



Nuclear Fuel Services, Inc.

Certified Mail
Return Receipt Requested

21G-23-0033
GOV-01-55
ACF-23-0058
February 20, 2023

Director
Office of Nuclear Material Safety & Safeguards
U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Reference: Docket No. 70-143; SNM License 124

Subject: **Biannual Effluent Monitoring Report July to December 2022**

Dear Director:

In accordance with the requirements set forth in 10 CFR Part 70.59, Nuclear Fuel Services, Inc. (NFS), submits the attached reports. Attachment 1 reports the Radioactivity in Effluent Liquid for the period July to December 2022. Attachment 2 reports the Radioactivity in Effluent Air for the period July to December 2022. Attachment 3 summarizes an evaluation of the dose and air activity concentrations for the maximally exposed offsite individual due to gaseous effluents during the period July to December 2022.

If you or your staff have any questions, require additional information, or wish to discuss this, please contact me or Mr. R. Jason Faddis, Deputy Environmental Protection and Industrial Safety Section Manager, at (423) 735-5438. Please reference our unique document identification number (21G-23-0033) in any correspondence concerning this letter.

Sincerely,

NUCLEAR FUEL SERVICES, INC.

Tim Knowles
Tim Knowles
Safety & Safeguards Director

IE48
NMSS20
NMSS

CJB/las
Attachments

- 1) Report of Radioactivity in Effluent Liquid for the Period July to December 2022
- 2) Report of Radioactivity in Effluent Air for the Period July to December 2022
- 3) Report of Gaseous Effluent Dose and Activity Concentrations for the Maximally Exposed Off-Site Individual for the Release Period July to December 2022

Copy:

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Mr. Larry Harris
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**Attachment 1
To Letter Dated February 20, 2023**

**Report of Radioactivity in Effluent Liquid for the Period
July to December 2022**

(2 Pages to Follow)

