS

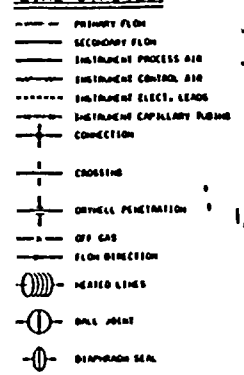
# PIPING, INSTRUMENT AND EQUIPMENT SYMBOLS



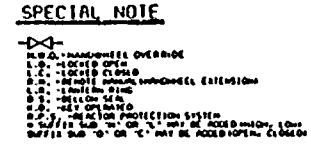
## VALVE SYMBOLS



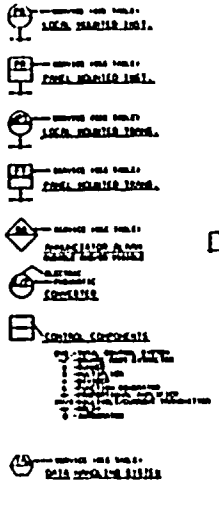
## LINE SYMBOLS



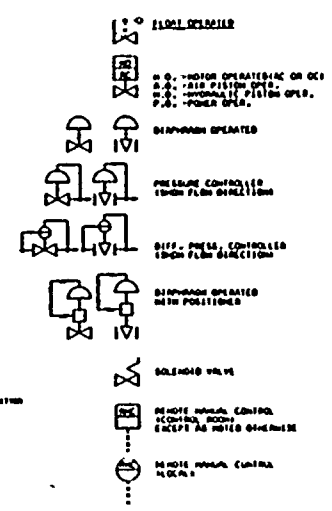
## SPECIAL NOTE



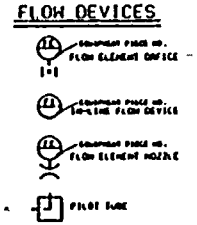
## INSTRUMENT SYMBOLS



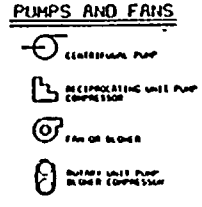
## CONTROL VALVE OPERATION



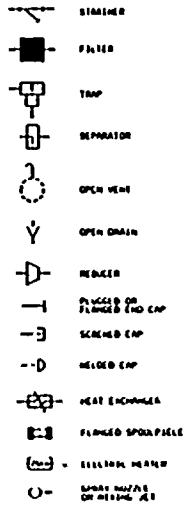
## FLOW DEVICES



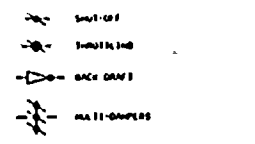
## PUMPS AND FANS



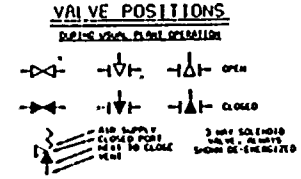
## PIPING SYMBOLS



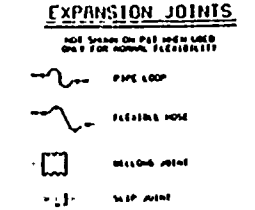
## VENTILATION DAMPERS



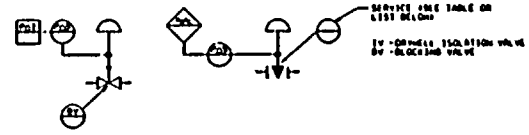
## VALVE POSITIONS



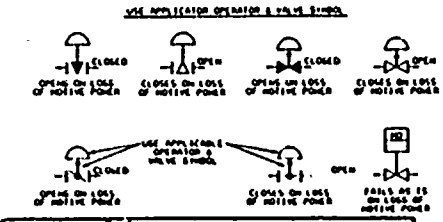
## EXPANSION JOINTS



## CONTROL VALVE DESIGNATION



## CONTROL VALVE OPERATION



| FIGURE D-0 |
|---|
| PIPING, INSTRUMENT AND EQUIPMENT SYMBOLS |
| NIAGARA MOHAWK POWER CORPORATION<br>NINE MILE POINT-UNIT 1<br>OFFSITE DOSE CALC. MANUAL |

D-0

A13901

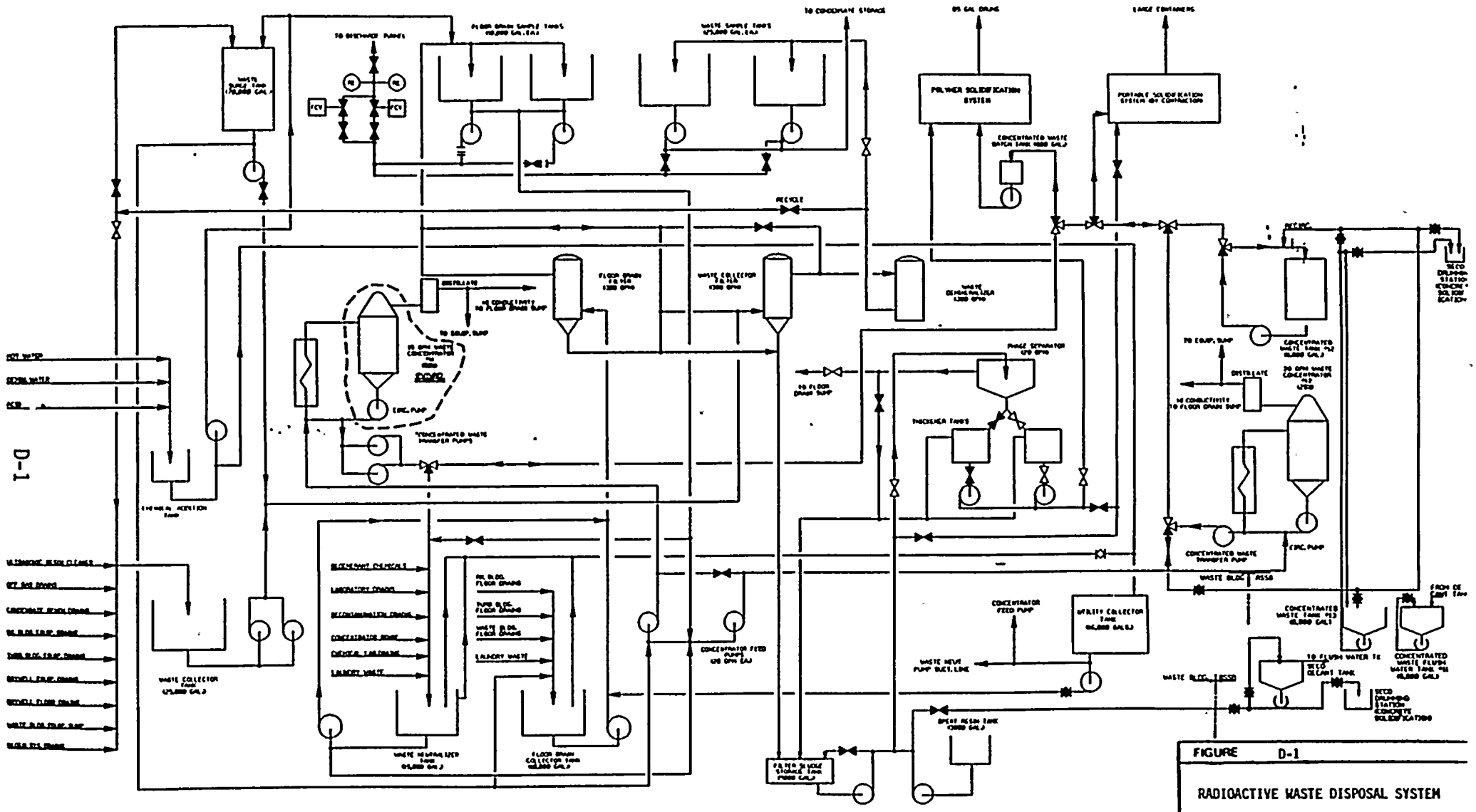



FIGURE D-1

RADIOACTIVE WASTE DISPOSAL SYSTEM

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 1
OFFSITE DOSE CALC. MANUAL

