**RESRAD GROUNDWATER EXPOSURE FACTORS FOR INITIAL SUITE RADIONUCLIDES (mrem/y per pCi/L)**
**Screening Values for Eliminating Low Dose Radionclides and Determining Radionuclide Mixture for Final Compliance Assessments**

| Radionuclide | MAX DOSE (mrem/y) (mrem/y) | GW Concentration (t=0, pCi/L) | GW Exposure Factor mrem/yr per pCi/L |
|---|---|---|---|
| Ag-108m | 2.498E-01 | 3.676E+01 | 6.80E-03 |
| Am-241 | 1.123E+01 | 5.643E+00 | 1.99E+00 |
| Am-243 | 1.121E+01 | 5.643E+00 | 1.99E+00 |
| C-14 | 2.706E+00 | 7.120E+02 | 3.80E-03 |
| Cm-243 | 1.526E+00 | 1.122E+00 | 1.36E+00 |
| Cm-244 | 1.221E+00 | 1.122E+00 | 1.09E+00 |
| Co-60 | 1.122E-01 | 4.480E+00 | 2.50E-02 |
| Cs-134 | 1.935E+00 | 2.212E+01 | 8.75E-02 |
| Cs-137 | 1.536E+00 | 2.212E+01 | 6.94E-02 |
| Eu-152 | 3.798E-02 | 1.050E+01 | 3.62E-03 |
| Eu-154 | 5.517E-02 | 1.050E+01 | 5.25E-03 |
| Eu-155 | 8.562E-03 | 1.050E+01 | 8.15E-04 |
| Fe-55 | 1.480E-04 | 3.500E-01 | 4.23E-04 |
| H-3 | 2.169E-01 | 4.891E+03 | 4.43E-05 |
| Nb-94 | 8.656E-02 | 2.212E+01 | 3.91E-03 |
| Ni-59 | 5.746E-03 | 1.608E+01 | 3.57E-04 |
| Ni-63 | 1.573E-02 | 1.608E+01 | 9.78E-04 |
| Np-237 | 2.026E+03 | 8.302E+02 | 2.44E+00 |
| Pm-147 | 5.569E-03 | 1.050E+01 | 5.30E-04 |
| Pu-238 | 1.003E+01 | 5.740E+00 | 1.75E+00 |
| Pu-239 | 1.114E+01 | 5.741E+00 | 1.94E+00 |
| Pu-240 | 1.114E+01 | 5.741E+00 | 1.94E+00 |
| Pu-241 | 3.571E-01 | 5.740E+00 | 6.22E-02 |
| Sb-125 | 1.894E+00 | 5.812E+01 | 3.26E-02 |
| Sr-90 | 4.362E+01 | 3.993E+02 | 1.09E-01 |
| Tc-99 | 5.142E+00 | 4.891E+03 | 1.05E-03 |

**BASEMENT FILL MODEL GROUNDWATER EXPOSURE FACTORS (mrem/y per pCi/L)**

| Radionuclide | Maximum Dose (mrem/y) | | | GW Concentration (pCi/L) | GW Exposure Factor (mrem/y per pCi/L) |
|---|---|---|---|---|---|
| | Drinking Water | Plant/Meat/Milk | Total | | |
| Co-60 | 5.40E-02 | 5.82E-02 | 1.12E-01 | 4.48E+00 | 2.50E-02 |
| Cs-134 | 6.58E-01 | 1.28E+00 | 1.94E+00 | 2.21E+01 | 8.75E-02 |
| Cs-137 | 5.23E-01 | 1.01E+00 | 1.54E+00 | 2.21E+01 | 6.94E-02 |
| Eu-152 | 3.17E-02 | 6.30E-03 | 3.80E-02 | 1.05E+01 | 3.62E-03 |
| Eu-154 | 4.61E-02 | 9.14E-03 | 5.52E-02 | 1.05E+01 | 5.26E-03 |
| H-3 | 1.38E-01 | 7.88E-02 | 2.17E-01 | 4.89E+03 | 4.43E-05 |
| Ni-63 | 4.42E-03 | 1.13E-02 | 1.57E-02 | 1.61E+01 | 9.78E-04 |
| Sr-90 | 2.87E+01 | 1.49E+01 | 4.36E+01 | 3.99E+02 | 1.09E-01 |

**CALCULATION OF GROUNDWATER AND FILL CONCENTRATION FACTORS FROM DUST-MS RESULTS**

**Reference:**

Zion*Solutions* TSD 14-009, Revison 1 Brookhaven National Laboratory (BNL) Report "Evaluation of Maximum Radionuclide Groundwater Concentrations for Basement Fill Model"

**DUST-MS Assumed Basement Inventory:**

| | DUST-MS Inventory (pCi) |
|---|---|
| Auxiliary | 6503 |
| Containment | 2759 |
| Turbine | 14679 |
| Spent Fuel Pool/Transfer Canals | 780 |
| Crib House/Forebay | 6940 |
| Waste Water Treatment Facility | 1124 |

**Calculations:**

**Input to Calculation**

**Conversion Factor** 1.00E-09 mCi/pCi

**Auxiliary Basement**

| | DUST-MS Results pCi/L | DUST-MS Results pCi/g | GW Conc Factor pC/L per mCi | Fill Conc Factor pCi/g per mCi | |
|---|---|---|---|---|---|
| Co-60 | 2.60E-08 | 5.80E-09 | 4.00E-03 | 8.92E-04 | 6.76E-07 |
| Cs-134 | 6.89E-07 | 3.10E-08 | 1.06E-01 | 4.77E-03 | |
| Cs-137 | 2.47E-06 | 1.11E-07 | 3.80E-01 | 1.71E-02 | |
| Eu-152 | 1.07E-07 | 1.03E-08 | 1.65E-02 | 1.58E-03 | |
| Eu-154 | 8.38E-08 | 7.96E-09 | 1.29E-02 | 1.22E-03 | |
| H-3 | 9.10E-04 | 0.00E+00 | 1.40E+02 | 0.00E+00 | |
| Ni-63 | 1.90E-06 | 1.18E-07 | 2.92E-01 | 1.81E-02 | |
| Sr-90 | 1.96E-05 | 4.51E-08 | 3.01E+00 | 6.94E-03 | |

**Containment**

| | DUST RESULTS pCi/L | DUST RESULTS pCi/g | GW Conc Factor pCi/L per mCi | Fill Conc Factor pCi/g per mCi |
|---|---|---|---|---|
| Co-60 | 1.26E-06 | 2.81E-07 | 4.57E-01 | 1.02E-01 |
| Cs-134 | 6.23E-06 | 2.80E-07 | 2.26E+00 | 1.01E-01 |
| Cs-137 | 6.23E-06 | 2.80E-07 | 2.26E+00 | 1.01E-01 |
| Eu-152 | 2.95E-06 | 2.81E-07 | 1.07E+00 | 1.02E-01 |
| Eu-154 | 2.95E-06 | 2.81E-07 | 1.07E+00 | 1.02E-01 |
| H-3 | 1.69E-03 | 0.00E+00 | 6.13E+02 | 0.00E+00 |
| Ni-63 | 4.53E-06 | 2.81E-07 | 1.64E+00 | 1.02E-01 |
| Sr-90 | 1.14E-04 | 2.62E-07 | 4.13E+01 | 9.50E-02 |

**Spent Fuel Pool/Transfer Tunnels**

| | DUST RESULTS pCi/L | DUST RESULTS pCi/g | GW Conc Factor pC/L per mCi | Fill Conc Factor pCi/g per mCi |
|---|---|---|---|---|
| Co-60 | 4.25E-07 | 9.48E-08 | 5.45E-01 | 1.22E-01 |
| Cs-134 | 1.13E-05 | 5.09E-07 | 1.45E+01 | 6.53E-01 |
| Cs-137 | 4.07E-05 | 1.83E-06 | 5.22E+01 | 2.35E+00 |
| Eu-152 | 1.75E-06 | 1.68E-07 | 2.24E+00 | 2.15E-01 |
| Eu-154 | 1.37E-06 | 1.30E-07 | 1.76E+00 | 1.67E-01 |
| H-3 | 1.49E-02 | 0.00E+00 | 1.91E+04 | 0.00E+00 |
| Ni-63 | 3.13E-05 | 1.94E-06 | 4.01E+01 | 2.49E+00 |
| Sr-90 | 3.21E-04 | 7.38E-07 | 4.12E+02 | 9.46E-01 |

**Turbine**

| | DUST RESULTS pCi/L | pCi/g | GW Conc Factor pC/L per mCi | Fill Conc Factor pCi/g per mCi |
|---|---|---|---|---|
| Co-60 | 1.68E-06 | 3.74E-07 | 1.14E-01 | 2.55E-02 |
| Cs-134 | 8.29E-06 | 3.73E-07 | 5.65E-01 | 2.54E-02 |
| Cs-137 | 8.29E-06 | 3.73E-07 | 5.65E-01 | 2.54E-02 |
| Eu-152 | 3.93E-06 | 3.74E-07 | 2.68E-01 | 2.55E-02 |
| Eu-154 | 3.93E-06 | 3.74E-07 | 2.68E-01 | 2.55E-02 |
| H-3 | 2.25E-03 | 0.00E+00 | 1.53E+02 | 0.00E+00 |
| Ni-63 | 6.02E-06 | 3.73E-07 | 4.10E-01 | 2.54E-02 |
| Sr-90 | 1.52E-04 | 3.49E-07 | 1.04E+01 | 2.38E-02 |

**Crib House/Forebay**

| | DUST RESULTS pCi/L | pCi/g | GW Conc Factor pC/L per mCi | Fill Conc Factor pCi/g per mCi |
|---|---|---|---|---|
| Co-60 | 6.78E-07 | 1.51E-07 | 9.77E-02 | 2.18E-02 |
| Cs-134 | 3.35E-06 | 1.51E-07 | 4.83E-01 | 2.18E-02 |
| Cs-137 | 3.35E-06 | 1.51E-07 | 4.83E-01 | 2.18E-02 |
| Eu-152 | 1.59E-06 | 1.51E-07 | 2.29E-01 | 2.18E-02 |
| Eu-154 | 1.59E-06 | 1.51E-07 | 2.29E-01 | 2.18E-02 |
| H-3 | 9.08E-04 | 0.00E+00 | 1.31E+02 | 0.00E+00 |
| Ni-63 | 2.44E-06 | 1.51E-07 | 3.52E-01 | 2.18E-02 |
| Sr-90 | 6.14E-05 | 1.41E-07 | 8.85E+00 | 2.03E-02 |