**Radioactivity in Effluent Liquid
 July 1, 2022 to December 31, 2022**

| Location | Total Volume (l) | Activity Concentration (µCi/ml) | Error Estimate (µCi/ml) | LLD (µCi/ml) | Quantity Released (Ci) | Quantity Released (g) | Fraction of ECV ¹ |
|---------------------------|------------------|---------------------------------|-------------------------|--------------|------------------------|-----------------------|------------------------------|
| Banner Spring Down | | | | | | | |
| Pu-238 | 446,898,000 | 1.44E-11 | 9.59E-11 | 2.04E-10 | 6.43E-06 | 3.76E-07 | 7.19E-04 |
| Pu-239/240 | 446,898,000 | 0.00E+00 | 1.01E-10 | 2.41E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Tc-99 | 446,898,000 | 9.56E-09 | 2.71E-08 | 4.67E-08 | 4.27E-03 | 2.53E-01 | 1.59E-04 |
| Th-228 | 446,898,000 | 0.00E+00 | 1.29E-10 | 3.14E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 446,898,000 | 1.07E-10 | 1.93E-10 | 3.34E-10 | 4.80E-05 | 2.38E-03 | 1.07E-03 |
| Th-232 | 446,898,000 | 1.66E-11 | 1.11E-10 | 2.29E-10 | 7.40E-06 | 6.79E+01 | 5.52E-04 |
| U-233/234 | 446,898,000 | 2.82E-10 | 2.49E-10 | 3.32E-10 | 1.26E-04 | 2.02E-02 | 9.40E-04 |
| U-235/236 | 446,898,000 | 5.35E-11 | 1.48E-10 | 2.21E-10 | 2.39E-05 | 1.11E+01 | 1.78E-04 |
| U-238 | 446,898,000 | 6.14E-11 | 1.40E-10 | 2.44E-10 | 2.75E-05 | 8.20E+01 | 2.05E-04 |
| | | | | | | Total: | 3.83E-03 |
| Sewer | | | | | | | |
| Pu-238 | 19,404,000 | 0.00E+00 | 1.47E-10 | 3.39E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Pu-239/240 | 19,404,000 | 0.00E+00 | 1.34E-10 | 3.49E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Tc-99 | 19,404,000 | 1.48E-08 | 2.83E-08 | 4.82E-08 | 2.88E-04 | 1.70E-02 | 2.47E-05 |
| Th-228 | 19,404,000 | 0.00E+00 | 1.56E-10 | 3.56E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 19,404,000 | 1.34E-10 | 2.44E-10 | 4.15E-10 | 2.61E-06 | 1.29E-04 | 1.34E-04 |
| Th-232 | 19,404,000 | 3.99E-12 | 1.21E-10 | 2.56E-10 | 7.74E-08 | 7.10E+01 | 1.33E-05 |
| U-232 | 19,404,000 | 0.00E+00 | 1.27E-10 | 2.90E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-233/234 | 19,404,000 | 6.74E-09 | 7.62E-10 | 1.77E-10 | 1.31E-04 | 2.10E-02 | 2.25E-03 |
| U-235/236 | 19,404,000 | 3.40E-10 | 1.81E-10 | 1.33E-10 | 6.60E-06 | 3.06E+00 | 1.13E-04 |
| U-238 | 19,404,000 | 6.93E-10 | 2.57E-10 | 1.39E-10 | 1.35E-05 | 4.02E+01 | 2.31E-04 |
| | | | | | | Total: | 2.76E-03 |
| West Ditch | | | | | | | |
| Pu-238 | 122,923,000 | 2.32E-11 | 1.09E-10 | 2.25E-10 | 2.85E-06 | 1.67E-07 | 1.16E-03 |
| Pu-239/240 | 122,923,000 | 2.19E-12 | 1.03E-10 | 2.26E-10 | 2.69E-07 | 4.32E-06 | 1.09E-04 |
| Tc-99 | 122,923,000 | 6.51E-09 | 2.65E-08 | 4.58E-08 | 8.00E-04 | 4.74E-02 | 1.09E-04 |
| Th-228 | 122,923,000 | 0.00E+00 | 1.55E-10 | 3.63E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 122,923,000 | 5.02E-11 | 1.93E-10 | 3.72E-10 | 6.17E-06 | 3.06E-04 | 5.02E-04 |
| Th-232 | 122,923,000 | 1.31E-11 | 1.10E-10 | 2.29E-10 | 1.61E-06 | 1.47E+01 | 4.36E-04 |
| U-233/234 | 122,923,000 | 1.44E-08 | 1.52E-09 | 4.18E-10 | 1.77E-03 | 2.83E-01 | 4.79E-02 |
| U-235/236 | 122,923,000 | 6.29E-10 | 3.75E-10 | 2.60E-10 | 7.73E-05 | 3.58E+01 | 2.10E-03 |
| U-238 | 122,923,000 | 9.79E-10 | 4.27E-10 | 3.25E-10 | 1.20E-04 | 3.59E+02 | 3.26E-03 |
| | | | | | | Total: | 5.56E-02 |
| WWTF | | | | | | | |
| Am-241 | 3,260,049 | 4.28E-11 | 1.08E-10 | 1.77E-10 | 1.40E-07 | 4.07E-08 | 2.14E-03 |
| Cs-137 | 3,260,049 | 3.01E-11 | 1.52E-09 | 1.62E-09 | 9.82E-08 | 1.13E-09 | 3.01E-05 |
| Na-22 | 3,260,049 | 0.00E+00 | 7.97E-10 | 1.44E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Np-237 | 3,260,049 | 5.62E-12 | 2.88E-10 | 6.20E-10 | 1.83E-08 | 2.60E-05 | 2.81E-04 |
| Pb-212 | 3,260,049 | 0.00E+00 | 3.28E-09 | 3.26E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Pu-238 | 3,260,049 | 2.58E-11 | 8.88E-11 | 1.61E-10 | 8.41E-08 | 4.92E-09 | 1.29E-03 |

¹ ECV: Effluent Concentration Value from 10-CFR-20, Appendix B.

Note: A value of "0" was substituted for negative analytical results.