MAIN CONDENSER AIR REMOVAL AND OFF GAS SYSTEM

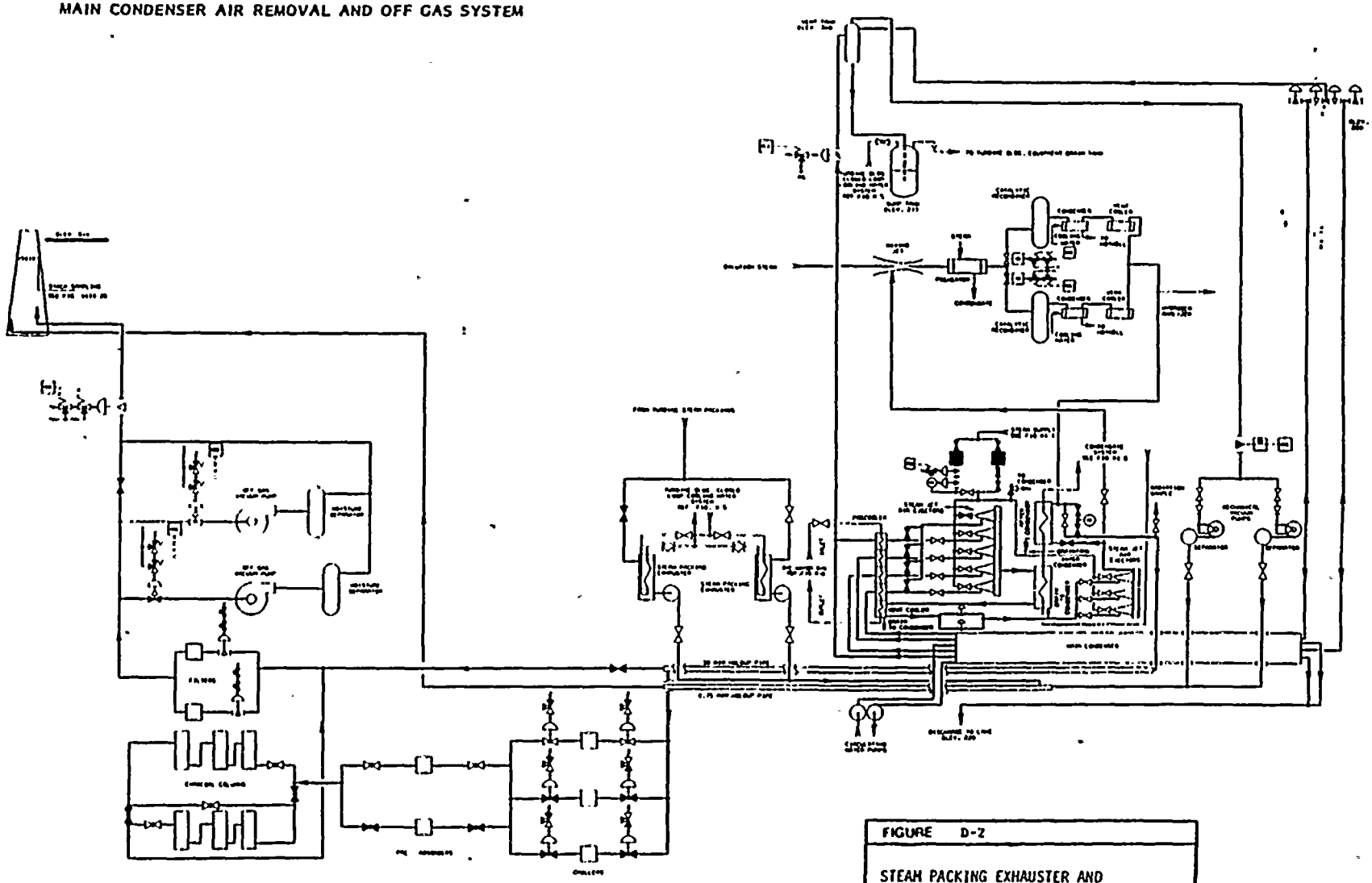


FIGURE D-2

STEAM PACKING EXHAUSTER AND RECOMBINER SYSTEM

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 1
OFFSITE DOSE CALC. MANUAL



