VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

August 31, 1989

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 89-618
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Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

Gentlemen:

**VIRGINIA ELECTRIC AND POWER COMPANY**
**NORTH ANNA POWER STATION UNITS 1 AND 2**
**SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT**

Enclosed is the North Anna Power Station Semi-Annual Radioactive Effluent Release Report for January 1, 1989 through June 30, 1989. The report submitted pursuant to North Anna Station Technical Specification 6.9.1.9, includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released during the previous six months, as outlined in Regulatory Guide 1.21, Revision 1, June 1974.

Very truly yours,

W. L. Stewart
Senior Vice President - Power

Enclosure

cc: United States Nuclear Regulatory Commission
Region II
101 Marietta Street, N.W.
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Mr. J. L. Caldwell
NRC Senior Resident Inspector
North Anna Power Station



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RADIOACTIVE EFFLUENT RELEASE REPORT

NORTH ANNA POWER STATION

(JANUARY 01, 1989 TO JUNE 30, 1989)

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## FORWARD

This report is submitted as required by Appendix A to Operating License Nos. NPF-4 and NPF-7, Technical Specifications for North Anna Power Station, Units 1 and 2, Virginia Electric and Power Company, Docket Nos. 50-338, 50-339, Section 6.9.1.9.

RADIOACTIVE EFFLUENT RELEASE REPORT

FOR THE

NORTH ANNA POWER STATION

(JANUARY 01, 1989 TO JUNE 30, 1989)

INDEX

## 1.0 PURPOSE AND SCOPE

The Radioactive Effluent Release Report includes in Attachment 1, a summary of the quantities of radioactive liquid and gaseous effluents and solid waste as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents of Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Tables 1, 2 and 3 of Appendix B thereof. The report submitted within 60 days after January 1 of each year includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site during the previous calendar year. The report submitted within 60 days after July 1 of each year has the same sections except for the assessment of radiation doses. The report also includes a list of unplanned releases during the reporting period, in Attachment 7.

As required by Technical Specification 6.15.2 changes to the ODCM for the time period covered by this report are included in Attachment 3. Information is provided to support the changes along with a package of those pages of the ODCM changed.

This report includes changes to the PCP with information and documentation necessary to support the rationale for the changes as required by Technical Specification 6.14.1, in Attachment 4.

Major changes to radioactive liquid, gaseous and solid waste treatment systems are reported in Attachment 5, as required by Technical Specification 6.16. Information to support the reason(s) for the change(s) and a summary of the 10 CFR 50.59 evaluation are included. In lieu of reporting major changes in this report, major changes to the radioactive waste treatment systems may be submitted as part of the annual FSAR update.

As required by Technical Specification 3.3.3.10.b and 3.3.3.11.b, a list and explanation for the inoperability of radioactive liquid and/or gaseous effluent monitors are provided in this report, in Attachment 6.

## 2.0 DISCUSSION

The basis for the calculation of the percent of technical specification for the critical organ in Table 1A of Attachment 1, is Technical Specification 3.11.2.1.b. Technical Specification 3.11.2.1.b requires that the dose rate for iodine-131, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days shall be less than or equal to 1500 mRem/yr to the critical organ at or beyond the site boundary. The critical organ is the child's thyroid; inhalation pathway.

The basis for the calculation of percent of technical specification for the total body and skin in Table 1A of Attachment 1, is Technical Specification 3.11.2.1.a. Technical Specification 3.11.2.1.a requires that the dose rate for noble gases to areas at or beyond site boundary shall be less than or equal to 500 mRem/yr to the total body and less than or equal to 3000 mRem/yr to the skin.

The basis for the calculation of the percent of technical specification in Table 2A of Attachment 1, is Technical Specification 3.11.1.1. Technical Specification 3.11.1.1 states that the concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10 CFR 20, 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 2.0E-4 microcuries/ml.

Percent of technical specification calculations are based on the total gaseous or liquid effluents released for that respective quarter.

The annual and quarterly doses, as reported in Attachment 2 of the report submitted within 60 days after January 1 of each year, are calculated according to the methodology presented in the ODCM. The beta and gamma air doses due to noble gases released from the site were calculated at site boundary. The maximum exposed member of the public from the releases of airborne iodine-131, tritium and all radionuclides in particulate form with half lives greater than 8 days, is defined as an infant, exposed through the grass-cow-milk pathway, with the critical organ being the thyroid. The maximum exposed member of the public from radioactive materials in liquid effluents in unrestricted areas is defined as an adult, exposed by either the invertebrate or fish pathway, with the critical organ being the liver. The total body dose was also determined for this individual.

Unplanned releases presented in Attachment 7 are defined according to the criteria presented in 10 CFR 50.73, as those gaseous radioactive releases that exceed 2 times the applicable concentrations of the limits specified in Appendix B, Table II, of 10 CFR 20 in unrestricted areas, when averaged over a time period of one hour, and/or as those liquid radioactive releases that exceed 2 times the limiting combined Maximum Permissible Concentration (MPC) specified in Appendix B, Table II, of 10 CFR 20 in unrestricted areas for all radionuclides except tritium and dissolved noble gases, when averaged over a time period of one hour.

The typical Lower Limit of Detection ( LLD ) capabilities of the radioactive effluent analysis instrumentation are presented in Attachment 8. These Lower Limit of Detection values are based upon conservative conditions (i.e., minimum sample volume and maximum delay time prior to analysis). Actual Lower Limit of Detection values may be lower. If a radioisotope is not detected when analyzing effluent samples, then the activity of that radioisotope will be reported as Not Detectable (N/D) on Attachment 1 of this report. When all radioisotopes listed on Attachment 1 for a particular quarter and release mode are less than the Lower Limits of Detection, then the totals for this period will be designated as Not Applicable (N/A).

## 3.0 SUPPLEMENTAL INFORMATION

As required by Technical Specification 3.12.2 and 6.9.1.9, Evaluation of the Land Use Census is to be made for identifying the new location(s) for dose calculations and/or environmental monitoring pursuant to Technical Specification 3.12.2 requirements. No new location(s) for dose calculations and/or environmental monitoring pursuant to Technical Specification 3.12.2 requirements were identified by the evaluation of the Land Use Census conducted during 1988.

As required by Technical Specification 3.12.1.c., the identification of the causes of the unavailability of milk or leafy vegetation samples, required by Technical Specification Table 4.12-1, and the identification of the new location(s) for obtaining replacement samples are listed. No unavailability of milk or leafy vegetation samples, as required by Technical Specification Table 4.12-1, occurred during the time period covered by this report.

ATTACHMENT 1

EFFLUENT RELEASE DATA

(01/89 - 06/89)

This attachment includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste, as outlined in Regulatory Guide 1.21.

TABLE 1A

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

SUMMATION OF ALL GASEOUS EFFLUENT RELEASES FOR 1989

| | UNITS | 1st QUARTER | 2nd QUARTER | ESTIMATED TOTAL PERCENT ERROR (%) |
|---|---|---|---|---|
| A. Fission and Activation Gases: | | | | |
| 1. Total Release. | Curies | 1.24E+3 | 5.00E-1 | 1.70E+1 |
| 2. Average Release Rate for Period. | μCi/sec | 1.59E+2 | 6.36E-2 | |
| B. Iodines: | | | | |
| 1. Total Iodine-131 Release. | Curies | 2.17E-3 | 5.73E-5 | 1.70E+1 |
| 2. Average Release Rate for Period. | μCi/sec | 2.79E-4 | 7.29E-6 | |
| C. PARTICULATES ($T_{1/2}$ > 8 days): | | | | |
| 1. Total Particulate ($T_{1/2}$ > 8 days) Release. | Curies | 2.70E-4 | 1.91E-4 | 1.70E+1 |
| 2. Average Release Rate for Period. | μCi/sec | 3.47E-5 | 2.43E-5 | |
| 3. Gross Alpha Radioactivity Release. | Curies | N/D | N/D | |
| D. Tritium: | | | | |
| 1. Total Release. | Curies | 2.03E+1 | 5.71E+0 | 1.70E+1 |
| 2. Average Release Rate for Period. | μCi/sec | 2.61E+0 | 7.26E-1 | |
| E. Percentage of Technical Specification Limits: | | | | |
| 1. Total Body Dose Rate. | % | 6.70E-2 | 3.82E-6 | |
| 2. Skin Dose Rate. | % | 2.42E-2 | 2.14E-6 | |
| 3. Critical Organ Dose Rate. | % | 4.59E-3 | 5.72E-4 | |

N/D is Not Detectable & N/A is Not Applicable

TABLE 1B

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

MIXED MODE GASEOUS EFFLUENT RELEASES FOR 1989



| | | CONTINUOUS MODE | | BATCH MODE | |
|---|---|---|---|---|---|
| NUCLIDES RELEASED | UNITS | 1st QUARTER | 2nd QUARTER | 1st QUARTER | 2nd QUARTER |
| Fission and Activation Gases: | | | | | |
| Krypton - 85 | Ci | N/D | N/D | 6.03E+1 | 9.55E-2 |
| Krypton - 85m | Ci | N/D | N/D | 3.96E-3 | N/D |
| Krypton - 87 | Ci | N/D | N/D | N/D | N/D |
| Krypton - 88 | Ci | N/D | N/D | N/D | N/D |
| Xenon - 133 | Ci | 1.56E+1 | 3.22E-1 | 6.47E+2 | 8.00E-2 |
| Xenon - 133m | Ci | N/D | N/D | 2.14E+0 | N/D |
| Xenon - 135 | Ci | 7.60E-1 | N/D | 2.16E-1 | N/D |
| Xenon - 135m | Ci | N/D | N/D | N/D | N/D |
| Xenon - 138 | Ci | N/D | N/D | N/D | N/D |
| Others (Specify) | | | | | |
| Krypton - 83m | Ci | N/D | N/D | 1.99E+0 | N/D |
| Xenon - 131m | Ci | N/D | N/D | 2.08E+1 | 2.09E-3 |
| | | | | | |
| Total for Period | Ci | 1.64E+1 | 3.22E-1 | 7.32E+2 | 1.78E-1 |
| | | | | | |
| Iodines: | | | | | |
| Iodine - 131 | Ci | 1.38E-5 | 2.59E-8 | N/D | N/D |
| Iodine - 133 | Ci | 1.15E-5 | N/D | N/D | N/D |
| Iodine - 135 | Ci | N/D | N/D | N/D | N/D |
| Others (Specify) | | | | | |
| | | | | | |
| Total For Period | Ci | 2.53E-5 | 2.59E-8 | N/A | N/A |
| | | | | | |
| Particulates: | | | | | |
| Manganese - 54 | Ci | N/D | N/D | N/A | N/A |
| Iron - 55 | Ci | 3.10E-13 | 1.00E-13 | N/A | N/A |
| Cobalt - 58 | Ci | N/D | N/D | N/A | N/A |
| Iron - 59 | Ci | N/D | N/D | N/A | N/A |
| Cobalt - 60 | Ci | 4.08E-6 | 1.47E-6 | N/A | N/A |
| Zinc - 65 | Ci | N/D | N/D | N/A | N/A |
| Strontium - 89 | Ci | N/D | N/D | N/A | N/A |
| Strontium - 90 | Ci | N/D | N/D | N/A | N/A |
| Molybdenum - 99 | Ci | N/D | N/D | N/A | N/A |
| Cesium - 134 | Ci | 4.47E-6 | 1.65E-6 | N/A | N/A |
| Cesium - 137 | Ci | 1.06E-5 | 4.16E-6 | N/A | N/A |

N/D is Not Detectable & N/A is Not Applicable

TABLE 1B

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

MIXED MODE GASEOUS EFFLUENT RELEASES FOR 1989



| | | CONTINUOUS MODE | | BATCH MODE | |
|---|---|---|---|---|---|
| NUCLIDES RELEASED | UNITS | 1st QUARTER | 2nd QUARTER | 1st QUARTER | 2nd QUARTER |
| Particulates (cont): | | | | | |
| Barium - 140 | Ci | N/D | N/D | N/A | N/A |
| Lanthanum - 140 | Ci | N/D | N/D | N/A | N/A |
| Cerium - 141 | Ci | N/D | N/D | N/A | N/A |
| Cerium - 144 | Ci | N/D | N/D | N/A | N/A |
| Others (Specify) | | | | | |
| Antimony - 122 ($T_{1/2}$ < 8 days) | Ci | 1.01E-6 | 1.72E-7 | N/A | N/A |
| | | | | | |
| Total for Period ($T_{1/2}$ > 8 days) | Ci | 1.92E-5 | 7.28E-6 | N/A | N/A |
| Total for Period ($T_{1/2}$ < 8 days) | Ci | 1.01E-6 | 1.72E-7 | N/A | N/A |
| | | | | | |
| Total for Period | Ci | 2.02E-5 | 7.45E-6 | N/A | N/A |
| | | | | | |
| GROSS ALPHA: | Ci | N/D | N/D | N/D | N/D |
| | | | | | |
| TRITIUM: | Ci | 7.71E-2 | 1.34E-1 | 3.16E-3 | 3.22E-4 |