**Radioactivity in Effluent Liquid
 July 1, 2022 to December 31, 2022**

| Location | Total Volume (l) | Activity Concentration (µCi/ml) | Error Estimate (µCi/ml) | LLD (µCi/ml) | Quantity Released (Ci) | Quantity Released (g) | Fraction of ECV ¹ |
|-------------|------------------|---------------------------------|-------------------------|--------------|------------------------|-----------------------|------------------------------|
| WWTF | | | | | | | |
| Pu-239/240 | 3,260,049 | 2.38E-11 | 8.78E-11 | 1.62E-10 | 7.76E-08 | 1.25E-06 | 1.19E-03 |
| Pu-241 | 3,260,049 | 0.00E+00 | 1.22E-08 | 2.09E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ra-224 | 3,260,049 | 1.07E-08 | 5.77E-09 | 1.02E-08 | 3.50E-05 | 2.20E-10 | 5.36E-02 |
| Tc-99 | 3,260,049 | 1.63E-08 | 5.95E-08 | 1.03E-07 | 5.30E-05 | 3.14E-03 | 2.71E-04 |
| Th-228 | 3,260,049 | 0.00E+00 | 1.19E-10 | 3.11E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 3,260,049 | 8.53E-11 | 1.90E-10 | 3.67E-10 | 2.78E-07 | 1.38E-05 | 8.53E-04 |
| Th-231 | 3,260,049 | 8.45E-09 | 3.71E-08 | 3.97E-08 | 2.75E-05 | 5.18E-11 | 1.69E-04 |
| Th-232 | 3,260,049 | 5.27E-11 | 1.33E-10 | 2.25E-10 | 1.72E-07 | 1.58E+00 | 1.76E-03 |
| U-232 | 3,260,049 | 2.04E-11 | 1.41E-10 | 2.80E-10 | 6.65E-08 | 3.11E-09 | 3.40E-04 |
| U-233/234 | 3,260,049 | 1.11E-08 | 9.67E-10 | 1.79E-10 | 3.63E-05 | 5.82E-03 | 3.71E-02 |
| U-235/236 | 3,260,049 | 5.32E-10 | 2.28E-10 | 1.61E-10 | 1.73E-06 | 8.03E-01 | 1.77E-03 |
| U-238 | 3,260,049 | 6.15E-11 | 1.01E-10 | 1.60E-10 | 2.01E-07 | 5.99E-01 | 2.05E-04 |
| | | | | | | Total: | 1.01E-01 |

¹ ECV: Effluent Concentration Value from 10-CFR-20, Appendix B.
 Note: A value of "0" was substituted for negative analytical results.

**Attachment 2
To Letter Dated February 20, 2023**

**Report of Radioactivity in Effluent Air for the Period
July to December 2022**

(3 Pages to Follow)

