

Virginia Administrative Code  
 Title 12. Health  
 Agency 5. Department Of Health  
 Chapter 481. Virginia Radiation Protection Regulations

## Part XVII. Schedules

### Article 7. Notification

#### 12VAC5-481-3680. Assigned protection factors for respirators.

|                                                                                     | Operating mode                    | Assigned Protection Factors |
|-------------------------------------------------------------------------------------|-----------------------------------|-----------------------------|
| I. Air Purifying Respirators (Particulate <sup>b</sup> only) <sup>c</sup> :         |                                   |                             |
| Filtering facepiece disposable <sup>d</sup>                                         | Negative Pressure                 | (d)                         |
| Facepiece, half <sup>e</sup>                                                        | Negative Pressure                 | 10                          |
| Facepiece, full                                                                     | Negative Pressure                 | 100                         |
| Facepiece, half                                                                     | Powered air-purifying respirators | 50                          |
| Facepiece, full                                                                     | Powered air-purifying respirators | 1000                        |
| Helmet/hood                                                                         | Powered air-purifying respirators | 1000                        |
| Facepiece, loose-fitting                                                            | Powered air-purifying respirators | 25                          |
| II. Atmosphere-supplying respirators (particulate, gases and vapors <sup>f</sup> ): |                                   |                             |
| 1. Air-line respirator:                                                             |                                   |                             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                            |                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------|
| Facepiece, half                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Demand                                                                     | 10                  |
| Facepiece, half                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Continuous Flow                                                            | 50                  |
| Facepiece, half                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Pressure Demand                                                            | 50                  |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Demand                                                                     | 100                 |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Continuous Flow                                                            | 1000                |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Pressure Demand                                                            | 1000                |
| Helmet/hood                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Continuous Flow                                                            | 1000                |
| Facepiece, loose-fitting                                                                                                                                                                                                                                                                                                                                                                                                                                              | Continuous Flow                                                            | 25                  |
| Suit                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Continuous Flow                                                            | (g)                 |
| 2. Self-contained breathing Apparatus (SCBA):                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                            |                     |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Demand                                                                     | <sup>h</sup> 100    |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Pressure Demand                                                            | <sup>i</sup> 10,000 |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Demand, Recirculating                                                      | <sup>h</sup> 100    |
| Facepiece, full                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Positive Pressure Recirculating                                            | <sup>i</sup> 10,000 |
| III. Combination Respirators:                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                            |                     |
| Any combination of air-purifying and atmosphere-supplying respirators                                                                                                                                                                                                                                                                                                                                                                                                 | Assigned protection factor for type and mode of operation as listed above. |                     |
| <sup>a</sup> These assigned protection factors apply only in a respiratory protection program that meets the requirements of this section. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances shall also comply with Department of Labor regulations. |                                                                            |                     |

Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix B to 10 CFR Part 20 are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

<sup>b</sup>Air purifying respirators with APF <100 shall be equipped with particulate filters that are at least 95% efficient. Air purifying respirators with APF = 100 shall be equipped with particulate filters that are at least 99% efficient. Air purifying respirators with APFs >100 shall be equipped with particulate filters that are at least 99.97% efficient.

<sup>c</sup>The licensee may apply to VDH for the use of an APF greater than 1 for absorbent cartridges as protection against airborne radioactive gases and vapors (e.g., radioiodine).

<sup>d</sup>Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use user seal check on this type of device. All other respiratory protection program requirements listed in 12VAC5-481-820 apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to 10 may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

<sup>e</sup>Under-chin type only. No distinction is made in this section between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece (e.g., disposable or reusable disposable). Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95 percent efficient and all other requirements of this section are met.

<sup>f</sup>The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external (submersion) dose considerations.

<sup>g</sup>No NIOSH approval schedule is currently available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met (i.e., 12VAC5-481-820).

<sup>h</sup>The licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health (IDLH).

<sup>i</sup>This type of respirator may be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure such as skin absorption shall be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

**Statutory Authority**

§ 32.1-229 of the Code of Virginia.

**Historical Notes**

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008; amended, Virginia Register Volume 32, Issue 24, eff. August 25, 2016.

**12VAC5-481-3690. (Repealed.)****Statutory Authority****Historical Notes**

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008; repealed, Virginia Register Volume 32, Issue 24, eff. August 25, 2016.

**12VAC5-481-3700. Quantities of licensed materials requiring labeling.**

| Radionuclide | Abbreviation | Quantity (μCi) |
|--------------|--------------|----------------|
| Hydrogen-3   | H-3          | 1,000          |
| Beryllium-7  | Be-7         | 1,000          |
| Beryllium-10 | Be-10        | 1              |
| Carbon-11    | C-11         | 1,000          |
| Carbon-14    | C-14         | 100            |
| Fluorine-18  | F-18         | 1,000          |
| Sodium-22    | Na-22        | 10             |
| Sodium-24    | Na-24        | 100            |
| Magnesium-28 | Mg-28        | 100            |

|               |       |       |
|---------------|-------|-------|
| Aluminum-26   | Al-26 | 10    |
| Silicon-31    | Si-31 | 1,000 |
| Silicon-32    | Si-32 | 1     |
| Phosphorus-32 | P-32  | 10    |
| Phosphorus-33 | P-33  | 100   |
| Sulfur-35     | S-35  | 100   |
| Chlorine-36   | Cl-36 | 10    |
| Chlorine-38   | Cl-38 | 1,000 |
| Chlorine-39   | Cl-39 | 1,000 |
| Argon-39      | Ar-39 | 1,000 |
| Argon-41      | Ar-41 | 1,000 |
| Potassium-40  | K-40  | 100   |
| Potassium-42  | K-42  | 1,000 |
| Potassium-43  | K-43  | 1,000 |
| Potassium-44  | K-44  | 1,000 |
| Potassium-45  | K-45  | 1,000 |
| Calcium-41    | Ca-41 | 100   |
| Calcium-45    | Ca-45 | 100   |
| Calcium-47    | Ca-47 | 100   |

|               |        |       |
|---------------|--------|-------|
| Scandium-43   | Sc-43  | 1,000 |
| Scandium-44m  | Sc-44m | 100   |
| Scandium-44   | Sc-44  | 100   |
| Scandium-46   | Sc-46  | 10    |
| Scandium-47   | Sc-47  | 100   |
| Scandium-48   | Sc-48  | 100   |
| Scandium-49   | Sc-49  | 1,000 |
| Titanium-44   | Ti-44  | 1     |
| Titanium-45   | Ti-45  | 1,000 |
| Vanadium-47   | V-47   | 1,000 |
| Vanadium-48   | V-48   | 100   |
| Vanadium-49   | V-49   | 1,000 |
| Chromium-48   | Cr-48  | 1,000 |
| Chromium-49   | Cr-49  | 1,000 |
| Chromium-51   | Cr-51  | 1,000 |
| Manganese-51  | Mn-51  | 1,000 |
| Manganese-52m | Mn-52m | 1,000 |
| Manganese-52  | Mn-52  | 100   |
| Manganese-53  | Mn-53  | 1,000 |

|              |        |       |
|--------------|--------|-------|
| Manganese-54 | Mn-54  | 100   |
| Manganese-56 | Mn-56  | 1,000 |
| Iron-52      | Fe-52  | 100   |
| Iron-55      | Fe-55  | 100   |
| Iron-59      | Fe-59  | 10    |
| Iron-60      | Fe-60  | 1     |
| Cobalt-55    | Co-55  | 100   |
| Cobalt-56    | Co-56  | 10    |
| Cobalt-57    | Co-57  | 100   |
| Cobalt-58m   | Co-58m | 1,000 |
| Cobalt-58    | Co-58  | 100   |
| Cobalt-60m   | Co-60m | 1,000 |
| Cobalt-60    | Co-60  | 1     |
| Cobalt-61    | Co-61  | 1,000 |
| Cobalt-62m   | Co-62m | 1,000 |
| Nickel-56    | Ni-56  | 100   |
| Nickel-57    | Ni-57  | 100   |
| Nickel-59    | Ni-59  | 100   |
| Nickel-63    | Ni-63  | 100   |

|            |        |       |
|------------|--------|-------|
| Nickel-65  | Ni-65  | 1,000 |
| Nickel-66  | Ni-66  | 10    |
| Copper-60  | Cu-60  | 1,000 |
| Copper-61  | Cu-61  | 1,000 |
| Copper-64  | Cu-64  | 1,000 |
| Copper-67  | Cu-67  | 1,000 |
| Zinc-62    | Zn-62  | 100   |
| Zinc-63    | Zn-63  | 1,000 |
| Zinc-65    | Zn-65  | 10    |
| Zinc-69m   | Zn-69m | 100   |
| Zinc-69    | Zn-69  | 1,000 |
| Zinc-71m   | Zn-71m | 1,000 |
| Zinc-72    | Zn-72  | 100   |
| Gallium-65 | Ga-65  | 1,000 |
| Gallium-66 | Ga-66  | 100   |
| Gallium-67 | Ga-67  | 1,000 |
| Gallium-68 | Ga-68  | 1,000 |
| Gallium-70 | Ga-70  | 1,000 |
| Gallium-72 | Ga-72  | 100   |



|              |       |       |
|--------------|-------|-------|
| Gallium-73   | Ga-73 | 1,000 |
| Germanium-66 | Ge-66 | 1,000 |
| Germanium-67 | Ge-67 | 1,000 |
| Germanium-68 | Ge-68 | 10    |
| Germanium-69 | Ge-69 | 1,000 |
| Germanium-71 | Ge-71 | 1,000 |
| Germanium-75 | Ge-75 | 1,000 |
| Germanium-77 | Ge-77 | 1,000 |
| Germanium-78 | Ge-78 | 1,000 |
| Arsenic-69   | As-69 | 1,000 |
| Arsenic-70   | As-70 | 1,000 |
| Arsenic-71   | As-71 | 100   |
| Arsenic-72   | As-72 | 100   |
| Arsenic-73   | As-73 | 100   |
| Arsenic-74   | As-74 | 100   |
| Arsenic-76   | As-76 | 100   |
| Arsenic-77   | As-77 | 100   |
| Arsenic-78   | As-78 | 1,000 |
| Selenium-70  | Se-70 | 1,000 |

|              |        |       |
|--------------|--------|-------|
| Selenium-73m | Se-73m | 1,000 |
| Selenium-73  | Se-73  | 100   |
| Selenium-75  | Se-75  | 100   |
| Selenium-79  | Se-79  | 100   |
| Selenium-81m | Se-81m | 1,000 |
| Selenium-81  | Se-81  | 1,000 |
| Selenium-83  | Se-83  | 1,000 |
| Bromine-74m  | Br-74m | 1,000 |
| Bromine-74   | Br-74  | 1,000 |
| Bromine-75   | Br-75  | 1,000 |
| Bromine-76   | Br-76  | 100   |
| Bromine-77   | Br-77  | 1,000 |
| Bromine-80m  | Br-80m | 1,000 |
| Bromine-80   | Br-80  | 1,000 |
| Bromine-82   | Br-82  | 100   |
| Bromine-83   | Br-83  | 1,000 |
| Bromine-84   | Br-84  | 1,000 |
| Krypton-74   | Kr-74  | 1,000 |
| Krypton-76   | Kr-76  | 1,000 |

|              |        |       |
|--------------|--------|-------|
| Krypton-77   | Kr-77  | 1,000 |
| Krypton-79   | Kr-79  | 1,000 |
| Krypton-81   | Kr-81  | 1,000 |
| Krypton-83m  | Kr-83m | 1,000 |
| Krypton-85m  | Kr-85m | 1,000 |
| Krypton-85   | Kr-85  | 1,000 |
| Krypton-87   | Kr-87  | 1,000 |
| Krypton-88   | Kr-88  | 1,000 |
| Rubidium-79  | Rb-79  | 1,000 |
| Rubidium-81m | Rb-81m | 1,000 |
| Rubidium-81  | Rb-81  | 1,000 |
| Rubidium-82m | Rb-82m | 1,000 |
| Rubidium-83  | Rb-83  | 100   |
| Rubidium-84  | Rb-84  | 100   |
| Rubidium-86  | Rb-86  | 100   |
| Rubidium-87  | Rb-87  | 100   |
| Rubidium-88  | Rb-88  | 1,000 |
| Rubidium-89  | Rb-89  | 1,000 |
| Strontium-80 | Sr-80  | 100   |