**Waste Water Treatment Facility**

| | DUST RESULTS pCi/L | pCi/g | GW Conc Factor pC/L per mCi | Fill Conc Factor pCi/g per mCi |
|---|---|---|---|---|
| Co-60 | 2.34E-05 | 5.22E-06 | 2.08E+01 | 4.64E+00 |
| Cs-134 | 1.16E-04 | 5.20E-06 | 1.03E+02 | 4.63E+00 |
| Cs-137 | 1.16E-04 | 5.20E-06 | 1.03E+02 | 4.63E+00 |
| Eu-152 | 5.43E-05 | 5.21E-06 | 4.83E+01 | 4.64E+00 |
| Eu-154 | 5.48E-05 | 5.21E-06 | 4.88E+01 | 4.64E+00 |
| H-3 | 3.13E-02 | 0.00E+00 | 2.78E+04 | 0.00E+00 |
| Ni-63 | 8.40E-05 | 5.21E-06 | 7.47E+01 | 4.64E+00 |
| Sr-90 | 2.12E-03 | 4.87E-06 | 1.89E+03 | 4.33E+00 |

**BFM Groundwater Dose Factors (Not adjusted for insignificant contributor dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canals | Turbine | Crib House/Forebay[1] | WWTF |
|---|---|---|---|---|---|---|
| | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) |
| Co-60 | 1.00E-04 | 1.14E-02 | 0.00E+00 | 2.87E-03 | 2.85E-03 | 5.21E-01 |
| Cs-134 | 9.27E-03 | 1.98E-01 | 0.00E+00 | 4.94E-02 | 4.91E-02 | 9.03E+00 |
| Cs-137 | 2.64E-02 | 1.57E-01 | 0.00E+00 | 3.92E-02 | 3.90E-02 | 7.17E+00 |
| Eu-152 | 5.96E-05 | 3.87E-03 | 0.00E+00 | 9.69E-04 | 9.64E-04 | 1.75E-01 |
| Eu-154 | 6.77E-05 | 5.62E-03 | 0.00E+00 | 1.41E-03 | 1.40E-03 | 2.56E-01 |
| H-3 | 6.21E-03 | 2.72E-02 | 0.00E+00 | 6.80E-03 | 6.75E-03 | 1.23E+00 |
| Ni-63 | 2.86E-04 | 1.61E-03 | 0.00E+00 | 4.01E-04 | 4.00E-04 | 7.31E-02 |
| Sr-90 | 3.29E-01 | 4.51E+00 | 0.00E+00 | 1.13E+00 | 1.12E+00 | 2.06E+02 |

**BFM Drilling Spoils Dose Factors (Reference: TSD 14-021, Table 5) (Not adjusted for insignificant contributor dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canals | Turbine | Crib House/Forebay[1] | WWTF |
|---|---|---|---|---|---|---|
| | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) |
| Co-60 | 1.07E-02 | 2.97E-02 | 1.58E-01 | 9.58E-03 | 2.07E-02 | 2.26E-01 |
| Cs-134 | 6.29E-03 | 1.72E-02 | 9.41E-02 | 5.54E-03 | 1.19E-02 | 1.31E-01 |
| Cs-137 | 3.22E-03 | 7.27E-03 | 4.83E-02 | 2.35E-03 | 5.05E-03 | 5.57E-02 |
| Eu-152 | 5.02E-03 | 1.38E-02 | 7.46E-02 | 4.45E-03 | 9.58E-03 | 1.05E-01 |
| Eu-154 | 5.57E-03 | 1.46E-02 | 8.25E-02 | 4.73E-03 | 1.02E-02 | 1.12E-01 |
| H-3 | 0.00E+00 | 0.00E+00 | 1.45E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 3.23E-08 | 5.61E-08 | 3.78E-07 | 1.86E-08 | 4.81E-08 | 4.16E-07 |
| Sr-90 | 6.26E-05 | 1.39E-04 | 7.60E-04 | 4.61E-05 | 1.16E-04 | 1.04E-03 |

Note 1: The Crib House/Forebay Groundwater and Drilling Spoils Dose Factors was adjusted higher to account for a revision that lowered the void volume. The demolition plan for the Crib House was revised to leave the interior walls as opposed to removing all interior walls per the original demolition plan. This resulted in a decrease in the Crib House saturated zone fill mass in the Basement Fill Model with a corresponding increase in the pCi/g and pCi/L values calculated in TSD 14-009. The BFM and DS dose factors are both directly proportional to the pCi/g and pCi/L concentrations which are inversely proportional to the ratio of the Revised Volume to the Original Volume for the Crib House/Forebay combined. The revised Crib House/Forebay volume and the ratio of the Revised/Original volume is provided in TSD 14-014, Revision 1 (Table 38)

Ratio of Revised/Original Crib House/Forebay Volume = 8.60E-01

**Soil DCGLs for ROC with Without insignificant Contributor Adjustment**

| Radionuclide | Surface Soil DCGL without Adjustment for Insignificant Contributors | Subsurface Soil DCGL without Adjustment for Insignificant Contributors |
|---|---|---|
| | (pCi/g) | (pCi/g) |
| Co-60 | 4.734E+00 | 3.825E+00 |
| Cs-134 | 7.524E+00 | 4.930E+00 |
| Cs-137 | 1.576E+01 | 8.606E+00 |
| Ni-63 | 3.969E+03 | 8.478E+02 |
| Sr-90 | 1.343E+01 | 1.840E+00 |

**Soil DCGLs for ROC with Insignificant Contributor Adjustment**

| Radionuclide | Surface Soil DCGL | Subsurface Soil DCGL |
|---|---|---|
| | (pCi/g) | (pCi/g) |
| Co-60 | 4.261 | 3.443 |
| Cs-134 | 6.772 | 4.437 |
| Cs-137 | 14.184 | 7.745 |
| Ni-63 | 3572.100 | 763.020 |
| Sr-90 | 12.087 | 1.656 |

| | |
|---|---|
| Insignificant radionuclide dose fraction | 10.000% |
| Adjustment Fraction | 0.900 |

**Table 17 – Industrial Use Concentrations "DCGLs" and Adjusted DCGLs**

**Soil DCGL Insignificant Contributor Dose Fraction Applied to Industrial Use DCGL**

| | |
|---|---|
| Soil Insignificant radionuclide dose fraction | 0.171% |
| Soil Adjustment Fraction | 0.998 |

| Radionuclide | Industrial Use DCGL (pCi/g) | Adjusted Industrial Use DCGL (pCi/g) |
|---|---|---|
| Co-60 | 12.36 | 12.34 |
| Cs-134 | 23.37 | 23.33 |
| Cs-137 | 55.86 | 55.76 |
| Eu-152 | 27.48 | 27.43 |
| Eu-154 | 25.47 | 25.43 |
| H-3 | 1819.00 | 1815.89 |
| Ni-63 | 9.50E+06 | 9.48E+06 |
| Sr-90 | 14.09 | 14.07 |

**Soil DCGLs Using Minimum Site-Speciifc Soil Kd Values**

| Radionuclide | Kd | Surface Soil DCGL without Adjustment for Insignificant Contributors | Subsurface Soil DCGL without Adjustment for Insignificant Contributors |
|---|---|---|---|
| | | (pCi/g) | (pCi/g) |
| Co-60 | 1161 | 4.734 | 3.825 |
| Cs-134 | 615 | 7.524 | 4.930 |
| Cs-137 | 615 | 15.76 | 8.606 |
| Ni-63 | 62 | 3995 | 848.6 |
| Sr-90 | 2.3 | 14.36 | 1.860 |

**Soil DCGLs Using Maximum Site-Speciifc Soil Kd Values**

| Radionuclide | Kd | Surface Soil DCGL without Adjustment for Insignificant Contributors | Subsurface Soil DCGL without Adjustment for Insignificant Contributors |
|---|---|---|---|
| | | (pCi/g) | (pCi/g) |
| Co-60 | 1161 | 4.734 | 3.825 |
| Cs-134 | 635 | 7.523 | 4.930 |
| Cs-137 | 635 | 15.76 | 8.606 |
| Ni-63 | 331 | 3969 | 847.8 |
| Sr-90 | 3.4 | 13.43 | 1.840 |

**Ratio of DCGLs (Maximum Kd DCGL/Minimum Kd DCGL)**

| Radionuclide | Surface Soil Ratio | Subsurface Soil Ratio |
|---|---|---|
| Co-60 | 1.00 | 1.00 |
| Cs-134 | 1.00 | 1.00 |
| Cs-137 | 1.00 | 1.00 |
| Ni-63 | 0.99 | 1.00 |
| Sr-90 | 0.94 | 0.99 |

**Dose Assessment Clean Concrete Fill at Detection Limit**

**Inputs to Calculation**

**Turbine Clean Clean Concrete Fill Surface Area and Volume (Reference: 6/29/16 email from Don Roth)**

| **Surface Area of Turbine Building Clean Concrete to be Used as Fill** | | |
|---|---|---|
| | **U1 SURFACE AREA (SQ. FT.)** | **U2 SURFACE AREA (SQ. FT.)** |
| EL 592 SLABS | 61,164 | 61,164 |
| EL 609 & 617 SLABS | 52,848 | 52,848 |
| EL 630 SLABS | 14,654 | 14,654 |
| EL 642 SLABS | 83,420 | 83,420 |
| EL 592 BEAMS | 3,800 | 3,800 |
| TURBINE FOUNDATION | 59,981 | 59,981 |
| PERIMETER WALLS | 1,728 | 1,728 |
| MASONRY WALLS | 56,570 | 56,570 |
| **TOTALS** | **334,165** | **334,165** |

| **Volume of Clean Turbine Concrete to be Used as Fill** | | |
|---|---|---|
| Volume | 21,525 | cubic yard |
| Volume | 1.65E+04 | m3 |

**Containment Clean Concrete Fill Surface Area and Volume (Drawing B-210, Reactor Building Containment Structural Arrangement Zion Station Unit No. 1&2 Commonwealth Edison Co. Chicago Illinios)**

| **Containmant Dimensions (cylinder)** | | | | |
|---|---|---|---|---|
| Diameter Exterior | 147.00 | ft | | |
| Diameter Interior | 140.00 | ft | | |
| Cylinder Height | 171.50 | ft | | |
| Thickness | 3.50 | ft | | |
| | | | | |
| **Containment Dimensions (Roof)** | | | | |
| Dome Radius Exterior | 20.17 | ft | | |
| Dome Radius Interior | 17.50 | ft | | |
| Thickness | 2.67 | ft | | |
| | | | | |
| Conversion Factor | 929.03 | cm2/ft2 | | |
| Conversion Factor | 28316.80 | cm3/ft3 | | |
| | | | | |
| **Containment Cylinder Surface Area and Volume** | | | | |
| Area of Outer Surface | 7.92E+04 | ft2 | 7.36E+07 | cm2 |
| Area of Inner Surface | 7.54E+04 | ft2 | 7.01E+07 | cm2 |
| Volume of Concrete Fil | 2.71E+05 | ft3 | 7.66E+09 | cm3 |
| | | | | |
| **Containment Roof Surface Area and Volume** | | | | |
| Area of Outer Surface | 2.56E+03 | ft2 | 2.37E+06 | cm2 |
| Area of Inner Surface | 1.92E+03 | ft2 | 1.79E+06 | cm2 |
| Volume of Concrete Fil | 5.96E+03 | ft3 | 1.69E+08 | cm3 |
| | | | | |
| **Containment Total Volume (one unit)** | | | 7.83E+03 | m3 |

| **Total Clean Concrete Fill Volume - Containment plus Turbine** | 3.21E+04 | m3 |
|---|---|---|