**Radioactivity in Effluent Air
 July 1, 2022 to December 31, 2022**

| Location | Total Volume (m ³) | Activity Concentration (μCi/ml) | Error Estimate (μCi/ml) | LLD (μCi/ml) | Quantity Released (Ci) | Quantity Released (g) | Fraction of ECV ¹ |
|----------------------------|--------------------------------|----------------------------------|-------------------------|--------------------------------|------------------------|-----------------------|------------------------------|
| Main Stack 416 | | 1071.79 m³/min | | 17.86 m³/sec | | | |
| Th-228 | 282,542,362 | 7.32E-16 | 1.50E-16 | 1.03E-16 | 2.07E-07 | 2.53E-10 | 3.66E-02 |
| Th-230 | 282,542,362 | 7.32E-16 | 1.50E-16 | 1.03E-16 | 2.07E-07 | 1.02E-05 | 3.66E-02 |
| Th-232 | 282,542,362 | 5.49E-16 | 1.12E-16 | 7.71E-17 | 1.55E-07 | 1.42E+00 | 1.37E-01 |
| U-234 | 282,542,362 | 1.73E-13 | 3.53E-14 | 2.42E-14 | 4.88E-05 | 7.81E-03 | 3.45E+00 |
| U-235 | 282,542,362 | 6.59E-15 | 1.35E-15 | 9.25E-16 | 1.86E-06 | 8.62E-01 | 1.10E-01 |
| U-238 | 282,542,362 | 1.83E-15 | 3.74E-16 | 2.57E-16 | 5.17E-07 | 1.54E+00 | 3.05E-02 |
| | | | | | | Total: | 3.80E+00 |
| Stack 185 Bldg. 131 | | 109.81 m³/min | | 1.83 m³/sec | | | |
| Pu-241 | 3,162,607 | 6.34E-16 | 8.88E-16 | 1.52E-15 | 2.00E-09 | 1.95E-11 | 7.92E-04 |
| Tc-99 | 3,162,607 | 2.05E-14 | 2.87E-14 | 4.92E-14 | 6.48E-08 | 3.83E-06 | 2.28E-05 |
| U-234 | 3,162,607 | 0.00E+00 | 7.24E-15 | 1.97E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 3,162,607 | 0.00E+00 | 2.24E-16 | 6.10E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 8.15E-04 |
| Stack 234 Bldg. 234 | | 277.56 m³/min | | 4.63 m³/sec | | | |
| Am-241 | 73,143,076 | 5.20E-18 | 2.78E-17 | 5.65E-17 | 3.80E-10 | 1.11E-10 | 2.60E-04 |
| Pu-238 | 73,143,076 | 6.35E-18 | 3.40E-17 | 6.91E-17 | 4.65E-10 | 2.72E-11 | 3.18E-04 |
| Pu-239/240 | 73,143,076 | 2.25E-17 | 1.21E-16 | 2.45E-16 | 1.65E-09 | 2.65E-08 | 1.13E-03 |
| Pu-241 | 73,143,076 | 6.78E-15 | 3.95E-15 | 5.90E-15 | 4.96E-07 | 4.81E-09 | 8.47E-03 |
| Th-228 | 73,143,076 | 3.47E-18 | 1.86E-17 | 3.77E-17 | 2.54E-10 | 3.10E-13 | 1.73E-04 |
| Th-230 | 73,143,076 | 4.33E-17 | 2.32E-16 | 4.71E-16 | 3.17E-09 | 1.57E-07 | 2.17E-03 |
| Th-232 | 73,143,076 | 5.49E-17 | 2.94E-16 | 5.96E-16 | 4.01E-09 | 3.68E-02 | 1.37E-02 |
| U-234 | 73,143,076 | 1.18E-16 | 6.34E-16 | 1.29E-15 | 8.66E-09 | 1.39E-06 | 2.37E-03 |
| U-238 | 73,143,076 | 3.47E-17 | 1.86E-16 | 3.77E-16 | 2.54E-09 | 7.57E-03 | 5.78E-04 |
| | | | | | | Total: | 2.92E-02 |
| Stack 327 Bldg. 330 | | 984.89 m³/min | | 16.41 m³/sec | | | |
| Pu-241 | 259,537,781 | 2.73E-15 | 4.48E-16 | 5.67E-16 | 7.09E-07 | 6.88E-09 | 3.41E-03 |
| Tc-99 | 259,537,781 | 8.83E-14 | 1.45E-14 | 1.83E-14 | 2.29E-05 | 1.36E-03 | 9.81E-05 |
| U-234 | 259,537,781 | 1.07E-13 | 1.24E-14 | 9.73E-15 | 2.77E-05 | 4.43E-03 | 2.13E+00 |
| U-235 | 259,537,781 | 3.30E-15 | 3.84E-16 | 3.01E-16 | 8.56E-07 | 3.96E-01 | 5.50E-02 |
| | | | | | | Total: | 2.19E+00 |
| Stack 421 Bldg. 100 | | 31.44 m³/min | | 0.52 m³/sec | | | |
| Pu-241 | 8,241,087 | 5.17E-15 | 1.26E-15 | 1.63E-15 | 4.26E-08 | 4.14E-10 | 6.46E-03 |
| Tc-99 | 8,241,087 | 1.67E-13 | 4.07E-14 | 5.26E-14 | 1.38E-06 | 8.15E-05 | 1.86E-04 |
| U-234 | 8,241,087 | 0.00E+00 | 1.61E-14 | 3.13E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 8,241,087 | 0.00E+00 | 4.98E-16 | 9.69E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 6.65E-03 |
| Stack 424 Bldg. 100 | | 28.96 m³/min | | 0.48 m³/sec | | | |
| Pu-241 | 7,580,797 | 1.73E-15 | 9.15E-16 | 1.22E-15 | 1.31E-08 | 1.28E-10 | 2.17E-03 |
| Tc-99 | 7,580,797 | 5.60E-14 | 2.96E-14 | 3.93E-14 | 4.25E-07 | 2.51E-05 | 6.23E-05 |

¹ ECV: Effluent Concentration Value from 10-CFR-20, Appendix B. Fraction of ECV at the stack is provided for reference only. Concentrations at off-site locations are significantly less than those reported here (at stack) due to the atmospheric dispersion that occurs before the effluent exits the site.

Note: A value of "0" was substituted for negative analytical results.