|               |        |       |
|---------------|--------|-------|
| Strontium-81  | Sr-81  | 1,000 |
| Strontium-83  | Sr-83  | 100   |
| Strontium-85m | Sr-85m | 1,000 |
| Strontium-85  | Sr-85  | 100   |
| Strontium-87m | Sr-87m | 1,000 |
| Strontium-89  | Sr-89  | 10    |
| Strontium-90  | Sr-90  | 0.1   |
| Strontium-91  | Sr-91  | 100   |
| Strontium-92  | Sr-92  | 100   |
| Yttrium-86m   | Y-86m  | 1,000 |
| Yttrium-86    | Y-86   | 100   |
| Yttrium-87    | Y-87   | 100   |
| Yttrium-88    | Y-88   | 10    |
| Yttrium-90m   | Y-90m  | 1,000 |
| Yttrium-90    | Y-90   | 10    |
| Yttrium-91m   | Y-91m  | 1,000 |
| Yttrium-91    | Y-91   | 10    |
| Yttrium-92    | Y-92   | 100   |
| Yttrium-93    | Y-93   | 100   |

|                      |        |       |
|----------------------|--------|-------|
| Yttrium-94           | Y-94   | 1,000 |
| Yttrium-95           | Y-95   | 1,000 |
| Zirconium-86         | Zr-86  | 100   |
| Zirconium-88         | Zr-88  | 10    |
| Zirconium-89         | Zr-89  | 100   |
| Zirconium-93         | Zr-93  | 1     |
| Zirconium-95         | Zr-95  | 10    |
| Zirconium-97         | Zr-97  | 100   |
| Niobium-88           | Nb-88  | 1,000 |
| Niobium-89m (66 min) | Nb-89m | 1,000 |
| Niobium-89 (122 min) | Nb-89  | 1,000 |
| Niobium-90           | Nb-90  | 100   |
| Niobium-93m          | Nb-93m | 10    |
| Niobium-94           | Nb-94  | 1     |
| Niobium-95m          | Nb-95m | 100   |
| Niobium-95           | Nb-95  | 100   |
| Niobium-96           | Nb-96  | 100   |
| Niobium-97           | Nb-97  | 1,000 |
| Niobium-98           | Nb-98  | 1,000 |

|                |        |       |
|----------------|--------|-------|
| Molybdenum-90  | Mo-90  | 100   |
| Molybdenum-93m | Mo-93m | 100   |
| Molybdenum-93  | Mo-93  | 10    |
| Molybdenum-99  | Mo-99  | 100   |
| Molybdenum-101 | Mo-101 | 1,000 |
| Technetium-93m | Tc-93m | 1,000 |
| Technetium-93  | Tc-93  | 1,000 |
| Technetium-94m | Tc-94m | 1,000 |
| Technetium-94  | Tc-94  | 1,000 |
| Technetium-96m | Tc-96  | 1,000 |
| Technetium-96  | Tc-96  | 100   |
| Technetium-97m | Tc-97m | 100   |
| Technetium-97  | Tc-97  | 1,000 |
| Technetium-98  | Tc-98  | 10    |
| Technetium-99m | Tc-99m | 1,000 |
| Technetium-99  | Tc-99  | 100   |
| Technetium-101 | Tc-101 | 1,000 |
| Technetium-104 | Tc-104 | 1,000 |
| Ruthenium-94   | Ru-94  | 1,000 |

|               |         |       |
|---------------|---------|-------|
| Ruthenium-97  | Ru-97   | 1,000 |
| Ruthenium-103 | Ru-103  | 100   |
| Ruthenium-105 | Ru-105  | 1,000 |
| Ruthenium-106 | Ru-106  | 1     |
| Rhodium-99m   | Rh-99m  | 1,000 |
| Rhodium-99    | Rh-99   | 100   |
| Rhodium-100   | Rh-100  | 100   |
| Rhodium-101m  | Rh-101m | 1,000 |
| Rhodium-101   | Rh-101  | 10    |
| Rhodium-102m  | Rh-102m | 10    |
| Rhodium-102   | Rh-102  | 10    |
| Rhodium-103m  | Rh-103m | 1,000 |
| Rhodium-105   | Rh-105  | 100   |
| Rhodium-106m  | Rh-106m | 1,000 |
| Rhodium-107   | Rh-107  | 1,000 |
| Palladium-100 | Pd-100  | 100   |
| Palladium-101 | Pd-101  | 1,000 |
| Palladium-103 | Pd-103  | 100   |
| Palladium-107 | Pd-107  | 10    |

|               |         |       |
|---------------|---------|-------|
| Palladium-109 | Pd-109  | 100   |
| Silver-102    | Ag-102  | 1,000 |
| Silver-103    | Ag-103  | 1,000 |
| Silver-104m   | Ag-104m | 1,000 |
| Silver-104    | Ag-104  | 1,000 |
| Silver-105    | Ag-105  | 100   |
| Silver-106m   | Ag-106m | 100   |
| Silver-106    | Ag-106  | 1,000 |
| Silver-108m   | Ag-108m | 1     |
| Silver-110m   | Ag-110m | 10    |
| Silver-111    | Ag-111  | 100   |
| Silver-112    | Ag-112  | 100   |
| Silver-115    | Ag-115  | 1,000 |
| Cadmium-104   | Cd-104  | 1,000 |
| Cadmium-107   | Cd-107  | 1,000 |
| Cadmium-109   | Cd-109  | 1     |
| Cadmium-113m  | Cd-113m | 0.1   |
| Cadmium-113   | Cd-113  | 100   |
| Cadmium-115m  | Cd-115m | 10    |



|                        |         |       |
|------------------------|---------|-------|
| Cadmium-115            | Cd-115  | 100   |
| Cadmium-117m           | Cd-117m | 1,000 |
| Cadmium-117            | Cd-117  | 1,000 |
| Indium-109             | In-109  | 1,000 |
| Indium-110 (69.1 min.) | In-110  | 1,000 |
| Indium-110 (4.9h)      | In-110  | 1,000 |
| Indium-111             | In-111  | 100   |
| Indium-112             | In-112  | 1,000 |
| Indium-113m            | In-113m | 1,000 |
| Indium-114m            | In-114m | 10    |
| Indium-115m            | In-115m | 1,000 |
| Indium-115             | In-115  | 100   |
| Indium-116m            | In-116m | 1,000 |
| Indium-117m            | In-117m | 1,000 |
| Indium-117             | In-117  | 1,000 |
| Indium-119m            | In-119m | 1,000 |
| Tin-110                | Sn-110  | 100   |
| Tin-111                | Sn-111  | 1,000 |
| Tin-113                | Sn-113  | 100   |

|                        |         |       |
|------------------------|---------|-------|
| Tin-117m               | Sn-117m | 100   |
| Tin-119m               | Sn-119m | 100   |
| Tin-121m               | Sn-121m | 100   |
| Tin-121                | Sn-121  | 1,000 |
| Tin-123m               | Sn-123m | 1,000 |
| Tin-123                | Sn-123  | 10    |
| Tin-125                | Sn-125  | 10    |
| Tin-126                | Sn-126  | 10    |
| Tin-127                | Sn-127  | 1,000 |
| Tin-128                | Sn-128  | 1,000 |
| Antimony-115           | Sb-115  | 1,000 |
| Antimony-116m          | Sb-116m | 1,000 |
| Antimony-116           | Sb-116  | 1,000 |
| Antimony-117           | Sb-117  | 1,000 |
| Antimony-118m          | Sb-118m | 1,000 |
| Antimony-119           | Sb-119  | 1,000 |
| Antimony-120 (16 min.) | Sb-120  | 1,000 |
| Antimony-120 (5.76d)   | Sb-120  | 100   |
| Antimony-122           | Sb-122  | 100   |

|                          |         |       |
|--------------------------|---------|-------|
| Antimony-124m            | Sb-124m | 1,000 |
| Antimony-124             | Sb-124  | 10    |
| Antimony-125             | Sb-125  | 100   |
| Antimony-126m            | Sb-126m | 1,000 |
| Antimony-126             | Sb-126  | 100   |
| Antimony-127             | Sb-127  | 100   |
| Antimony-128 (10.4 min.) | Sb-128  | 1,000 |
| Antimony-128 (9.01h)     | Sb-128  | 100   |
| Antimony-129             | Sb-129  | 100   |
| Antimony-130             | Sb-130  | 1,000 |
| Antimony-131             | Sb-131  | 1,000 |
| Tellurium-116            | Te-116  | 1,000 |
| Tellurium-121m           | Te-121m | 10    |
| Tellurium-121            | Te-121  | 100   |
| Tellurium-123m           | Te-123m | 10    |
| Tellurium-123            | Te-123  | 100   |
| Tellurium-125m           | Te-125m | 10    |
| Tellurium-127m           | Te-127m | 10    |
| Tellurium-127            | Te-127  | 1,000 |

|                |         |       |
|----------------|---------|-------|
| Tellurium-129m | Te-129m | 10    |
| Tellurium-129  | Te-129  | 1,000 |
| Tellurium-131m | Te-131m | 10    |
| Tellurium-131  | Te-131  | 100   |
| Tellurium-132  | Te-132  | 10    |
| Tellurium-133m | Te-133m | 100   |
| Tellurium-133  | Te-133  | 1,000 |
| Tellurium-134  | Te-134  | 1,000 |
| Iodine-120m    | I-120m  | 1,000 |
| Iodine-120     | I-120   | 100   |
| Iodine-121     | I-121   | 1,000 |
| Iodine-123     | I-123   | 100   |
| Iodine-124     | I-124   | 10    |
| Iodine-125     | I-125   | 1     |
| Iodine-126     | I-126   | 1     |
| Iodine-128     | I-128   | 1,000 |
| Iodine-129     | I-129   | 1     |
| Iodine-130     | I-130   | 10    |
| Iodine-131     | I-131   | 1     |

|             |         |       |
|-------------|---------|-------|
| Iodine-132m | I-132m  | 100   |
| Iodine-132  | I-132   | 100   |
| Iodine-133  | I-133   | 10    |
| Iodine-134  | I-134   | 1,000 |
| Iodine-135  | I-135   | 100   |
| Xenon-120   | Xe-120  | 1,000 |
| Xenon-121   | Xe-121  | 1,000 |
| Xenon-122   | Xe-122  | 1,000 |
| Xenon-123   | Xe-123  | 1,000 |
| Xenon-125   | Xe-125  | 1,000 |
| Xenon-127   | Xe-127  | 1,000 |
| Xenon-129m  | Xe-129m | 1,000 |
| Xenon-131m  | Xe-131m | 1,000 |
| Xenon-133m  | Xe-133m | 1,000 |
| Xenon-133   | Xe-133  | 1,000 |
| Xenon-135m  | Xe-135m | 1,000 |
| Xenon-135   | Xe-135  | 1,000 |
| Xenon-138   | Xe-138  | 1,000 |
| Cesium-125  | Cs-125  | 1,000 |

|             |         |       |
|-------------|---------|-------|
| Cesium-127  | Cs-127  | 1,000 |
| Cesium-129  | Cs-129  | 1,000 |
| Cesium-130  | Cs-130  | 1,000 |
| Cesium-131  | Cs-131  | 1,000 |
| Cesium-132  | Cs-132  | 100   |
| Cesium-134m | Cs-134m | 1,000 |
| Cesium-134  | Cs-134  | 10    |
| Cesium-135m | Cs-135m | 1,000 |
| Cesium-135  | Cs-135  | 100   |
| Cesium-136  | Cs-136  | 10    |
| Cesium-137  | Cs-137  | 10    |
| Cesium-138  | Cs-138  | 1,000 |
| Barium-126  | Ba-126  | 1,000 |
| Barium-128  | B-128   | 100   |
| Barium-131m | Ba-131m | 1,000 |
| Barium-131  | Ba-131  | 100   |
| Barium-133m | Ba-133m | 100   |
| Barium-133  | Ba-133  | 100   |
| Barium-135m | Ba-135m | 100   |