N/D is Not Detectable & N/A is Not Applicable

TABLE 1C

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR 1989



| | | CONTINUOUS MODE | | BATCH MODE | |
|---|---|---|---|---|---|
| NUCLIDES RELEASED | UNITS | 1st QUARTER | 2nd QUARTER | 1st QUARTER | 2nd QUARTER |
| Fission and Activation Gases: | | | | | |
| Krypton - 85 | Ci | N/D | N/D | N/D | N/D |
| Krypton - 85m | Ci | N/D | N/D | 1.31E+0 | N/D |
| Krypton - 87 | Ci | N/D | N/D | 6.29E-1 | N/D |
| Krypton - 88 | Ci | N/D | N/D | 2.65E+0 | N/D |
| Xenon - 133 | Ci | 4.00E+2 | N/D | 5.17E+1 | N/D |
| Xenon - 133m | Ci | N/D | N/D | 4.44E-1 | N/D |
| Xenon - 135 | Ci | 1.70E+1 | N/D | 1.66E+1 | 3.46E-4 |
| Xenon - 135m | Ci | N/D | N/D | 1.67E-1 | N/D |
| Xenon - 138 | Ci | N/D | N/D | 4.69E-2 | N/D |
| Others (Specify) | | | | | |
| Argon - 41 | Ci | N/D | N/D | 1.74E+0 | N/D |
| | | | | | |
| | | | | | |
| Total for Period | Ci | 4.17E+2 | N/A | 7.53E+1 | 3.46E-4 |
| | | | | | |
| Iodines: | | | | | |
| Iodine - 131 | Ci | 2.16E-3 | 5.73E-5 | 1.09E-7 | N/D |
| Iodine - 133 | Ci | 4.28E-3 | 8.52E-5 | 1.90E-8 | N/D |
| Iodine - 135 | Ci | N/D | N/D | 2.92E-8 | N/D |
| Others (Specify) | | | | | |
| Iodine - 132 | Ci | N/D | N/D | 1.89E-8 | N/D |
| Iodine - 134 | Ci | N/D | N/D | 1.55E-8 | N/D |
| | | | | | |
| | | | | | |
| Total For Period | Ci | 6.44E-3 | 1.43E-4 | 1.91E-7 | N/A |
| | | | | | |
| Particulates: | | | | | |
| Manganese - 54 | Ci | N/D | N/D | N/D | N/D |
| Iron - 55 | Ci | 4.20E-14 | 3.10E-14 | N/A | N/A |
| Cobalt - 58 | Ci | 2.13E-5 | 4.47E-5 | N/D | N/D |
| Iron - 59 | Ci | N/D | N/D | N/D | N/D |
| Cobalt - 60 | Ci | 3.98E-5 | 5.31E-5 | N/D | N/D |
| Zinc - 65 | Ci | N/D | N/D | N/D | N/D |
| Strontium - 89 | Ci | N/D | N/D | N/A | N/A |
| Strontium - 90 | Ci | N/D | N/D | N/A | N/A |
| Molybdenum - 99 | Ci | N/D | N/D | N/D | N/D |
| Cesium - 134 | Ci | 1.90E-5 | 6.48E-7 | 6.04E-10 | N/D |
| | | | | | |

N/D is Not Detectable & N/A is Not Applicable

TABLE 1C
NORTH ANNA POWER STATION
RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR 1989



| | | CONTINUOUS MODE | | BATCH MODE | |
|---|---|---|---|---|---|
| NUCLIDES RELEASED | UNITS | 1st QUARTER | 2nd QUARTER | 1st QUARTER | 2nd QUARTER |
| Particulates (cont): | | | | | |
| Cesium - 137 | Ci | 1.61E-4 | 8.55E-5 | 1.03E-9 | N/D |
| Barium - 140 | Ci | N/D | N/D | N/D | N/D |
| Lanthanum - 140 | Ci | N/D | N/D | N/D | N/D |
| Cerium - 141 | Ci | N/D | N/D | N/D | N/D |
| Cerium - 144 | Ci | N/D | N/D | N/D | N/D |
| Others (Specify) | Ci | | | | |
| Sodium - 24 ($T_{1/2}$ < 8 days) | Ci | N/D | N/D | 1.02E-8 | N/D |
| Rhodium - 106 ($T_{1/2}$ < 8 days) | Ci | N/D | N/D | 1.39E-8 | N/D |
| Cesium - 138 ($T_{1/2}$ < 8 days) | Ci | N/D | N/D | 1.97E-8 | N/D |
| Cerium - 143 $T_{1/2}$ < 8 days) | Ci | N/D | N/D | 2.43E-4 | N/D |
| Antimony - 125 | Ci | 9.40E-6 | N/D | N/D | N/D |
| | | | | | |
| Total For Period ($T_{1/2}$ > 8 days) | Ci | 2.51E-4 | 1.84E-4 | 1.63E-9 | N/A |
| Total for Period ($T_{1/2}$ < 8 days) | Ci | N/A | N/A | 2.43E-4 | N/A |
| | | | | | |
| Total for Period | Ci | 2.51E-4 | 1.84E-4 | 2.43E-4 | N/A |
| | | | | | |
| GROSS ALPHA: | Ci | N/D | N/D | N/D | N/D |
| | | | | | |
| TRITIUM: | Ci | 1.99E+1 | 5.57E+0 | 2.51E-1 | 6.74E-3 |

N/D is Not Detectable & N/A is Not Applicable

TABLE 2A

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

SUMMATION OF ALL LIQUID EFFLUENT RELEASES FOR 1989

| | UNITS | 1st QUARTER | 2nd QUARTER | ESTIMATED TOTAL PERCENT ERROR (%) |
|---|---|---|---|---|
| A. Fission & Activation Products: | | | | |
| 1. Total liquid effluent release (not including tritium, noble gases and gross alpha). | Curies | 4.63E-1 | 2.30E-1 | 1.70E+1 |
| 2. Average diluted concentration of liquid effluents during the period. | µCi/ml | 8.94E-10 | 6.91E-10 | |
| 3. Percent of applicable Tech. Spec. limit. | % | 1.30E-2 | 2.71E-3 | |
| B. Tritium: | | | | |
| 1. Total liquid effluent release of tritium. | Curies | 1.80E+2 | 1.23E+2 | 1.70E+1 |
| 2. Average diluted concentration of tritium during the period. | µCi/ml | 3.47E-7 | 3.69E-7 | |
| 3. Percent of applicable Tech. Spec. limit. | % | 1.16E-2 | 1.23E-2 | |
| C. Dissolved and Entrained Noble Gases: | | | | |
| 1. Total liquid effluent release of noble gases. | Curies | 3.14E+0 | 3.40E-2 | 1.70E+1 |
| 2. Average diluted concentration of noble gases during the period. | µCi/ml | 6.06E-9 | 1.02E-10 | |
| 3. Percent of applicable Tech. Spec. limit. | % | 3.03E-3 | 5.12E-5 | |
| D. Gross Alpha Radioactivity: | | | | |
| 1. Total liquid effluent release of gross alpha. | Curies | N/D | N/D | 1.70E+1 |
| E. Total volume of liquid effluent released (prior to dilution) during the period. | Liters | 6.48E+7 | 4.17E+7 | 5.C[illegible]E+0 |
| F. Total volume of dilution water used during the period. | Liters | 5.18E+11 | 3.33E+11 | 5.C0E+0 |

N/D is Not Detectable & N/A is Not Applicable

TABLE 2B
NORTH ANNA POWER STATION
RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR 1989



| | | CONTINUOUS MODE | | BATCH MODE | |
|---|---|---|---|---|---|
| NUCLIDES RELEASED | UNITS | 1st QUARTER | 2nd QUARTER | 1st QUARTER | 2nd QUARTER |
| Fission and Activation Products: | | | | | |
| Chromium - 51 | Ci | 4.19E-3 | 3.72E-3 | N/D | N/D |
| Manganese - 54 | Ci | 8.74E-4 | 1.09E-3 | 1.14E-4 | 7.40E-6 |
| Iron - 55 | Ci | N/D | 1.00E-4 | N/A | N/A |
| Cobalt - 58 | Ci | 1.91E-1 | 6.68E-2 | N/D | 2.93E-4 |
| Iron - 59 | Ci | N/D | N/D | N/D | N/D |
| Cobalt - 60 | Ci | 2.80E-2 | 6.54E-2 | N/D | 4.79E-5 |
| Zinc - 65 | Ci | N/D | N/D | N/D | N/D |
| Strontium - 89 | Ci | N/D | N/D | N/A | N/A |
| Strontium - 90 | Ci | N/D | N/D | N/A | N/A |
| Zirconium - 95 | Ci | N/D | N/D | N/D | N/D |
| Niobium - 95 | Ci | 2.28E-4 | 1.33E-3 | N/D | N/D |
| Iodine - 131 | Ci | 1.51E-2 | 1.09E-3 | 2.88E-8 | N/D |
| Cesium - 134 | Ci | 4.55E-2 | 4.86E-3 | N/D | 5.90E-4 |
| Cesium - 137 | Ci | 7.56E-2 | 1.14E-2 | 8.69E-6 | 5.76E-4 |
| Barium - 140 | Ci | 2.42E-4 | N/D | N/D | N/D |
| Cerium - 141 | Ci | N/D | N/D | N/D | N/D |
| Cerium - 144 | Ci | N/D | N/D | N/D | N/D |
| Molybdenum - 99 ($T_{1/2}$ < 8 days) | Ci | N/D | N/D | N/D | N/D |
| Technetium - 99m($T_{1/2}$ < 8 days) | Ci | N/D | N/D | N/D | N/D |
| Lanthanum - 140 ($T_{1/2}$ < 8 days) | Ci | N/D | N/D | N/D | N/D |
| Others (specify) | | | | | |
| Sodium - 24 ( $T_{1/2}$ < 8 days ) | Ci | 2.68E-5 | 3.66E-5 | 3.08E-5 | N/D |
| Rhodium - 106 ($T_{1/2}$ < 8 days) | Ci | N/D | 3.65E-4 | N/D | N/D |
| Antimony - 122 ($T_{1/2}$ < 8 days) | Ci | 4.83E-3 | N/D | N/D | 5.22E-5 |
| Cesium - 138 ($T_{1/2}$ < 8 days) | Ci | N/D | 4.92E-6 | N/D | N/D |
| Cerium - 143 ($T_{1/2}$ < 8 days) | Ci | 1.09E-4 | N/D | N/D | N/D |
| Cobalt - 57 | Ci | 1.46E-4 | 3.70E-5 | N/D | N/D |
| Strontium - 85 | Ci | 7.48E-5 | 7.64E-5 | N/D | N/D |
| Silver - 110m | Ci | 1.55E-3 | 1.70E-2 | N/D | N/D |
| Antimony - 124 | Ci | 5.45E-4 | 2.31E-3 | N/D | N/D |
| Antimony - 125 | Ci | 8.84E-2 | 5.22E-2 | N/D | N/D |
| Tellurium - 129m | Ci | 1.12E-4 | 1.48E-4 | N/D | N/D |
| Iodine - 132 | Ci | 2.06E-4 | N/D | 4.61E-8 | N/D |
| Iodine - 133 | Ci | 3.57E-3 | N/D | 8.79E-8 | N/D |
| Iodine - 134 | Ci | N/D | N/D | 7.88E-8 | N/D |
| | | | | | |