**Radioactivity in Effluent Air
 July 1, 2022 to December 31, 2022**

| Location | Total Volume (m ³) | Activity Concentration (μCi/ml) | Error Estimate (μCi/ml) | LLD (μCi/ml) | Quantity Released (Ci) | Quantity Released (g) | Fraction of ECV ¹ |
|------------------------------|--------------------------------|---------------------------------|-------------------------|-------------------------------|------------------------|-----------------------|------------------------------|
| Stack 424 Bldg. 100 | | 28.96 m³/min | | 0.48 m³/sec | | | |
| U-234 | 7,580,797 | 0.00E+00 | 9.35E-15 | 2.34E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 7,580,797 | 0.00E+00 | 2.89E-16 | 7.25E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 2.23E-03 |
| Stack 573 Bldg 306-W | | 109.25 m³/min | | 1.82 m³/sec | | | |
| Pu-241 | 28,788,613 | 8.75E-16 | 7.07E-16 | 1.12E-15 | 2.52E-08 | 2.45E-10 | 1.09E-03 |
| Tc-99 | 28,788,613 | 2.83E-14 | 2.29E-14 | 3.63E-14 | 8.15E-07 | 4.82E-05 | 3.14E-05 |
| U-234 | 28,788,613 | 0.00E+00 | 6.89E-15 | 2.11E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 28,788,613 | 0.00E+00 | 2.13E-16 | 6.51E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 1.13E-03 |
| Stack 600 Bldg. 110 | | 306.61 m³/min | | 5.11 m³/sec | | | |
| Pu-241 | 80,779,818 | 1.68E-15 | 5.27E-16 | 7.66E-16 | 1.36E-07 | 1.32E-09 | 2.10E-03 |
| Tc-99 | 80,779,818 | 5.44E-14 | 1.70E-14 | 2.48E-14 | 4.39E-06 | 2.60E-04 | 6.04E-05 |
| U-234 | 80,779,818 | 1.87E-14 | 7.73E-15 | 1.40E-14 | 1.51E-06 | 2.43E-04 | 3.75E-01 |
| U-235 | 80,779,818 | 5.80E-16 | 2.39E-16 | 4.34E-16 | 4.68E-08 | 2.17E-02 | 9.66E-03 |
| | | | | | | Total: | 3.87E-01 |
| Stack 615 Bldg. 306-W | | 48.73 m³/min | | 0.81 m³/sec | | | |
| Pu-241 | 12,842,199 | 8.00E-16 | 7.62E-16 | 1.21E-15 | 1.03E-08 | 9.97E-11 | 1.00E-03 |
| Tc-99 | 12,842,199 | 2.59E-14 | 2.46E-14 | 3.90E-14 | 3.32E-07 | 1.97E-05 | 2.87E-05 |
| U-234 | 12,842,199 | 0.00E+00 | 6.98E-15 | 2.26E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 12,842,199 | 0.00E+00 | 2.16E-16 | 7.00E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 1.03E-03 |
| Stack 646 Bldg. 110 | | 33.49 m³/min | | 0.56 m³/sec | | | |
| Pu-241 | 8,823,943 | 1.06E-15 | 8.28E-16 | 1.25E-15 | 9.34E-09 | 9.07E-11 | 1.32E-03 |
| Tc-99 | 8,823,943 | 3.42E-14 | 2.68E-14 | 4.03E-14 | 3.02E-07 | 1.79E-05 | 3.80E-05 |
| U-234 | 8,823,943 | 0.00E+00 | 7.67E-15 | 2.32E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 8,823,943 | 0.00E+00 | 2.37E-16 | 7.18E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 1.36E-03 |
| Stack 701 Bldg. 307 | | 115.84 m³/min | | 1.93 m³/sec | | | |
| Pu-241 | 30,527,272 | 9.24E-16 | 8.48E-16 | 1.32E-15 | 2.82E-08 | 2.74E-10 | 1.15E-03 |
| Tc-99 | 30,527,272 | 2.99E-14 | 2.74E-14 | 4.28E-14 | 9.12E-07 | 5.39E-05 | 3.32E-05 |
| U-234 | 30,527,272 | 0.00E+00 | 8.97E-15 | 2.52E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 30,527,272 | 0.00E+00 | 2.77E-16 | 7.78E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 1.19E-03 |
| Stack 702 Bldg. 307 | | 154.72 m³/min | | 2.58 m³/sec | | | |
| Pu-241 | 40,772,676 | 7.79E-16 | 7.37E-16 | 1.16E-15 | 3.18E-08 | 3.08E-10 | 9.74E-04 |
| Tc-99 | 40,772,676 | 2.52E-14 | 2.38E-14 | 3.75E-14 | 1.03E-06 | 6.08E-05 | 2.80E-05 |
| U-234 | 40,772,676 | 0.00E+00 | 7.84E-15 | 2.20E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