**Conversion Factors and Assumptions**

| | | |
|---|---|---|
| Conversion Factor | 0.0929 | m2/ft2 |
| Conversion Factor | 1.0000E+06 | cm3 per m3 |
| Conversion Factor | 1.000E+04 | cm2 per m2 |
| concrete density | 2.35 | g/cm3 |
| Non-detect Maximum | 5000 | dpm/100 cm2 |
| Conversion factor | 2.2 | dpm/pCi |
| Conversion Factor | 1.00E-09 | mCi/pCi |
| conversion Factor | 7.65E-01 | m3/yd3 |
| Conversion Factor | 7.65E+05 | cm3/yd3 |

**Calculation**

| | | |
|---|---|---|
| **Total Inventory Gamma in Turbine Clean Conrete Debris at MDC** | 1.41E+01 | mCi |
| **Total Inventory Gamma in Containment Clean Conrete Debris at MDC** | 6.72E+00 | mCi |

**Inventory per m3 of fill**

| | | |
|---|---|---|
| **Turbine** | 8.57E-04 | mCi/m3 |
| **Containment** | 4.29E-04 | mCi/m3 |

| **Basement** | **Fill Volume (m3)[1]** | **gamma inventory (mCi)** |
|---|---|---|
| Unit 1 Containment Bu | 1.21E+04 | 1.04E+01 |
| Unit 2 Containment Bu | 1.21E+04 | 1.04E+01 |
| Auxiliary Building | 3.76E+04 | 3.22E+01 |
| Turbine Building | 4.26E+04 | 3.65E+01 |
| Crib House and Foreba | 3.92E+04 | 3.36E+01 |
| WWTF | 1.01E+03 | 8.66E-01 |
| Spent Fuel Pool and Tr | 1.04E+03 | 8.92E-01 |

Note 1: Fill volumes from TSD 14-021 Revision 1, Table 23

**Insignificant Contributor (IC) Dose Adjustement Factor:**

| | **Assigned IC Dose Percentage** | **IC Dose Adjustment Factor** |
|---|---|---|
| Auxiliary | 5.00% | 1.05 |
| Containment | 10.00% | 1.11 |
| Basements other than Auxiliary and Containment | 5.00% | 1.05 |

**Basement Dose Factors (adjusted for insignificant dose contribution)**

| | **Auxiliary** | **Containment** | **Spent Fuel Pool/ Transfer Canals[1]** | **Turbine** | **Crib House/ Forebay** | **WWTF** |
|---|---|---|---|---|---|---|
| | **(mrem/y per mCi)** | **(mrem/y per mCi)** | **(mrem/y per mCi)** | **(mrem/y per mCi)** | **(mrem/y per mCi)** | **(mrem/y per mCi)** |
| Co-60 | 1.14E-02 | 4.44E-02 | 4.44E-02 | 1.30E-02 | 2.46E-02 | 7.60E-01 |
| Cs-134 | 1.59E-02 | 2.17E-01 | 2.17E-01 | 5.52E-02 | 6.16E-02 | 9.17E+00 |
| Cs-137 | 2.98E-02 | 1.65E-01 | 1.65E-01 | 4.17E-02 | 4.43E-02 | 7.22E+00 |
| Eu-152 | 5.35E-03 | 1.92E-02 | 1.92E-02 | 5.65E-03 | 1.10E-02 | 2.86E-01 |
| Eu-154 | 5.93E-03 | 2.19E-02 | 2.19E-02 | 6.38E-03 | 1.21E-02 | 3.74E-01 |
| H-3 | 6.21E-03 | 2.72E-02 | 2.72E-02 | 6.80E-03 | 6.75E-03 | 1.23E+00 |
| Ni-63 | 2.86E-04 | 1.61E-03 | 1.61E-03 | 4.01E-04 | 4.00E-04 | 7.31E-02 |
| Sr-90 | 3.29E-01 | 4.51E+00 | 4.51E+00 | 1.13E+00 | 1.12E+00 | 2.06E+02 |

Note 1: SFP/Transfer Canal Dose Factors set equal to Containment to account for groundwater pathway

**Maximum Basement Activity**

| | **mCi** | **mCi** | **mCi** | **mCi** | **mCi** | **mCi** |
|---|---|---|---|---|---|---|
| Co-60 | 2.20E+03 | 5.63E+02 | 5.63E+02 | 1.93E+03 | 1.01E+03 | 3.29E+01 |
| Cs-134 | 1.57E+03 | 1.15E+02 | 1.15E+02 | 4.53E+02 | 4.06E+02 | 2.73E+00 |
| Cs-137 | 8.40E+02 | 1.52E+02 | 1.52E+02 | 6.00E+02 | 5.64E+02 | 3.46E+00 |
| Eu-152 | 4.68E+03 | 1.30E+03 | 1.30E+03 | 4.43E+03 | 2.26E+03 | 8.76E+01 |
| Eu-154 | 4.22E+03 | 1.14E+03 | 1.14E+03 | 3.92E+03 | 2.06E+03 | 6.69E+01 |
| H-3 | 4.03E+03 | 9.20E+02 | 9.20E+02 | 3.68E+03 | 3.71E+03 | 2.02E+01 |
| Ni-63 | 8.75E+04 | 1.56E+04 | 1.56E+04 | 6.23E+04 | 6.25E+04 | 3.42E+02 |
| Sr-90 | 7.59E+01 | 5.54E+00 | 5.54E+00 | 2.21E+01 | 2.22E+01 | 1.21E-01 |

**ROC Mixture for Containment (Reference: TSD 14-019, Revision 1 Table 20)**

| | Perent Activity | Ratio to Cs-137 |
|---|---|---|
| Co-60 | 4.675% | 6.92E-02 |
| Cs-134 | 0.008% | 1.21E-04 |
| Cs-137 | 67.582% | 1.00E+00 |
| Eu-152 | 0.436% | 6.45E-03 |
| Eu-154 | 0.058% | 8.57E-04 |
| H-3 | 0.074% | 1.10E-03 |
| Ni-63 | 26.275% | 3.89E-01 |
| Sr-90 | 0.027% | 4.05E-04 |
| ROC Total Percent Acti | 99.136% | |
| | | |
| Insignificant Contributo | 0.864% | |
| Total | 100.000% | |

**ROC Mixture for Auxiliary Basement (Reference: TSD 14-019, Revision 1 Table 20)**

| | Perent Activity | Ratio to Cs-137 |
|---|---|---|
| Co-60 | 0.908% | 1.22E-02 |
| Cs-134 | 0.010% | 1.38E-04 |
| Cs-137 | 74.597% | 1.00E+00 |
| Ni-63 | 23.480% | 3.15E-01 |
| Sr-90 | 0.051% | 6.83E-04 |
| ROC Total | 99.046% | |
| Percent Activity | | |
| Insignificant Con | 0.954% | |
| Total | 100.00% | |

**Clean Concrete Hypothetical Dose Containment ROC Mixture**

| | Auxiliary | Containment | Spent Fuel Pool/ Transfer Canals | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | mrem/yr | mrem/yr | mrem/yr | mrem/yr | mrem/yr | mrem/yr |
| Co-60 | 2.54E-02 | 3.19E-02 | 2.74E-03 | 3.27E-02 | 5.73E-02 | 4.55E-02 |
| Cs-134 | 6.18E-05 | 2.71E-04 | 2.33E-05 | 2.43E-04 | 2.50E-04 | 9.57E-04 |
| Cs-137 | 9.60E-01 | 1.71E+00 | 1.47E-01 | 1.52E+00 | 1.49E+00 | 6.26E+00 |
| Eu-152 | 1.11E-03 | 1.28E-03 | 1.10E-04 | 1.33E-03 | 2.40E-03 | 1.60E-03 |
| Eu-154 | 1.64E-04 | 1.95E-04 | 1.67E-05 | 2.00E-04 | 3.49E-04 | 2.77E-04 |
| H-3 | 2.19E-04 | 3.09E-04 | 2.65E-05 | 2.72E-04 | 2.48E-04 | 1.17E-03 |
| Ni-63 | 3.58E-03 | 6.48E-03 | 5.57E-04 | 5.70E-03 | 5.23E-03 | 2.46E-02 |
| Sr-90 | 4.30E-03 | 1.90E-02 | 1.63E-03 | 1.67E-02 | 1.53E-02 | 7.22E-02 |
| **Total** | **9.94E-01** | **1.77E+00** | **1.52E-01** | **1.58E+00** | **1.57E+00** | **6.40E+00** |

**Clean Concrete Hypothetical Dose Auxiliary ROC Mixture**

| | Auxiliary | Containment | Spent Fuel Pool/ Transfer Canals | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | mrem/yr | mrem/yr | mrem/yr | mrem/yr | mrem/yr | mrem/yr |
| Co-60 | 4.47E-03 | 5.61E-03 | 4.82E-04 | 5.76E-03 | 1.01E-02 | 8.00E-03 |
| Cs-134 | 7.08E-05 | 3.11E-04 | 2.67E-05 | 2.79E-04 | 2.86E-04 | 1.10E-03 |
| Cs-137 | 9.60E-01 | 1.71E+00 | 1.47E-01 | 1.52E+00 | 1.49E+00 | 6.26E+00 |
| Ni-63 | 2.90E-03 | 5.25E-03 | 4.51E-04 | 4.61E-03 | 4.23E-03 | 1.99E-02 |
| Sr-90 | 7.25E-03 | 3.20E-02 | 2.75E-03 | 2.82E-02 | 2.58E-02 | 1.22E-01 |
| **Total** | **9.74E-01** | **1.75E+00** | **1.51E-01** | **1.56E+00** | **1.53E+00** | **6.41E+00** |

**Calculation of Basement Surface DCGLs (pCi/m$^2$)**

**Inputs to Calculation**

| | | |
|---|---|---|
| Conversion Factor | 1.00E+09 | pCi/mCi |
| Dose Limit | 25 | mrem/yr |
| Conversion Factor | 0.0929 | $m^2/ft^2$ |
| Conversion Factor | 0.0283 | $m^3/ft^3$ |