N/D is Not Detectable & N/A is Not Applicable

TABLE 2B

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

LIQUID EFFLUENT RELEASES FOR 1989



| | | CONTINUOUS MODE | | BATCH MODE | |
|---|---|---|---|---|---|
| NUCLIDES RELEASED | UNITS | 1st QUARTER | 2nd QUARTER | 1st QUARTER | 2nd QUARTER |
| Fission and Activation Products: (cont.) | | | | | |
| Iodine - 135 | Ci | 8.52E-4 | N/D | N/D | N/D |
| Cesium - 136 | Ci | 5.41E-4 | N/D | N/D | N/D |
| | | | | | |
| Total for Period ($T_{1/2}$ > 8 days) | Ci | 4.57E-1 | 2.28E-1 | 1.23E-4 | 1.51E-3 |
| Total for Period ($T_{1/2}$ < 8 days) | Ci | 4.97E-3 | 4.07E-4 | 3.08E-5 | 5.22E-5 |
| | | | | | |
| Total for Period | Ci | 4.63E-1 | 2.28E-1 | 1.54E-4 | 1.57E-3 |
| | | | | | |
| | | | | | |
| Dissolved and Entrained Noble Gases: | | | | | |
| Xenon - 133 | Ci | 3.02E+0 | 1.61E-2 | 2.00E-2 | N/D |
| Xenon - 135 | Ci | 3.39E-2 | 2.83E-4 | 1.21E-2 | N/D |
| Others (specify) | | | | | |
| Argon - 41 | Ci | 6.19E-6 | 8.21E-6 | 1.39E-4 | 7.61E-6 |
| Krypton - 85 | Ci | 1.73E-2 | 1.76E-2 | N/D | N/D |
| Krypton - 85m | Ci | N/D | N/D | 8.55E-4 | N/D |
| Krypton - 87 | Ci | N/D | N/D | 1.06E-4 | N/D |
| Krypton - 88 | Ci | 7.89E-4 | N/D | 8.95E-4 | N/D |
| Xenon - 131m | Ci | 6.74E-3 | N/D | N/D | N/D |
| Xenon - 133m | Ci | 2.95E-2 | N/D | 6.45E-4 | N/D |
| Xenon - 135m | Ci | 4.73E-3 | N/D | N/D | N/D |
| | | | | | |
| | | | | | |
| Total for Period: | Ci | 3.11E+0 | 3.40E-2 | 3.48E-2 | 7.61E-6 |
| | | | | | |
| Tritium | Ci | 1.80E+2 | 1.23E+2 | 5.58E-2 | 1.47E-3 |
| | | | | | |
| Gross Alpha | Ci | N/D | N/D | N/D | N/D |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

N/D is Not Detectable & N/A is Not Applicable

TABLE 3

NORTH ANNA POWER STATION

RADIOACTIVE EFFLUENT RELEASE REPORT

SUMMATION OF SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

FOR 01-01-89 THROUGH 06-30-89



A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

| 1. Type of Waste | UNIT | 6-MONTH PERIOD | ESTIMATED TOTAL PERCENT ERROR (%) |
|---|---|---|---|
| a. Spent resins, filter sludges, | $m^3$ | 7.52E+1* | 2.50 E+1 |
| evaporator bottoms, etc. | Ci | 7.25E+2 | 2.50 E+1 |
| b. Dry compressible waste, | $m^3$ | 3.80E+2** | 2.50 E+1 |
| contaminated equipment, etc. | Ci | 4.45E+1 | 2.50 E+1 |
| c. Irradiated components, control | $m^3$ | 0.00E0 | 0.00 E0 |
| rods, etc. | Ci | 0.00E0 | 0.00 E0 |
| d. Other (describe) | $m^3$ | 0.00E0 | 0.00 E0 |
| Contaminated Oil | Ci | 0.00E0 | 0.00 E0 |

2. Estimate of major nuclide composition (by type of waste)

| | | | |
|---|---|---|---|
| a. Co - 60 | % | 4.68E+1 | 2.50 E+1 |
| Ni - 63 | % | 2.57E+1 | 2.50 E+1 |
| Fe - 55 | % | 1.32E+1 | 2.50 E+1 |
| Cs - 137 | % | 1.02E+1 | 2.50 E+1 |
| Cs - 134 | % | 1.55E+0 | 2.50 E+1 |
| Mn - 54 | % | 1.07E+0 | 2.50 E+1 |
| | % | . E | . E |
| | % | . E | . E |
| b. Cr - 51 | % | 2.77E+1 | 2.50 E+1 |
| Fe - 55 | % | 2.68E+1 | 2.50 E+1 |
| Co - 60 | % | 2.55E+1 | 2.50 E+1 |
| Ni - 63 | % | 4.16E+0 | 2.50 E+1 |
| Ru - 103 | % | 3.55E+0 | 2.50 E+1 |
| Co - 58 | % | 3.50E+0 | 2.50 E+1 |
| Nb - 95 | % | 3.41E+0 | 2.50 E+1 |
| Mn - 54 | % | 1.23E+0 | 2.50 E+1 |
| Zr - 95 | % | 1.15E+0 | 2.50 E+1 |
| Pu - 241 | % | 1.00E+0 | 2.50 E+1 |
| | % | . E | . E |
| | % | . E | . E |
| c. None | % | . E | . E |
| | % | . E | . E |
| | % | . E | . E |
| | % | . E | . E |

# TABLE 3
# NORTH ANNA POWER STATION
# RADIOACTIVE EFFLUENT RELEASE REPORT
# SUMMATION OF SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS
# FOR 01-01-89 THROUGH 06-30-89



| 2. Estimated of major nuclide composition (by type of waste) (cont.) | UNIT | 6-MONTH PERIOD | ESTIMATED TOTAL PERCENT ERROR (%) |
|---|---|---|---|
| d. | % | . E | . E |
| | % | . E | . E |
| | % | . E | . E |
| | % | . E | . E |
| | % | . E | . E |
| | | | |

3. Solid Waste Disposition

| NUMBER OF SHIPMENTS | MODE OF TRANSPORTATION | DESTINATION |
|---|---|---|
| 13 | Truck | Barnwell, SC |
| 9 | Truck | Oak Ridge, TN (SEG) |
| 4 | Truck | Oak Ridge, TN (Quadrex) |

B. IRRADIATED FUEL SHIPMENTS (Disposition)

| NUMBER OF SHIPMENTS | MODE OF TRANSPORTATION | DESTINATION |
|---|---|---|
| 0 | N/A | N/A |

* 474.3 ft³ of Bead Resin was shipped from North Anna to a licensed waste processor for volume reduction. Therefore the volume as listed for this waste type is not representative of the actual volume buried. The total volume buried for the reporting period was 57.1 $m^3$.

** 12 shipments of Dry Compressible Waste were shipped from North Anna to a licensed waste processor for volume reduction. Therefore the volume as listed for this waste type is not representative of the actual volume buried. The total volume buried for the reporting period was 165.2 $m^3$.

ATTACHMENT 2

ANNUAL AND QUARTERLY DOSES

(01/89 - 06/89)

An assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site for each calendar quarter for the calendar year of this report along with an annual total of each effluent pathway will be made pursuant to Technical Specification 6.9.1.9 in the Radioactive Effluent Release Report submitted within sixty (60) days after January 01, 1990.

ATTACHMENT 3

(01/89 - 06/89)

REVISIONS TO OFFSITE DOSE CALCULATION MANUAL (ODCM)

As required by Technical Specification 6.15, revisions to the ODCM for the time period covered by this report are synopsized below. Supporting documentation and affected pages of the ODCM are attached.

---

05-31-89: Revisions were made to the ODCM Section 4 to correct the overestimation of the Liquid Effluent pathway doses at low circulating water flow rates.

# NORTH ANNA
# REQUEST TO CHANGE PROCEDURE AND ROUTING FORM

ADM-5.4
Attachment 2
Page 1 of 1
Date 12-09-88

Procedure No: HP-ODCM-4 1 Unit No: 1 & 2 2 Rev. Date: 12-29-88 3
Title: OFFSITE DOSE CALCULATION MANUAL - SECTION 4 - LIQUID EFFLUENT DOSE LIMITS 4

Changes Requested: See attached marked up procedure for exact changes 5

References: 6

Reason: Correct overestimation of Liquid Effluent pathway doses at low Circulating Water flow rates 7

Requested By: William C. Barnes III 8 Department: Health Physics 9 Date: 05-30-89 10

Safety ☒ NSQ ☐ Non-Safety ☐ Classification Change ☐ 11
New ☐ Revision ☒ Deletion ☐ Required Distrubution Date: 6-30-89
Review Record (5.3) ☐ Review Checklist (5.4) ☒

RECEIVED RECORDS ROOM JUN 01 1989

This Section To Be Performed By The Cognizant Supervisor NSM 12
Does This Change The Operating Methods As Described In The UFSAR? YES ☐ NO ☒
Does This Change Involve A Change To Tech. Specs? YES ☐ NO ☒
Does This Change Involve A Possible Unreviewed Safety Question? YES ☐ NO ☒
If All "NO" No "Safety Analysis" Is Required. If Any "YES", A "Safety Analysis" Is Required.
(10CFR50.59) Approved Copy To Be Provided To Licensing Coord. For Inclusion In Annual Report.

| ORDER | TITLE | INIT. | DATE | ORDER | TITLE | INIT. | DATE 13 |
|---|---|---|---|---|---|---|---|
| | Sta. Procedures | | | | | | |
| ① | Cognizant Supv. | [initials] | 5-30-89 | | | | |
| ② | Supt. HP | [initials] | 5-30-89 | | | | |
| ③ | Manager QA/QC | [initials] | 5/31/89 | | | | |
| | | | | Return To: | | | |

14 Approved SNSOC 15 16
YES ☒ NO ☐ Chairman Signature [signature] Date 5/31/89
Immediate Selective Control Distribution ☐ 17 Staggered Implementation Date: 18

| | Action Completed Date | Initials 19 |
|---|---|---|
| Typing, First Time<br>Affix Attachment 3 if entire procedure was retyped. | 6-6-89 | NSM |
| Proof Reading (I) | 06-07-89 | WCB |
| Typing Corrections (I) 06-07-89 WCB | 6-8-89 | NSM |
| Proof Reading (II) | 06-08-89 | WCB |
| Typing Corrections (II) | | |
| Proof Reading (III) | | |
| Typing Corrections (III) | | |
| Drafting | 6-6-89 | [initials] |
| Station Records, for Processing and Distribution 06-08-89 WCB | | |

Special Notes/Instructions 20

(1)

PROC. NO: HP-ODCM-4 CURRENT REV: yes DATE: 12-29-88

PROCEDURE TITLE: Offsite Dose Calculation Manual - Section 4 - Liquid Effluent Dose Limits

FOR NEW, REVISED, OR PROGRAMATIC UPGRADE:

(CHECK) (2)

✓ Human Factors Review Criteria (Ref: Attachment 9)

✓ Radiological Work Practices Criteria (Ref: Attachment 10)

✓ General Procedure Review Criteria (Ref: Attachment 11)

FOR CHANGES:

(CHECK) (3)

✓ Latest revision of existing procedure used

✓ Changes and location of their placement clear

✓ Deletions do not remove committed material/information

✓ Additions clearly portray equipment, readings, data, etc.

N/A Setpoints and/or acceptance criteria changed

✓ Calculational basis provided or updated per ADM-17.15

(4)

Review Completed By: William C. Brown Jr. Date: 05-30-89

Department: Health Physics

| SNSOC | CHAIRMAN |
|---|---|
| | |
| SIGNATURE | DATE |

TECHNICAL JUSTIFICATION TO CHANGE HP-ODCM-4

IAW T.S. 6.15.2

A. It is requested to change the following items of HP-ODCM-4 (see attached pages showing changes and newly approved and dated pages for details.

1. Page 2 of 10

   ° Label the expression for calculating the dose contribution as "(2.1)".

   ° Clarify the definition for $f_i$.

2. Page 3, 4 of 10

   ° Include a new section 2.2 for the derivation of the dose commitment factor $B_i$ which is independent of the released concentration.

3. Pages 4, 5 of 10

   ° Change the examples 3.1, 3.2, 3.3 to reflect the use of $B_i$ dose factors depending on activity released (not on concentration).

4. Pages 6 of 10, Table 4.0

   ° Change to $f_i$ and $A_i$ factors calculated on 3402 cfs averaged Circulating Water flow rate.

5. Table 4.1

   ° Include this new table of dose factors which depend on activity released.

6. Attachment 1

   ° Change to Effective Dilution Flows and $f_i$ factors based on 3402 cfs averaged Circulating Water flow rate.

7. Attachment 3

   ° Change to $A_i$ factors based on 3402 cfs averaged Circulating Water flow rate.

This change of HP-ODCM-4 methodology is requested to correctly compensate for concentration effects caused by recirculation of lake water at various Circulating Water flow rates. Overestimation of liquid pathway doses for periods of low Circulating Water flow rates is eliminated. The derivation of the method is explained in section 2.2 of the revised HP-ODCM-4. The calculation of dose factors is shown in detail for the most significant liquid pathway nuclide Cs-137 as part of the verification calculation performed per Administrative procedure ADM-17.15 (attached).

B. This change will improve the accuracy of dose calculations of low Circulating Water flow rates.

C. Documentation that these changes have been reviewed and found acceptable by SNSOC is provided by the dated signature of the SNSOC Chairman on this change request and on Attachment 3.0 of ADM-5.4.