|               |         |       |
|---------------|---------|-------|
| Barium-139    | Ba-139  | 1,000 |
| Barium-140    | Ba-140  | 100   |
| Barium-141    | Ba-141  | 1,000 |
| Barium-142    | Ba-142  | 1,000 |
| Lanthanum-131 | La-131  | 1,000 |
| Lanthanum-132 | La-132  | 100   |
| Lanthanum-135 | La-135  | 1,000 |
| Lanthanum-137 | La-137  | 10    |
| Lanthanum-138 | La-138  | 100   |
| Lanthanum-140 | La-140  | 100   |
| Lanthanum-141 | La-141  | 100   |
| Lanthanum-142 | La-142  | 1,000 |
| Lanthanum-143 | La-143  | 1,000 |
| Cerium-134    | Ce-134  | 100   |
| Cerium-135    | Ce-135  | 100   |
| Cerium-137m   | Ce-137m | 100   |
| Cerium-137    | Ce-137  | 1,000 |
| Cerium-139    | Ce-139  | 100   |
| Cerium-141    | Ce-141  | 100   |

|                   |         |       |
|-------------------|---------|-------|
| Cerium-143        | Ce-143  | 100   |
| Cerium-144        | Ce-144  | 1     |
| Praseodymium-136  | Pr-136  | 1,000 |
| Praseodymium-137  | Pr-137  | 1,000 |
| Praseodymium-138m | Pe-138m | 1,000 |
| Praseodymium-139  | Pe-139  | 1,000 |
| Praseodymium-142m | Pe-142m | 1,000 |
| Praseodymium-142  | Pe-142  | 100   |
| Praseodymium-143  | Pe-143  | 100   |
| Praseodymium-144  | Pe-144  | 1,000 |
| Praseodymium-145  | Pe-145  | 100   |
| Praseodymium-147  | Pe-147  | 1,000 |
| Neodymium-136     | Nd-136  | 1,000 |
| Neodymium-138     | Nd-138  | 100   |
| Neodymium-139m    | Nd-139m | 1,000 |
| Neodymium-139     | Nd-139  | 1,000 |
| Neodymium-141     | Nd-141  | 1,000 |
| Neodymium-147     | Nd-147  | 100   |
| Neodymium-149     | Nd-149  | 1,000 |



|                 |         |       |
|-----------------|---------|-------|
| Neodymium-151   | Nd-151  | 1,000 |
| Promethium-141  | Pm-141  | 1,000 |
| Promethium-143  | Pm-143  | 100   |
| Promethium-144  | Pm-144  | 10    |
| Promethium-145  | Pm-145  | 10    |
| Promethium-146  | Pm-146  | 1     |
| Promethium-147  | Pm-147  | 10    |
| Promethium-148m | Pm-148m | 10    |
| Promethium-148  | Pm-148  | 10    |
| Promethium-149  | Pm-149  | 100   |
| Promethium-150  | Pm-150  | 1,000 |
| Promethium-151  | Pm-151  | 100   |
| Samarium-141m   | Sm-141m | 1,000 |
| Samarium-141    | Sm-141  | 1,000 |
| Samarium-142    | Sm-142  | 1,000 |
| Samarium-145    | Sm-145  | 100   |
| Samarium-146    | Sm-146  | 1     |
| Samarium-147    | Sm-147  | 100   |
| Samarium-151    | Sm-151  | 10    |

|                       |         |       |
|-----------------------|---------|-------|
| Samarium-153          | Sm-153  | 100   |
| Samarium-155          | Sm-155  | 1,000 |
| Samarium-156          | Sm-156  | 1,000 |
| Europium-145          | Eu-145  | 100   |
| Europium-146          | Eu-146  | 100   |
| Europium-147          | Eu-147  | 100   |
| Europium-148          | Eu-148  | 10    |
| Europium-149          | Eu-149  | 100   |
| Europium-150 (12.62h) | Eu-150  | 100   |
| Europium-150 (34.2y)  | Eu-150  | 1     |
| Europium-152m         | Eu-152m | 100   |
| Europium-152          | Eu-152  | 1     |
| Europium-154          | Eu-154  | 1     |
| Europium-155          | Eu-155  | 10    |
| Europium-156          | Eu-156  | 100   |
| Europium-157          | Eu-157  | 100   |
| Europium-158          | Eu-158  | 1,000 |
| Gadolinium-145        | Gd-145  | 1,000 |
| Gadolinium-146        | Gd-146  | 10    |

|                      |         |       |
|----------------------|---------|-------|
| Gadolinium-147       | Gd-147  | 100   |
| Gadolinium-148       | Gd-148  | 0.001 |
| Gadolinium-149       | Gd-149  | 100   |
| Gadolinium-151       | Gd-151  | 10    |
| Gadolinium-152       | Gd-152  | 100   |
| Gadolinium-153       | Gd-153  | 10    |
| Gadolinium-159       | Gd-159  | 100   |
| Terbium-147          | Tb-147  | 1,000 |
| Terbium-149          | Tb-149  | 100   |
| Terbium-150          | Tb-150  | 1,000 |
| Terbium-151          | Tb-151  | 100   |
| Terbium-153          | Tb-153  | 1,000 |
| Terbium-154          | Tb-154  | 100   |
| Terbium-155          | Tb-155  | 1,000 |
| Terbium-156m (5.0h)  | Tb-156m | 1,000 |
| Terbium-156m (24.4h) | Tb-156m | 1,000 |
| Terbium-156          | Tb-156  | 100   |
| Terbium-157          | Tb-157  | 10    |
| Terbium-158          | Tb-158  | 1     |

|                |         |       |
|----------------|---------|-------|
| Terbium-160    | Tb-160  | 10    |
| Terbium-161    | Tb-161  | 100   |
| Dysprosium-155 | Dy-155  | 1,000 |
| Dysprosium-157 | Dy-157  | 1,000 |
| Dysprosium-159 | Dy-159  | 100   |
| Dysprosium-165 | Dy-165  | 1,000 |
| Dysprosium-166 | Dy-166  | 100   |
| Holmium-155    | Ho-155  | 1,000 |
| Holmium-157    | Ho-157  | 1,000 |
| Holmium-159    | Ho-159  | 1,000 |
| Holmium-161    | Ho-161  | 1,000 |
| Holmium-162m   | Ho-162m | 1,000 |
| Holmium-162    | Ho-162  | 1,000 |
| Holmium-164m   | Hp-164m | 1,000 |
| Holmium-164    | Ho-164  | 1,000 |
| Holmium-166m   | Ho-166m | 1     |
| Holmium-166    | Ho-166  | 100   |
| Holmium-167    | Ho-167  | 1,000 |
| Erbium-161     | Er-161  | 1,000 |

|               |        |       |
|---------------|--------|-------|
| Erbium-165    | Er-165 | 1,000 |
| Erbium-169    | Er-169 | 100   |
| Erbium-171    | Er-171 | 100   |
| Erbium-172    | Er-172 | 100   |
| Thulium-162   | Tm-162 | 1,000 |
| Thulium-166   | Tm-166 | 100   |
| Thulium-167   | Tm-167 | 100   |
| Thulium-170   | Tm-170 | 10    |
| Thulium-171   | Tm-171 | 10    |
| Thulium-172   | Tm-172 | 100   |
| Thulium-173   | Tm-173 | 100   |
| Thulium-175   | Tm-175 | 1,000 |
| Ytterbium-162 | Yb-162 | 1,000 |
| Ytterbium-166 | Yb-166 | 100   |
| Ytterbium-167 | Yb-167 | 1,000 |
| Ytterbium-169 | Yb-169 | 100   |
| Ytterbium-175 | Yb-175 | 100   |
| Ytterbium-177 | Yb-177 | 1,000 |
| Ytterbium-178 | Yb-178 | 1,000 |

|               |         |       |
|---------------|---------|-------|
| Lutetium-169  | Lu-169  | 100   |
| Lutetium-170  | Lu-170  | 100   |
| Lutetium-171  | Lu-171  | 100   |
| Lutetium-172  | Lu-172  | 100   |
| Lutetium-173  | Lu-173  | 10    |
| Lutetium-174m | Lu-174m | 10    |
| Lutetium-174  | Lu-174  | 10    |
| Lutetium-176m | Lu-176m | 1,000 |
| Lutetium-176  | Lu-176  | 100   |
| Lutetium-177m | Lu-177m | 10    |
| Lutetium-177  | Lu-177  | 100   |
| Lutetium-178m | Lu-178m | 1,000 |
| Lutetium-178  | Lu-178  | 1,000 |
| Lutetium-179  | Lu-179  | 1,000 |
| Hafnium-170   | Hf-170  | 100   |
| Hafnium-172   | Hf-172  | 1     |
| Hafnium-173   | Hf-173  | 1,000 |
| Hafnium-175   | Hf-175  | 100   |
| Hafnium-177m  | Hf-177m | 1,000 |

|               |         |       |
|---------------|---------|-------|
| Hafnium-178m  | Hf-178m | 0.1   |
| Hafnium-179m  | Hf-179m | 10    |
| Hafnium-180m  | Hf-180m | 1,000 |
| Hafnium-181   | Hf-181  | 10    |
| Hafnium-182m  | Hf-182m | 1,000 |
| Hafnium-182   | Hf-182  | 0.1   |
| Hafnium-183   | Hf-183  | 1,000 |
| Hafnium-184   | Hf-184  | 100   |
| Tantalum-172  | Ta-172  | 1,000 |
| Tantalum-173  | Ta-173  | 1,000 |
| Tantalum-174  | Ta-174  | 1,000 |
| Tantalum-175  | Ta-175  | 1,000 |
| Tantalum-176  | Ta-176  | 100   |
| Tantalum-177  | Ta-177  | 1,000 |
| Tantalum-178  | Ta-178  | 1,000 |
| Tantalum-179  | Ta-179  | 100   |
| Tantalum-180m | Ta-180m | 1,000 |
| Tantalum-180  | Ta-180  | 100   |
| Tantalum-182m | Ta-182m | 1,000 |

|                     |         |       |
|---------------------|---------|-------|
| Tantalum-182        | Ta-182  | 10    |
| Tantalum-183        | Ta-183  | 100   |
| Tantalum-184        | Ta-184  | 100   |
| Tantalum-185        | Ta-185  | 1,000 |
| Tantalum-186        | Ta-186  | 1,000 |
| Tungsten-176        | W-176   | 1,000 |
| Tungsten-177        | W-177   | 1,000 |
| Tungsten-178        | W-178   | 1,000 |
| Tungsten-179        | W-179   | 1,000 |
| Tungsten-181        | W-181   | 1,000 |
| Tungsten-185        | W-185   | 100   |
| Tungsten-187        | W-187   | 100   |
| Tungsten-188        | W-188   | 10    |
| Rhenium-177         | Re-177  | 1,000 |
| Rhenium-178         | Re-178  | 1,000 |
| Rhenium-181         | Re-181  | 1,000 |
| Rhenium-182 (12.7h) | Re-182  | 1,000 |
| Rhenium-182 (64.0h) | Re-182  | 100   |
| Rhenium-184m        | Re-184m | 10    |



|              |         |       |
|--------------|---------|-------|
| Rhenium-184  | Re-184  | 100   |
| Rhenium-186m | Re-186m | 10    |
| Rhenium-186  | Re-186  | 100   |
| Rhenium-187  | Re-187  | 1,000 |
| Rhenium-188m | Re-188m | 1,000 |
| Rhenium-188  | Re-188  | 100   |
| Rhenium-189  | Re-189  | 100   |
| Osmium-180   | Os-180  | 1,000 |
| Osmium-181   | Os-181  | 1,000 |
| Osmium-182   | Os-182  | 100   |
| Osmium-185   | Os-185  | 100   |
| Osmium-189m  | Os-189m | 1,000 |
| Osmium-191m  | Os-191m | 1,000 |
| Osmium-191   | Os-191  | 100   |
| Osmium-193   | Os-193  | 100   |
| Osmium-194   | Os-194  | 1     |
| Iridium-182  | Ir-182  | 1,000 |
| Iridium-184  | Ir-184  | 1,000 |
| Iridium-185  | Ir-185  | 1,000 |