**BFM Groundwater Dose Factors (Not adjusted for insignificant contributor dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) |
| Co-60 | 1.00E-04 | 1.14E-02 | 0.00E+00 | 2.87E-03 | 2.85E-03 | 5.21E-01 |
| Cs-134 | 9.27E-03 | 1.98E-01 | 0.00E+00 | 4.94E-02 | 4.91E-02 | 9.03E+00 |
| Cs-137 | 2.64E-02 | 1.57E-01 | 0.00E+00 | 3.92E-02 | 3.90E-02 | 7.17E+00 |
| Eu-152 | 5.96E-05 | 3.87E-03 | 0.00E+00 | 9.69E-04 | 9.64E-04 | 1.75E-01 |
| Eu-154 | 6.77E-05 | 5.62E-03 | 0.00E+00 | 1.41E-03 | 1.40E-03 | 2.56E-01 |
| H-3 | 6.21E-03 | 2.72E-02 | 0.00E+00 | 6.80E-03 | 6.75E-03 | 1.23E+00 |
| Ni-63 | 2.86E-04 | 1.61E-03 | 0.00E+00 | 4.01E-04 | 4.00E-04 | 7.31E-02 |
| Sr-90 | 3.29E-01 | 4.51E+00 | 0.00E+00 | 1.13E+00 | 1.12E+00 | 2.06E+02 |

**BFM Drilling Spoils Dose Factors (Not adjusted for insignificant contributor dose)**

| | Auxiliary[1] | Containment[1] | Spent Fuel Pool/Transfer Canal | Turbine[1] | Crib House/ Forebay[1] | WWTF[1] |
|---|---|---|---|---|---|---|
| | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) |
| Co-60 | 1.07E-02 | 2.97E-02 | 1.58E-01 | 9.58E-03 | 2.07E-02 | 2.26E-01 |
| Cs-134 | 6.29E-03 | 1.72E-02 | 9.41E-02 | 5.54E-03 | 1.19E-02 | 1.31E-01 |
| Cs-137 | 3.22E-03 | 7.27E-03 | 4.83E-02 | 2.35E-03 | 5.05E-03 | 5.57E-02 |
| Eu-152 | 5.02E-03 | 1.38E-02 | 7.46E-02 | 4.45E-03 | 9.58E-03 | 1.05E-01 |
| Eu-154 | 5.57E-03 | 1.46E-02 | 8.25E-02 | 4.73E-03 | 1.02E-02 | 1.12E-01 |
| H-3 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 |
| Ni-63 | 3.23E-08 | 5.61E-08 | 3.78E-07 | 1.86E-08 | 4.81E-08 | 4.16E-07 |
| Sr-90 | 6.26E-05 | 1.39E-04 | 7.60E-04 | 4.61E-05 | 1.16E-04 | 1.04E-03 |

**Note 1:** BFM DFs for H-3 were reported as zero in TSD 14-019, Table 11. A non-zero value is required for the DCGL calculation. The lowest non-zero DF reported for all nuclides was H-3 in the SFP which was conservatively applied as the H-3 DF for all Basements.

**Basement Surface Areas**

| Survey Unit | Wall and Floor Surface Area $m^2$ |
|---|---|
| Auxiliary Building 542 | |
| Floor and All Walls | 6503 |
| Containment Basement | 2759 |
| SFP/Transfer Canal[3] | 723 |
| Turbine Building | |
| Basement | 14864 |
| Crib House/Forebay[1,2] | 13842 |
| WWTF | 1124 |

Reference: TSD 14-014, Table 64

**Note 1:** Crib House/Forebay Volume listed in TSD 14-009, Revision 1 adjusted lower by factor of 0.86 due to revision of decommissioning approach entailing leaving walls
(Reference: TSD 14-014 Revision 1, Table 38)
Correction factor of 1/0.86 already applied to BFM Dose Factors in "ROC BFM Dose Factors" Tab
**Note 2:** Revised Crib House Forebay Surface Area due to leaving interior walls
Reference: TSD 14-014 Revision 1, Table 64
**Note 3:** Revised SFP/Transfer Tunnel Surface Area in TSD 14-014, Revision 1
Reference: TSD 14-014 Revision 1, Table 64

| | Surface Area $ft^2$ | Surface Area $m^2$ |
|---|---|---|
| Circ Water Discharge Tunnel[1] (2) | 52400 | 4868 |
| Circ Discharge Piping[3] | 11570 | 1075 |
| Circ Water Intake Pipe[2] (2) | 47491 | 4412 |
| Buttress Pits/Tendon Tunnels[4] | 20626 | 1916 |

Note 1: Reference TSD 14-014, Table 64. Area includes Unit 1 and Unit 2 Discharge Tunnels
Note 2: TSD 14-016 Table 46. Area includes Unit 1 and Unit 2 Intake Pipes
Note 3: TSD 14-016, Table 50
Note 4: TSD 14-014, Revision 2, Tables 60 & 63, and TSD 13-005 Rev 1 Table 15

**Summation Surface Area Used for Basement DCGL Calulation**

| Basement | Structure Areas Included in DCGL Calculation | Total SA ($m^2$) |
|---|---|---|
| Containment | Containment + SFP/Transfer Canal | 3482 |
| Auxiliary | Auxiliary + SFP/Transfer Canal | 7226 |
| Turbine | Turbine + Circulating Water Discharge Tunnels (2) + Circulating Water Intake Pipe (2) + Circ Discharge Pipe + Buttress Pits/Tendon Tunnels | 27135 |
| Crib House/Forebay | Crib House/Forebay + Circulating Water Intake Pipe (2) | 18254 |
| SFP/Transfer Canal | SFP/Transfer Canal | 723 |

**BFM Groundwater DCGLs (Not Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ |
| Co-60 | 3.46E+10 | 6.28E+08 | NA | 3.21E+08 | 4.81E+08 | 4.27E+07 |
| Cs-134 | 3.73E+08 | 3.63E+07 | NA | 1.86E+07 | 2.79E+07 | 2.46E+06 |
| Cs-137 | 1.31E+08 | 4.58E+07 | NA | 2.35E+07 | 3.51E+07 | 3.10E+06 |
| Eu-152 | 5.81E+10 | 1.85E+09 | NA | 9.51E+08 | 1.42E+09 | 1.27E+08 |
| Eu-154 | 5.11E+10 | 1.28E+09 | NA | 6.55E+08 | 9.78E+08 | 8.68E+07 |
| H-3 | 5.58E+08 | 2.64E+08 | NA | 1.36E+08 | 2.03E+08 | 1.80E+07 |
| Ni-63 | 1.21E+10 | 4.47E+09 | NA | 2.30E+09 | 3.42E+09 | 3.04E+08 |
| Sr-90 | 1.05E+07 | 1.59E+06 | NA | 8.14E+05 | 1.22E+06 | 1.08E+05 |

**BFM Drilling Spoils DCGLs (Not Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ |
| Co-60 | 3.23E+08 | 2.42E+08 | 2.19E+08 | 9.61E+07 | 6.61E+07 | 9.83E+07 |
| Cs-134 | 5.50E+08 | 4.18E+08 | 3.67E+08 | 1.66E+08 | 1.15E+08 | 1.69E+08 |
| Cs-137 | 1.07E+09 | 9.88E+08 | 7.16E+08 | 3.93E+08 | 2.71E+08 | 4.00E+08 |
| Eu-152 | 6.89E+08 | 5.21E+08 | 4.64E+08 | 2.07E+08 | 1.43E+08 | 2.12E+08 |
| Eu-154 | 6.22E+08 | 4.90E+08 | 4.19E+08 | 1.95E+08 | 1.34E+08 | 1.99E+08 |
| H-3 | 2.38E+15 | 4.94E+15 | 2.38E+16 | 6.34E+14 | 9.42E+14 | 1.53E+16 |
| Ni-63 | 1.07E+14 | 1.28E+14 | 9.15E+13 | 4.96E+13 | 2.85E+13 | 5.34E+13 |
| Sr-90 | 5.53E+10 | 5.15E+10 | 4.55E+10 | 2.00E+10 | 1.18E+10 | 2.14E+10 |

**Basement $DCGL_B$ (Not Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal[1] | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ | $pCi/m^2$ |
| Co-60 | 3.20E+08 | 1.75E+08 | 1.75E+08 | 7.40E+07 | 5.81E+07 | 2.97E+07 |
| Cs-134 | 2.22E+08 | 3.34E+07 | 3.34E+07 | 1.68E+07 | 2.24E+07 | 2.43E+06 |
| Cs-137 | 1.17E+08 | 4.38E+07 | 4.38E+07 | 2.22E+07 | 3.11E+07 | 3.08E+06 |
| Eu-152 | 6.81E+08 | 4.07E+08 | 4.07E+08 | 1.70E+08 | 1.30E+08 | 7.94E+07 |
| Eu-154 | 6.14E+08 | 3.54E+08 | 3.54E+08 | 1.50E+08 | 1.18E+08 | 6.04E+07 |
| H-3 | 5.58E+08 | 2.64E+08 | 2.64E+08 | 1.36E+08 | 2.03E+08 | 1.80E+07 |
| Ni-63 | 1.21E+10 | 4.47E+09 | 4.47E+09 | 2.30E+09 | 3.42E+09 | 3.04E+08 |
| Sr-90 | 1.05E+07 | 1.59E+06 | 1.59E+06 | 8.14E+05 | 1.22E+06 | 1.08E+05 |

Note 1: $DCGL_B$ for SFP/Transfer Canal equal to the lower of the Auxiliary or Containment DCGL which was Containment for all ROC

**Insignificant Contributor Dose Adjustment Factor**

| | Assigned IC Dose Percentage | IC Dose Adjustment Factor |
|---|---|---|
| Auxiliary | 5.00% | 0.95 |
| Containment | 10.00% | 0.90 |
| Basements other than Auxiliary and Containment | 5.00% | 0.95 |

**Adjusted BFM Groundwater DCGLs (Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ |
| Co-60 | 3.28E+10 | 5.65E+08 | NA | 3.05E+08 | 4.57E+08 | 4.05E+07 |
| Cs-134 | 3.55E+08 | 3.27E+07 | NA | 1.77E+07 | 2.65E+07 | 2.34E+06 |
| Cs-137 | 1.25E+08 | 4.12E+07 | NA | 2.23E+07 | 3.34E+07 | 2.95E+06 |
| Eu-152 | 5.52E+10 | 1.67E+09 | NA | 9.03E+08 | 1.35E+09 | 1.21E+08 |
| Eu-154 | 4.85E+10 | 1.15E+09 | NA | 6.22E+08 | 9.29E+08 | 8.24E+07 |
| H-3 | 5.30E+08 | 2.38E+08 | NA | 1.29E+08 | 1.93E+08 | 1.71E+07 |
| Ni-63 | 1.15E+10 | 4.02E+09 | NA | 2.18E+09 | 3.25E+09 | 2.89E+08 |
| Sr-90 | 9.98E+06 | 1.43E+06 | NA | 7.74E+05 | 1.16E+06 | 1.03E+05 |