D-2

REACTOR BUILDING VENTILATION SYSTEM

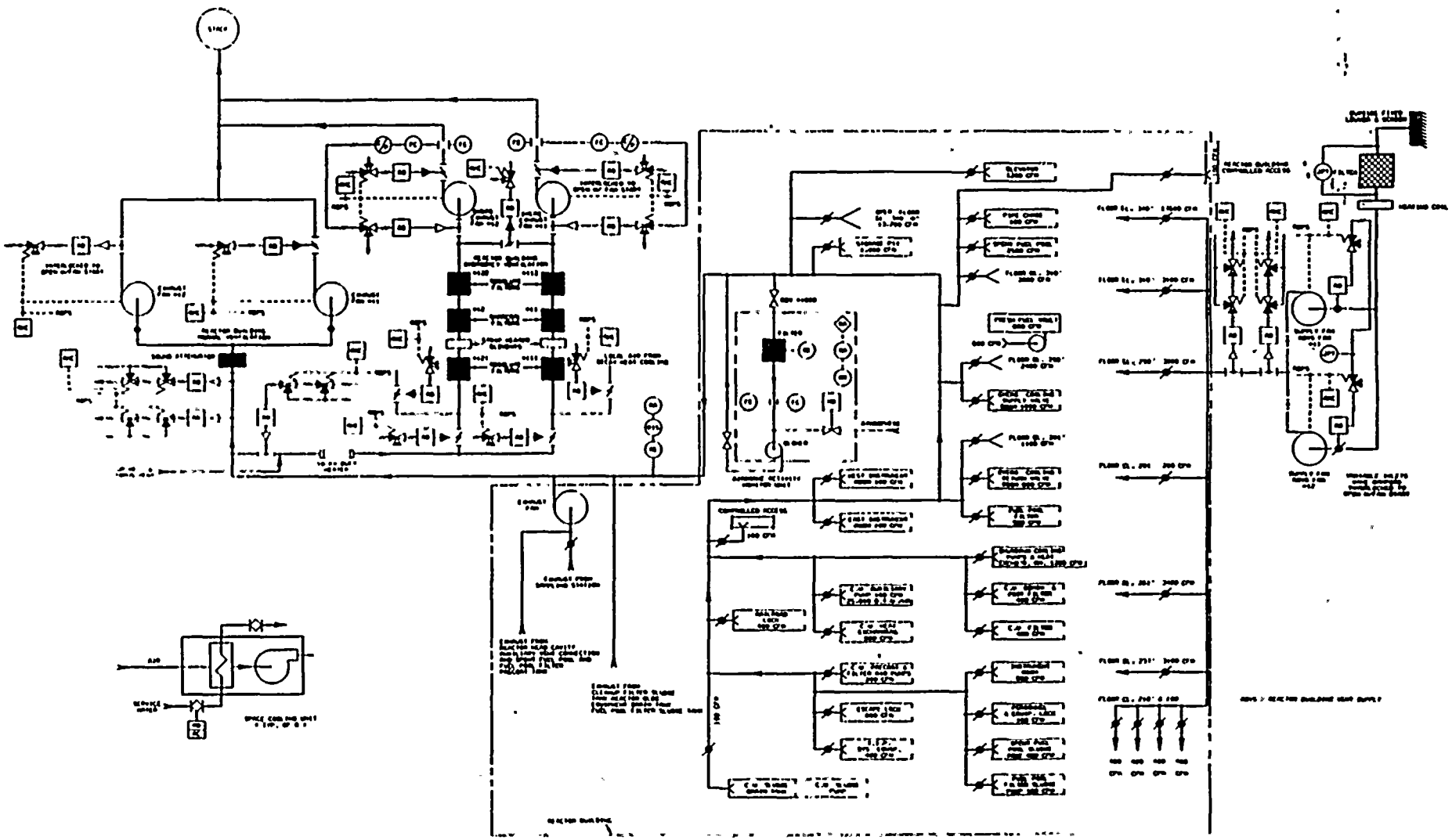


FIGURE D-3

REACTOR BUILDING VENTILATION SYSTEM

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 1
OFFSITE DOSE CALC. MANUAL