CALCULATION WORKSHEET
NORTH ANNA POWER STATION
VIRGINIA POWER

| | | | |
|---|---|---|---|
| APPLICABLE DOCUMENT(s) HP-ODCM - 4 | 1 | | |
| DESCRIPTION Calculational Justification For Liquid Effluent Dose Factor Changes | 2 | | |
| PREPARED BY William C Barnum | 3 | DATE 05-30-89 | 4 |
| CALCULATIONS VERIFIED BY E. Breyer | 5 | DATE 5-30-89 | 6 |
| APPROVED BY COGNIZANT SUPERVISOR AH Stafford | 7 | DATE 5-31-89 | 8 |

PROVIDE:
1) Purpose
2) Assumptions
3) References
4) Calculations
5) Conclusions

1.0 PURPOSE

1.1 Concentration effects of liquid effluent pathway nuclides caused by recirculation in the North Anna lake system are corrected for at the maximum Circulating Water flow rate. On long term average this will introduce a moderate amount of conservativism. When applied exclusively to periods of low Circulating Water flow rates, liquid pathway doses are overestimated by a factor of maximum/actual number of Circulating Water pumps running. This revision of HP-ODCM-4 is introduced to correctly take concentration effects at all Circulating Water flow rates into account.

1.2 Result is a simplification of the liquid pathway ingestion dose calculation to a simple multiplication of activity released (Ci) times dose factor ($B_i$ in mrem/Ci) for each nuclide.

2.0 ASSUMPTIONS

2.1 Calculations are based on the assumption that the composition of nuclides released remains such, that the main contribution to liquid pathway doses is caused by nuclides with half-lives long compared to the average recirculation time of the lake system of approximately 46 days. This assumption is well founded through past experience which shows that liquid

USE ADD'L PAGES AS REQUIRED

## 2.0 ASSUMPTIONS (cont.)

pathway dose at NAPS is almost exclusively caused by the two long-lived nuclides Cs-137 and Cs-134. Results of the calculations, support this assumption by showing the highest dose commitment factors for Cs-134 and Cs-137 (Table 4.1) (Sr-90 also has a very high dose commitment factor but contributes little because of low actual releases). The next important nuclide is the long-lived H-3, with an almost five decade lower dose commitment factor but generally much higher activity releases than any other nuclide.

2.2 Actual calculations are performed on the assumption that on average 7 out of the 8 circulating water pumps are running (Ref. 3.2) thus accounting for periods with less than 8 pumps operating, i.e. during outages, or when flow is throttled at periods of low lake temperatures. The corresponding Circulating Water flow rate is 3402 $ft^3$/sec. This assumption is not critical, because for the long-lived, dominating nuclides, liquid effluent dose commitment factors are practically independent of the circulating water flow rate.

2.3 It is assumed that liquid waste flow rates are small compared to the Circulating Water flow rate. As an example, even at the relatively high waste discharge rate of 60,000 gallons per 8 hrs = 125 gpm this is only 8E-5 of the Circulating Water flow of 7 x 218000 gpm. This simplification has a negligible but nevertheless conservative effect on the calculation of dose commitment factors.

## 3.0 REFERENCES


3.1 HP-ODCM-4, Revision 12-29-88.

3.2 Memorandum W.A. Thornton to A.H. Stafford, 3-31-89 "Evaluation of North Anna Liquid Waste Dose Factors".

3.3 UFSAR, Chapter 11.2.

3.4 Radioactive Decay Tables, D.C. Kocher, 1981.

3.5 USNRC Regulatory Guide ..109, 10-1977.


## 4.0 CALCULATIONS

4.1 Site related Liquid Pathway Dose Commitment Factors for Adults ($A_i$ in mrem-ml/µCi-hr) have been recalculated for 3402 cfs Circulating Water flow rate based on Ref. 3.2 Results are listed in Attachment 3 of the revised HP-ODCM-4. By eliminating the dependence on the activity concentration, $B_i$ dose commitment dose commitment factors were derived from the $A_i$ factors. Calculated dose commitment is based on the total activity released for each nuclide. This derivation has been incorporated as Section 2.2 into Ref. 3.1 to document the change in methodology. Following are the verification calculations for $A_i$ and $B_i$ factors for Cs-137, the most significant nuclide of the liquid effluent exposure pathway at North Anna.

4.2 All calculations are based on the following parameters for the North Anna lake system consisting of Resevoir and (Cooling) Lagoon. Nomenclature is consistant with Chapter 11.2 of the UFSAR (Ref. 3.3):

| Parameter | Value | Source |
|---|---|---|
| Volume Resevoir | $V_R$ = 1.06E10 $ft^3$ | UFSAR |
| Volume Cool. Lagoon | $V_L$ = 2.66E9 $ft^3$ | UFSAR |
| Res. - Lag. Flow Rate | $R_{RL}$ = 3402 $ft^3$/sec | Ref. 3.2 |
| Lag. - Res. Flow Rate | $R_{LR}$ = 3411 $ft^3$/sec | $R_{RL}$+9 $ft^3$/sec |
| Resev. Overflow Rate | $R_{OR}$ = 220 $ft^3$/sec | UFSAR |

4.3 Calculation for Cs-137

4.3.1 The following table provides an overview of the results of calculations performed to obtain $A_i$ and $B_i$ values (i denotes the nuclide i.e. Cs-137).

VERIFICATION CALCULATION, $A_i$ & $B_i$ FACTORS FOR Cs-137

| PARAMETER | CALCULATED RESULTS | CALCULATION NUMBER | VERIFIED HP-ODCM-4 VALUE |
|---|---|---|---|
| Cs-137 Decay Const. | $\lambda$ = 7.29E-10 $sec^{-1}$ | 1. | --- |
| Cs-137 Res. Rem. Const. | $\lambda_R$ = 3.434E-7 $sec^{-1}$ | 2. | --- |
| Cs-137 Lag. Rem. Const. | $\lambda_L$ = 1.283E-6 $sec^{-1}$ | 3. | --- |
| Effect. Dil. Flow | $F_{eff}$ = 215.3 cfs | 4. | 215 cfs |
| Dil. Mult. Factor | $f_i$ = 15.8 | 5. | 15.8 |
| Drink Wat. Dil. Fac. | $D_w$ = 1.462 | 6. | --- |
| Fish Ingest. Dil. Fac. | $D_a$ = 1.0032 | 7. | --- |
| Total Body $A_i$ Dse. C. Fac. | $A_i = 3.448 \frac{mrem\text{-}ml}{hr\text{-}\mu Ci}$ | 8. | 3.45E+5 |
| Total Body $B_i$ Dse. C. Fac. | $B_i$ = 15.7 mrem/Ci | 9. | 15.8 mrem/Ci |

Calculations performed are identified in column three and explained in detail below. Results of these calculations in column two agree with the parameters to be verifed in column four. Minor differences are caused by rounding errors.

4.0 CALCULATIONS (cont.)

dose commitment factors were derived from the $A_i$ factors. Calculated dose commitment is based on the total activity released for each nuclide. This derivation has been incorporated as Section 2.2 into Ref. 3.1 to document the change in methodology. Following are the verification calculations for $A_i$ and $B_i$ factors for Cs-137, the most significant nuclide of the liquid effluent exposure pathway at North Anna.

4.2 All calculations are based on the following parameters for the North Anna lake system consisting of Resevoir and (Cooling) Lagoon. Nomenclature is consistant with Chapter 11.2 of the UFSAR (Ref. 3.3):

| Parameter | Value | Source |
|---|---|---|
| Volume Reservoir | $V_R = 1.06E10\ ft^3$ | UFSAR |
| Volume Cool. Lagoon | $V_L = 2.66E9\ ft^3$ | UFSAR |
| Res. - Lag. Flow Rate | $R_{RL} = 3402\ ft^3/sec$ | Ref. 3.2 |
| Lag. - Res. Flow Rate | $R_{LR} = 3411\ ft^3/sec$ | $R_{RL} + 9\ ft^3/sec$ |
| Resev. Overflow Rate | $R_{OR} = 220\ ft^3/sec$ | UFSAR |

4.3 Calculation for Cs-137

4.3.1 The following table provides an overview of the results of calculations performed to obtain $A_i$ and $B_i$ values (i denotes the nuclide i.e. Cs-137).

VERIFICATION CALCULATION, $A_i$ & $B_i$ FACTORS FOR Cs-137

| PARAMETER | CALCULATED RESULTS | CALCULATION NUMBER | VERIFIED HP-ODCM-4 VALUE |
|---|---|---|---|
| Cs-137 Decay Const. | $\lambda = 7.29E-10\ sec^{-1}$ | 1. | --- |
| Cs-137 Res. Rem. Const. | $\lambda_R = 3.434E-7\ sec^{-1}$ | 2. | --- |
| Cs-137 Lag. Rem. Const. | $\lambda_L = 1.283E-6\ sec^{-1}$ | 3. | --- |
| Effect. Dil. Flow | $F_{eff} = 215.3$ cfs | 4. | 215 cfs |
| Dil. Mult. Factor | $f_i = 15.8$ | 5. | 15.8 |
| Drink Wat. Dil. Fac. | $D^w = 1.462$ | 6. | --- |
| Fish Ingest. Dil. Fac. | $D_a = 1.0032$ | 7. | --- |
| Total Body $A_i$ Dse. C. Fac. | $A_i = 3.448E+5\ \frac{mrem\text{-}ml}{hr\text{-}\mu Ci}$ | 8. | 3.45E+5 |
| Total Body $B_i$ Dse. C. Fac. | $B_i = 15.7$ mrem/Ci | 9. | 15.8 mrem/Ci |

Calculations performed are identified in column three and explained in detail below. Results of these calculations in column two agree with the parameters to be verifed in column four. Minor differences are caused by rounding errors.

4.0 CALCULATIONS (cont.)

4.3.2 Detailed Calculations

1. Decay constant for Cs-137 (30.17 yr half-life, Ref. 3.4).

$$\lambda = \ln 2/T_{1/2} = \ln 2/(30.17 \text{ yr} \times 3.15E7 \text{ sec/yr}) = \underline{7.29E-10 \text{ sec}^{-1}}$$

2. Resevoir Cs-137 Removal Constant

$$\lambda_R = (R_{OR} + R_{RL})/V_R + \lambda \qquad \text{(Ref. 3.3)}$$

$$= \frac{(220+3402) \text{ cfs}}{1.06E10 \text{ ft}^3} + 7.29E-10 \text{ sec}^{-1} = \underline{3.42427E-7 \text{ sec}^{-1}}$$

3. Cooling Lagoon Cs-137 Removal Constant

$$\lambda_L = R_{LR}/V_L + \lambda \qquad \text{(Ref. 3.3)}$$

$$= 3411 \text{ cfs}/2.66E+9 \text{ ft}^3 + 7.24E-10 \text{ sec}^{-1} = \underline{1.28305E-6 \text{ sec}^{-1}}$$

4. Effective Dilution Flow $F_{eff}$

$$F_{eff} = R_{RL} \, (1-R_{RL}R_{LR}/\lambda_L\lambda_R V_L V_R)$$

$F_{eff}$ as defined here is derived from expression 11.2-8 of (Ref.3.3) as the ratio of the radioactivity release rate (P in Ci/sec) over the activity concentration in the discharge canal ($C_C$ in $\mu Ci/cm^3$), converted to cfs.

$$F_{eff} = 3402 \text{ cfs}[1-3402 \times 3411/(1.283E-6 \times 3.424E-7 \times 1.06E10 \times 2.66E9)]$$

$$= 3402 \text{ cfs} \times 6.327E-2 = \underline{215.3 \text{ cfs}}$$

This means that on average because of the recirculation effects in the resevoir lagoon system only 215.3 cfs of the 3402 cfs circulating water flow rate actually contribute to the dilution of Cs-137.

4.0 CALCULATIONS (cont.)

4.3.2 Detailed Calculations

1. Decay constant for Cs-137 (30.17 yr half-life, Ref. 3.4).

$$\lambda = \ln 2/T_{\frac{1}{2}} = \ln 2/30.17 \text{ yr} \times 3.15E7 \text{ sec/yr} = \underline{7.29E\text{-}10 \text{ sec}^{-1}}$$

2. Resevoir Cs-137 Removal Constant

$$\lambda_R = (R_{OR} + R_{RL})/V_R + \lambda \qquad \text{(Ref. 3.3)}$$

$$= \frac{(220+3402) \text{ cfs}}{1.06E10 \text{ ft}^3} + 7.29E\text{-}10 \text{ sec}^{-1} = \underline{3.42427E\text{-}7 \text{ sec}^{-1}}$$

3. Cooling Lagoon Cs-137 Removal Constant

$$\lambda_L = R_{LR}/V_L + \lambda \qquad \text{(Ref. 3.3)}$$

$$= 3411 \text{ cfs}/2.66E{+}9 \text{ ft}^3 + 7.24E\text{-}10 \text{ sec}^{-1} = \underline{1.28305E\text{-}6 \text{ sec}^{-1}}$$

4. Effective Dilution Flow $F_{eff}$

$$F_{eff} = R_{RL} \, (1 - R_{RL}/\lambda_L \lambda_R V_L V_R)$$

$F_{eff}$ as defined here is derived from expression 11.2-8 of (Ref.3.3) as the ratio of the radioactivity release rate (P in Ci/sec) over the activity concentration in the discharge canal ($C_C$ in µCi/cm³), converted to cfs.

$$F_{eff} = 3402 \text{ cfs}(1 - 3402 \times 3411/1.283E\text{-}6 \times 3.424E\text{-}7 \times 1.06E10 \times 2.66E9)$$

$$= 3402 \text{ cfs} \times 6.327E\text{-}2 = \underline{215.3 \text{ cfs}}$$

This means that on average because of the recirculation effects in the resevoir lagoon system only 215.3 cfs of the 3402 cfs circulating water flow rate actually contribute to the dilution of Cs-137.