|                         |         |       |
|-------------------------|---------|-------|
| Iridium-186             | Ir-186  | 100   |
| Iridium-187             | Ir-187  | 1,000 |
| Iridium-188             | Ir-188  | 100   |
| Iridium-189             | Ir-189  | 100   |
| Iridium-190m            | Ir-190m | 1,000 |
| Iridium-190             | Ir-190  | 100   |
| Iridium-192 (73.8d)     | Ir-192  | 1     |
| Iridium-192m (1.4 min.) | Ir-192m | 10    |
| Iridium-194m            | Ir-194m | 10    |
| Iridium-194             | Ir-194  | 100   |
| Iridium-195m            | Ir-195m | 1,000 |
| Iridium-195             | Ir-95   | 1,000 |
| Platinum-186            | Pt-186  | 1,000 |
| Platinum-188            | Pt-188  | 100   |
| Platinum-189            | Pt-189  | 1,000 |
| Platinum-191            | Pt-191  | 100   |
| Platinum-193m           | Pt-193m | 100   |
| Platinum-193            | Pt-193  | 1,000 |
| Platinum-195m           | Pt-195m | 100   |

|               |         |       |
|---------------|---------|-------|
| Platinum-197m | Pt-197m | 1,000 |
| Platinum-197  | Pt-197  | 100   |
| Platinum-199  | Pt-199  | 1,000 |
| Platinum-200  | Pt-200  | 100   |
| Gold-193      | Au-193  | 1,000 |
| Gold-194      | Au-194  | 100   |
| Gold-195      | Au-195  | 10    |
| Gold-198m     | Au-198m | 100   |
| Gold-198      | Au-198  | 100   |
| Gold-199      | Au-199  | 100   |
| Gold-200m     | Au-200m | 100   |
| Gold-200      | Au-200  | 1,000 |
| Gold-201      | Au-201  | 1,000 |
| Mercury-193m  | Hg-193m | 100   |
| Mercury-193   | Hg-193  | 1,000 |
| Mercury-194   | Hg-194  | 1     |
| Mercury-195m  | Hg-195m | 100   |
| Mercury-195   | Hg-195  | 1,000 |
| Mercury-197m  | Hg-197m | 100   |

|               |         |       |
|---------------|---------|-------|
| Mercury-197   | Hg-197  | 1,000 |
| Mercury-199m  | Hg-199m | 1,000 |
| Mercury-203   | Hg-203  | 100   |
| Thallium-194m | Tl-194m | 1,000 |
| Thallium-194  | Tl-194  | 1,000 |
| Thallium-195  | Tl-195  | 1,000 |
| Thallium-197  | Tl-197  | 1,000 |
| Thallium-198m | Tl-198m | 1,000 |
| Thallium-198  | Tl-198  | 1,000 |
| Thallium-199  | Tl-199  | 1,000 |
| Thallium-200  | Tl-200  | 1,000 |
| Thallium-201  | Tl-201  | 1,000 |
| Thallium-202  | Tl-202  | 100   |
| Thallium-204  | Tl-204  | 100   |
| Lead-195m     | Pb-195m | 1,000 |
| Lead-198      | Pb-198  | 1,000 |
| Lead-199      | Pb-199  | 1,000 |
| Lead-200      | Pb-200  | 100   |
| Lead-201      | Pb-201  | 1,000 |

|              |         |       |
|--------------|---------|-------|
| Lead-202m    | Pb-202m | 1,000 |
| Lead-202     | Pb-202  | 10    |
| Lead-203     | Pb-203  | 1,000 |
| Lead-205     | Pb-205  | 100   |
| Lead-209     | Pb-209  | 1,000 |
| Lead-210     | Pb-210  | 0.01  |
| Lead-211     | Pb-211  | 100   |
| Lead-212     | Pb-212  | 1     |
| Lead-214     | Pb-214  | 100   |
| Bismuth-200  | Bi-200  | 1,000 |
| Bismuth-201  | Bi-201  | 1,000 |
| Bismuth-202  | Bi-202  | 1,000 |
| Bismuth-203  | Bi-203  | 100   |
| Bismuth-205  | Bi-205  | 100   |
| Bismuth-206  | Bi-206  | 100   |
| Bismuth-207  | Bi-207  | 10    |
| Bismuth-210m | Bi-210m | 0.1   |
| Bismuth-210  | Bi-210  | 1     |
| Bismuth-212  | Bi-212  | 10    |

|              |        |       |
|--------------|--------|-------|
| Bismuth-213  | Bi-213 | 10    |
| Bismuth-214  | Bi-214 | 100   |
| Polonium-203 | Po-203 | 1,000 |
| Polonium-205 | Po-205 | 1,000 |
| Polonium-207 | Po-207 | 1,000 |
| Polonium-210 | Po-210 | 0.1   |
| Astatine-207 | At-207 | 100   |
| Astatine-211 | At-211 | 10    |
| Radon-220    | Rn-220 | 1     |
| Radon-222    | Rn-222 | 1     |
| Francium-222 | Fr-222 | 100   |
| Francium-223 | Fr-223 | 100   |
| Radium-223   | Ra-223 | 0.1   |
| Radium-224   | Ra-224 | 0.1   |
| Radium-225   | Ra-225 | 0.1   |
| Radium-226   | Ra-226 | 0.1   |
| Radium-227   | Ra-227 | 1,000 |
| Radium-228   | Ra-228 | 0.1   |
| Actinium-224 | Ac-224 | 1     |

|                  |        |       |
|------------------|--------|-------|
| Actinium-225     | Ac-225 | 0.01  |
| Actinium-226     | Ac-226 | 0.1   |
| Actinium-227     | Ac-227 | 0.001 |
| Actinium-228     | Ac-228 | 1     |
| Thorium-226      | Th-226 | 10    |
| Thorium-227      | Th-227 | 0.01  |
| Thorium-228      | Th-228 | 0.001 |
| Thorium-229      | Th-229 | 0.001 |
| Thorium-230      | Th-230 | 0.001 |
| Thorium-231      | Th-231 | 100   |
| Thorium-232      | Th-232 | 100   |
| Thorium-234      | Th-234 | 10    |
| Thorium-natural  |        | 100   |
| Protactinium-227 | Pa-227 | 10    |
| Protactinium-228 | Pa-228 | 1     |
| Protactinium-230 | Pa-230 | 0.1   |
| Protactinium-231 | Pa-231 | 0.001 |
| Protactinium-232 | Pa-232 | 1     |
| Protactinium-233 | Pa-233 | 100   |

|                                        |        |       |
|----------------------------------------|--------|-------|
| Protactinium-234                       | Pa-234 | 100   |
| Uranium-230                            | U-230  | 0.01  |
| Uranium-231                            | U-231  | 100   |
| Uranium-232                            | U-232  | 0.001 |
| Uranium-233                            | U-233  | 0.001 |
| Uranium-234                            | U-234  | 0.001 |
| Uranium-235                            | U-235  | 0.001 |
| Uranium-236                            | U-236  | 0.001 |
| Uranium-237                            | U-237  | 100   |
| Uranium-238                            | U-238  | 100   |
| Uranium-239                            | U-239  | 1,000 |
| Uranium-240                            | U-240  | 100   |
| Uranium-natural                        |        | 100   |
| Neptunium-232                          | Np-232 | 100   |
| Neptunium-233                          | Np-233 | 1,000 |
| Neptunium-234                          | Np-234 | 100   |
| Neptunium-235                          | Np-235 | 100   |
| Neptunium-236 (1.15x10 <sup>5</sup> y) | Np-236 | 0.001 |
| Neptunium-236 (22.5h)                  | Np-236 | 1     |



|               |        |       |
|---------------|--------|-------|
| Neptunium-237 | Np-237 | 0.001 |
| Neptunium-238 | Np-238 | 10    |
| Neptunium-239 | Np-239 | 100   |
| Neptunium-240 | Np-240 | 1,000 |
| Plutonium-234 | Pu-234 | 10    |
| Plutonium-235 | Pu-235 | 1,000 |
| Plutonium-236 | Pu-236 | 0.001 |
| Plutonium-237 | Pu-237 | 100   |
| Plutonium-238 | Pu-238 | 0.001 |
| Plutonium-239 | Pu-239 | 0.001 |
| Plutonium-240 | Pu-240 | 0.001 |
| Plutonium-241 | Pu-241 | 0.01  |
| Plutonium-242 | Pu-242 | 0.001 |
| Plutonium-243 | Pu-243 | 1,000 |
| Plutonium-244 | Pu-244 | 0.001 |
| Plutonium-245 | Pu-245 | 100   |
| Americium-237 | Am-237 | 1,000 |
| Americium-238 | Am-238 | 100   |
| Americium-239 | Am-239 | 1,000 |

|                |         |       |
|----------------|---------|-------|
| Americium-240  | Am-240  | 100   |
| Americium-241  | Am-241  | 0.001 |
| Americium-242m | Am-242m | 0.001 |
| Americium-242  | Am-242  | 10    |
| Americium-243  | Am-243  | 0.001 |
| Americium-244m | Am-244m | 100   |
| Americium-244  | Am-244  | 10    |
| Americium-245  | Am-245  | 1,000 |
| Americium-246m | Am-246m | 1,000 |
| Americium-246  | Am-246  | 1,000 |
| Curium-238     | Cm-238  | 100   |
| Curium-240     | Cm-240  | 0.1   |
| Curium-241     | Cm-241  | 1     |
| Curium-242     | Cm-242  | 0.01  |
| Curium-243     | Cm-243  | 0.001 |
| Curium-244     | Cm-244  | 0.001 |
| Curium-245     | Cm-245  | 0.001 |
| Curium-246     | Cm-246  | 0.001 |
| Curium-247     | Cm-247  | 0.001 |

|                 |        |       |
|-----------------|--------|-------|
| Curium-248      | Cm-248 | 0.001 |
| Curium-249      | Cm-249 | 1,000 |
| Berkelium-245   | Bk-245 | 100   |
| Berkelium-246   | Bk-246 | 100   |
| Berkelium-247   | Bk-247 | 0.001 |
| Berkelium-249   | Bk-249 | 0.1   |
| Berkelium-250   | Bk-250 | 10    |
| Californium-244 | Cf-244 | 100   |
| Californium-246 | Cf-246 | 1     |
| Californium-248 | Cf-248 | 0.01  |
| Californium-249 | Cf-249 | 0.001 |
| Californium-250 | Cf-250 | 0.001 |
| Californium-251 | Cf-251 | 0.001 |
| Californium-252 | Cf-252 | 0.001 |
| Californium-253 | Cf-253 | 0.1   |
| Californium-254 | Cf-254 | 0.001 |
| Einsteinium-250 | Es-250 | 100   |
| Einsteinium-251 | Es-251 | 100   |
| Einsteinium-253 | Es-253 | 0.1   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------|
| Einsteinium-254m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Es-254m | 1     |
| Einsteinium-254                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Es-254  | 0.01  |
| Fermium-252                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fm-252  | 1     |
| Fermium-253                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fm-253  | 1     |
| Fermium-254                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fm-254  | 10    |
| Fermium-255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fm-255  | 1     |
| Fermium-257                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fm-257  | 0.01  |
| Mendelevium-257                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Md-257  | 10    |
| Mendelevium-258                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Md-258  | 0.01  |
| Any radionuclide other than alpha emitter radionuclides not listed above, or mixtures of beta emitters of unknown composition                                                                                                                                                                                                                                                                                                                                                                    |         | 0.01  |
| Any alpha-emitting radionuclide not listed above or mixtures of alpha-emitters of unknown composition                                                                                                                                                                                                                                                                                                                                                                                            |         | 0.001 |
| <sup>1</sup> The quantities listed above were derived by taking 1/10 of the most restrictive ALI listed in table 1, columns 1 and 2 of 10 CFR Part 20, Appendix B, rounding to the nearest factor of 10, and arbitrarily constraining the values listed between 0.001 and 1,000 $\mu$ Ci. Values of 100 $\mu$ Ci have been assigned for radionuclides having a radioactive half-life in excess of $10^9$ years (except rhenium, 1000 $\mu$ Ci) to take into account their low specific activity. |         |       |

NOTE: For purposes of 10 CFR 20.1902(e), 10 CFR 20.1905(a), and 10 CFR 20.2201(a) where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" (i.e., "unity").