D-3

WASTE DISPOSAL BUILDING VENTILATION SYSTEM

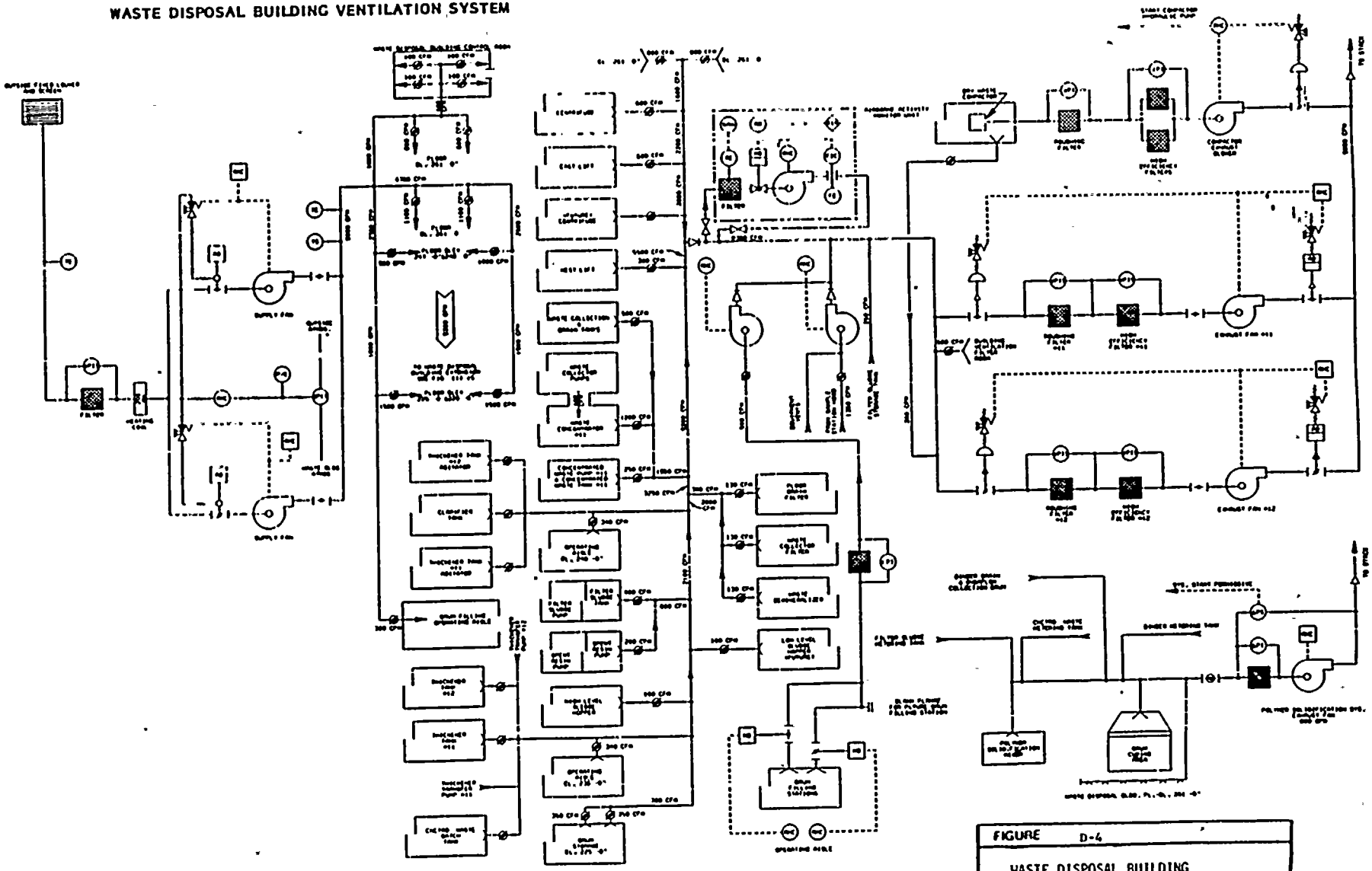


FIGURE D-4

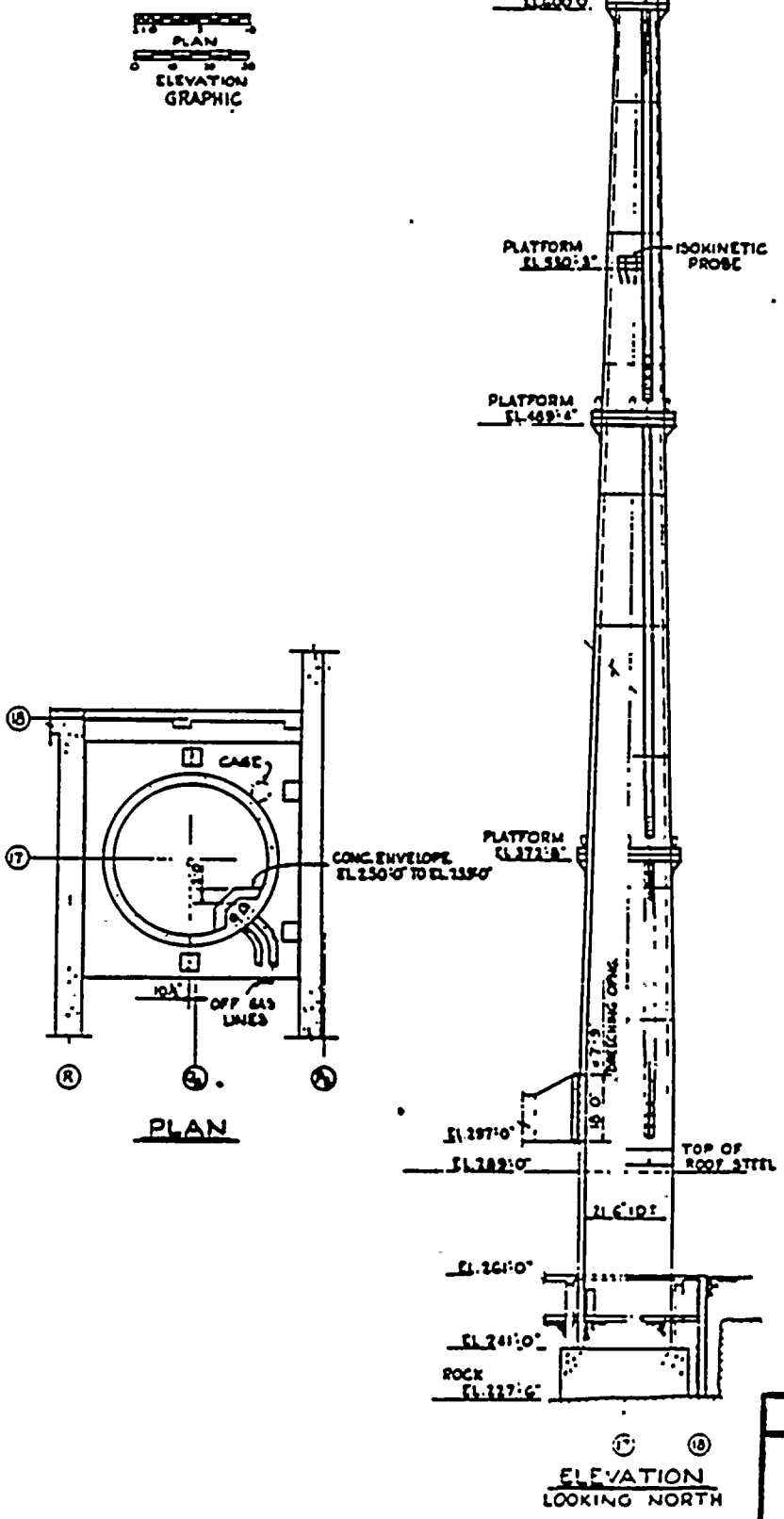
WASTE DISPOSAL BUILDING VENTILATION SYSTEM

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 1
OFFSITE DOSE CALC. MANUAL



D-4

# STACK - PLAN AND ELEVATION




| FIGURE D-5 |
| --- |
| NMP-1 Stack |
| NIAGARA MOHAWK POWER CORPORATION<br>NINE MILE POINT-UNIT 1<br>OFFSITE DOSE CALC. MANUAL |