4.0 CALCULATIONS (cont.)

5. The Individual Dilution Multiplication Factor $f_i$ is the dimensionless ratio of circulating water flow rate over the effective dilution flow rate. From 4. above it follows:

$$f_i = 1/(6.327E-2) = 15.8$$

6. Drinking Water Dilution Factor (Ref. 3.1, Sec. 2.1)

$$D_w = 1/[(C_C/C_L)x(C_L/C_R) \text{ x } .73]$$

where $C_C$, $C_L$ and $C_R$ denote concentrations in the Discharge Canal, the Lagoon and Resevoir respectively. $C_C/C_L$ is the cooling Lagoon dilution factor and $C_L/C_R$ is the Lagoon to Resevoir dilution factor. Expressions 11.2-5,6,7 of Ref. 3.3 are used here:

$$C_C/C_L = R_{RL}/\lambda_L \text{ x } V_L = 3402/1.28E-6 \text{ x } 2.66E9 = .996841$$

$$C_R/C_S = R_{LR}/\lambda_R \text{ x } V_R = 3411/3.424E-7 \text{ x } 1.06E10 = .93974$$

such that $D_w = 1/.996841 \text{ x } .93974 \text{ x } .73 = 1.462$

7. Fish Pathway Dilution Factor

$$D_a = C_L/C_C = 1/.996841 = \underline{1.0032}$$

8. Site Related Ingestion Dose Commitment Factor ($A_i$ in mrem-ml/μCi-hr) as defined in Ref 3.1.

$$A_i = 1.14E+05 \ (730/D_w + 21 \ BF_i/D_a) \ DF_i$$

where $D_w$ and $D_a$ are as defined under Item 6 on 7 above.

$BF_i$ is the Bioacumulation factor in fish from Ref. 3.5 (2000 for Cs).

$DF_i$ is the critical organ dose conversion factor from Ref. 3.5 (7.14E-5 mrem whole body per pCi of Cs-137 ingested).

4.0 CALCULATIONS (cont.)

$$A_i = 1.14E+5 \times (730/1.462 + 21 \times 2000/1.0032)\ 7.14E-5$$

$$= 3.45E+5\ (mrem/hr)/(\mu Ci/ml)$$

9. Site Specific Liquid Pathway Dose Commitment Factors ($B_i$ in mrem/Ci)

$$B_i = A_i \times f_i/\text{CIRC FLOW}$$

where $A_i$ is from 8., $f_i$ from 5. and CIRC FLOW is 3402 cfs (ref. 3.2), i.e.:

$$B_i = \frac{3.45E5\ (mrem\text{-}ml)/(hr\text{-}\mu Ci) \times 15.8 \times 1E6\ \mu Ci/Ci}{3402\ ft^3/sec \times 2.832E4\ ml/ft^3 \times 3600\ sec/hr} = 15.72\ mrem/Ci$$

5.0 CONCLUSION

5.1 The methodology of calculating liquid effluent pathway doses has been simplified by introducing dose commitment factors (Table 4.1, Ref. 3.1) which are independent of concentration and eliminate overestimation of liquid pathway doses at low Circulating Water flow rates. Tabulated values have been verified for the most significant nuclide (Cs-137) by hand calculation. This can be repeated for any other nuclide with the guidance provided in Section 4.3 above.

# NORTH ANNA POWER STATION

## OFFSITE DOSE CALCULATION MANUAL

## SECTION 4

## LIQUID EFFLUENT DOSE LIMITS

1. TECHNICAL SPECIFICATION REQUIREMENT

Technical Specification 3.11.1.2 requires that: "The dose or dose commitment to the maximum exposed MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from each reactor unit, to UNRESTRICTED AREAS (see Figure 5.1-1) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to the critical organ, and

b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to the critical organ".

2. CALCULATION

2.1 Dose contribution shall be calculated for all radionuclides identified in liquid effluents released to UNRESTRICTED AREAS based on the following expressions:

$$D = t\ F \sum_i f_i\ C_i\ A_i \quad (2.1)$$

Where:

D = the cumulative dose commitment to the total body or critical organ, from the liquid effluents for the time period t, in mrem;

t = the length of the time period over which $C_i$ and F are averaged for all liquid releases, hours;

F = the near field average dilution factor for $C_i$ during any liquid effluent release. Defined as the ratio of the average undiluted liquid waste flow during release to the average flow from the site discharge structure to UNRESTRICTED AREAS;

$f_i$ = the individual dilution multiplication factor to account for increases in concentration of longlived nuclides due to recirculation, listed in Table 4.0. $f_i$ is the ratio of the total dilution flow over the effective dilution flow.

$C_i$ = the average concentration of radionuclide, i, in undiluted liquid effluent during time period, t, from any liquid releases, in µCi/ml;

$A_i$ = the site related ingestion dose commitment factor to the total body or critical organ of an adult for each identified principal gamma and beta emmitter listed in Table 4.0, in mrem-ml per hr-µCi;

$$A_i = 1.14E{+}05\ (730/D_w + 21BF_i/D_a)\ DF_i$$

where:

1.14E+05 = 1E+06 pCi/μCi x 1E+03 ml/kg ÷ 8760 hr/yr, units conversion factor;

730 = adult water consumption, kg/yr from NUREG-0133;

$D_w$ = 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. Dw includes the dilution contributions from the North Anna Dam to Doswell (0.73), the Waste Heat Treatment Facility ($C_c/C_L$), and Lake Anna ($C_L/C_R$). The potable water mixing ratio is calculated as $1/(C_c/C_L)(C_L/C_R) \times .73 = C_R/(C_c \times .73)$ where $C_c/C_L$ and $C_R$ are the respective concentrations for the considered nuclide in the Discharge Channel, Waste Heat Treatment Facility (Lagoon) and the Reservoir. Calculation is per Expressions 11.2 - 5, 11.2 - 6, and 11.2 - 8 UFSAR.

$BF_i$ = the bioaccumulation factor for nuclide, i, in fish, pCi/kg per pCi/l, from Table A-1 Regulatory Guide 1.109;

$D_a$ = dilution factor for the fish pathway, calculated as $C_L/C_c$ where $C_L$ and $C_c$ are the concentrations for the considered nuclide in the Discharge Channel and the Waste Heat Treatment Facility (Lagoon). Calculation is per Expressions 11.2 - 5, 11.2 - 6 UFSAR.

$DF_i$ = the critical organ dose conversion factor for nuclide, i, for adults, in mrem/pCi, from Table E-11 of Regulatory Guide 1.109, Rev. 1.

2.2 Expression (2.1) is simplified for actual dose calculations by introducing:

$$F = \frac{\text{WASTE FLOW}}{\text{CIRC. (WATER) FLOW + WASTE FLOW}} \approx \frac{\text{WASTE FLOW}}{\text{CIRC. FLOW}}$$

and

$$f_i = \frac{\text{CIRC. FLOW}}{\text{EFFECTIVE DIL FLOW}_i}$$

Effective dilution flow rates for individual nuclides i are listed on Attachment 1.0 and Table 4.1. Then the total released activity ($Q_i$) for the considered time period and the ith nuclide is written as :

$$Q_i = t \times C_i \times \text{WASTE FLOW}$$

and Expression (2.1) reduces to

$$D = \sum_i Q_i \frac{A_i}{\text{EFF. DIL. FLOW}_i}$$

For the long lived, dose controlling nuclides the effective dilution flow is essentially the over (dam) flow rate out of the North Anna Lake system, i.e. the liquid pathway dose is practically independent from the circulating water flow rate. However, to accurately assess long range average effects of reduced circulating water flow rates during outages or periods of low lake water temperatures, calculations are based on an average of 7 out of 8 circulating water pumps running at 218000 gpm = 485.6 cft/sec per pump.

By defining $B_i = A_i/\text{EFF. DIL. FLOW}_i$ the dose calculation is reduced to a two factor formula.

$$D = \sum_i Q_i \times B_i \qquad (2.2)$$

Values for $B_i$ (mrem/Ci) and EFF. DIL. $\text{FLOW}_i$ are listed in Table 4.1.

3. EXAMPLE

3.1 Compilation of data from release records for a 31 day period provides the following information:

Total Volume of Undiluted Liquid Effluent Released = 2.00E+10 ml

Average Concentration of Radionuclides in Undiluted Liquid Effluent and Total Activities released are:

Cs-134 = 6.23E-08 µCi/ml x 2.00E+10 ml x 1.00E-6 = 1.25E-3 Ci
Cs-137 = 2.13E-07 µCi/ml x 2.00E+10 ml x 1.00E-6 = 4.26E-3 Ci
I-131 = 5.17E-07 µCi/ml x 2.00E+10 ml x 1.00E-6 = 1.03E-2 Ci
Co-58 = 1.53E-07 µCi/ml x 2.00E+10 ml x 1.00E-6 = 3.06E-3 Ci
Co-60 = 7.27E-07 µCi/ml x 2.00E+10 ml x 1.00E-6 = 1.45E-2 Ci
H-3 = 4.62E-03 µCi/ml x 2.00E+10 ml x 1.00E-6 = 9.24E+1 Ci

3.2 31 Day Total Body Calculation:

$$D = \sum_i Q_i \times B_i$$

Obtain total body $B_i$ values from Table 5.0

| Nuclide | $Q_i$ (Ci) | | $B_i$ (mrem/Ci) | | Total Body Dose |
|---|---|---|---|---|---|
| Cs-134 | 1.25E-3 | X | 1.73E+1 | = | 2.16E-2 mrem |
| Cs-137 | 4.26E-3 | X | 1.57E+1 | = | 6.69E-2 mrem |
| I-131 | 1.03E-2 | X | 3.22E-4 | = | 3.32E-6 mrem |
| Co-58 | 3.06E-3 | X | 2.04E-3 | = | 6.24E-6 mrem |
| Co-60 | 1.45E-2 | X | 3.18E-2 | = | 4.61E-4 mrem |
| H-3 | 9.24E+1 | X | 2.66E-4 | = | 2.46E-2 mrem |
| | | | | | 1.14E-1 mrem |

D = 1.14E-01 mrem Total Body

3.3 31 Day Critical Organ Calculation:

$$D = \sum_i Q_i \times B_i$$

| Nuclide | $Q_i$ (Ci) | | $B_i$ (mrem/Ci) | | Total Body Dose |
|---|---|---|---|---|---|
| Cs-134 | 1.25E-3 | X | 2.11E+1 | = | 2.64E-2 mrem |
| Cs-137 | 4.26E-3 | X | 2.40E+1 | = | 1.02E-1 mrem |
| I-131 | 1.03E-2 | X | 5.62E-4 | = | 5.79E-6 mrem |
| Co-58 | 3.06E-3 | X | 9.10E-4 | = | 2.78E-6 mrem |
| Co-60 | 1.45E-2 | X | 1.44E-2 | = | 2.09E-4 mrem |
| H-3 | 9.24E+1 | X | 2.66E-4 | = | 2.46E-2 mrem |
| | | | | | 1.53E-1 mrem |

D = 1.53E-1 mrem Critical Organ

4. QUARTERLY COMPOSITE ANALYSES

For radionuclides not determined in each batch or weekly composite, the dose contribution to the current monthly or calendar quarter cumulative summation may be approximated by assuming an average monthly concentration based on the previous monthly or quarterly composite analyses. However, for reporting purposes, the calculated dose contribution shall be based on the actual composite analyses.