#### Statutory Authority

§ 32.1-229 of the Code of Virginia.

#### Historical Notes

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008.

**12VAC5-481-3710. Requirements for transfers of low-level radioactive waste intended for disposal at licensed land disposal facilities and manifests.****A. Manifest.**

1. A waste generator, waste collector, or waste processor that transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility must prepare a manifest reflecting information requested on applicable NRC Forms 540 (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper)) and 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description)) and, if necessary, on an applicable NRC Form 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation)). NRC Forms 540 and 540A must be completed and must physically accompany the pertinent low-level waste shipment.
  2. Upon agreement between shipper and consignee, NRC Forms 541, 541A, 542, and 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms.
  3. Licensees are not required by the agency, the NRC, or another agreement state to comply with the manifesting requirements of this subpart when they ship:
    - a. Low-level radioactive waste for processing and expect its return, such as for storage under their license, prior to disposal at a licensed land disposal facility;
    - b. Low-level radioactive waste that is being returned to the licensee that is the waste generator or generator; or
    - c. Radioactively contaminated material to a waste processor that becomes the processor's residual waste.
  4. For guidance in completing the forms required under subdivision 1 of this subsection, refer to the instructions that accompany the forms. Copies of manifests required by this subpart may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.
  5. NRC Forms 540, 540A, 541, 541A, 542, and 542A, and the accompanying instructions, in hard copy, may be obtained by writing or calling the Office of Information Services, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (800) 368-5642, or by visiting the NRC's website at [www.nrc.gov](http://www.nrc.gov).
  6. This section includes information requirements of the DOT, as codified in 49 CFR Part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency (EPA) regulations, as codified in 40 CFR Part 259, 261 or elsewhere, is not addressed in this section and must be provided on the required EPA forms. However, the required EPA forms must accompany the uniform low-level radioactive waste manifest required by this section.
- B. General information.** The shipper of the radioactive waste must provide the following information on the uniform manifest:
1. The name, facility address, and telephone number of the licensee shipping the waste;

2. An explicit declaration indicating whether the shipper is acting as a waste generator, waste collector, waste processor, or a combination of these identifiers for purposes of the manifested shipment; and

3. The name, address, and telephone number, or the name and EPA identification number for the carrier transporting the waste.

C. Shipment information. The shipper of the radioactive waste must provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages or disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment;
5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in special nuclear material and the total mass of uranium and thorium in source material.

D. Disposal container and waste information. The shipper of the radioactive waste must provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of any high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types, such as activated materials, contaminated equipment,

mechanical filters, sealed source or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container must be reported; and

11. The total radioactivity within each container.

E. Uncontainerized waste information. The shipper of the radioactive waste must provide the following information on the uniform manifest regarding waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;
3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;
4. For waste consigned to a disposal facility, the classification of the waste according to 12VAC5-481-2571. Waste not meeting the structural stability requirements of 12VAC5-481-2572 must be identified;
5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

F. Multigenerator disposal container information.

1. This subsection applies to disposal containers enclosing mixtures of waste originating from different generators. The origin of the low-level radioactive waste resulting from a waste processor's activities may be attributable to one or more generators, including waste generators. This subsection also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.
2. For homogeneous mixtures of waste, such as incinerator ash, the shipper must provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.
3. For heterogeneous mixtures of waste, such as the combined products from a large compactor, the shipper must identify each generator contributing waste to the disposal container and for discrete waste types, such as activated materials, contaminated equipment, mechanical filters, sealed source or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, the shipper must provide the following:
  - a. The volume of waste within the disposal container;
  - b. A physical and chemical description of the waste, including the solidification agent, if any;
  - c. The total weight percentage of chelating agents for any disposal container containing more than 0.1 percent chelating agent by weight, plus the identity of the principal chelating agent;

d. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in 12VAC5-481-2572; and

e. Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material, if contained in the waste.

G. Certification. An authorized representative of the waste generator, waste processor, or waste collector must certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the DOT and the agency, NRC or another agreement state. A waste collector, in signing the certification, is certifying that nothing has been done to the collected waste that would invalidate the waste generator's certification.

H. Control and tracking; transfers. A licensee that transfers radioactive waste to a land disposal facility or a licensed waste collector must comply with subdivisions 1 through 9 of this subsection. A licensee that transfers waste to a licensed waste processor for waste treatment or repackaging must comply with subdivisions 4 through 9 of this subsection. A licensee shall:

1. Prepare all wastes so that the waste is classified according to 12VAC5-481-2571, and meets the waste characteristics requirements in 12VAC5-481-2572;
2. Label each disposal container of waste, or transport package if potential radiation hazards preclude labeling of the individual disposal container, to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, according to 12VAC5-481-2571;
3. Conduct a quality assurance program to ensure compliance with 12VAC5-481-2571 and 12VAC5-481-2572. The program must include management evaluation of audits;
4. Prepare the uniform low-level radioactive waste manifest as required by this part;
5. Forward a copy or electronically transfer the uniform low-level radioactive waste manifest to the intended consignee so that receipt of the manifest precedes the low-level radioactive waste shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee, or both;
6. Include NRC Form 540, and Form 540A if required, with the shipment regardless of the option chosen in subdivision 5 of this subsection;
7. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;
8. Retain a copy of or electronically store the uniform low-level radioactive waste manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Part I (12VAC5-481-10 et seq.), Part III (12VAC5-481-380 et seq.), Part IV (12VAC5-481-600 et seq.) and Part X (12VAC5-481-2250 et seq.); and
9. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this part, conduct an investigation according to subsection L of this section.

I. Control and tracking; prepackaged waste. A waste collector licensee that handles only prepackaged waste must:



1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of NRC Form 540;
  2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this section. The waste collector must ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;
  3. Forward a copy or electronically transfer the uniform low-level radioactive waste manifest to the intended consignee so that receipt of the manifest precedes the low-level radioactive waste shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee, or both;
  4. Include NRC Form 540, and 540A if required, with the shipment regardless of the option chosen in subdivision 4 of this subsection;
  5. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;
  6. Retain a copy of or electronically store the uniform low-level radioactive waste manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required under Part I (12VAC5-481-10 et seq.), Part III (12VAC5-481-380 et seq.), Part IV (12VAC5-481-600 et seq.) and Part X (12VAC5-481-2250 et seq.);
  7. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this section, conduct an investigation according to subsection L of this section; and
  8. Notify the shipper and the agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.
- J. Control and tracking; treatment or repackaging. A licensed waste processor that treats or repackages waste must:
1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of NRC Form 540;
  2. Prepare a new manifest that meets the requirements of this section. Preparation of the new manifest reflects that the waste processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest must identify the waste generators, the preprocessed waste volume, and the other information as required under subsection F of this section;
  3. Prepare all wastes so that the waste is classified according to 12VAC5-481-2571, and meets the waste characteristics requirements in 12VAC5-481-2572;
  4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with 12VAC5-481-2571 and 12VAC5-481-2572;
  5. Conduct a quality assurance program to ensure compliance with 12VAC5-481-2571 and 12VAC5-481-2572. The program must include management evaluation of audits;
  6. Forward a copy or electronically transfer the uniform low-level radioactive waste manifest to the intended consignee so that receipt of the manifest precedes the low-level radioactive waste shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to

the consignee, or both;

7. Include NRC Form 540, and Form 540A if required, with the shipment regardless of the option chosen in subdivision 6 of this subsection;
8. Receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;
9. Retain a copy of or electronically store the uniform low-level radioactive waste manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Part I (12VAC5-481-10 et seq.), Part III (12VAC5-481-380 et seq.), Part IV (12VAC5-481-600 et seq.) and Part X (12VAC5-481-2250 et seq.);
10. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this part, conduct an investigation according to subsection L; and
11. Notify the shipper and the agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

K. Control and tracking; land disposal facility. A land disposal facility operator shall:

1. Acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of NRC Form 540 to the shipper. The shipper to be notified is the licensee that last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the uniform low-level radioactive waste manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating the discrepancy;
2. Maintain copies of all completed manifests and electronically store the information required by 12VAC5-481-2630, until the agency terminates the license; and
3. Notify the shipper and the agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

L. Investigation. A shipment or part of a shipment for which acknowledgment is not received within the times set forth in this part must:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and
2. Be traced and reported. The investigation must include tracing the shipment and filing a report with the agency. A licensee that conducts a trace investigation must file a written report with the agency within two weeks of completing the investigation.

#### **Statutory Authority**

§ 32.1-229 of the Code of Virginia.

#### **Historical Notes**

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008; amended, Virginia Register Volume 25, Issue 2, eff. November 1, 2008.

#### **12VAC5-481-3720. Exempt concentrations schedule.**

| Element (atomic number) | Isotope | Col. I                                      | Col. II                                                  |
|-------------------------|---------|---------------------------------------------|----------------------------------------------------------|
|                         |         | Gas<br>Concentration<br>$\mu\text{Ci/ml}^1$ | Liquid and Solid<br>Concentration<br>$\mu\text{Ci/ml}^2$ |
| Antimony (51)           | Sb-122  |                                             | $3 \times 10^{-4}$                                       |
|                         | Sb-124  |                                             | $2 \times 10^{-4}$                                       |
|                         | Sb-125  |                                             | $1 \times 10^{-3}$                                       |
| Argon (18)              | A-37    | $1 \times 10^{-3}$                          |                                                          |
|                         | A-41    | $4 \times 10^{-7}$                          |                                                          |
| Arsenic (33)            | As-73   |                                             | $5 \times 10^{-3}$                                       |
|                         | As-74   |                                             | $5 \times 10^{-4}$                                       |
|                         | As-76   |                                             | $2 \times 10^{-4}$                                       |
|                         | As-77   |                                             | $8 \times 10^{-4}$                                       |
| Barium (56)             | Ba-131  |                                             | $2 \times 10^{-3}$                                       |
|                         | Ba-140  |                                             | $3 \times 10^{-4}$                                       |
| Beryllium (4)           | Be-7    |                                             | $2 \times 10^{-2}$                                       |
| Bismuth (83)            | Bi-206  |                                             | $4 \times 10^{-4}$                                       |
| Bromine (35)            | Br-82   | $4 \times 10^{-7}$                          | $3 \times 10^{-3}$                                       |
| Cadmium (48)            | Cd-109  |                                             | $2 \times 10^{-3}$                                       |
|                         | Cd-115M |                                             | $3 \times 10^{-4}$                                       |

|                 |         |                    |                    |
|-----------------|---------|--------------------|--------------------|
|                 | Cd-115  |                    | $3 \times 10^{-4}$ |
| Calcium (20)    | Ca-45   |                    | $9 \times 10^{-5}$ |
|                 | Ca-47   |                    | $5 \times 10^{-4}$ |
| Carbon (6)      | C-14    | $1 \times 10^{-6}$ | $8 \times 10^{-3}$ |
| Cerium (58)     | Ce-141  |                    | $9 \times 10^{-4}$ |
|                 | Ce-143  |                    | $4 \times 10^{-4}$ |
|                 | Ce-144  |                    | $1 \times 10^{-4}$ |
| Cesium (55)     | Cs-131  |                    | $2 \times 10^{-2}$ |
|                 | Cs-134m |                    | $6 \times 10^{-2}$ |
|                 | Cs-134  |                    | $9 \times 10^{-5}$ |
| Chlorine (17)   | Cl-38   | $9 \times 10^{-7}$ | $4 \times 10^{-3}$ |
| Chromium (24)   | Cr-51   |                    | $2 \times 10^{-2}$ |
| Cobalt (27)     | Co-57   |                    | $5 \times 10^{-3}$ |
|                 | Co-58   |                    | $1 \times 10^{-3}$ |
|                 | Co-60   |                    | $5 \times 10^{-4}$ |
| Copper (29)     | Cu-64   |                    | $3 \times 10^{-3}$ |
| Dysprosium (66) | Dy-165  |                    | $4 \times 10^{-3}$ |
|                 | Dy-166  |                    | $4 \times 10^{-4}$ |
| Erbium (68)     | Er-169  |                    | $9 \times 10^{-4}$ |
|                 | Er-171  |                    |                    |