**Adjusted BFM Drilling Spoils DCGLs (Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ |
| Co-60 | 3.07E+08 | 2.18E+08 | 2.08E+08 | 9.13E+07 | 6.28E+07 | 9.34E+07 |
| Cs-134 | 5.23E+08 | 3.77E+08 | 3.49E+08 | 1.58E+08 | 1.09E+08 | 1.61E+08 |
| Cs-137 | 1.02E+09 | 8.89E+08 | 6.80E+08 | 3.73E+08 | 2.58E+08 | 3.80E+08 |
| Eu-152 | 6.54E+08 | 4.69E+08 | 4.41E+08 | 1.97E+08 | 1.36E+08 | 2.01E+08 |
| Eu-154 | 5.91E+08 | 4.41E+08 | 3.98E+08 | 1.85E+08 | 1.28E+08 | 1.89E+08 |
| H-3 | 2.26E+15 | 4.45E+15 | 2.26E+16 | 6.02E+14 | 8.95E+14 | 1.45E+16 |
| Ni-63 | 1.02E+14 | 1.15E+14 | 8.69E+13 | 4.71E+13 | 2.70E+13 | 5.08E+13 |
| Sr-90 | 5.25E+10 | 4.63E+10 | 4.32E+10 | 1.90E+10 | 1.12E+10 | 2.03E+10 |

**Adjusted Basement $DCGL_B$ (Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal[1] | Turbine | Crib House/ Forebay | WWTF |
|---|---|---|---|---|---|---|
| | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ |
| Co-60 | 3.04E+08 | 1.57E+08 | 1.57E+08 | 7.03E+07 | 5.52E+07 | 2.83E+07 |
| Cs-134 | 2.11E+08 | 3.01E+07 | 3.01E+07 | 1.59E+07 | 2.13E+07 | 2.31E+06 |
| Cs-137 | 1.11E+08 | 3.94E+07 | 3.94E+07 | 2.11E+07 | 2.96E+07 | 2.93E+06 |
| Eu-152 | 6.47E+08 | 3.66E+08 | 3.66E+08 | 1.62E+08 | 1.23E+08 | 7.55E+07 |
| Eu-154 | 5.83E+08 | 3.19E+08 | 3.19E+08 | 1.43E+08 | 1.12E+08 | 5.74E+07 |
| H-3 | 5.30E+08 | 2.38E+08 | 2.38E+08 | 1.29E+08 | 1.93E+08 | 1.71E+07 |
| Ni-63 | 1.15E+10 | 4.02E+09 | 4.02E+09 | 2.18E+09 | 3.25E+09 | 2.89E+08 |
| Sr-90 | 9.98E+06 | 1.43E+06 | 1.43E+06 | 7.74E+05 | 1.16E+06 | 1.03E+05 |

Note 1: DCGL for SFP/Transfer Canal equal to the lower of the Auxiliary or Containment DCGL which was Containment for all ROC.

**Calculation of Embedded Pipe DCGL**

**Inputs to Calculation**

| | | |
|---|---|---|
| Conversion Factor | 1.00E+09 | pCi/mCi |
| Dose Limit | 25 | mrem/yr |
| Conversion Factor | 0.0929 | $m^2/ft^2$ |

**Insignificant Contributor Dose Adjustment Factor**

| | Assigned IC Dose Percentage | IC Dose Adjustment Factor |
|---|---|---|
| Auxiliary | 0.05 | 0.95 |
| Containment | 0.10 | 0.90 |
| Basements other than Auxiliary and Containment | 0.05 | 0.95 |

**Auxiliary Basement Embedded Pipe (Floor Drains) (adjusted for insignificant contributor dose)**
**Inputs to Calculation**

| | |
|---|---|
| Auxiliary Floor Drain Surface Area | 299.41 $m^2$ |

**Auxiliary Floor Drains DCGL (adjusted for insignificant contributor dose)**

| | Auxiliary Basement Dose Factor (mrem/y per mCi) | Auxiliary Floor Drain DCGL ($pCi/m^2$) |
|---|---|---|
| Co-60 | 1.08E-02 | 7.33E+09 |
| Cs-134 | 1.56E-02 | 5.10E+09 |
| Cs-137 | 2.96E-02 | 2.68E+09 |
| Ni-63 | 2.86E-04 | 2.78E+11 |
| Sr-90 | 3.29E-01 | 2.41E+08 |

**Turbine Basement Embedded Pipe (Floor Drains) (adjusted for insignificant contributor dose)**
**Inputs to Calculation**

| | |
|---|---|
| Turbine Floor Drain Surface Area | 302.43 $m^2$ |

**Turbine Embedded Pipe DCGL (adjusted for Insignificant Contributor Dose)**

| | Turbine Basement Dose Factor (mrem/y per mCi) | Turbine Floor Drain DCGL ($pCi/m^2$) |
|---|---|---|
| Co-60 | 1.25E-02 | 6.31E+09 |
| Cs-134 | 5.49E-02 | 1.43E+09 |
| Cs-137 | 4.16E-02 | 1.89E+09 |
| Ni-63 | 4.01E-04 | 1.96E+11 |
| Sr-90 | 1.13E+00 | 6.94E+07 |

**Unit 1 and Unit 2 Containment Embedded Pipe (IC-Sump Drain) (adjusted for insignificant contributor dose)**
**Inputs to Calculation**

| | |
|---|---|
| Containment IC-Sump Pipe Surface Area | 1.05 $m^2$ |
| Nominal Area for DCGL Calculation | 100 $m^2$ |

**Containment Unit 1 and Unit 2 IC-Sump Embedded Pipe DCGL[1] (adjusted for insignificant contributor dose)**

| | Containment Basement Dose Factor (mrem/y per mCi) | IC-Sump Embedded Pipe DCGL ($pCi/m^2$) |
|---|---|---|
| Co-60 | 4.11E-02 | 5.47E+09 |
| Cs-134 | 2.15E-01 | 1.05E+09 |
| Cs-137 | 1.64E-01 | 1.37E+09 |
| Eu-152 | 1.76E-02 | 1.28E+10 |
| Eu-154 | 2.03E-02 | 1.11E+10 |
| H-3 | 2.72E-02 | 8.28E+09 |
| Ni-63 | 1.61E-03 | 1.40E+11 |
| Sr-90 | 4.51E+00 | 4.98E+07 |

Note 1: IC-Sump DCGLs listed applies to both Unit1 1 and Unit 2 IC-Sump pipes
Unit 1 and Unit 2 IC-sump pipes are separate survey units

**Unit 1 and Unit 2 Steam Tunnel Embedded Pipe (Floor Drains) (adjusted for insignificant contrubutor dose)**
**Inputs to Calculation**

| | |
|---|---|
| Steam Tunnel Floor Drain Area[1] | 46.88 $m^2$ |

Note 1: Larger of Unit 1 and Unit 2 Steam Tunnel drains used to minimze DCGL. Lower drain area is 46.39 $m^2$ (Unit 2).

**Unit 1 and Unit 2 Steam Tunnel Embedded Pipe DCGL (adjusted for insignificant contributor dose)**

| | Turbine Basement Dose Factor (mrem/y per mCi) | Turbine Embedded Pipe DCGL ($pCi/m^2$) |
|---|---|---|
| Co-60 | 1.25E-02 | 4.07E+10 |
| Cs-134 | 5.49E-02 | 9.22E+09 |
| Cs-137 | 4.16E-02 | 1.22E+10 |
| Ni-63 | 4.01E-04 | 1.26E+12 |
| Sr-90 | 1.13E+00 | 4.48E+08 |

**Unit 1 and Unit 2 Tendon Tunnel Embedded Pipe (Floor Drains) (adjusted for insignificant contrubutor dose)**
**Inputs to Calculation**

| | |
|---|---|
| Tendon Tunnel Floor Drain Area | 51.41 $m^2$ |

**Tendon Tunnel Embedded Pipe DCGL (adjusted for insignificant contributor dose)**

| | Containment Basement Dose Factor (mrem/y per mCi) | Turbine Basement Dose Factor (mrem/y per mCi) | Tendon Tunnel Embedded Pipe DCGL Containment ($pCi/m^2$) | Tendon Tunnel Embedded Pipe DCGL Turbine ($pCi/m^2$) |
|---|---|---|---|---|
| Co-60 | 4.11E-02 | 1.25E-02 | 1.06E+10 | 3.52E+10 |
| Cs-134 | 2.15E-01 | 5.49E-02 | 2.04E+09 | 7.97E+09 |
| Cs-137 | 1.64E-01 | 4.16E-02 | 2.67E+09 | 1.05E+10 |
| Eu-152 | 1.76E-02 | 5.41E-03 | 2.48E+10 | 8.08E+10 |
| Eu-154 | 2.03E-02 | 6.14E-03 | 2.16E+10 | 7.13E+10 |
| H-3 | 2.72E-02 | 6.80E-03 | 1.61E+10 | 6.44E+10 |
| Ni-63 | 1.61E-03 | 4.01E-04 | 2.72E+11 | 1.09E+12 |
| Sr-90 | 4.51E+00 | 1.13E+00 | 9.70E+07 | 3.87E+08 |

**Drilling Spoils Area Factor Calculation for Class 1 Survey Units**

**Inputs to Calculation**

**Adjusted BFM Drilling Spoils DCGL (Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Spent Fuel Pool/Transfer Canal | Containment |
|---|---|---|---|
| | pCi/$m^2$ | pCi/$m^2$ | pCi/m2 |
| Co-60 | 3.07E+08 | 2.08E+08 | 2.18E+08 |
| Cs-134 | 5.23E+08 | 3.49E+08 | 3.77E+08 |
| Cs-137 | 1.02E+09 | 6.80E+08 | 8.89E+08 |
| Eu-152 | 6.54E+08 | 4.41E+08 | 4.69E+08 |
| Eu-154 | 5.91E+08 | 3.98E+08 | 4.41E+08 |
| H-3 | 2.26E+15 | 2.26E+16 | 4.45E+15 |
| Ni-63 | 1.02E+14 | 8.69E+13 | 1.15E+14 |
| Sr-90 | 5.25E+10 | 4.32E+10 | 4.63E+10 |