¹ ECV: Effluent Concentration Value from 10-CFR-20, Appendix B. Fraction of ECV at the stack is provided for reference only. Concentrations at off-site locations are significantly less than those reported here (at stack) due to the atmospheric dispersion that occurs before the effluent exits the site.

Note: A value of "0" was substituted for negative analytical results.

**Radioactivity in Effluent Air
 July 1, 2022 to December 31, 2022**

| Location | Total Volume (m ³) | Activity Concentration (μCi/ml) | Error Estimate (μCi/ml) | LLD (μCi/ml) | Quantity Released (Ci) | Quantity Released (g) | Fraction of ECV ¹ |
|-----------------------------------|--------------------------------|---------------------------------|-------------------------|--------------------------------|------------------------|-----------------------|------------------------------|
| Stack 702 Bldg. 307 | | 154.72 m³/min | | 2.58 m³/sec | | | |
| U-235 | 40,772,676 | 0.00E+00 | 2.43E-16 | 6.81E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 1.00E-03 |
| Stack 703 Exhaust Room Air | | 769.00 m³/min | | 12.82 m³/sec | | | |
| Pu-241 | 202,647,063 | 2.16E-14 | 2.23E-14 | 3.61E-14 | 4.38E-06 | 4.25E-08 | 2.70E-02 |
| Th-228 | 202,647,063 | 0.00E+00 | 7.46E-16 | 2.09E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 202,647,063 | 0.00E+00 | 4.30E-16 | 1.20E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-232 | 202,647,063 | 0.00E+00 | 6.11E-16 | 1.71E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-234 | 202,647,063 | 0.00E+00 | 4.67E-15 | 1.31E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 202,647,063 | 0.00E+00 | 4.83E-16 | 1.35E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-238 | 202,647,063 | 0.00E+00 | 5.88E-16 | 1.64E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 2.70E-02 |
| Stack 773 Bldg. 440 | | 153.85 m³/min | | 2.56 m³/sec | | | |
| Pu-241 | 40,541,352 | 3.03E-14 | 3.09E-14 | 4.87E-14 | 1.23E-06 | 1.19E-08 | 3.79E-02 |
| Th-228 | 40,541,352 | 0.00E+00 | 1.29E-15 | 3.99E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 40,541,352 | 0.00E+00 | 1.66E-15 | 5.13E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-232 | 40,541,352 | 0.00E+00 | 1.10E-15 | 3.42E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-234 | 40,541,352 | 0.00E+00 | 3.40E-15 | 1.05E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 40,541,352 | 0.00E+00 | 5.98E-16 | 1.85E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-238 | 40,541,352 | 0.00E+00 | 1.20E-15 | 3.70E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 3.79E-02 |
| Stack 774 Bldg. 301 | | 317.23 m³/min | | 5.29 m³/sec | | | |
| Tc-99 | 83,576,743 | 6.60E-13 | 2.24E-14 | 1.86E-14 | 5.52E-05 | 3.27E-03 | 7.34E-04 |
| Th-228 | 83,576,743 | 0.00E+00 | 1.90E-16 | 4.91E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-230 | 83,576,743 | 0.00E+00 | 6.49E-16 | 1.67E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Th-232 | 83,576,743 | 0.00E+00 | 3.85E-16 | 9.93E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-234 | 83,576,743 | 0.00E+00 | 1.73E-15 | 4.47E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 83,576,743 | 0.00E+00 | 1.13E-16 | 2.91E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-238 | 83,576,743 | 0.00E+00 | 8.16E-16 | 2.11E-15 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 7.34E-04 |
| Stack 796 Bldg. 100 | | 17.95 m³/min | | 0.30 m³/sec | | | |
| Pu-241 | 4,730,821 | 1.32E-15 | 8.22E-16 | 1.16E-15 | 6.24E-09 | 6.06E-11 | 1.65E-03 |
| Tc-99 | 4,730,821 | 4.27E-14 | 2.66E-14 | 3.75E-14 | 2.02E-07 | 1.19E-05 | 4.74E-05 |
| U-234 | 4,730,821 | 0.00E+00 | 7.35E-15 | 2.20E-14 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| U-235 | 4,730,821 | 0.00E+00 | 2.27E-16 | 6.81E-16 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| | | | | | | Total: | 1.70E-03 |