OFF GAS BUILDING VENTILATION SYSTEM

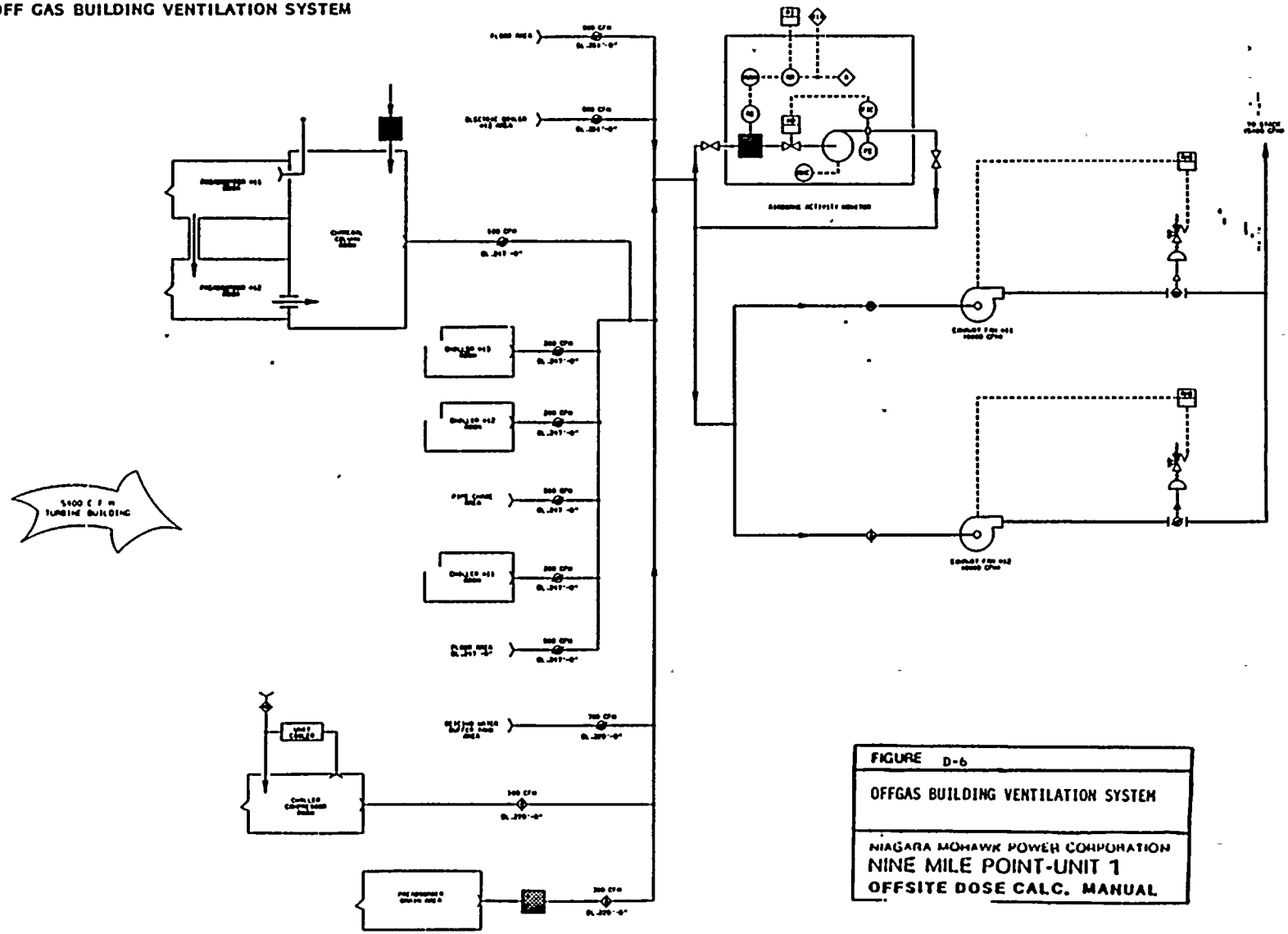


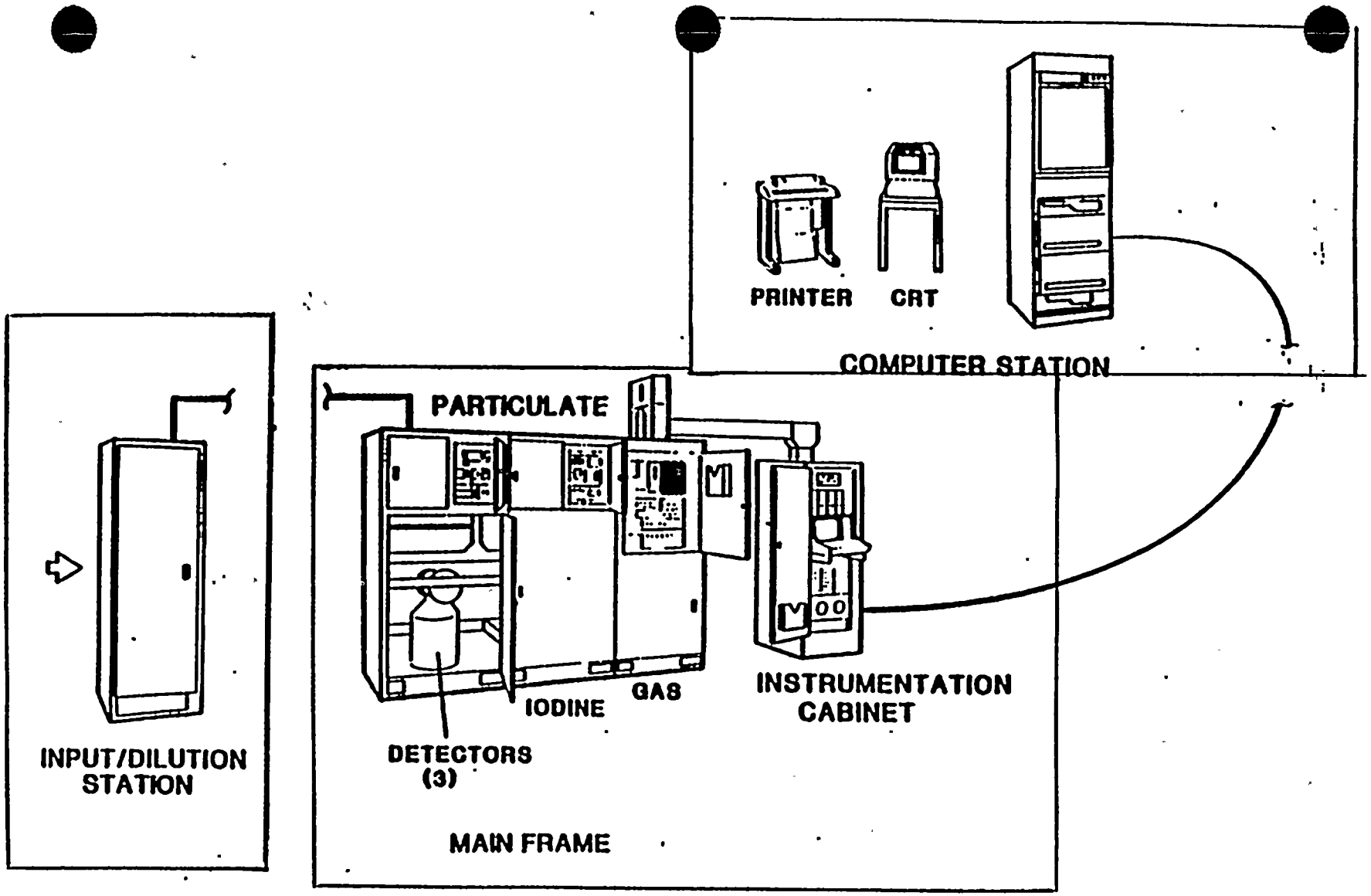
FIGURE D-6

OFFGAS BUILDING VENTILATION SYSTEM

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 1
OFFSITE DOSE CALC. MANUAL



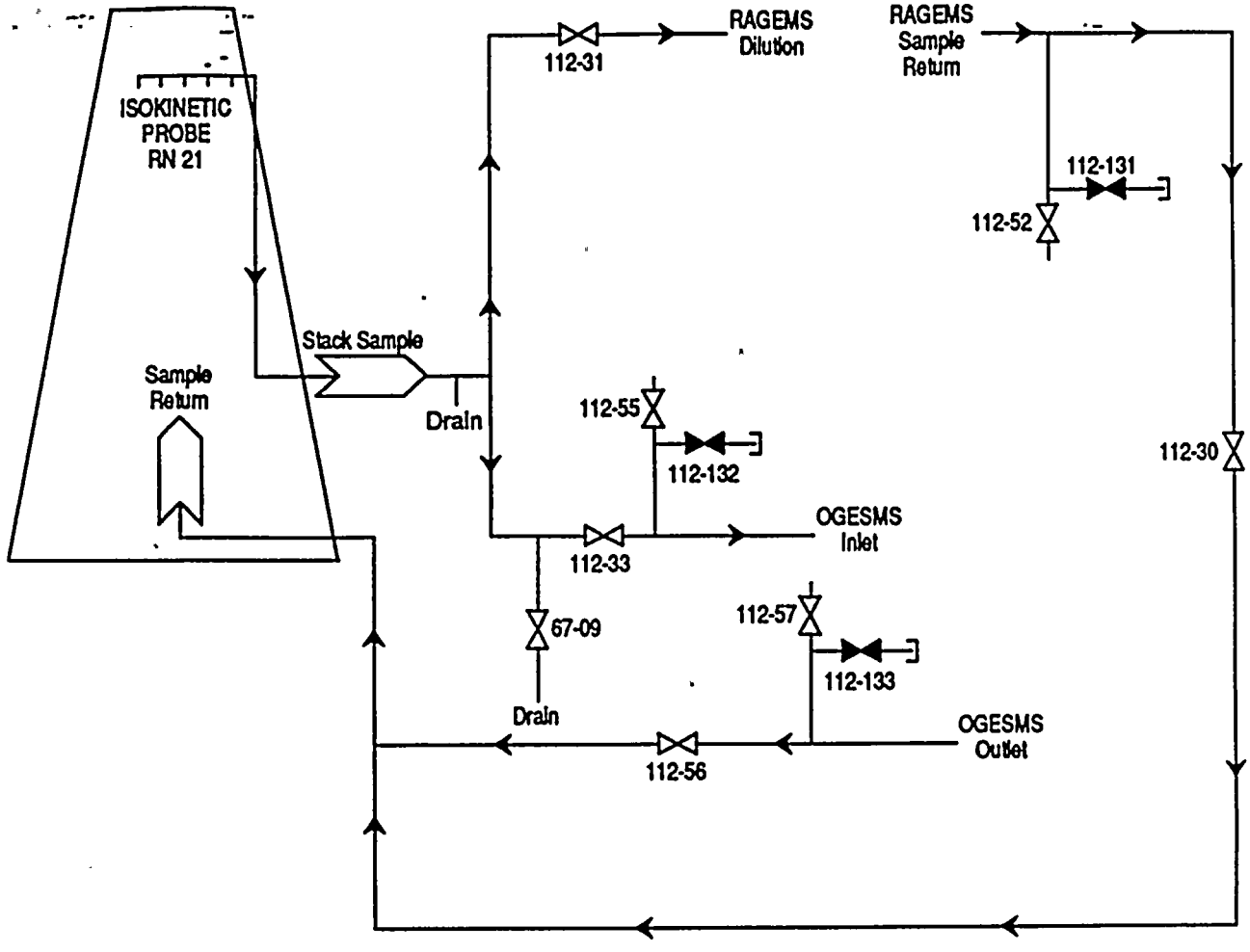
D-6




| FIGURE D- 7 |
| --- |
| Simplified View of Model 400 Stack Monitor |
| NIAGARA MOHAWK POWER CORPORATION<br>NINE MILE POINT-UNIT 1<br>OFFSITE DOSE CALC. MANUAL |



D-7




| Figure D-8 |
| --- |
| Stack Sample and Sample Return |
| NIAGARA MOHAWK POWER CORPORATION<br>**NINE MILE POINT - UNIT 1**<br>OFFSITE DOSE CALC. MANUAL |