## TABLE 4.0

## SITE RELATED LIQUID PATHWAY INGESTION DOSE FACTORS AND INDIVIDUAL DILUTION MULTIPLICATION FACTORS

## NAPS UNIT 1 AND 2

| Radionuclide | Individual Dilution Multiplication Factor (fi) | Total Body $A_i$ $\frac{mrem/hr}{\mu Ci/ml}$ | Critical Organ* $A_i$ $\frac{mrem/hr}{\mu Ci/ml}$ |
|---|---|---|---|
| H-3 | 14.9 | 6.18E+00 | 6.18E+00 |
| Na-24 | 1.0 | 3.71E+01 | 3.71E+01 |
| Cr-51 | 1.7 | 1.10E+00 | -------- |
| Mn-54 | 7.0 | 8.62E+02 | 4.52E+03 |
| Fe-55 | 11.3 | 1.30E+02 | 5.56E+02 |
| Fe-59 | 2.2 | 9.47E+02 | 2.47E+03 |
| Co-58 | 2.8 | 2.49E+02 | 1.11E+02 |
| Co-60 | 13.3 | 8.27E+02 | 3.75E+02 |
| Zn-65 | 6.1 | 3.28E+04 | 7.25E+04 |
| Rb-86 | 1.5 | 3.53E+04 | 7.59E+04 |
| Sr-89 | 2.3 | 8.70E+02 | -------- |
| Sr-90 | 15.8 | 2.39E+05 | -------- |
| Y-91 | 2.5 | 3.42E-01 | -------- |
| Zr-95 | 2.7 | 2.98E-01 | 1.70E-01 |
| Zr-97 | 1.0 | 1.50E-04 | 3.27E-04 |
| Nb-95 | 1.0 | 4.87E+01 | 9.07E+01 |
| Mo-99 | 1.0 | 7.48E+00 | 3.93E+01 |
| Ru-103 | 2.0 | 4.10E+00 | -------- |
| Ru-106 | 7.6 | 2.65E+01 | -------- |
| Ag-110m | 6.2 | 4.94E+00 | 8.32E+00 |
| Sb-124 | 2.6 | 4.37E+01 | 2.08E+00 |
| Sb-125 | 11.4 | 2.46E+01 | 1.16E+00 |
| Te-125m | 2.5 | 3.23E+02 | 8.73E+02 |
| Te-127m | 3.7 | 7.82E+02 | 2.29E+03 |
| Te-129m | 1.9 | 1.52E+03 | 3.58E+03 |
| Te-131m | 1.0 | 1.12E+02 | 1.35E+02 |
| Te-132 | 1.0 | 5.04E+02 | 5.37E+02 |
| I-131 | 1.2 | 9.66E+01 | 1.69E+02 |
| I-132 | 1.0 | 1.03E-01 | 2.95E-01 |
| I-133 | 1.0 | 3.47E+00 | 1.14E+01 |
| I-134 | 1.0 | 2.15E-02 | 6.00E-02 |
| I-135 | 1.0 | 6.58E-01 | 1.78E+00 |
| Cs-134 | 10.3 | 5.80E+05 | 7.09E+05 |
| Cs-136 | 1.3 | 6.01E+04 | 8.35E+04 |
| Cs-137 | 15.8 | 3.45E+05 | 5.26E+05 |
| Cs-138 | 1.0 | 9.18E-01 | 1.85E+00 |
| Ba-140 | 1.3 | 2.65E+01 | 5.08E-01 |
| La-140 | 1.0 | 4.47E-03 | 1.69E-02 |
| Ce-141 | 1.8 | 2.14E-02 | 1.89E-01 |
| Ce-143 | 1.0 | 1.35E-04 | 1.22E+00 |
| Ce-144 | 6.6 | 1.41E+00 | 1.10E+01 |
| Np-239 | 1.0 | 5.13E-04 | 9.31E-04 |

*Critical Organ is defined in HP-ODCM-A2, Page 2 of 2.

## TABLE 4.1

## LIQUID PATHWAY DOSE COMMITMENT FACTORS FOR ADULTS (mrem/Ci)

$(B_i = A_i*Fi/CIRC\ FLOW = A_i/EFF\ DIL\ FLOW_i)$

| # | NUCLIDE | EFF. DIL. FLOW (cft/sec) | TOT. BODY $B_i$ (mrem/Ci) | CRIT. ORG. $B_i$ (mrem/Ci) |
|---|---|---|---|---|
| 1 | H-3 | 2.28E+02 | 2.66E-04 | 2.66E-04 |
| 2 | Na-24 | 3.39E+03 | 1.07E-04 | 1.07E-04 |
| 3 | Cr-51 | 1.99E+03 | 5.44E-06 | N/A |
| 4 | Mn-54 | 4.88E+02 | 1.73E-02 | 9.08E-02 |
| 5 | Fe-55 | 3.01E+02 | 4.23E-03 | 1.81E-02 |
| 6 | Fe-59 | 1.57E+03 | 5.93E-03 | 1.55E-02 |
| 7 | Co-58 | 1.20E+03 | 2.04E-03 | 9.10E-04 |
| 8 | Co-60 | 2.55E+02 | 3.18E-02 | 1.44E-02 |
| 9 | Zn-65 | 5.60E+02 | 5.74E-01 | 1.27E+00 |
| 10 | Rb-86 | 2.34E+03 | 1.48E-01 | 3.18E-01 |
| 11 | Sr-89 | 1.46E+03 | 5.84E-03 | N/A |
| 12 | Sr-90 | 2.16E+02 | 1.09E+01 | N/A |
| 13 | Y-91 | 1.34E+03 | 2.50E-06 | N/A |
| 14 | Zr-95 | 1.27E+03 | 2.30E-06 | 1.31E-06 |
| 15 | Zr-97 | 3.39E+03 | 4.33E-10 | 9.46E-10 |
| 16 | Nb-95 | 3.25E+03 | 1.47E-04 | 2.74E-04 |
| 17 | Mo-99 | 3.30E+03 | 2.22E-05 | 1.17E-04 |
| 18 | Ru-103 | 1.68E+03 | 2.40E-05 | N/A |
| 19 | Ru-106 | 4.48E+02 | 5.80E-04 | N/A |
| 20 | Ag-110m | 5.52E+02 | 8.78E-05 | 1.48E-04 |
| 21 | Sb-124 | 1.32E+03 | 3.25E-04 | 1.55E-05 |
| 22 | Sb-125 | 2.98E+02 | 8.10E-04 | 3.80E-05 |
| 23 | Te-125m | 1.35E+03 | 2.35E-03 | 6.35E-03 |
| 24 | Te-127m | 9.16E+02 | 8.37E-03 | 2.46E-02 |
| 25 | Te-129m | 1.82E+03 | 8.19E-03 | 1.93E-02 |
| 26 | Te-131m | 3.38E+03 | 3.27E-04 | 3.92E-04 |
| 27 | Te-132 | 3.27E+03 | 1.51E-03 | 1.61E-03 |
| 28 | I-131 | 2.94E+03 | 3.22E-04 | 5.62E-04 |
| 29 | I-132 | 3.40E+03 | 2.98E-07 | 8.51E-07 |
| 30 | I-133 | 3.39E+03 | 1.00E-05 | 3.29E-05 |
| 31 | I-134 | 3.40E+03 | 6.19E-08 | 1.73E-07 |
| 32 | I-135 | 3.40E+03 | 1.90E-06 | 5.15E-06 |
| 33 | Cs-134 | 3.29E+02 | 1.73E+01 | 2.11E+01 |
| 34 | Cs-136 | 2.62E+03 | 2.25E-01 | 3.12E-01 |
| 35 | Cs-137 | 2.15E+02 | 1.57E+01 | 2.40E+01 |
| 36 | Cs-138 | 3.40E+03 | 2.65E-06 | 5.34E-06 |
| 37 | Ba-140 | 2.65E+03 | 9.83E-05 | 1.88E-06 |
| 38 | La-140 | 3.36E+03 | 1.31E-08 | 4.94E-08 |
| 39 | Ce-141 | 1.85E+03 | 1.14E-07 | 1.00E-06 |
| 40 | Ce-143 | 3.37E+03 | 3.93E-10 | 3.55E-06 |
| 41 | Ce-144 | 5.14E+02 | 2.70E-05 | 2.10E-04 |
| 42 | Np-239 | 3.32E+03 | 1.51E-09 | 2.75E-09 |

ATTACHMENT 1.0

## NORTH ANNA LAKE SPECIFIC DATA

See UFSAR CH 11.25 and ODCM 4 for Nomenclature

| | | | |
|---|---|---|---|
| Volumes : | Reservoir | VR = 1.06E+10 | cft |
| | Lagoon | VL = 2.66E+09 | cft |
| Flow Rates : | Reservoir to Lagoon | RRL = 3402 | cfs/sec |
| (7 circ pumps) | Lagoon to Reservoir | RLR = 3411 | cfs/sec |
| | Lake over Dam | ROR = 220 | cfs/sec |
| Evap. Rates : | Reservoir | RER = 59 | cfs/sec |
| | Lagoon | REL = 21 | cfs/sec |

| # | NUCLIDE | HALFLIFE (sec) | BIOACCUM. FACTOR | EFF.DIL.FLOW (cfs) | fi INDIVIDUAL DIL. FACTOR |
|---|---|---|---|---|---|
| 1 | H-3 | 3.89E+08 | 0.9 | 228 | 14.9 |
| 2 | Na-24 | 5.40E+04 | 100.0 | 3394 | 1.0 |
| 3 | Cr-51 | 2.39E+06 | 200.0 | 1991 | 1.7 |
| 4 | Mn-54 | 2.70E+07 | 400.0 | 488 | 7.0 |
| 5 | Fe-55 | 8.52E+07 | 100.0 | 301 | 11.3 |
| 6 | Fe-59 | 3.86E+06 | 100.0 | 1566 | 2.2 |
| 7 | Co-58 | 6.12E+06 | 50.0 | 1197 | 2.8 |
| 8 | Co-60 | 1.66E+08 | 50.0 | 255 | 13.3 |
| 9 | Zn-65 | 2.11E+07 | 2000.0 | 560 | 6.1 |
| 10 | Rb-86 | 1.61E+06 | 2000.0 | 2342 | 1.5 |
| 11 | Sr-89 | 4.37E+06 | 30.0 | 1460 | 2.3 |
| 12 | Sr-90 | 9.02E+08 | 30.0 | 216 | 15.8 |
| 13 | Y-91 | 5.06E+06 | 25.0 | 1342 | 2.5 |
| 14 | Zr-95 | 5.53E+06 | 3.3 | 1272 | 2.7 |
| 15 | Zr-97 | 6.08E+04 | 3.3 | 3393 | 1.0 |
| 16 | Nb-95 | 3.12E+05 | 30000.0 | 3246 | 1.0 |
| 17 | Mo-99 | 2.38E+05 | 10.0 | 3300 | 1.0 |
| 18 | Ru-103 | 3.40E+06 | 10.0 | 1675 | 2.0 |
| 19 | Ru-106 | 3.18E+07 | 10.0 | 448 | 7.6 |
| 20 | Ag-110m | 2.16E+07 | 2.3 | 552 | 6.2 |
| 21 | Sb-124 | 5.20E+06 | 1.0 | 1320 | 2.6 |
| 22 | Sb-125 | 8.74E+07 | 1.0 | 298 | 11.4 |
| 23 | Te-125m | 5.01E+06 | 400.0 | 1349 | 2.5 |
| 24 | Te-127m | 9.42E+06 | 400.0 | 916 | 3.7 |
| 25 | Te-129m | 2.90E+06 | 400.0 | 1816 | 1.9 |
| 26 | Te-131m | 1.08E+05 | 400.0 | 3375 | 1.0 |
| 27 | Te-132 | 2.82E+05 | 400.0 | 3269 | 1.0 |
| 28 | I-131 | 6.95E+05 | 15.0 | 2944 | 1.2 |
| 29 | I-132 | 8.28E+03 | 15.0 | 3402 | 1.0 |
| 30 | I-133 | 7.49E+04 | 15.0 | 3388 | 1.0 |
| 31 | I-134 | 3.16E+03 | 15.0 | 3402 | 1.0 |
| 32 | I-135 | 2.38E+04 | 15.0 | 3400 | 1.0 |
| 33 | Cs-134 | 6.50E+07 | 2000.0 | 329 | 10.3 |
| 34 | Cs-136 | 1.14E+06 | 2000.0 | 2624 | 1.3 |
| 35 | Cs-137 | 9.51E+08 | 2000.0 | 215 | 15.8 |
| 36 | Cs-138 | 1.93E+03 | 2000.0 | 3402 | 1.0 |
| 37 | Ba-140 | 1.11E+06 | 4.0 | 2645 | 1.3 |
| 38 | La-140 | 1.45E+05 | 25.0 | 3357 | 1.0 |
| 39 | Ce-141 | 2.81E+06 | 1.0 | 1846 | 1.8 |
| 40 | Ce-143 | 1.19E+05 | 1.0 | 3370 | 1.0 |
| 41 | Ce-144 | 2.46E+07 | 1.0 | 514 | 6.6 |
| 42 | Np-239 | 2.04E+05 | 10.0 | 3322 | 1.0 |