¹ ECV: Effluent Concentration Value from 10-CFR-20, Appendix B. Fraction of ECV at the stack is provided for reference only. Concentrations at off-site locations are significantly less than those reported here (at stack) due to the atmospheric dispersion that occurs before the effluent exits the site.

Note: A value of "0" was substituted for negative analytical results.

**Attachment 3
To Letter Dated February 20, 2023**

**Report of Gaseous Effluent Dose and Activity Concentrations
for the Maximally Exposed
Off-Site Individual for the Release Period
July to December 2022**

(4 Pages to Follow)

Report of Potential Gaseous Effluent Dose to the Maximally Exposed Offsite Individual and on the Maximum Radionuclide Concentrations for the Period: July to December 2022

Introduction

During this biannual period, NRC License SNM-124, Section 9.1.1.3, required NFS to assess the total effective dose equivalent (TEDE) to the maximally exposed offsite receptor and the maximum radioactive air concentrations at the site boundary attributable to NFS' air effluents. The required biannual assessment has been completed and the details of the assessment are provided in the subsequent sections.

Summary of Methods

In accordance with SNM-124, Section 9.1.1.4, and internal procedure NFS-HS-A-27, the U.S. Department of Energy's CAP88-PC computer program was used to estimate off-site doses and activity concentrations for gaseous effluents. NFS operated sixteen (16) radiological stacks during the second half of 2022. Based on effluent types and stack physical characteristics, releases from these stacks were grouped into effective stacks for modeling purposes. To accommodate the co-location limitation of the model, the effective stacks were taken to be at the approximate center of the plant site. The distance to the site boundary (nearest model receptor distance) was conservatively taken to be 150 meters for all sectors.

Meteorological data was based on the average wind speed and direction frequencies from the onsite meteorological tower covering the time period for this report. Atmospheric stability class D (neutral atmosphere) was used for all releases (default value recommended by the U.S. Environmental Protection Agency in "User's Guide for COMPLY"). The most conservative inhalation class was assumed for each radionuclide released. A particle size (activity median aerodynamic diameter or AMAD) of 1.0 micron was assumed for modeling purposes since no information on actual particle sizes exists.

Because CAP88-PC models releases over an entire year, the six-month source term (i.e., total curies of each radionuclide released over the period, given in Attachment 2) was annualized (i.e., transformed into a 12-month release) so that airborne activity concentrations would not be under-estimated during the release period.

Summary of Results

Doses are reported in Table 1 below and are derived from the CAP88-PC "Synopsis Report." These doses are at the location of the maximally exposed (off-site) individual (MEI). The results include an adjustment (using the normalization factor mentioned above) to convert the "annualized" doses back to those doses that were actually received in the six-month release period. Activity concentrations reported in Table 2 come directly from the CAP88-PC "Concentration Tables" report; no adjustments are needed for these concentrations. The CAP88-PC output reports are available for review at NFS.

Table 1 summarizes the six-month dose to a hypothetical individual at the MEI location, which was determined to be approximately 450 meters Northeast from the center of the plant site. The TEDE to the MEI was estimated to be 4.8E-03 mrem for gaseous effluents released during the second half of 2022. The highest organ committed dose equivalent (CDE) to the MEI was estimated to be 1.7E-02 mrem to the lungs. These MEI doses are well below the Environmental Radiological Monitoring Program action levels and applicable regulatory limits/ALARA constraints.