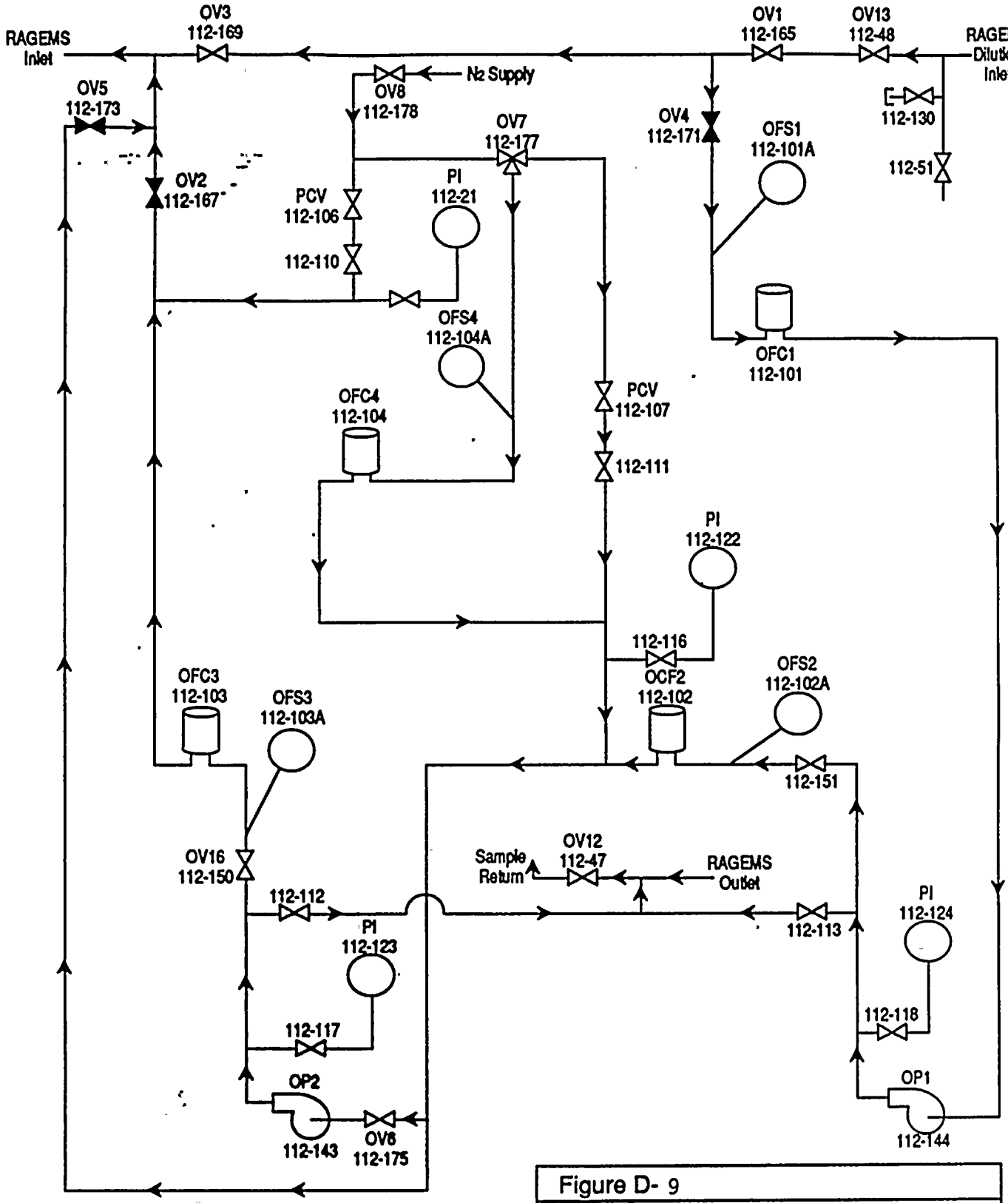



Figure D- 9

RAGEMS Dilution Schematic

NIAGARA MOHAWK POWER CORPORATION
**NINE MILE POINT - UNIT 1**
OFFSITE DOSE CALC. MANUAL

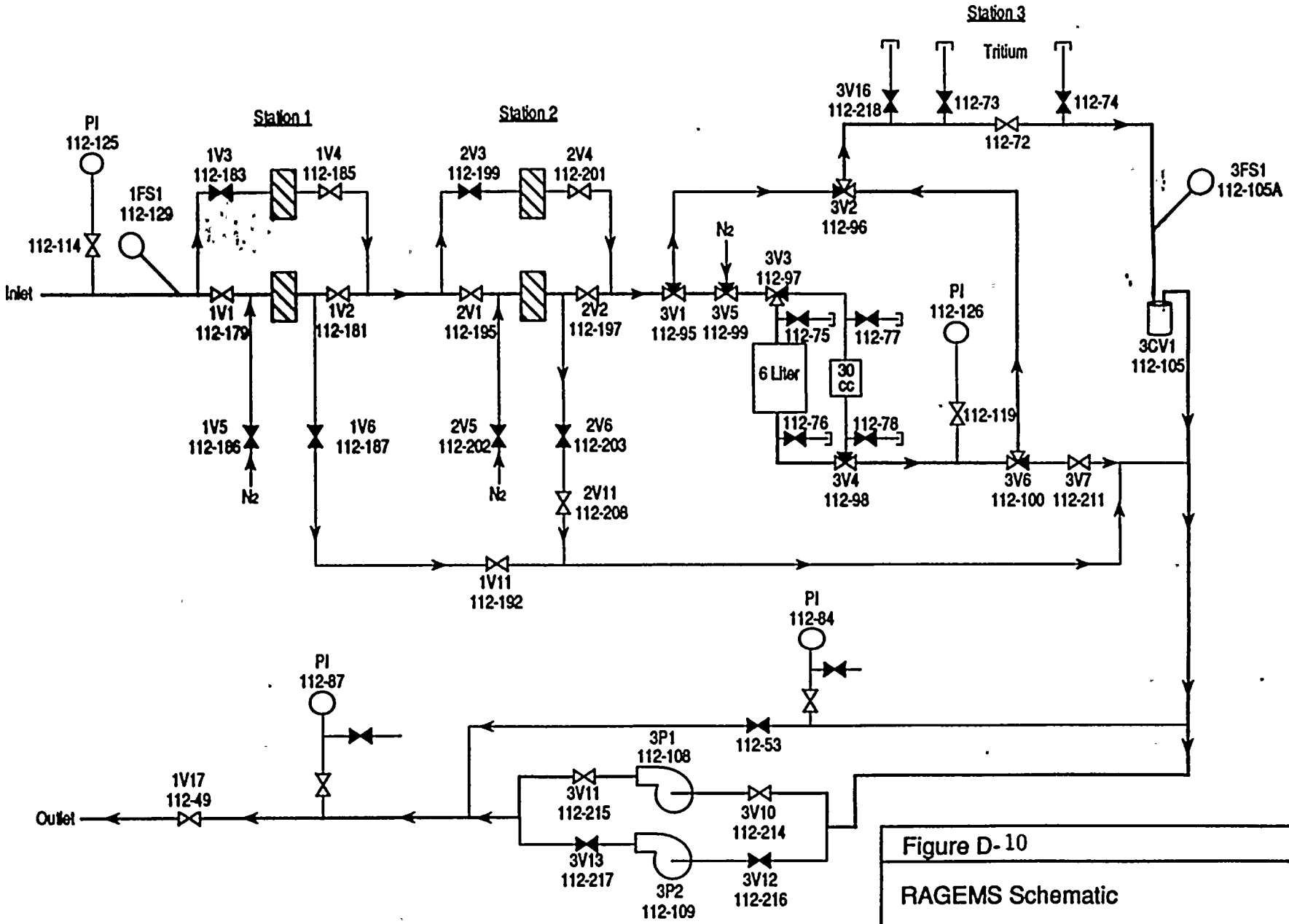



Figure D-10

RAGEMS Schematic

NIAGARA MOHAWK POWER CORPORATION
**NINE MILE POINT - UNIT 1**
OFFSITE DOSE CALC. MANUAL



D-10

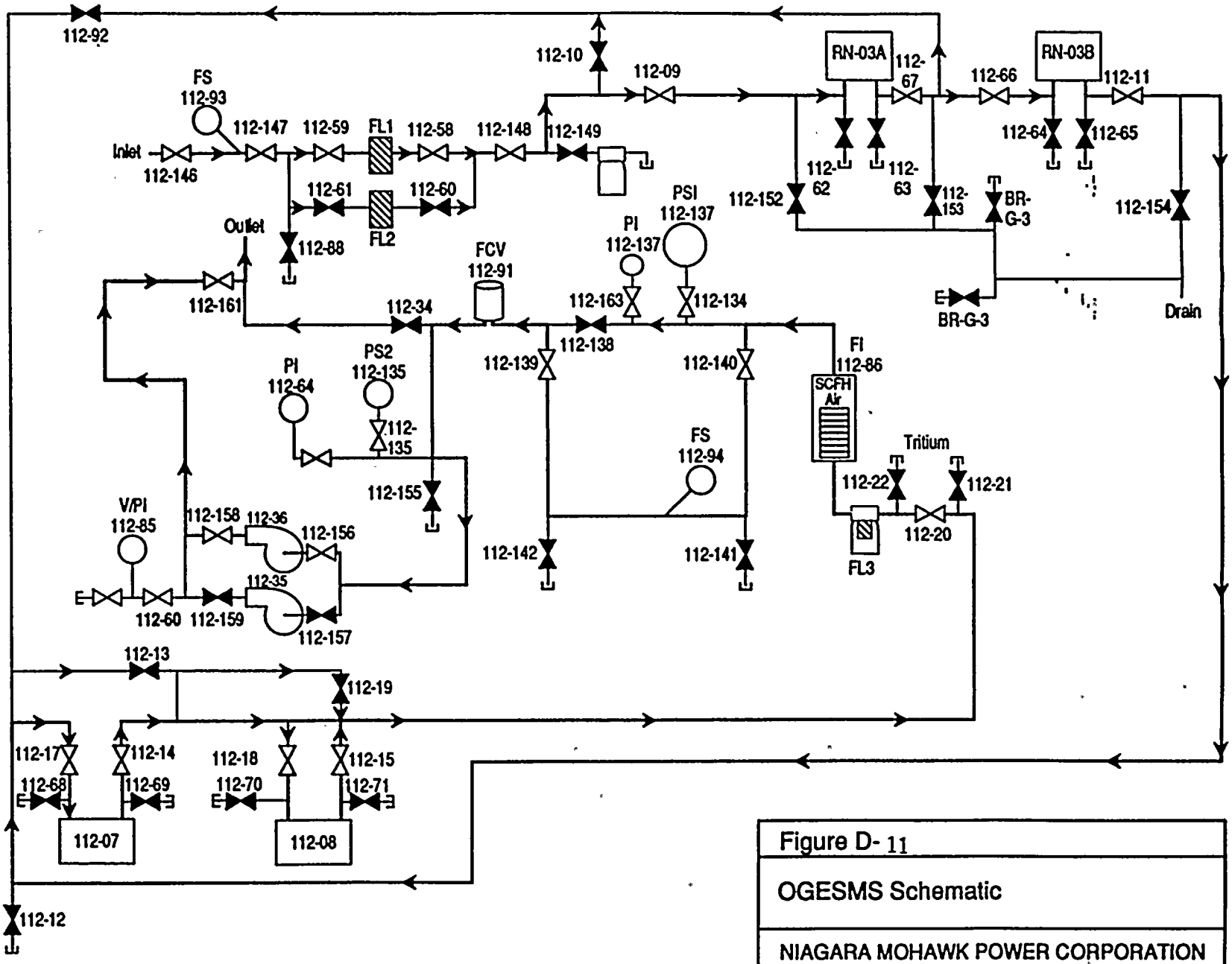



Figure D- 11

OGESMS Schematic

NIAGARA MOHAWK POWER CORPORATION
**NINE MILE POINT - UNIT 1**
OFFSITE DOSE CALC. MANUAL



D-11

ATTACHMENT 2

| NIAGARA MOHAWK | LICENSING DOCUMENT CHANGE REQUEST | LDCR No: 1 93 0044 | Rev 0 |
|---|---|---|---|

PART 1—INITIATION



| A. Affected Doc | OPL | UFS | Plans & Programs | |
|---|---|---|---|---|
| ☒ Unit 1 | ☐ Facility Operating License | ☐ UFSAR | ☐ Site Emergency Plan (SEP) | ☐ ISI Program Plan (ISI) |
| ☐ Unit 2 | ☐ Technical Specifications | ☐ Quality Assur Program | ☐ Security Plans (SPS) | ☐ IST Program Plan (IST) |
| ☐ Site | ☐ Environmental Prot Plan | ☐ Fire Prot Program | ☐ Process Control Program (PCP) | ☐ Core Operating Limits Rept (COL) |
| | | | ☒ Offsite Dose Calc Manual (ODM) | |

B. Description ☒ Permanent ☐ Temporary, Expected Duration: _____

EDT 11/29/93