ATTACHMENT 2.0

INGESTION DOSE FACTORS FOR ADULTS
(mrem/pCi ingested)

| # | Nuclide | BONE | LIVER | W. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| 1 | H-3 | - - - - | 1.05E-07 | 1.05E-07 | 1.05E-07 | 1.05E-07 | 1.05E-07 | 1.05E-07 |
| 2 | Na-24 | 1.70E-06 | 1.70E-06 | 1.70E-06 | 1.70E-06 | 1.70E-06 | 1.70E-06 | 1.70E-06 |
| 3 | Cr-51 | - - - - | - - - - | 2.66E-09 | 1.59E-09 | 5.86E-10 | 3.53E-09 | 6.69E-07 |
| 4 | Mn-54 | - - - - | 4.57E-06 | 8.72E-07 | - - - - | 1.36E-06 | - - - - | 1.40E-05 |
| 5 | Fe-55 | 2.75E-06 | 1.90E-06 | 4.43E-07 | - - - - | - - - - | 1.06E-06 | 1.09E-06 |
| 6 | Fe-59 | 4.34E-06 | 1.02E-05 | 3.91E-06 | - - - - | - - - - | 2.85E-06 | 3.40E-05 |
| 7 | Co-58 | - - - - | 7.45E-07 | 1.67E-06 | - - - - | - - - - | - - - - | 1.51E-05 |
| 8 | Co-60 | - - - - | 2.14E-06 | 4.72E-06 | - - - - | - - - - | - - - - | 4.02E-05 |
| 9 | Zn-65 | 4.84E-06 | 1.54E-05 | 6.96E-06 | - - - - | 1.03E-05 | - - - - | 9.70E-06 |
| 10 | Rb-86 | - - - - | 2.11E-05 | 9.83E-06 | - - - - | - - - - | - - - - | 4.16E-06 |
| 11 | Sr-89 | 3.08E-04 | - - - - | 8.84E-06 | - - - - | - - - - | - - - - | 4.94E-05 |
| 12 | Sr-90 | 7.58E-09 | - - - - | 1.86E-03 | - - - - | - - - - | - - - - | 2.19E-04 |
| 13 | Y-91 | 1.41E-07 | - - - - | 3.77E-09 | - - - - | - - - - | - - - - | 7.76E-05 |
| 14 | Zr-95 | 3.04E-08 | 3.75E-09 | 6.60E-09 | - - - - | 1.53E-08 | - - - - | 3.09E-05 |
| 15 | Zr-97 | 1.68E-09 | 3.39E-10 | 1.55E-10 | - - - - | 5.12E-10 | - - - - | 1.05E-04 |
| 16 | Nb-95 | 6.22E-09 | 3.46E-09 | 1.86E-09 | - - - - | 3.42E-09 | - - - - | 2.10E-05 |
| 17 | Mo-99 | - - - - | 4.31E-06 | 8.20E-07 | - - - - | 9.76E-06 | - - - - | 9.99E-06 |
| 18 | Ru-103 | 1.85E-07 | - - - - | 7.97E-08 | - - - - | 7.06E-07 | - - - - | 2.16E-05 |
| 19 | Ru-106 | 2.75E-06 | - - - - | 3.48E-07 | - - - - | 5.31E-06 | - - - - | 1.78E-04 |
| 20 | Ag-110m | 1.60E-07 | 1.48E-07 | 8.79E-08 | - - - - | 2.91E-07 | - - - - | 6.04E-05 |
| 21 | Sb-124 | 2.80E-06 | 5.29E-08 | 1.11E-06 | 6.79E-09 | - - - - | 2.18E-06 | 7.95E-05 |
| 22 | Sb-125 | 1.79E-06 | 2.00E-08 | 4.26E-07 | 1.82E-09 | - - - - | 1.38E-06 | 1.97E-05 |
| 23 | Te-125m | 2.68E-06 | 9.71E-07 | 3.59E-07 | 8.06E-07 | 1.09E-05 | - - - - | 1.07E-05 |
| 24 | Te-127m | 6.77E-06 | 2.42E-06 | 8.25E-07 | 1.73E-06 | 2.75E-05 | - - - - | 2.27E-05 |
| 25 | Te-129m | 1.15E-05 | 4.29E-06 | 1.82E-06 | 3.95E-06 | 4.80E-05 | - - - - | 5.79E-05 |
| 26 | Te-131m | 1.73E-06 | 8.46E-07 | 7.05E-07 | 1.34E-06 | 8.57E-06 | - - - - | 8.40E-05 |
| 27 | Te-132 | 2.52E-06 | 1.63E-06 | 1.53E-06 | 1.80E-06 | 1.57E-05 | - - - - | 7.71E-05 |
| 28 | I-131 | 4.16E-06 | 5.95E-06 | 3.41E-06 | 1.95E-03 | 1.02E-05 | - - - - | 1.57E-06 |
| 29 | I-132 | 2.03E-07 | 5.43E-07 | 1.90E-07 | 1.90E-05 | 8.65E-07 | - - - - | 1.02E-07 |
| 30 | I-133 | 1.42E-06 | 2.47E-06 | 7.53E-07 | 3.63E-04 | 4.31E-06 | - - - - | 2.22E-06 |
| 31 | I-134 | 1.06E-07 | 2.88E-07 | 1.03E-07 | 4.99E-06 | 4.58E-07 | - - - - | 2.51E-10 |
| 32 | I-135 | 4.43E-07 | 1.16E-06 | 4.28E-07 | 7.65E-05 | 1.86E-06 | - - - - | 1.31E-06 |
| 33 | Cs-134 | 6.22E-05 | 1.48E-04 | 1.21E-04 | - - - - | 4.79E-05 | 1.59E-05 | 2.59E-06 |
| 34 | Cs-136 | 6.51E-06 | 2.57E-05 | 1.85E-05 | - - - - | 1.43E-05 | 1.96E-06 | 2.92E-06 |
| 35 | Cs-137 | 7.97E-05 | 1.09E-04 | 7.14E-05 | - - - - | 3.70E-05 | 1.23E-05 | 2.11E-06 |
| 36 | Cs-138 | 5.52E-08 | 1.09E-07 | 5.40E-08 | - - - - | 8.01E-08 | 7.91E-09 | 4.65E-13 |
| 37 | Ba-140 | 2.03E-05 | 2.55E-08 | 1.33E-06 | - - - - | 8.67E-09 | 1.46E-08 | 4.18E-05 |
| 38 | La-140 | 2.50E-09 | 1.26E-09 | 3.33E-10 | - - - - | - - - - | - - - - | 9.25E-05 |
| 39 | Ce-141 | 9.36E-09 | 6.33E-09 | 7.18E-10 | - - - - | 2.94E-09 | - - - - | 2.42E-05 |
| 40 | Ce-143 | 1.65E-09 | 1.22E-06 | 1.35E-10 | - - - - | 5.37E-10 | - - - - | 4.56E-05 |
| 41 | Ce-144 | 4.88E-07 | 2.04E-07 | 2.62E-08 | - - - - | 1.21E-07 | - - - - | 1.65E-04 |
| 42 | Np-239 | 1.19E-09 | 1.17E-10 | 6.45E-11 | - - - - | 3.65E-10 | - - - - | 2.40E-05 |

## ATTACHMENT 3.0

### SITE RELATED INGESTION DOSE COMMITMENT FACTORS FOR ADULTS
(mrem-ml/uCi-hr)

| # | Nuclide | BONE | LIVER | W. BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| 1 | H-3 | - - - - | 6.18E+00 | 6.18E+00 | 6.18E+00 | 6.18E+00 | 6.18E+00 | 6.18E+00 |
| 2 | Na-24 | 3.71E+01 | 3.71E+01 | 3.71E+01 | 3.71E+01 | 3.71E+01 | 3.71E+01 | 3.71E+01 |
| 3 | Cr-51 | - - - - | - - - - | 1.10E+00 | 6.59E-01 | 2.43E-01 | 1.46E+00 | 2.77E+02 |
| 4 | Mn-54 | - - - - | 4.52E+03 | 8.62E+02 | - - - - | 1.34E+03 | - - - - | 1.38E+04 |
| 5 | Fe-55 | 8.05E+02 | 5.56E+02 | 1.30E+02 | - - - - | - - - - | 3.10E+02 | 3.19E+02 |
| 6 | Fe-59 | 1.05E+03 | 2.47E+03 | 9.47E+02 | - - - - | - - - - | 6.90E+02 | 8.24E+03 |
| 7 | Co-58 | - - - - | 1.11E+02 | 2.49E+02 | - - - - | - - - - | - - - - | 2.25E+03 |
| 8 | Co-60 | - - - - | 3.75E+02 | 8.27E+02 | - - - - | - - - - | - - - - | 7.04E+03 |
| 9 | Zn-65 | 2.28E+04 | 7.25E+04 | 3.28E+04 | - - - - | 4.85E+04 | - - - - | 4.57E+04 |
| 10 | Rb-86 | - - - - | 7.59E+04 | 3.53E+04 | - - - - | - - - - | - - - - | 1.50E+04 |
| 11 | Sr-89 | 3.03E+04 | - - - - | 8.70E+02 | - - - - | - - - - | - - - - | 4.86E+03 |
| 12 | Sr-90 | 9.74E-01 | - - - - | 2.39E+05 | - - - - | - - - - | - - - - | 2.81E+04 |
| 13 | Y-91 | 1.28E+01 | - - - - | 3.42E-01 | - - - - | - - - - | - - - - | 7.04E+03 |
| 14 | Zr-95 | 1.37E+00 | 1.70E-01 | 2.98E-01 | - - - - | 6.92E-01 | - - - - | 1.40E+03 |
| 15 | Zr-97 | 1.62E-03 | 3.27E-04 | 1.50E-04 | - - - - | 4.94E-04 | - - - - | 1.01E+02 |
| 16 | Nb-95 | 1.63E+02 | 9.07E+01 | 4.87E+01 | - - - - | 8.96E+01 | - - - - | 5.50E+05 |
| 17 | Mo-99 | - - - - | 3.93E+01 | 7.48E+00 | - - - - | 8.90E+01 | - - - - | 9.11E+01 |
| 18 | Ru-103 | 9.52E+00 | - - - - | 4.10E+00 | - - - - | 3.63E+01 | - - - - | 1.11E+03 |
| 19 | Ru-106 | 2.10E+02 | - - - - | 2.65E+01 | - - - - | 4.05E+02 | - - - - | 1.36E+04 |
| 20 | Ag-110m | 9.00E+00 | 8.32E+00 | 4.94E+00 | - - - - | 1.64E+01 | - - - - | 3.40E+03 |
| 21 | Sb-124 | 1.10E+02 | 2.08E+00 | 4.37E+01 | 2.67E-01 | - - - - | 8.58E+01 | 3.13E+03 |
| 22 | Sb-125 | 1.03E+02 | 1.16E+00 | 2.46E+01 | 1.05E-01 | - - - - | 7.98E+01 | 1.14E+03 |
| 23 | Te-125m | 2.41E+03 | 8.73E+02 | 3.23E+02 | 7.24E+02 | 9.80E+03 | - - - - | 9.62E+03 |
| 24 | Te-127m | 6.42E+03 | 2.29E+03 | 7.82E+02 | 1.64E+03 | 2.61E+04 | - - - - | 2.15E+04 |
| 25 | Te-129m | 9.58E+03 | 3.58E+03 | 1.52E+03 | 3.29E+03 | 4.00E+04 | - - - - | 4.83E+04 |
| 26 | Te-131m | 2.76E+02 | 1.35E+02 | 1.12E+02 | 2.14E+02 | 1.37E+03 | - - - - | 1.34E+04 |
| 27 | Te-132 | 8.30E+02 | 5.37E+02 | 5.04E+02 | 5.93E+02 | 5.17E+03 | - - - - | 2.54E+04 |
| 28 | I-131 | 1.18E+02 | 1.69E+02 | 9.66E+01 | 5.52E+04 | 2.89E+02 | - - - - | 4.45E+01 |
| 29 | I-132 | 1.10E-01 | 2.95E-01 | 1.03E-01 | 1.03E+01 | 4.70E-01 | - - - - | 5.55E-02 |
| 30 | I-133 | 6.54E+00 | 1.14E+01 | 3.47E+[illegible] | 1.67E+03 | 1.98E+01 | - - - - | 1.02E+01 |
| 31 | I-134 | [illegible].21E-02 | 6.00E-02 | 2.15E-02 | 1.04E+00 | 9.55E-02 | - - - - | 5.23E-05 |
| 32 | I-135 | 6.81E-01 | 1.78E+00 | 6.58E-01 | 1.18E+02 | 2.86E+00 | - - - - | 2.02E+00 |
| 33 | Cs-134 | 2.98E+05 | 7.09E+05 | 5.80E+05 | - - - - | 2.29E+05 | 7.62E+04 | 1.24E+04 |
| 34 | Cs-136 | 2.12E+04 | 8.35E+04 | 6.01E+04 | - - - - | 4.65E+04 | 6.37E+03 | 9.49E+02 |
| 35 | Cs-137 | 3.85E+05 | 5.26E+05 | 3.45E+05 | - - - - | 1.79E+05 | 5.94E+04 | 1.02E+04 |
| 36 | Cs-138 | 9.39E-01 | 1.85E+00 | 9.18E-01 | - - - - | 1.36E+00 | 1.35E-01 | 7.91E-06 |
| 37 | Ba-140 | 4.04E+02 | 5.08E-01 | 2.65E+01 | - - - - | 1.73E-01 | 2.91E-01 | 8.33E+02 |
| 38 | La-140 | 3.35E-02 | 1.69E-02 | 4.47E-03 | - - - - | - - - - | - - - - | 1.24E+03 |
| 39 | Ce-141 | 2.79E-01 | 1.89E-01 | 2.14E-02 | - - - - | 8.76E-02 | - - - - | 7.21E+02 |
| 40 | Ce-143 | 1.65E-03 | 1.22E+00 | 1.35E-04 | - - - - | 5.36E-04 | - - - - | 4.56E+01 |
| 41 | Ce-144 | 2.63E+01 | 1.10E+01 | 1.41E+00 | - - - - | 6.52E+00 | - - - - | 8.89E+03 |
| 42 | Np-239 | 9.46E-03 | 9.31E-04 | 5.13E-04 | - - - - | 2.90E-03 | - - - - | 1.91E+02 |

ATTACHMENT 4

(01/89 - 06/89)

REVISIONS TO PROCESS CONTROL PROGRAM (PCP)

As required by Technical Specification 6.14, revisions to the PCP for the time period covered by this report are synopsized below. Supporting documentation and affected pages of the PCP are attached.