**Adjusted Basment DCGL (Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Spent Fuel Pool/Transfer Canal | Containment |
|---|---|---|---|
| | pCi/$m^2$ | pCi/$m^2$ | pCi/$m^2$ |
| Co-60 | 3.04E+08 | 1.57E+08 | 1.57E+08 |
| Cs-134 | 2.11E+08 | 3.01E+07 | 3.01E+07 |
| Cs-137 | 1.11E+08 | 3.94E+07 | 3.94E+07 |
| Eu-152 | 6.47E+08 | 3.66E+08 | 3.66E+08 |
| Eu-154 | 5.83E+08 | 3.19E+08 | 3.19E+08 |
| H-3 | 5.30E+08 | 2.38E+08 | 2.38E+08 |
| Ni-63 | 1.15E+10 | 4.02E+09 | 4.02E+09 |
| Sr-90 | 9.98E+06 | 1.43E+06 | 1.43E+06 |

| | |
|---|---|
| **Conversion Factor** | 0.0929 $m^2/ft^2$ |

**Floor Surface Area and Total Surface Area used for DCGL Calculation**

| | Floor Area ($ft^2$) | Floor Area[1] ($m^2$) | Total Area Used for DCGL Calculation ($m^2$) |
|---|---|---|---|
| Auxiliary Basement | 27149 | 2522 | 7226 |
| SFP/Transfer Canal | 2448 | 227 | 723 |
| Containment | 16489 | 1532 | 3482 |

Note 1: Reference TSD 14-021 , Revision 1, Table 2

**Concentration Corresponding to 25 mrem/yr for Drilling Spoils Only**
**Assuming all Activity in Floor (Adjusted for Insignificant Contributor)**

| | Auxiliary | Spent Fuel Pool/Transfer Canal | Containment |
|---|---|---|---|
| | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ |
| Co-60 | 8.78E+08 | 6.60E+08 | 4.95E+08 |
| Cs-134 | 1.50E+09 | 1.11E+09 | 8.56E+08 |
| Cs-137 | 2.93E+09 | 2.16E+09 | 2.02E+09 |
| Eu-152 | 1.88E+09 | 1.40E+09 | 1.07E+09 |
| Eu-154 | 1.69E+09 | 1.27E+09 | 1.00E+09 |
| H-3 | 6.48E+15 | 7.18E+16 | 1.01E+16 |
| Ni-63 | 2.91E+14 | 2.76E+14 | 2.62E+14 |
| Sr-90 | 1.50E+11 | 1.37E+11 | 1.05E+11 |

**Drilling Spoils Area Factors**

| | Auxiliary | Spent Fuel Pool/Transfer Canal | Containment |
|---|---|---|---|
| Co-60 | 2.89E+00 | 4.20E+00 | 3.15E+00 |
| Cs-134 | 7.09E+00 | 3.69E+01 | 2.84E+01 |
| Cs-137 | 2.63E+01 | 5.49E+01 | 5.13E+01 |
| Eu-152 | 2.90E+00 | 3.82E+00 | 2.91E+00 |
| Eu-154 | 2.90E+00 | 3.97E+00 | 3.15E+00 |
| H-3 | 1.22E+07 | 3.02E+08 | 4.25E+07 |
| Ni-63 | 2.53E+04 | 6.87E+04 | 6.51E+04 |
| Sr-90 | 1.51E+04 | 9.60E+04 | 7.36E+04 |

**BFM Dose Factors for Initial Suite Radionculides (not adjusted for insignificant contributor dose fraction)**

**BFM Dose Factors for Initial Suite (Reference:TSD 14-019, Table 12).**

| Radionuclide | Aux mrem/year per mCi | Containment mrem/year per mCi | Spent Fuel mrem/year per mCi | Turbine mrem/year per mCi | Crib House mrem/year per mCi | WWTF mrem/year per mCi |
|---|---|---|---|---|---|---|
| Ag-108m | 1.78E-02 | 4.61E-02 | 1.85E-01 | 1.30E-02 | 1.77E-02 | 1.32E+00 |
| Am-241 | 2.58E-01 | 1.15E+00 | 3.06E-03 | 2.86E-01 | 2.45E-01 | 5.22E+01 |
| Am-243 | 2.64E-01 | 1.15E+00 | 2.51E-02 | 2.86E-01 | 2.46E-01 | 5.22E+01 |
| C-14 | 6.49E-02 | 2.84E-01 | 3.72E-06 | 7.09E-02 | 6.08E-02 | 1.29E+01 |
| Cm-243 | 2.69E-02 | 1.57E-01 | 1.56E-02 | 3.94E-02 | 3.43E-02 | 7.09E+00 |
| Cm-244 | 1.74E-02 | 1.24E-01 | 7.09E-04 | 3.11E-02 | 2.67E-02 | 5.66E+00 |
| Co-60 | 1.08E-02 | 4.11E-02 | 1.58E-01 | 1.25E-02 | 2.03E-02 | 7.48E-01 |
| Cs-134 | 1.56E-02 | 2.15E-01 | 9.41E-02 | 5.49E-02 | 5.25E-02 | 9.16E+00 |
| Cs-137 | 2.96E-02 | 1.64E-01 | 4.83E-02 | 4.16E-02 | 3.79E-02 | 7.22E+00 |
| Eu-152 | 5.08E-03 | 1.76E-02 | 7.46E-02 | 5.41E-03 | 9.07E-03 | 2.81E-01 |
| Eu-154 | 5.63E-03 | 2.03E-02 | 8.25E-02 | 6.13E-03 | 9.97E-03 | 3.68E-01 |
| Eu-155 | 2.91E-04 | 1.37E-03 | 4.55E-03 | 3.77E-04 | 4.64E-04 | 4.36E-02 |
| Fe-55 | 8.09E-07 | 1.51E-05 | 3.71E-08 | 3.78E-06 | 3.23E-06 | 6.85E-04 |
| H-3 | 6.21E-03 | 2.72E-02 | 1.45E-09 | 6.80E-03 | 5.80E-03 | 1.23E+00 |
| Nb-94 | 1.41E-02 | 2.86E-02 | 1.79E-01 | 8.61E-03 | 1.37E-02 | 5.55E-01 |
| Ni-59 | 1.35E-04 | 5.87E-04 | 1.77E-07 | 1.47E-04 | 1.26E-04 | 2.67E-02 |
| Ni-63 | 2.86E-04 | 1.61E-03 | 3.78E-07 | 4.01E-04 | 3.44E-04 | 7.31E-02 |
| Np-237 | 4.92E+01 | 2.13E+02 | 3.53E-02 | 5.34E+01 | 4.57E+01 | 9.73E+03 |
| Pm-147 | 3.01E-05 | 5.67E-04 | 1.56E-06 | 1.42E-04 | 1.22E-04 | 2.59E-02 |
| Pu-238 | 2.11E-01 | 1.03E+00 | 1.11E-03 | 2.56E-01 | 2.19E-01 | 4.66E+01 |
| Pu-239 | 2.61E-01 | 1.14E+00 | 1.23E-03 | 2.84E-01 | 2.43E-01 | 5.18E+01 |
| Pu-240 | 2.61E-01 | 1.14E+00 | 1.22E-03 | 2.84E-01 | 2.43E-01 | 5.18E+01 |
| Pu-241 | 4.58E-03 | 3.65E-02 | 5.85E-05 | 9.11E-03 | 7.80E-03 | 1.66E+00 |
| Sb-125 | 1.32E-02 | 1.98E-01 | 4.11E-02 | 4.99E-02 | 4.40E-02 | 8.82E+00 |
| Sr-90 | 3.29E-01 | 4.51E+00 | 7.60E-04 | 1.13E+00 | 9.67E-01 | 2.06E+02 |
| Tc-99[1] | 1.48E-01 | 6.44E-01 | 1.45E-09 | 1.61E-01 | 1.38E-01 | 2.93E+01 |

Note 1: BFM DF for Tc-99 was reported as zero in TSD 14-019, Table 11. A non-zero value is required for the DCGL calculation. The lowest non-zero DF reported for all nuclides in SFP was conservatively applied to Tc-99. The nuclide with the lowest SFP DF was H-3 with a value of 1.45E-09 mrem/yr per mCi and was assigned to Tc-99

| Survey Unit | Wall and Floor Surface Area[1] $m^2$ |
|---|---|
| Auxiliary Building 542 Floor and All Walls | 7226 |
| Containment Basement | 3482 |
| SFP/Transfer Canal | 723 |
| Turbine Building Basement | 27135 |
| Crib House/Forebay | 18254 |
| WWTF | 1124 |

Reference:

| | | |
|---|---|---|
| Dose Limit | 25 | mrem/yr |
| Conversion Factor | 1.00E+09 | pCi/mCi |