To A milk location was added to the environmental monitoring program, and therefore had to be updated in the Unit 1 ODCM.

| C. Page | Section, Figure, Table | Page | Section, Figure, Table |
|---|---|---|---|
| ~~66~~ | Table 5.1 | | |
| xv 69 | Map Figure 5.1-2 EDT 11/29/93 | | |
| EDT 11/29/93 | ~~APPENDIX E~~ | | |

D. Source of Change / References

memo from B. Zacharek to E.D. Thomas, dated August 20, 1993.
(Environmental group request for update to information in the Unit 1 ODCM.) EDT 11/29/93

| E. NIP-SEV-01 Review | F. Originator (Print) | Date |
|---|---|---|
| ☒ Preliminary Evaluation/Safety Review Attached ☐ Safety Evaluation No.: D93-204 | E.D. Thomas | 11/29/93 |

PART 2—REVIEW / APPROVAL

| A. SME (Print/Initial) ☐ N/A | Date | B. Resp Org Branch Manager (Print/Initial) | Date |
|---|---|---|---|
| E.D. Thomas EDT | 11/29/93 | A. Vierling AV | 11/30/93 |

| C. Effectiveness Review | D. SORC ☐ N/R | E. SRAB ☒ N/R |
|---|---|---|
| ☐ N/R ☒ Attached | Mtg No.: 93-088-1 Mtg Date: 12/14/93 | Mtg No.: Mtg Date: |

| F. Plant Mgr ☐ N/R | G. NRC (NIP-IRG-01 Submittal Required) ☐ N/R |
|---|---|
| ☒ Obtained per Doc Coversheet ☐ Obtained per NIP-IRG-01 ☐ Obtained per NIP-SEV-01 | ☒ Letter No./Date: ~~SARERR~~ VIA SARERR - 3/1/94 ☐ NRC App'l Date: |