|                 |                     |                    |                    |
|-----------------|---------------------|--------------------|--------------------|
|                 |                     |                    | $1 \times 10^{-3}$ |
| Europium (63)   | Eu-152<br>(9.2 hrs) |                    | $6 \times 10^{-4}$ |
|                 | Eu-155              |                    | $2 \times 10^{-3}$ |
| Fluorine (9)    | F-18                | $2 \times 10^{-6}$ | $8 \times 10^{-3}$ |
| Gadolinium (64) | Gd-153              |                    | $2 \times 10^{-3}$ |
|                 | Gd-159              |                    | $8 \times 10^{-4}$ |
| Gallium (31)    | Ga-72               |                    | $4 \times 10^{-4}$ |
| Germanium (32)  | Ge-71               |                    | $2 \times 10^{-2}$ |
| Gold (79)       | Au-196              |                    | $2 \times 10^{-3}$ |
|                 | Au-198              |                    | $5 \times 10^{-4}$ |
|                 | Au-199              |                    | $2 \times 10^{-3}$ |
| Hafnium (72)    | Hf-81               |                    | $7 \times 10^{-4}$ |
| Hydrogen (1)    | H-3                 | $5 \times 10^{-6}$ | $3 \times 10^{-2}$ |
| Indium (49)     | In-113M             |                    | $1 \times 10^{-2}$ |
|                 | In-114M             |                    | $2 \times 10^{-4}$ |
| Iodine (53)     | I-126               | $3 \times 10^{-9}$ | $2 \times 10^{-5}$ |
|                 | I-131               | $3 \times 10^{-9}$ | $2 \times 10^{-5}$ |
|                 | I-132               | $8 \times 10^{-8}$ | $6 \times 10^{-4}$ |
|                 | I-133               | $1 \times 10^{-8}$ | $7 \times 10^{-5}$ |

|                 |         |                    |                    |
|-----------------|---------|--------------------|--------------------|
|                 | I-134   | $2 \times 10^{-7}$ | $1 \times 10^{-3}$ |
| Iridium (77)    | Ir-190  |                    | $2 \times 10^{-3}$ |
|                 | Ir-192  |                    | $4 \times 10^{-4}$ |
|                 | Ir-194  |                    | $3 \times 10^{-4}$ |
| Iron (26)       | Fe-55   |                    | $8 \times 10^{-3}$ |
|                 | Fe-59   |                    | $6 \times 10^{-4}$ |
| Krypton (36)    | Kr-85M  | $1 \times 10^{-6}$ |                    |
|                 | Kr-85   | $3 \times 10^{-6}$ |                    |
| Lanthanum (57)  | La-140  |                    | $2 \times 10^{-4}$ |
| Lead (82)       | Pb-203  |                    | $4 \times 10^{-3}$ |
| Lutetium (71)   | Lu-177  |                    | $1 \times 10^{-3}$ |
| Manganese (25)  | Mn-52   |                    | $3 \times 10^{-4}$ |
|                 | Mn-54   |                    | $1 \times 10^{-3}$ |
|                 | Mn-56   |                    | $1 \times 10^{-3}$ |
| Mercury (80)    | Hg-197M |                    | $2 \times 10^{-3}$ |
|                 | Hg-197  |                    | $3 \times 10^{-3}$ |
|                 | Hg-203  |                    | $2 \times 10^{-4}$ |
| Molybdenum (42) | Mo-99   |                    | $2 \times 10^{-3}$ |
| Neodymium (60)  | Nd-147  |                    | $6 \times 10^{-4}$ |

|                          |         |  |                    |
|--------------------------|---------|--|--------------------|
|                          | Nd-149  |  | $3 \times 10^{-3}$ |
| Nickel (28)              | Ni-65   |  | $1 \times 10^{-3}$ |
| Niobium (Columbium) (41) | Nb-95   |  | $1 \times 10^{-3}$ |
|                          | Nb-97   |  | $9 \times 10^{-3}$ |
| Osmium (76)              | Os-185  |  | $7 \times 10^{-4}$ |
|                          | Os-191M |  | $3 \times 10^{-2}$ |
|                          | Os-191  |  | $2 \times 10^{-3}$ |
|                          | Os-193  |  | $6 \times 10^{-4}$ |
| Palladium (46)           | Pd-103  |  | $3 \times 10^{-3}$ |
|                          | Pd-109  |  | $9 \times 10^{-4}$ |
| Phosphorus (15)          | P-32    |  | $2 \times 10^{-4}$ |
| Platinum (78)            | Pt-191  |  | $1 \times 10^{-3}$ |
|                          | Pt-193M |  | $1 \times 10^{-2}$ |
|                          | Pt-197M |  | $1 \times 10^{-2}$ |
|                          | Pt-197  |  | $1 \times 10^{-3}$ |
| Potassium (19)           | K-42    |  | $3 \times 10^{-3}$ |
| Praseodymium (59)        | Pr-142  |  | $3 \times 10^{-4}$ |
|                          | Pr-143  |  | $5 \times 10^{-4}$ |
| Promethium (61)          | Pm-147  |  | $2 \times 10^{-3}$ |
|                          | Pm-149  |  | $4 \times 10^{-4}$ |

|                |         |  |                    |
|----------------|---------|--|--------------------|
| Rhenium (75)   | Re-183  |  | $6 \times 10^{-3}$ |
|                | Re-186  |  | $9 \times 10^{-4}$ |
|                | Re-188  |  | $6 \times 10^{-4}$ |
| Rhodium (45)   | Rh-103M |  | $1 \times 10^{-1}$ |
|                | Rh-105  |  | $1 \times 10^{-3}$ |
| Rubidium (37)  | Rb-86   |  | $7 \times 10^{-4}$ |
| Ruthenium (44) | Ru-97   |  | $4 \times 10^{-4}$ |
|                | Ru-103  |  | $8 \times 10^{-4}$ |
|                | Ru-105  |  | $1 \times 10^{-3}$ |
|                | Ru-106  |  | $1 \times 10^{-4}$ |
| Samarium (62)  | Sm-153  |  | $8 \times 10^{-4}$ |
| Scandium (21)  | Sc-46   |  | $4 \times 10^{-4}$ |
|                | Sc-47   |  | $9 \times 10^{-4}$ |
|                | Sc-48   |  | $3 \times 10^{-4}$ |
| Selenium (34)  | Se-75   |  | $3 \times 10^{-3}$ |
| Silicon (14)   | Si-31   |  | $9 \times 10^{-3}$ |
| Silver (47)    | Ag-105  |  | $1 \times 10^{-3}$ |
|                | Ag-110M |  | $3 \times 10^{-4}$ |
|                | Ag-111  |  | $4 \times 10^{-4}$ |



|                 |         |                    |                    |
|-----------------|---------|--------------------|--------------------|
| Sodium (11)     | Na-24   |                    | $2 \times 10^{-3}$ |
| Strontium (38)  | Sr-85   |                    | $1 \times 10^{-4}$ |
|                 | Sr-89   |                    | $1 \times 10^{-4}$ |
|                 | Sr-91   |                    | $7 \times 10^{-4}$ |
|                 | Sr-92   |                    | $7 \times 10^{-4}$ |
| Sulfur (16)     | S-35    | $9 \times 10^{-8}$ | $6 \times 10^{-4}$ |
| Tantalum (73)   | Ta-182  |                    | $4 \times 10^{-4}$ |
| Technetium (43) | Tc-96M  |                    | $1 \times 10^{-1}$ |
|                 | Tc-96   |                    | $1 \times 10^{-3}$ |
| Tellurium (52)  | Te-125M |                    | $2 \times 10^{-3}$ |
|                 | Te-125M |                    | $6 \times 10^{-4}$ |
|                 | Te-127  |                    | $3 \times 10^{-3}$ |
|                 | Te-129M |                    | $3 \times 10^{-4}$ |
|                 | Te-131M |                    | $6 \times 10^{-4}$ |
|                 | Te-132  |                    | $3 \times 10^{-4}$ |
| Terbium (65)    | Tb-160  |                    | $4 \times 10^{-4}$ |
| Thallium (81)   | Tl-200  |                    | $4 \times 10^{-3}$ |
|                 | Tl-201  |                    | $3 \times 10^{-3}$ |
|                 | Tl-202  |                    | $1 \times 10^{-3}$ |
|                 | Tl-204  |                    | $1 \times 10^{-3}$ |

|                         |         |                    |                    |
|-------------------------|---------|--------------------|--------------------|
| Thulium (69)            | Tm-170  |                    | $5 \times 10^{-4}$ |
|                         | Tm-171  |                    | $5 \times 10^{-3}$ |
| Tin (50)                | Sn-113  |                    | $9 \times 10^{-4}$ |
|                         | Sn-125  |                    | $2 \times 10^{-4}$ |
| Tungsten (Wolfram) (74) | W-181   |                    | $4 \times 10^{-3}$ |
|                         | W-187   |                    | $7 \times 10^{-4}$ |
| Vanadium (23)           | V-48    |                    | $3 \times 10^{-4}$ |
| Xenon (54)              | Xe-131M | $4 \times 10^{-6}$ |                    |
|                         | Xe-133  | $3 \times 10^{-6}$ |                    |
|                         | Xe-135  | $1 \times 10^{-6}$ |                    |
| Ytterbium (70)          | Yb-175  |                    | $1 \times 10^{-3}$ |
| Yttrium (39)            | Y-90    |                    | $2 \times 10^{-4}$ |
|                         | Y-91M   |                    | $3 \times 10^{-2}$ |
|                         | Y-91    |                    | $3 \times 10^{-4}$ |
|                         | Y-92    |                    | $6 \times 10^{-4}$ |
|                         | Y-93    |                    | $3 \times 10^{-4}$ |
| Zinc (30)               | Zn-65   |                    | $1 \times 10^{-3}$ |
|                         | Zn-69M  |                    | $7 \times 10^{-4}$ |
|                         | Zn-69   |                    | $2 \times 10^{-2}$ |

|                                                                                                                                         |       |                     |                    |
|-----------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------|--------------------|
| Zirconium (40)                                                                                                                          | Zr-95 |                     | $6 \times 10^{-4}$ |
|                                                                                                                                         | Zr-97 |                     | $2 \times 10^{-4}$ |
| Beta and/or gamma emitting radioactive material not listed above with half-life less than three years                                   |       | $1 \times 10^{-10}$ | $1 \times 10^{-6}$ |
| Footnotes:<br><br><sup>1</sup> Values are given only for those materials normally used as gases.<br><br><sup>2</sup> μCi/gm for solids. |       |                     |                    |

NOTE 1: Many radioisotopes disintegrate into isotopes that are also radioactive. In expressing the concentrations, the activity stated is that of the parent isotope and takes into account the daughters.

NOTE 2: For purposes of 12VAC5-481-400 A where there is involved a combination of isotopes, the limit for the combination should be derived as follows:

Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (i.e., unity).

Example:

$$\frac{\text{Concentration of Isotope A in product}}{\text{Exempt concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in product}}{\text{Exempt concentration of Isotope B}} \leq 1$$

#### Statutory Authority

§ 32.1-229 of the Code of Virginia.

#### Historical Notes

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008.