**Combined DCGLs for Initial Suite not adjusted for Insignificant Contributor Dose Fraction**

| Radionuclide | Auxiliary ($pCi/m^2$) | Containment $pCi/m^2$ | Spent Fuel $pCi/m^2$ | Turbine $pCi/m^2$ | Crib House $pCi/m^2$ | WWTF $pCi/m^2$ |
|---|---|---|---|---|---|---|
| Ag-108m | 1.94E+08 | 1.56E+08 | 1.87E+08 | 7.09E+07 | 7.73E+07 | 1.69E+07 |
| Am-241 | 1.34E+07 | 6.26E+06 | 1.13E+10 | 3.22E+06 | 5.58E+06 | 4.26E+05 |
| Am-243 | 1.31E+07 | 6.26E+06 | 1.38E+09 | 3.22E+06 | 5.56E+06 | 4.26E+05 |
| C-14 | 5.33E+07 | 2.53E+07 | 9.29E+12 | 1.30E+07 | 2.25E+07 | 1.72E+06 |
| Cm-243 | 1.28E+08 | 4.57E+07 | 2.22E+09 | 2.34E+07 | 3.99E+07 | 3.14E+06 |
| Cm-244 | 1.99E+08 | 5.78E+07 | 4.88E+10 | 2.96E+07 | 5.13E+07 | 3.93E+06 |
| Co-60 | 3.20E+08 | 1.75E+08 | 2.19E+08 | 7.40E+07 | 6.76E+07 | 2.97E+07 |
| Cs-134 | 2.22E+08 | 3.34E+07 | 3.67E+08 | 1.68E+07 | 2.61E+07 | 2.43E+06 |
| Cs-137 | 1.17E+08 | 4.38E+07 | 7.16E+08 | 2.22E+07 | 3.62E+07 | 3.08E+06 |
| Eu-152 | 6.81E+08 | 4.07E+08 | 4.64E+08 | 1.70E+08 | 1.51E+08 | 7.90E+07 |
| Eu-154 | 6.14E+08 | 3.54E+08 | 4.19E+08 | 1.50E+08 | 1.37E+08 | 6.05E+07 |
| Eu-155 | 1.19E+10 | 5.25E+09 | 7.60E+09 | 2.45E+09 | 2.95E+09 | 5.10E+08 |
| Fe-55 | 4.28E+12 | 4.77E+11 | 9.33E+14 | 2.44E+11 | 4.25E+11 | 3.25E+10 |
| H-3 | 5.58E+08 | 2.64E+08 | 2.38E+16 | 1.36E+08 | 2.36E+08 | 1.80E+07 |
| Nb-94 | 2.46E+08 | 2.51E+08 | 1.93E+08 | 1.07E+08 | 9.96E+07 | 4.00E+07 |
| Ni-59 | 2.57E+10 | 1.22E+10 | 1.95E+14 | 6.29E+09 | 1.09E+10 | 8.33E+08 |
| Ni-63 | 1.21E+10 | 4.47E+09 | 9.15E+13 | 2.30E+09 | 3.98E+09 | 3.04E+08 |
| Np-237 | 7.04E+04 | 3.37E+04 | 9.80E+08 | 1.73E+04 | 3.00E+04 | 2.29E+03 |
| Pm-147 | 1.15E+11 | 1.27E+10 | 2.21E+13 | 6.49E+09 | 1.13E+10 | 8.60E+08 |
| Pu-238 | 1.64E+07 | 7.00E+06 | 3.11E+10 | 3.60E+06 | 6.25E+06 | 4.77E+05 |
| Pu-239 | 1.32E+07 | 6.30E+06 | 2.82E+10 | 3.24E+06 | 5.63E+06 | 4.29E+05 |
| Pu-240 | 1.33E+07 | 6.30E+06 | 2.83E+10 | 3.24E+06 | 5.63E+06 | 4.29E+05 |
| Pu-241 | 7.56E+08 | 1.97E+08 | 5.92E+11 | 1.01E+08 | 1.76E+08 | 1.34E+07 |
| Sb-125 | 2.63E+08 | 3.62E+07 | 8.41E+08 | 1.85E+07 | 3.11E+07 | 2.52E+06 |
| Sr-90 | 1.05E+07 | 1.59E+06 | 4.55E+10 | 8.14E+05 | 1.42E+06 | 1.08E+05 |
| Tc-99 | 2.34E+07 | 1.11E+07 | 2.38E+16 | 5.72E+06 | 9.95E+06 | 7.60E+05 |

**Drill Spoils Dose Factors for Initial Suite (Reference: TSD 14-021)**

| Nuclide | Aux Building Drill Spoils mrem/yr per mCi | CTMT Drill Spoils mrem per mCi | SFB Drill Spoils mrem/yr per mCi | Turbine Drill Spoils mrem/yr per mCi | Crib House Drill Spoils mrem/yr per mCi | WWTF Drill Spoils mrem/yr per mCi |
|---|---|---|---|---|---|---|
| Ag-108m | 1.23E-02 | 2.05E-02 | 1.85E-01 | 6.61E-03 | 1.23E-02 | 1.57E-01 |
| Am-241 | 1.51E-04 | 3.14E-04 | 3.06E-03 | 9.76E-05 | 1.49E-04 | 2.91E-03 |
| Am-243 | 1.58E-03 | 2.73E-03 | 2.51E-02 | 8.75E-04 | 1.55E-03 | 2.16E-02 |
| C-14 | 3.08E-07 | 4.27E-07 | 3.72E-06 | 1.42E-07 | 3.08E-07 | 3.11E-06 |
| Cm-243 | 9.93E-04 | 1.70E-03 | 1.56E-02 | 5.47E-04 | 9.87E-04 | 1.34E-02 |
| Cm-244 | 2.55E-05 | 6.63E-05 | 7.09E-04 | 1.97E-05 | 2.50E-05 | 7.21E-04 |
| Co-60 | 1.07E-02 | 2.97E-02 | 1.58E-01 | 9.58E-03 | 1.78E-02 | 2.26E-01 |
| Cs-134 | 6.29E-03 | 1.72E-02 | 9.41E-02 | 5.54E-03 | 1.02E-02 | 1.31E-01 |
| Cs-137 | 3.22E-03 | 7.27E-03 | 4.83E-02 | 2.35E-03 | 4.34E-03 | 5.57E-02 |
| Eu-152 | 5.02E-03 | 1.38E-02 | 7.46E-02 | 4.45E-03 | 8.24E-03 | 1.05E-01 |
| Eu-154 | 5.57E-03 | 1.46E-02 | 8.25E-02 | 4.73E-03 | 8.77E-03 | 1.12E-01 |
| Eu-155 | 2.83E-04 | 4.95E-04 | 4.55E-03 | 1.58E-04 | 2.77E-04 | 3.84E-03 |
| Fe-55 | 2.97E-09 | 4.20E-09 | 3.71E-08 | 1.39E-09 | 2.97E-09 | 3.29E-08 |
| H-3 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 |
| Nb-94 | 1.20E-02 | 1.98E-02 | 1.79E-01 | 6.40E-03 | 1.19E-02 | 1.52E-01 |
| Ni-59 | 1.51E-08 | 2.04E-08 | 1.77E-07 | 6.77E-09 | 1.50E-08 | 1.52E-07 |
| Ni-63 | 3.23E-08 | 5.61E-08 | 3.78E-07 | 1.86E-08 | 4.14E-08 | 4.16E-07 |
| Np-237 | 2.91E-03 | 4.04E-03 | 3.53E-02 | 1.34E-03 | 2.89E-03 | 3.01E-02 |
| Pm-147 | 9.32E-08 | 1.68E-07 | 1.56E-06 | 5.35E-08 | 9.15E-08 | 1.35E-06 |
| Pu-238 | 3.97E-05 | 1.04E-04 | 1.11E-03 | 3.08E-05 | 3.89E-05 | 1.13E-03 |
| Pu-239 | 4.41E-05 | 1.15E-04 | 1.23E-03 | 3.40E-05 | 4.30E-05 | 1.25E-03 |
| Pu-240 | 4.38E-05 | 1.14E-04 | 1.22E-03 | 3.38E-05 | 4.28E-05 | 1.24E-03 |
| Pu-241 | 2.97E-06 | 6.03E-06 | 5.85E-05 | 1.88E-06 | 2.92E-06 | 5.56E-05 |
| Sb-125 | 2.75E-03 | 4.52E-03 | 4.11E-02 | 1.46E-03 | 2.69E-03 | 3.45E-02 |
| Sr-90 | 6.26E-05 | 1.39E-04 | 7.60E-04 | 4.61E-05 | 9.96E-05 | 1.04E-03 |
| Tc-99 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 | 1.45E-09 |

Note 1: BFM DF for Tc-99 and H-3 were reported as zero in TSD 14-019, Table 11 (except for H-3 in SFP). A non-zero value is required for the DCGL calculation.

The nuclide with the lowest DF was H-3 with a value of 1.45E-09 mrem/yr per mCi which was assigned to Tc-99 and H-3

**Drilling Spoils DCGLs for Initial Suite not adjusted for Insignificant Contributor Dose Fraction**

| Radionuclide | Auxiliary (pCi/m2) | Containment pCi/m2 | Spent Fuel pCi/m2 | Turbine pCi/m2 | Crib House pCi/m2 | WWTF pCi/m2 |
|---|---|---|---|---|---|---|
| Ag-108m | 2.80E+08 | 3.50E+08 | 1.87E+08 | 1.39E+08 | 1.12E+08 | 1.42E+08 |
| Am-241 | 2.29E+10 | 2.28E+10 | 1.13E+10 | 9.44E+09 | 9.19E+09 | 7.64E+09 |
| Am-243 | 2.19E+09 | 2.63E+09 | 1.38E+09 | 1.05E+09 | 8.82E+08 | 1.03E+09 |
| C-14 | 1.12E+13 | 1.68E+13 | 9.29E+12 | 6.51E+12 | 4.45E+12 | 7.14E+12 |
| Cm-243 | 3.49E+09 | 4.22E+09 | 2.22E+09 | 1.69E+09 | 1.39E+09 | 1.66E+09 |
| Cm-244 | 1.36E+11 | 1.08E+11 | 4.88E+10 | 4.69E+10 | 5.47E+10 | 3.08E+10 |
| Co-60 | 3.23E+08 | 2.42E+08 | 2.19E+08 | 9.61E+07 | 7.69E+07 | 9.83E+07 |
| Cs-134 | 5.50E+08 | 4.18E+08 | 3.67E+08 | 1.66E+08 | 1.34E+08 | 1.69E+08 |
| Cs-137 | 1.07E+09 | 9.88E+08 | 7.16E+08 | 3.93E+08 | 3.16E+08 | 4.00E+08 |
| Eu-152 | 6.89E+08 | 5.21E+08 | 4.64E+08 | 2.07E+08 | 1.66E+08 | 2.12E+08 |
| Eu-154 | 6.22E+08 | 4.90E+08 | 4.19E+08 | 1.95E+08 | 1.56E+08 | 1.99E+08 |
| Eu-155 | 1.22E+10 | 1.45E+10 | 7.60E+09 | 5.82E+09 | 4.94E+09 | 5.79E+09 |
| Fe-55 | 1.16E+15 | 1.71E+15 | 9.33E+14 | 6.65E+14 | 4.62E+14 | 6.77E+14 |
| H-3 | 2.38E+15 | 4.94E+15 | 2.38E+16 | 6.34E+14 | 9.42E+14 | 1.53E+16 |
| Nb-94 | 2.87E+08 | 3.62E+08 | 1.93E+08 | 1.44E+08 | 1.16E+08 | 1.47E+08 |
| Ni-59 | 2.28E+14 | 3.51E+14 | 1.95E+14 | 1.36E+14 | 9.10E+13 | 1.46E+14 |
| Ni-63 | 1.07E+14 | 1.28E+14 | 9.15E+13 | 4.96E+13 | 3.31E+13 | 5.34E+13 |
| Np-237 | 1.19E+09 | 1.78E+09 | 9.80E+08 | 6.89E+08 | 4.74E+08 | 7.38E+08 |
| Pm-147 | 3.71E+13 | 4.26E+13 | 2.21E+13 | 1.72E+13 | 1.50E+13 | 1.65E+13 |
| Pu-238 | 8.72E+10 | 6.91E+10 | 3.11E+10 | 2.99E+10 | 3.52E+10 | 1.96E+10 |
| Pu-239 | 7.85E+10 | 6.27E+10 | 2.82E+10 | 2.71E+10 | 3.18E+10 | 1.78E+10 |
| Pu-240 | 7.89E+10 | 6.29E+10 | 2.83E+10 | 2.72E+10 | 3.20E+10 | 1.79E+10 |
| Pu-241 | 1.16E+12 | 1.19E+12 | 5.92E+11 | 4.90E+11 | 4.69E+11 | 4.00E+11 |
| Sb-125 | 1.26E+09 | 1.59E+09 | 8.41E+08 | 6.32E+08 | 5.09E+08 | 6.45E+08 |
| Sr-90 | 5.53E+10 | 5.15E+10 | 4.55E+10 | 2.00E+10 | 1.37E+10 | 2.14E+10 |
| Tc-99 | 2.38E+15 | 4.94E+15 | 2.38E+16 | 6.34E+14 | 9.42E+14 | 1.53E+16 |