Table 1. Organ Doses and Total Effective Dose Equivalent at the MEI Location

| Organ | Committed Dose Equivalent (mrem per second half of 2022) |
|--|--|
| Adrenals | 3.6E-04 |
| Urinary Bladder Wall | 4.7E-04 |
| Bone Surface | 9.0E-03 |
| Brain | 3.6E-04 |
| Breasts | 3.7E-04 |
| Stomach Wall | 1.2E-02 |
| Small Intestine | 4.0E-04 |
| Upper Large Intestine Wall | 2.9E-03 |
| Lower Large Intestine Wall | 7.8E-03 |
| Kidneys | 3.0E-03 |
| Liver | 9.8E-04 |
| Muscle | 3.6E-04 |
| Ovaries | 3.7E-04 |
| Pancreas | 3.6E-04 |
| Red Bone Marrow | 1.2E-03 |
| Skin | 5.7E-04 |
| Spleen | 3.6E-04 |
| Testes | 3.8E-04 |
| Thymus | 3.6E-04 |
| Thyroid | 6.0E-03 |
| Gall Bladder Wall | 3.6E-04 |
| Heart Wall | 3.6E-04 |
| Uterus | 3.6E-04 |
| Extra-thoracic | 1.5E-02 |
| Lungs | 1.7E-02 |
| Total Effective Dose Equivalent | 4.8E-03 mrem |
| Location of MEI: | 450 meters Northeast |

Table 2 summarizes the maximum radioactive air concentrations at or beyond the site boundary, as determined by CAP88-PC, for the radionuclides released. The total sum of fractions was estimated to be 5.6E-04 and indicates that exposures to the offsite public from gaseous effluents were much less than 1% of the 10 CFR 20, Appendix B, Table 2, Col. 1 values for all offsite receptors including the site boundary. It is noted that the location of the maximum airborne concentration for a given radionuclide does not necessarily correspond to the MEI location. This is due primarily to the fact that the maximum concentrations for individual nuclides can vary due to differences in values input into the dispersion model for each of the effective stacks - such inputs include stack height, stack diameter, flow rate, and total radionuclide activities released per stack. Another reason for the disparity is the fact that the MEI dose includes both inhalation and ingestion pathways.

Table 2. Maximum Predicted Airborne Concentrations at or Beyond the Site Boundary

| Maximum Predicted Airborne Concentrations at or Beyond the Site Boundary | | | | | |
|--|--------------------------------|------------------------|-----------|---|---|
| Nuclide | Maximum Concentration (µCi/mL) | Concentration Location | | 10 CFR 20, App. B, Table 2, Col. 1 Value (µCi/mL) | Ratio of Maximum Concentration to 10 CFR 20 Value |
| | | Sector | Dist. (m) | | |
| ⁹⁹ Tc | 4.5E-17 | NE | 450 | 9.E-10 | 4.9E-08 |
| ²²⁸ Th | 4.6E-20 | NE | 700 | 2.E-14 | 2.3E-06 |
| ²³⁰ Th | 4.7E-20 | NE | 700 | 2.E-14 | 2.4E-06 |
| ²³² Th | 3.6E-20 | NE | 700 | 4.E-15 | 9.1E-06 |
| ²³⁴ U | 2.6E-17 | NE | 500 | 5.E-14 | 5.2E-04 |
| ²³⁵ U | 8.8E-19 | NE | 550 | 6.E-14 | 1.5E-05 |
| ²³⁸ U | 1.2E-19 | NE | 700 | 6.E-14 | 1.9E-06 |
| ²³⁸ Pu | 9.9E-22 | NE | 200 | 2.E-14 | 5.0E-08 |
| ²³⁹ Pu | 3.5E-21 | NE | 200 | 2.E-14 | 1.8E-07 |
| ²⁴¹ Pu | 5.3E-18 | NE | 350 | 8.E-13 | 6.6E-06 |
| ²⁴¹ Am | 8.1E-22 | NE | 200 | 2.E-14 | 4.1E-08 |
| Sum of Fractions: | | | | | 5.6E-04 |

The TEDE to the MEI for gaseous effluents released during 2022 is provided in Table 3. The results for the 1st half of 2022 were previously reported in *Biannual Effluent Monitoring Report January to June 2022* (21G-22-0097). The annual dose is well below the Environmental Radiological Monitoring Program action levels and applicable regulatory limits/ALARA constraints.

Table 3. Annual Dose to the MEI for Gaseous Effluents Released During 2022

| Period Covered | Direction | Distance (m) | TEDE (mrem) |
|-----------------------|------------------|---------------------|--------------------|
| 2 nd Half | NE | 450 | 4.8E-03 |
| 1 st Half | NNE | 550 | 2.3E-03 |
| Annual Total | | | 7.1E-03 |