#### 12VAC5-481-3730. Exempt quantities.

|                       |             |
|-----------------------|-------------|
| Radioactive material  | Microcuries |
| Antimony 122 (Sb 122) | 100         |
|                       |             |

|                        |     |
|------------------------|-----|
| Antimony 124 (Sb 124)  | 10  |
| Antimony 125 (Sb 125)  | 10  |
| Arsenic 73 (As 73)     | 100 |
| Arsenic 74 (As 74)     | 10  |
| Arsenic 76 (As 76)     | 10  |
| Arsenic 77 (as 77)     | 100 |
| Barium 131 (Ba 131)    | 10  |
| Barium 133 (Ba 133)    | 10  |
| Barium 140 (Ba 140)    | 10  |
| Bismuth 210 (Bi 210)   | 1   |
| Bromine 82 (Br 82)     | 10  |
| Cadmium109 (Cd 109)    | 10  |
| Cadmium 115m (Cd 115m) | 10  |
| Cadmium115 (Cd 115)    | 100 |
| Calcium 45 (Ca 45)     | 10  |
| Calcium 47 (Ca 47)     | 10  |
| Carbon 14 (C 14)       | 100 |
| Cerium 141 (Ce 141)    | 100 |
| Cerium 143 (Ce 143)    | 100 |
| Cerium 144 (Ce 144)    | 1   |

|                         |       |
|-------------------------|-------|
| Cesium 129 (Cs 129)     | 100   |
| Cesium 131 (Cs 131)     | 1,000 |
| Cesium 134m (Cs 134m)   | 100   |
| Cesium 134 (Cs 134)     | 1     |
| Cesium 135 (Cs 135)     | 10    |
| Cesium 136 (Cs 136)     | 10    |
| Cesium 137 (Cs 137)     | 10    |
| Chlorine 36 (Cl 36)     | 10    |
| Chlorine 38 (Cl 38)     | 10    |
| Chromium 51 (Cr 51)     | 1,000 |
| Cobalt 57 (Co 57)       | 100   |
| Cobalt 58m (Co 58m)     | 10    |
| Cobalt 58 (Co 58)       | 10    |
| Cobalt 60 (Co 60)       | 1     |
| Copper 64 (Cu 64)       | 100   |
| Dysprosium 165 (Dy 165) | 10    |
| Dysprosium 166(Dy 166)  | 100   |
| Erbium 169 (Er 169)     | 100   |
| Erbium 171 (Er 171)     | 100   |
|                         |       |

|                                   |       |
|-----------------------------------|-------|
| Europium 152 9.2 h (Eu 152 9.2 h) | 100   |
| Europium 152 13 yr (Eu 152 13 yr) | 1     |
| Europium 154 (Eu 154)             | 1     |
| Europium 155(Eu 155)              | 10    |
| Fluorine 18 (F 18)                | 1,000 |
| Gadolinium 153 (Gd 153)           | 10    |
| Gadolinium 159 (Gd 159)           | 100   |
| Gallium 67 (Ga 67)                | 100   |
| Gallium 72 (Ga 72)                | 10    |
| Germanium 68 (Ge 68)              | 10    |
| Germanium 71 (Ga 71)              | 100   |
| Gold 195 (Au 195)                 | 10    |
| Gold 198 (Au 198)                 | 100   |
| Gold 199 (Au 199)                 | 100   |
| Hafnium 181 (Hf 181)              | 10    |
| Holmium 166 (Ho 166)              | 100   |
| Hydrogen 3 (H3)                   | 1,000 |
| Indium 111 (In 111)               | 100   |
| Indium 113m (In 113m)             | 100   |
| Indium 114m(In 114m)              | 10    |

|                        |     |
|------------------------|-----|
| Indium 115m(In 115m)   | 100 |
| Indium 115 (In 115)    | 10  |
| Iodine 123 (I 123)     | 100 |
| Iodine 125 (I 125)     | 1   |
| Iodine 126 (I 126)     | 1   |
| Iodine 129 (I 129)     | 0,1 |
| Iodine 131 (I 131)     | 1   |
| Iodine 132 (I 132)     | 10  |
| Iodine 133 (I 133)     | 1   |
| Iodine 134 (I 134)     | 10  |
| Iodine 135 (I 135)     | 10  |
| Iridium 192 (Ir 192)   | 10  |
| Iridium 194 (Ir 194)   | 100 |
| Iron 52 (Fe 52)        | 10  |
| Iron 55 (Fe 55)        | 100 |
| Iron 59 (Fe 59)        | 10  |
| Krypton 85 (Kr 85)     | 100 |
| Krypton 87 (Kr 87)     | 10  |
| Lanthanum 140 (La 140) | 10  |
|                        |     |

|                        |     |
|------------------------|-----|
| Lutetium 177 (Lu 177)  | 100 |
| Manganese 52 (Mn 52)   | 10  |
| Manganese 54 (Mn 54)   | 10  |
| Manganese 56 (Mn 56)   | 10  |
| Mercury 197m (Hg 197m) | 100 |
| Mercury 197 (Hg 197)   | 100 |
| Mercury 203 (Hg 203)   | 10  |
| Molybdenum 99 (Mo 99)  | 100 |
| Neodymium 147 (Nd 147) | 100 |
| Neodymium 149 (Nd 149) | 100 |
| Nickel 59 (Ni 59)      | 100 |
| Nickel 63 (Ni 63)      | 10  |
| Nickel 65 (Ni 65)      | 100 |
| Niobium 93m (Nb 93m)   | 10  |
| Niobium 95 (Nb 95)`    | 10  |
| Niobium 97 (Nb 97)     | 10  |
| Osmium 185 (Os 185)    | 10  |
| Osmium 191m (Os 191)   | 100 |
| Osmium 191 (Os 191)    | 100 |
| Osmium 193 (Os 193)    | 100 |



|                           |     |
|---------------------------|-----|
| Palladium 103 (Pd 103)    | 100 |
| Palladium 109(Pd 109)     | 100 |
| Phosphorus 32 (P 32)      | 10  |
| Platinum 191 (Pt 191)     | 100 |
| Platinum 193m(Pt 193m)    | 100 |
| Platinum 193 (Pt 193)     | 100 |
| Platinum 197m(Pt 197m)    | 100 |
| Platinum 197 (Pt 197)     | 100 |
| Polonium 210 (Po 210)     | 0.1 |
| Potassium 42 (K 42)       | 10  |
| Potassium 43 (K 43)       | 10  |
| Praseodymium 142 (Pr 142) | 100 |
| Praseodymium 143 (Pr 143) | 100 |
| Promethium 147 (Pm 147)   | 10  |
| Promethium 149 (Pm 149)   | 10  |
| Rhenium 186 (Re 186)      | 100 |
| Rhenium 188 (Re 188)      | 100 |
| Rhodium 103m (Rh 103m)    | 100 |
| Rhodium 105 (Rh 105)      | 100 |
|                           |     |

|                        |     |
|------------------------|-----|
| Rubidium 81 (Rb81)     | 10  |
| Rubidium 86 (R86)      | 10  |
| Rubidium 87 (Rb87)     | 10  |
| Ruthenium 97 (Ru 97)   | 100 |
| Ruthenium 103 (Ru 103) | 10  |
| Ruthenium 105(Ru 105)  | 10  |
| Ruthenium 106(Ru 106)  | 1   |
| Samarium 151(Sm 151)   | 10  |
| Samarium 153(Sm 153)   | 100 |
| Scandium 46 (Sc 46)    | 10  |
| Scandium 47 (Sc 47)    | 100 |
| Scandium 48 (Sc 48)    | 10  |
| Selenium 75 (Se 75)    | 10  |
| Silicon 31 (Si 31)     | 100 |
| Silver 105 (Ag 105)    | 10  |
| Silver 110m (Ag 110m)  | 1   |
| Silver 111 (Ag 111)    | 100 |
| Sodium 22 (Na 22)      | 10  |
| Sodium 24 (Na 24)      | 10  |
| Strontium 85 (Sr 85)   | 10  |

|                            |     |
|----------------------------|-----|
| Strontium 89 (Sr 89)       | 1   |
| Strontium 90 (Sr 90)       | 0.1 |
| Strontium 91 (Sr 91)       | 10  |
| Strontium 92 (Sr 92)       | 10  |
| Sulphur 35 (S 35)          | 100 |
| Tantalum 182 (Ta 182)      | 10  |
| Technetium 96 (Tc 96)      | 10  |
| Technetium 97m (Tc 97m)    | 100 |
| Technetium 97 (Tc 97)      | 100 |
| Technetium 99m (Tc 99m)    | 100 |
| Technetium 99 (Tc 99)      | 10  |
| Tellurium 125 m (Te 125 m) | 10  |
| Tellurium 127m (Te 127m)   | 10  |
| Tellurium 127 (Te 127)     | 100 |
| Tellurium 129m (Te 129m)   | 10  |
| Tellurium 129 (Te 129)     | 100 |
| Tellurium 131m (Te 131m)   | 10  |
| Tellurium 132 (Te 132)     | 10  |
| Terbium 160 (Tb 160)       | 10  |
|                            |     |

|                        |       |
|------------------------|-------|
| Thallium 200 (Tl 200)  | 100   |
| Thallium 201 (Tl 201)  | 100   |
| Thallium 202 (Tl 202)  | 100   |
| Thallium 204 (Tl 204)  | 10    |
| Thulium 170 (Tm 170)   | 10    |
| Thulium 171 (Tm 171)   | 10    |
| Tin 113 (Sn 113)       | 10    |
| Tin 125 (Sn 125)       | 10    |
| Tungsten 181 (W 181)   | 10    |
| Tungsten 185 (W 185)   | 10    |
| Tungsten 187 (W 187)   | 100   |
| Vanadium 48 (V 48)     | 10    |
| Xenon 131m (Xe 131m)   | 1,000 |
| Xenon 133 (Xe 133)     | 100   |
| Xenon 135 (Xe 135)     | 100   |
| Ytterbium 175 (Yb 175) | 100   |
| Yttrium 87 (Y 87)      | 10    |
| Yttrium 88 (Y 88)      | 10    |
| Yttrium 90 (Y 90)      | 10    |
| Yttrium 91 (Y91)       | 10    |

|                                                                                              |       |
|----------------------------------------------------------------------------------------------|-------|
| Yttrium 92 (Y92)                                                                             | 100   |
| Yttrium 93 (Y93)                                                                             | 100   |
| Zinc 65 (Zn 65)                                                                              | 10    |
| Zinc 69m (Zn 69m)                                                                            | 100   |
| Zinc 69 (Zn 69)                                                                              | 1,000 |
| Zirconium 93 (Zr 93)                                                                         | 10    |
| Zirconium 95 (Zr 95)                                                                         | 10    |
| Zirconium 97 (Zr 97)                                                                         | 10    |
| Any radioactive material not listed above<br>other than alpha emitting radioactive materials | 0.1   |

**Statutory Authority**

§ 32.1-229 of the Code of Virginia.

**Historical Notes**

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008.