**Calculation of Penetration DCGLs (pCi/$m^2$)**

**Inputs to Calculation**

| | | |
|---|---|---|
| Conversion Factor | 1.00E+09 | pCi/mCi |
| Dose Limit | 25 | mrem/yr |
| Conversion Factor | 0.0929 | $m^2/ft^2$ |
| Conversion Factor | 0.0283 | $m^3/ft^3$ |

**BFM Groundwater Dose Factors (Not adjusted for insignificant contributor dose)**

| | **Auxiliary** | **Containment** | **Spent Fuel Pool/Transfer Canal** | **Turbine** | **Crib House/Forebay** | **WWTF** |
|---|---|---|---|---|---|---|
| | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) |
| Co-60 | 1.00E-04 | 1.14E-02 | 0.00E+00 | 2.87E-03 | 2.85E-03 | 5.21E-01 |
| Cs-134 | 9.27E-03 | 1.98E-01 | 0.00E+00 | 4.94E-02 | 4.91E-02 | 9.03E+00 |
| Cs-137 | 2.64E-02 | 1.57E-01 | 0.00E+00 | 3.92E-02 | 3.90E-02 | 7.17E+00 |
| Eu-152 | 5.96E-05 | 3.87E-03 | 0.00E+00 | 9.69E-04 | 9.64E-04 | 1.75E-01 |
| Eu-154 | 6.77E-05 | 5.62E-03 | 0.00E+00 | 1.41E-03 | 1.40E-03 | 2.56E-01 |
| H-3 | 6.21E-03 | 2.72E-02 | 0.00E+00 | 6.80E-03 | 6.75E-03 | 1.23E+00 |
| Ni-63 | 2.86E-04 | 1.61E-03 | 0.00E+00 | 4.01E-04 | 4.00E-04 | 7.31E-02 |
| Sr-90 | 3.29E-01 | 4.51E+00 | 0.00E+00 | 1.13E+00 | 1.12E+00 | 2.06E+02 |

**BFM Drilling Spoils Dose Factors (Reference: TSD 14-021, Table 5) (Not adjusted for insignificant contributor dose)**

| | **Auxiliary** | **Containment** | **Spent Fuel Pool/Transfer Canal** | **Turbine** | **Crib House/Forebay** | **WWTF** |
|---|---|---|---|---|---|---|
| | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) | (mrem/y per mCi) |
| Co-60 | 1.07E-02 | 2.97E-02 | 1.58E-01 | 9.58E-03 | 2.07E-02 | 2.26E-01 |
| Cs-134 | 6.29E-03 | 1.72E-02 | 9.41E-02 | 5.54E-03 | 1.19E-02 | 1.31E-01 |
| Cs-137 | 3.22E-03 | 7.27E-03 | 4.83E-02 | 2.35E-03 | 5.05E-03 | 5.57E-02 |
| Eu-152 | 5.02E-03 | 1.38E-02 | 7.46E-02 | 4.45E-03 | 9.58E-03 | 1.05E-01 |
| Eu-154 | 5.57E-03 | 1.46E-02 | 8.25E-02 | 4.73E-03 | 1.02E-02 | 1.12E-01 |
| H-3 | 0.00E+00 | 0.00E+00 | 1.45E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 3.23E-08 | 5.61E-08 | 3.78E-07 | 1.86E-08 | 4.81E-08 | 4.16E-07 |
| Sr-90 | 6.26E-05 | 1.39E-04 | 7.60E-04 | 4.61E-05 | 1.16E-04 | 1.04E-03 |

**Penetration Surface Area (Reference TSD 14-016)**

| **Basement** | **Surface Area $m^2$** |
|---|---|
| Containment | 242.36 |
| Auxiliary | 948.75 |
| Turbine | 1081.14 |
| Crib House/Forebay | 1.14 |
| SFP/Transfer Canal | 337.45 |
| WWTF | 0.89 |

**Ratio of Instant Release Groundwater Concentration versus Diffusion Release for Auxiliary Basement DUST Model**

(Reference: BNL Report "Evaluation of Maximum Radionuclide Groundwater Concentrations for Basement Fill Model, Zion Restortaion Project", Revison 3, Attachment G)

| | Diffusion Release | Instant Release | Concentration Ratio |
|---|---|---|---|
| | pCi/L | pCi/L | |
| Co-60 | 2.89E-08 | 7.58E-07 | 26.23 |
| Cs-134 | 7.63E-07 | 3.75E-06 | 4.91 |
| Cs-137 | 2.74E-06 | 3.75E-06 | 1.37 |
| Eu-152 | 1.19E-07 | 1.78E-06 | 14.96 |
| Eu-154 | 9.32E-08 | 1.78E-06 | 19.1 |
| H-3 | 1.01E-03 | 1.02E-03 | 1.01 |
| Ni-63 | 2.11E-06 | 2.73E-06 | 1.29 |
| Sr-90 | 2.18E-05 | 6.87E-05 | 3.15 |

**Insignificant Contributor Dose Adjustment Factor**

| | Assigned IC Dose Percentage | IC Dose Adjustment Factor |
|---|---|---|
| Auxiliary | 5.00% | 0.95 |
| Containment | 10.00% | 0.90 |
| Basements other than Auxiliary and Containment | 5.00% | 0.95 |

**Penetration DCGL (Adjusted for Insignificant Contributor Dose)**

| | Auxiliary | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/ Forebay[1] | WWTF[2] |
|---|---|---|---|---|---|---|
| | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ |
| Co-60 | 8.82E+07 | 2.26E+09 | 4.45E+08 | 1.76E+09 | NA | NA |
| Cs-134 | 3.28E+08 | 4.32E+08 | 7.48E+08 | 4.00E+08 | NA | NA |
| Cs-137 | 6.17E+08 | 5.66E+08 | 1.46E+09 | 5.29E+08 | NA | NA |
| Eu-152 | 3.29E+08 | 5.26E+09 | 9.44E+08 | 4.06E+09 | NA | NA |
| Eu-154 | 2.33E+08 | 4.58E+09 | 8.53E+08 | 3.58E+09 | NA | NA |
| H-3 | 3.99E+09 | 3.42E+09 | 4.84E+16 | 3.23E+09 | NA | NA |
| Ni-63 | 6.79E+10 | 5.78E+10 | 1.86E+14 | 5.48E+10 | NA | NA |
| Sr-90 | 2.41E+07 | 2.06E+07 | 9.26E+10 | 1.94E+07 | NA | NA |

Note 1: Crib House/Forebay penentration surface area of 1.14 m$^2$ will be included with Crib House/Forebay surfaces survey unit - surface DCGL will apply
Note 2: WWTF penenraton surface area surface area of 0.89 m$^c$ will be included in WWTF surface survey unit - surface DCGL will apply

**Lower Action Level for Remdiation and Grouting Action of Auxiliary Penetration Survey Unit**

| | Auxiliary |
|---|---|
| | pCi/m$^2$ |
| Co-60 | 1.16E+07 |
| Cs-134 | 4.30E+07 |
| Cs-137 | 8.11E+07 |
| Eu-152 | 4.32E+07 |
| Eu-154 | 3.05E+07 |
| H-3 | 5.24E+08 |
| Ni-63 | 8.91E+09 |
| Sr-90 | 3.17E+06 |

**Basement Wall/Floor Surface DCGLs**

| | Containment | Spent Fuel Pool/Transfer Canal | Turbine | Crib House/Forebay | WWTF |
|---|---|---|---|---|---|
| | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ | pCi/m$^2$ |
| Co-60 | 1.57E+08 | 1.57E+08 | 7.03E+07 | 5.52E+07 | 2.83E+07 |
| Cs-134 | 3.01E+07 | 3.01E+07 | 1.59E+07 | 2.13E+07 | 2.31E+06 |
| Cs-137 | 3.94E+07 | 3.94E+07 | 2.11E+07 | 2.96E+07 | 2.93E+06 |
| Eu-152 | 3.66E+08 | 3.66E+08 | 1.62E+08 | 1.23E+08 | 7.55E+07 |
| Eu-154 | 3.19E+08 | 3.19E+08 | 1.43E+08 | 1.12E+08 | 5.74E+07 |
| H-3 | 2.38E+08 | 2.38E+08 | 1.29E+08 | 1.93E+08 | 1.71E+07 |
| Ni-63 | 4.02E+09 | 4.02E+09 | 2.18E+09 | 3.25E+09 | 2.89E+08 |
| Sr-90 | 1.43E+06 | 1.43E+06 | 7.74E+05 | 1.16E+06 | 1.03E+05 |

**Penetration Remediation and Grouting Action Levels**

| | Aux/CTMT | Aux/SFP | Aux/Turbine | CTMT/SFP | SFP/Turbine | Minimum Aux, CTMT, SFP, Turbine |
|---|---|---|---|---|---|---|
| Co-60 | 1.16E+07 | 1.16E+07 | 1.16E+07 | 1.57E+08 | 7.03E+07 | 1.16E+07 |
| Cs-134 | 3.01E+07 | 3.01E+07 | 1.59E+07 | 3.01E+07 | 1.59E+07 | 1.59E+07 |
| Cs-137 | 3.94E+07 | 3.94E+07 | 2.11E+07 | 3.94E+07 | 2.11E+07 | 2.11E+07 |
| Eu-152 | 4.32E+07 | 4.32E+07 | 4.32E+07 | 3.66E+08 | 1.62E+08 | 4.32E+07 |
| Eu-154 | 3.05E+07 | 3.05E+07 | 3.05E+07 | 3.19E+08 | 1.43E+08 | 3.05E+07 |
| H-3 | 2.38E+08 | 2.38E+08 | 1.29E+08 | 2.38E+08 | 1.29E+08 | 1.29E+08 |
| Ni-63 | 4.02E+09 | 4.02E+09 | 2.18E+09 | 4.02E+09 | 2.18E+09 | 2.18E+09 |
| Sr-90 | 1.43E+06 | 1.43E+06 | 7.74E+05 | 1.43E+06 | 7.74E+05 | 7.74E+05 |