PART 3—IMPLEMENTATION

| | |
|---|---|
| A. OPL Only: Affected Documents Updated | ☐ |
| B. UFS Only: Need "As-Built" or Affect Document | ☐ |
| C. Other: ODCM U-1 Rev. 13 | ☐ |

PART 4—CLOSURE

| A. ☒ Incorp'd into Parent Doc, Close Change Tracking OR B. ☐ Not Yet Incorp'd into Parent Doc, App'd for Rev: _____ | Incorp'd Rev: 13 |
|---|---|
| C. Closed by (Print/Initial) Elizabeth D. Thomas EDT | Date 12/20/93 |

ATTACHMENT 3

| NIAGARA MOHAWK | EFFECTIVENESS REVIEW | LDCR No. | Rev |
|---|---|---|---|
| | | 1 9 3 0 M | 0 0 |

☐ **UFSAR** Page 2 of 2

A. *Quality Assurance Program*

- Does the change(s) cease to satisfy the criteria of 10CFR50 Appendix B or reduce SAR program commitments previously accepted by the NRC? ☐ Yes ☐ No

B *Fire Protection Program*

- Does the change(s) adversely affect the ability to achieve and maintain safe shutdown in the event of a fire? ☐ Yes ☐ No

☐ **SITE EMERGENCY PLAN**

- Does the change(s) decrease effectiveness of the SEP? ☐ Yes ☐ No
- Does the SEP, as changed, cease to meet the standards of 10CFR50.47(b) and 10CFR50 Appendix E? ☐ Yes ☐ No

☐ **SECURITY PLANS**

- Document:
- Does the change(s) decrease the effectiveness of the Physical Security Plan or Security Personnel Training and Qualification Plan prepared pursuant to 10CFR50.34(c) or 10CFR73? ☐ Yes ☐ No
- Does the change(s) decrease the effectiveness of the first four categories of informational Background, Generic Planning Base, Licensee Planning Base, and/or responsibility matrix of the Safeguards Contingency Plan prepared pursuant to 10CFR50.34(d) or 10CFR73? ☐ Yes ☐ No

☐ **PROCESS CONTROL PROGRAM**

- Does the change(s) reduce the overall conformance of the solidified waste product to existing criteria for solid wastes in accordance with Technical Specifications? ☐ Yes ☐ No

☒ **ODCM**

- Does the change(s) reduce the accuracy of reliability of the dose calculations or setpoint determinations in accordance with Technical Specifications? ☐ Yes ☐ No

**BASIS**

The change is in accordance with Unit 1 Technical Specifications 3.5 and NAC requirements and only updates sampling locations. Any change to calculations will only increase the accuracy and reliability due to consistency with T.S. This change does not affect setpoint calculations.

**PREPARER**

| (Print/Initial) | Date |
|---|---|
| Elizabeth D. Thomas EDT | 11/3/03 |

# 10CFR50.59 PRELIMINARY EVALUATION

**TITLE:** Revision 13 to the Unit 1 Offsite Dose Calculation Manual

**DESCRIPTION OF PROPOSED CHANGE:** ***Permanent*** or Temporary

(1) A new Technical Specification milk location was added to the Radiological Environmental Monitoring Program.

**DOCUMENTS REVIEWED:** (1) Memo from B. Zacharek to B. Thomas, dated August 20, 1993.

I. SAFETY IMPACT EVALUATION

A. Is the SAR affected?

1. Does the proposal change the facility or procedures from their description in the SAR? (Yes/*No*) *This change is an update of information based on compliance with NRC Regulations and Technical Specification Requirements, and does not involve a description of the facility or procedures in the SAR.*

   a. Does the proposed change alter the design, function, or method of performing the function or a component, system, or structure described in the SAR? (Yes/*No*) *This change is an update of information based on compliance with NRC Regulations and Technical Specification Requirements, and does not involve any components, systems, or structures described in the SAR.*

   b. Does the proposed change alter procedures discussed in the initial operations and organizational chapters of the FSAR or the other procedural-type commitments, such as the emergency plan and modes and sequences of plant operation described in the SAR? (Yes/*No*) *This change is an update of information based on compliance with NRC Regulations and Technical Specification Requirements, and does not involve any procedures discussed in the initial operations and organizational chapters of the FSAR or other procedural-type commitments.*

## 10CFR50.59 PRELIMINARY EVALUATION
(Cont'd)

2. Does the proposal involve a test or experiment not described in the SAR? (Yes/*No*) *This change is an update of information based on compliance with NRC Regulations and Technical Specification Requirements, and does not involve a test or experiment described in the SAR.*

3. Could the proposal affect nuclear safety in a way not previously evaluated in the SAR? (Yes/*No*) *This change is an update of information based on compliance with NRC Regulations and Technical Specification Requirements, and complies with all NRC requirements and in no way affects nuclear safety.*

   If the answer to all the above questions is "NO", a safety evaluation is not required. If the answer is "YES" to any items in A, a detailed Safety Evaluation is required to determine if an Unreviewed Safety Question exists.

B. Is a change to the Technical Specifications necessary? (Yes/*No*)
If Yes, go to NIP-LPP-01.

DETAILED SAFETY EVALUATION IS REQUIRED? __YES _X_NO

# 10CFR50.59 PRELIMINARY EVALUATION
(Cont'd)

II. ENVIRONMENTAL IMPACT EVALUATION

A. Will the change, test or experiment:

*1. Result in a significant increase in any adverse environmental impact previously reviewed and evaluated in the NMP2 Final Environmental Statement - Operating License Stage (FES-OL) and other NRC Environmental impact assessments? YES ***NO***

2. Result in a significant change in the effluents or power level? YES ***NO***

*3. Result in an activity not confined to on-site areas previously disturbed during site preparation and plant construction? YES ***NO***

4. Concern a matter not previously reviewed and evaluated in the documents specified in question "1" above, which may have a significant adverse environmental impact? YES ***NO***

*5. Constitute a decrease in the effectiveness of the NMP2 Environmental Protection Plan (EPP)? YES ***NO***

B. Is a change to the Environmental Protection Plan necessary? YES ***NO***

If the answer to all the above questions is "NO", the Environmental Evaluation is complete and no further action is required.

If the answer is "YES" to any items in II.A or II.B above, a detailed Environmental Evaluation is required to determine if an Unreviewed Environmental Question exits. Contact Supervisor Environmental Protection.

DETAILED ENVIRONMENTAL EVALUATION IS REQUIRED? YES ***NO***

# 10CFR50.59 PRELIMINARY EVALUATION
(Cont'd)

III. IDENTIFICATION OF SAR CHANGES

A. Are SAR changes required? (Yes/*No*)

LDCR No. *See note below.*

Affected figures, tables, text sections (also indicate sheets for tables and figures and pages for text)_____

_____

IV. IDENTIFICATION OF IMPACT ON PREVIOUS COMMITMENTS

A. Excluding statements made in the SAR, does this change impact any commitments made to the NRC? (Yes/*No*)

If yes, list commitment, agency.

1. _____ agency

2. _____ agency

B. Does commitment(s) need to be changed? (Yes/*No*)

If yes, notify the NRC Program Director.

V. SIGNATURES

Preparer: Elizabeth A. Thomas — Responsible Individual — Date: 11/30/93

Approver: [signature] Mgr. Tech Sp. — Approver/Title — Date: 11/30/93

* Contact the NMP Supervisor Environmental Protection for assistance in answering these questions, if necessary.

Note: There is an ODCM change which requires an LDCR No. 1-93-ODM-004, but this is not considered a SAR change.