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No revisions to the Radiation Protection Plan procedure HP-7.2.20 "Process Control Program" (PCP) were required for the time period covered by this report.

# ATTACHMENT 5

## (01/89 - 06/89)

## MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS

As required by Technical Specification 6.16, major changes to radioactive liquid, gaseous and solid waste treatment systems for the time period covered by this report are reported below. Supporting information as to the reason(s) for the change(s) and a summary of the 10 CFR Part 50.59 evaluation are included.

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No major changes to the radioactive liquid, gaseous, and solid waste treatment systems were made for the time period covered by this report.

ATTACHMENT 6

(01/89 - 06/89)

INOPERABILITY OF RADIOACTIVE LIQUID AND GASEOUS EFFLUENT INSTRUMENTATION

As required by Technical Specification 3.3.3.10.b and 3.3.3.11.b, a list and explanation for the inoperability of radioactive liquid and/or gaseous effluent monitors is provided in this report.

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On November 27, 1987, 01-LW-P-28, the liquid waste effluent discharge proportional sampling pump was declared inoperable. 01-LW-P-28 has had operability problems due to clogging of the pump head check valves and the back pressure regulator. The disassembly and replacement of the pump head check valves, pump diaphragm and back pressure regulator were completed under Work Order #084266 on February 6, 1989 after numerous clarifier demin post filter changeouts, line flushes, delays in parts availability and sludge accumulation problems. A test run continued to experience sludge accumulation problems. EWR #88-157 was initiated to solve the continued clogging problems by moving the pump suction to the top of the pipe. EWR #88-157 was written and SNSOC approved by March 7, 1989, but implementation by the I & C Dept. was delayed until June 16, 1989, because of problems with additional parts availabilty for piping changes due to potential crud trap considerations and plant condition requirement for work on the discharge line. The pump was rebuilt under Work Order #094934 and the relocation of the pump suction line was completed under Work Order #089818 for EWR #88-157 by June 27, 1989. A overnight test run developed problems with "Trash" accumulation under the back pressure PCV diaphragms. I & C Dept. is continuing to work on solving these operability problems.

ATTACHMENT 6

(01/89 - 06/89)

INOPERABILITY OF RADIOACTIVE LIQUID AND GASEOUS EFFLUENT INSTRUMENTATION

(cont.)

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On February 28, 1989, 01-LW-RM-111, the liquid waste effluent radiation monitor was declared inoperable due to high monitor readings. A signal conductor was repaired and functionally tested under Work Order #089416. A broken wire in the detector cable was repaired and functionally tested under Work Order #094974. Calibration of the radiation monitor was satisfactorily completed. Work Order #089318 was initiated on March 6, 1989 to decontaminate or replace the radiation monitor pig. A refurbished pig, new flange and half couplings are in stock and work was scheduled to be performed in conjunction with 01-LW-P-28 repair work. On June 17, 1989, an attempt was made to change the pig but the refurbished pig was not as described in the Tech. Manual and did not fit. Requisition #8500-3609 was initiated with Westinghouse to identify and provide the correct pig. Due to the extreme cost of a correct replacement pig, Engineering initiated EWR #89-409 to evaluate using one of our available pigs, with modifications to fit. Engineering is continuing to work on solving this problem.

On March 4, 1989, 01-GW-H2R-102, the waste gas decay tank hydrogen and recorder was declared inoperable due to low hydrogen readings. Repairs to the analyzer were made under Work Order #088610, but failed to solve the problem. On March 28, 1989, EWR #88-225 was initiated to replace the bad hygrogen analyzer. The replacement analyzer and Tech. manuals were not available until May 12, 1989. Due to Engineering and I & C Dept. manpower restrictions, EWR #88-225 is not planned to be written and installation completed until August 16, 1989.

ATTACHMENT 6

(01/89 - 06/89)

INOPERABILITY OF RADIOACTIVE LIQUID AND GASEOUS

EFFLUENT INSTRUMENTATION

(cont.)

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On February 28, 1989, 01-LW-RM-111, the liquid waste effluent radiation monitor was declared inoperable due to high monitor readings. A signal conductor was repaired and functionally tested under Work Order #089416. A broken wire in the detector cable was repaired and functionally tested under Work Order #094974. Calibration of the radiation monitor was satisfactorily completed. Work Order #089318 was initiated on March 6, 1989 to decontaminate or replace the radiation monitor pig. A refurbished pig, new flange and half couplings are in stock and work was scheduled to be performed in conjunction with 01-LW-P-28 repair work. On June 17, 1989, an attempt was made to change the pig but the refurbished pig was not as described in the Tech. Manual and did not fit. Requisition #8500-3609 was initiated with Westinghouse to identify and provide the correct pig. Due to the extreme cost of a correct replacement pig, Engineering initiated EWR #89-409 to evaluate using one of our available pigs, with modifications to fit. Engineering is continuing to work on solving this problem.

On March 4, 1989, 01-GW-H2R-102, the waste gas decay tank hydrogen analyzer recorder was declared inoperable due to low hydrogen readings. Repairs to the analyzer were made under Work Order #088610, but failed to solve the problem. On March 28, 1989, EWR #88-225 was initiated to replace the bad hygrogen analyzer. The replacement analyzer and Tech. manuals were not available until May 12, 1989. Due to Engineering and I & C Dept. manpower restrictions, EWR #88-225 is not planned to be written and installation completed until August 16, 1989.

ATTACHMENT 6

(01/89 - 06/89)

INOPERABILITY OF RADIOACTIVE LIQUID AND GASEOUS

EFFLUENT INSTRUMENTATION

(cont.)

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On May 12, 1989, 01-VG-RM-104, the Ventilation Vent "A" gaseous radiation monitor was declared inoperable due to the sample pump experiencing trip problems. The "A" stack radiation monitor sample pump (01-VG-P-103) repairs were made under Work Order #093566. Flow calibration for 01-VG-P-103 was performed under Work Order #095464. 01-VG-P-103 was returned to service on June 6, 1989, but experienced high amps being drawn by the pump motor. An observation/evaluation period was implemented to ensure 01-VG-P-103 would operate properly. 01-VG-RM-104 was declared OPERABLE on June 20, 1989.

## ATTACHMENT 7

## (01/89 - 06/89)

## UNPLANNED RELEASES

As required by Technical Specification 6.9.1.9, a list of unplanned releases, defined according to the criteria presented in 10 CFR part 50.73, from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents made during the reporting period is made below.

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No unplanned releases, as defined according to the criteria presented in 10CFR Part 50.73, occurred during the time period covered by this report.

# ATTACHMENT 8

## Lower Limits of Detection For Effluent Sample Analysis (01/89 - 06/89)

Gaseous Effluents

| Radioisotope | Required L.L.D. (μCi/ml) | Typical L.L.D. (μCi/ml) |
|---|---|---|
| Krypton - 87 | 1.0E-4 | 1.52E-7 - 3.50E-7 |
| Krypton - 88 | 1.0E-4 | 1.98E-7 - 4.23E-7 |
| Xenon - 133 | 1.0E-4 | 1.24E-7 - 3.02E-7 |
| Xenon - 133m | 1.0E-4 | 5.63E-7 - 1.27E-6 |
| Xenon - 135 | 1.0E-4 | 6.39E-8 - 1.56E-7 |
| Xenon - 135m | 1.0E-4 | 2.81E-7 - 6.74E-7 |
| Xenon - 138 | 1.0E-4 | 7.86E-7 - 1.73E-6 |
| Iodine - 131 | 1.0E-12 | 4.49E-14 - 6.18E-14 |
| Manganese - 54 | 1.0E-11 | 4.50E-14 - 4.70E-14 |
| Cobalt - 58 | 1.0E-11 | 4.56E-14 - 5.04E-14 |
| Iron - 59 | 1.0E-11 | 9.11E-14 - 9.75E-14 |
| Cobalt - 60 | 1.0E-11 | 8.08E-14 - 1.15E-13 |
| Zinc - 65 | 1.0E-11 | 1.03E-13 - 1.36E-13 |
| Strontium - 89 | 1.0E-11 | 5.00E-15 - 1.00E-11 |
| Strontium - 90 | 1.0E-11 | 7.00E-16 - 2.00E-12 |
| Molybdenum - 99 | 1.0E-11 | 2.58E-13 - 3.70E-13 |
| Cesium - 134 | 1.0E-11 | 3.55E-14 - 4.95E-14 |
| Cesium - 137 | 1.0E-11 | 4.67E-14 - 6.56E-14 |
| Cerium - 141 | 1.0E-11 | 4.32E-14 - 5.19E-14 |
| Cerium - 144 | 1.0E-11 | 1.90E-13 - 2.43E-13 |
| Gross Alpha | 1.0E-11 | 1.09E-14 - 1.63E-14 |
| Tritium | 1.0E-6 | 1.33E-7 - 1.58E-7 |

ATTACHMENT 8

Lower Limits of Detection For Effluent Sample Analysis
(01/89 - 06/89)
( cont. )

Liquid Effluents

| Radioisotope | Required L.L.D. (µCi/ml) | Typical L.L.D. (µCi/ml) |
|---|---|---|
| Krypton - 87 | 1.0E-5 | 5.90E-8 - 6.34E-8 |
| Krypton - 88 | 1.0E-5 | 7.84E-8 - 9.65E-8 |
| Xenon - 133 | 1.0E-5 | 5.53E-8 - 6.81E-8 |
| Xenon - 133m | 1.0E-5 | 2.23E-7 - 2.69E-7 |
| Xenon - 135 | 1.0E-5 | 2.72E-8 - 2.99E-8 |
| Xenon - 135m | 1.0E-5 | 1.13E-7 |
| Xenon - 138 | 1.0E-5 | 2.99E-7 - 3.65E-7 |
| Iodine - 131 | 1.0E-6 | 2.57E-8 - 3.45E-8 |
| Manganese - 54 | 5.0E-7 | 2.60E-8 - 2.83E-8 |
| Iron - 55 | 1.0E-6 | 1.00E-6 |
| Cobalt - 58 | 5.0E-7 | 2.64E-8 - 3.04E-8 |
| Iron - 59 | 5.0E-7 | 5.14E-8 - 5.66E-8 |
| Cobalt - 60 | 5.0E-7 | 4.65E-8 - 6.47E-8 |
| Zinc - 65 | 5.0E-7 | 5.81E-8 - 7.89E-8 |
| Strontium - 89 | 5.0E-8 | 3.00E-8 - 4.00E-8 |
| Strontium - 90 | 5.0E-8 | 5.00E-9 - 1.00E-8 |
| Molybdenum - 99 | 5.0E-7 | 1.53E-7 - 2.25E-7 |
| Cesium - 134 | 5.0E-7 | 2.23E-8 - 3.05E-8 |
| Cesium - 137 | 5.0E-7 | 2.86E-8 - 4.02E-8 |
| Cerium - 141 | 5.0E-7 | 3.45E-8 - 4.10E-8 |
| Cerium - 144 | 5.0E-7 | 1.52E-7 - 1.95E-7 |
| Gross Alpha | 1.0E-7 | 6.28E-9 - 9.42E-9 |
| Tritium | 1.0E-5 | 3.68E-6 - 4.36E-6 |