**12VAC5-481-3740. Quantities of radioactive materials requiring consideration of the need for an emergency plan for responding to a release.**

| Radioactive material <sup>1</sup> | Release fraction | Quantity (curies) |
|-----------------------------------|------------------|-------------------|
| Actinium-228                      | 0.001            | 4,000             |
| Americium-241                     | .001             | 2                 |
| Americium-242                     | .001             | 2                 |
| Americium-243                     | .001             | 2                 |
| Antimony-124                      | .01              | 4,000             |
|                                   |                  |                   |

|                                |      |           |
|--------------------------------|------|-----------|
| Antimony-126                   | .01  | 6,000     |
| Barium-133                     | .01  | 10,000    |
| Barium-140                     | .01  | 30,000    |
| Bismuth-207                    | .01  | 5,000     |
| Bismuth-210                    | .01  | 600       |
| Cadmium-109                    | .01  | 1,000     |
| Cadmium-113                    | .01  | 80        |
| Calcium-45                     | .01  | 20,000    |
| Californium-252                | .001 | g (20 mg) |
| Carbon-14 (non-carbon dioxide) | .01  | 50,000    |
| Cerium-141                     | .01  | 10,000    |
| Cerium-144                     | .01  | 300       |
| Cesium-134                     | .01  | 2,000     |
| Cesium-137                     | .01  | 3,000     |
| Chlorine-36                    | .5   | 100       |
| Chromium-51                    | .01  | 300,000   |
| Cobalt-60                      | .001 | 5,000     |
| Copper-64                      | .01  | 200,000   |
| Curium-242                     | .001 | 60        |
| Curium-243                     | .001 | 3         |

|                |      |           |
|----------------|------|-----------|
| Curium-244     | .001 | 4         |
| Curium-245     | .001 | 2         |
| Europium-152   | .01  | 500       |
| Europium-154   | .01  | 400       |
| Europium-155   | .01  | 3,000     |
| Germanium-68   | .01  | 2,000     |
| Gadolinium-153 | .01  | 5,000     |
| Gold-198       | .01  | 30,000    |
| Hafnium-172    | .01  | 400       |
| Hafnium-181    | .01  | 7,000     |
| Holmium-166m   | .01  | 100       |
| Hydrogen-3     | .5   | 20,000    |
| Iodine-125     | .5   | 10        |
| Iodine-131     | .5   | 10        |
| Indium-114m    | .01  | 1,000     |
| Iridium-192    | .001 | 40,000    |
| Iron-55        | .01  | 40,000    |
| Iron-59        | .01  | 7,000     |
| Krypton-85     | 1.0  | 6,000,000 |
|                |      |           |

|                |      |        |
|----------------|------|--------|
| Lead-210       | .01  | 8      |
| Manganese-56   | .01  | 60,000 |
| Mercury-203    | .01  | 10,000 |
| Molybdenum-99  | .01  | 30,000 |
| Neptunium-237  | .001 | 2      |
| Nickel-63      | .01  | 20,000 |
| Niobium-94     | .01  | 300    |
| Phosphorus-32  | .5   | 100    |
| Phosphorus-33  | .5   | 1,000  |
| Polonium-210   | .01  | 10     |
| Potassium-42   | .01  | 9,000  |
| Promethium-145 | .01  | 4,000  |
| Promethium-147 | .01  | 4,000  |
| Radium-226     | .001 | 100    |
| Ruthenium-106  | .01  | 200    |
| Samarium-151   | .01  | 4,000  |
| Scandium-46    | .01  | 3,000  |
| Selenium-75    | .01  | 10,000 |
| Silver-110m    | .01  | 1,000  |
| Sodium-22      | .01  | 9,000  |



|                |     |         |
|----------------|-----|---------|
| Sodium-24      | .01 | 10,000  |
| Strontium-89   | .01 | 3,000   |
| Strontium-90   | .01 | 90      |
| Sulfur-35      | .5  | 900     |
| Technitium-99  | .01 | 10,000  |
| Technitium-99m | .01 | 400,000 |
| Tellurium-127m | .01 | 5,000   |
| Tellurium-129m | .01 | 5,000   |
| Terbium-160    | .01 | 4,000   |
| Thulium-170    | .01 | 4,000   |
| Tin-113        | .01 | 10,000  |
| Tin-123        | .01 | 3,000   |
| Tin-126        | .01 | 1,000   |
| Titanium-44    | .01 | 100     |
| Vanadium-48    | .01 | 7,000   |
| Xenon-133      | 1.0 | 900,000 |
| Yttrium-91     | .01 | 2,000   |
| Zinc-65        | .01 | 5,000   |
| Zirconium-93   | .01 | 400     |
|                |     |         |

|                                                                 |       |        |
|-----------------------------------------------------------------|-------|--------|
| Zirconium-95                                                    | .01   | 5,000  |
| Any other beta-gamma emitter                                    | .01   | 10,000 |
| Mixed fission products                                          | .01   | 1,000  |
| Mixed corrosion products                                        | .01   | 10,000 |
| Contaminated equipment beta-gamma                               | .001  | 10,000 |
| Irradiated material, any form other than solid noncombustible   | .01   | 1,000  |
| Irradiated material, solid noncombustible                       | .001  | 10,000 |
| Mixed radioactive waste, beta-gamma                             | .01   | 1,000  |
| Packaged mixed waste, beta-gamma <sup>2</sup>                   | .001  | 10,000 |
| Any other alpha emitter                                         | .001  | 2      |
| Contaminated equipment, alpha                                   | .0001 | 20     |
| Packaged waste, alpha <sup>2</sup>                              | .0001 | 20     |
| Combinations of radioactive materials listed above <sup>1</sup> |       |        |

<sup>1</sup>For combinations of radioactive materials, consideration of the need for an emergency plan is required if the sum of the ratios of the quantity of each radioactive material authorized to the quantity listed for that material in this section exceeds one.

<sup>2</sup>Waste packaged in Type B containers does not require an emergency plan.

#### Statutory Authority

§ 32.1-229 of the Code of Virginia.

#### Historical Notes

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008.

**12VAC5-481-3750. Quantities for use with decommissioning.**

| Materials     | Microcuries |
|---------------|-------------|
| Americium-241 | .01         |
| Antimony-122  | 100         |
| Antimony-124  | 10          |
| Antimony-125  | 10          |
| Arsenic-73    | 100         |
| Arsenic-74    | 10          |
| Arsenic-76    | 10          |
| Arsenic-77    | 100         |
| Barium-131    | 10          |
| Barium-133    | 10          |
| Barium-140    | 10          |
| Bismuth-210   | 1           |
| Bromine-82    | 10          |
| Cadmium-109   | 10          |
| Cadmium-115m  | 10          |
| Cadmium-115   | 100         |
| Calcium-45    | 10          |
| Calcium-47    | 10          |
|               |             |

|             |       |
|-------------|-------|
| Carbon-14   | 100   |
| Cerium-141  | 100   |
| Cerium-143  | 100   |
| Cerium-144  | 1     |
| Cesium-131  | 1,000 |
| Cesium-134m | 100   |
| Cesium-134  | 1     |
| Cesium-135  | 10    |
| Cesium-136  | 10    |
| Cesium-137  | 10    |
| Chlorine-36 | 10    |
| Chlorine-38 | 10    |
| Chromium-51 | 1,000 |
| Cobalt-55   | 100   |
| Cobalt-56   | 10    |
| Cobalt-57   | 100   |
| Cobalt-58m  | 10    |
| Cobalt-58   | 10    |
| Cobalt-60   | 1     |
| Copper-64   | 100   |

|                    |       |
|--------------------|-------|
| Dysprosium-165     | 10    |
| Dysprosium-166     | 100   |
| Erbium-169         | 100   |
| Erbium-171         | 100   |
| Europium-152 9.2h  | 100   |
| Europium-152 13 yr | 1     |
| Europium-154       | 1     |
| Europium-155       | 10    |
| Fluorine-18        | 1,000 |
| Gadolinium-153     | 10    |
| Gadolinium-159     | 100   |
| Gallium-72         | 10    |
| Germanium-71       | 100   |
| Gold-198           | 100   |
| Gold-199           | 100   |
| Hafnium-181        | 10    |
| Holmium-166        | 100   |
| Hydrogen-3         | 1,000 |
| Indium-113m        | 100   |
|                    |       |

|               |     |
|---------------|-----|
| Indium-114m   | 10  |
| Indium-115m   | 100 |
| Indium-115    | 10  |
| Iodine-125    | 1   |
| Iodine-126    | 1   |
| Iodine-129    | 0.1 |
| Iodine-131    | 1   |
| Iodine-132    | 10  |
| Iodine-133    | 1   |
| Iodine-134    | 10  |
| Iodine-135    | 10  |
| Iridium-192   | 10  |
| Iridium-194   | 100 |
| Iron-55       | 100 |
| Iron-59       | 10  |
| Krypton-85    | 100 |
| Krypton-87    | 10  |
| Lanthanum-140 | 10  |
| Lutetium-177  | 100 |
| Manganese-52  | 10  |

|               |     |
|---------------|-----|
| Manganese-54  | 10  |
| Manganese-56  | 10  |
| Mercury-197m  | 100 |
| Mercury-197   | 100 |
| Mercury-203   | 10  |
| Molbdenum-99  | 100 |
| Neodymium-147 | 100 |
| Neodymium-149 | 100 |
| Nickel-59     | 100 |
| Nickel-63     | 10  |
| Nickel-65     | 100 |
| Niobium-93m   | 10  |
| Niobium-95    | 10  |
| Niobium-97    | 10  |
| Osmium-185    | 10  |
| Osmium-191m   | 100 |
| Osmium-191    | 100 |
| Osmium-193    | 100 |
| Palladium-103 | 100 |
|               |     |

|                  |     |
|------------------|-----|
| Palladium-109    | 100 |
| Phosphorus-32    | 10  |
| Platinum-191     | 100 |
| Platinum-193m    | 100 |
| Platinum-193     | 100 |
| Platinum-197m    | 100 |
| Platinum-197     | 100 |
| Plutonium-239    | .01 |
| Polonium-210     | 0.1 |
| Potassium-42     | 10  |
| Praseodymium-142 | 100 |
| Praseodymium-143 | 100 |
| Promethium-147   | 10  |
| Promethium-149   | 10  |
| Radium-226       | .01 |
| Rhenium-186      | 100 |
| Rhenium-188      | 100 |
| Rhodium-103m     | 100 |
| Rhodium-105      | 100 |
| Rubidium-86      | 10  |



|               |     |
|---------------|-----|
| Rubidium-87   | 10  |
| Ruthenium-97  | 100 |
| Ruthenium-103 | 10  |
| Ruthenium-105 | 10  |
| Ruthenium-106 | 1   |
| Samarium-151  | 10  |
| Samarium-153  | 100 |
| Scandium-46   | 10  |
| Scandium-47   | 100 |
| Scandium-48   | 10  |
| Seleium-75    | 10  |
| Silicon-31    | 100 |
| Silver-105    | 10  |
| Silver-110m   | 1   |
| Silver-111    | 100 |
| Sodium-24     | 10  |
| Strontium-85  | 10  |
| Strontium-89  | 1   |
| Strontium-90  | 0.1 |
|               |     |

|                |     |
|----------------|-----|
| Strontium-91   | 10  |
| Strontium-92   | 10  |
| Sulphur-35     | 100 |
| Tantalum-182   | 10  |
| Technetium-96  | 10  |
| Technetium-97m | 100 |
| Technetium-97  | 100 |
| Technetium-99m | 100 |
| Technetium-99  | 10  |
| Tellurium-125m | 10  |
| Tellurium127m  | 10  |
| Tellurium-127  | 100 |
| Tellurium129m  | 10  |
| Tellurium-129  | 100 |
| Tellurium-131m | 10  |
| Tellurium-132  | 10  |
| Terbium-160    | 10  |
| Thallium-200   | 100 |
| Thallium-201   | 100 |
| Thallium-202   | 100 |

|                                |       |
|--------------------------------|-------|
| Thallium-204                   | 10    |
| Thorium (natural) <sup>1</sup> | 100   |
| Thulium-170                    | 10    |
| Thulium-171                    | 10    |
| Tin-113                        | 10    |
| Tin-125                        | 10    |
| Tungsten-181                   | 10    |
| Tungsten-185                   | 10    |
| Tungsten-187                   | 100   |
| Uranium (natural) <sup>2</sup> | 100   |
| Uranium-233                    | .01   |
| Uranium-234--Uranium-235       | .01   |
| Vandium-48                     | 10    |
| Xenon-131m                     | 1,000 |
| Xenon-133                      | 100   |
| Xenon-135                      | 100   |
| Ytterbium-175                  | 100   |
| Yttrium-90                     | 10    |
| Yttrium-91                     | 10    |

|                                                                                                                                                                                |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Yttrium-92                                                                                                                                                                     | 100   |
| Yttrium-93                                                                                                                                                                     | 100   |
| Zinc-65                                                                                                                                                                        | 10    |
| Zinc-69m                                                                                                                                                                       | 100   |
| Zinc-69                                                                                                                                                                        | 1,000 |
| Zirconium-93                                                                                                                                                                   | 10    |
| Zirconium-95                                                                                                                                                                   | 10    |
| Zirconium-97                                                                                                                                                                   | 10    |
| Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition                                                                          | .01   |
| Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition                                                 | .1    |
| <sup>1</sup> Based on alpha disintegration rate of Th-232, Th-230, and their daughter products.<br><sup>2</sup> Based on alpha disintegration rate of U-238, U-234, and U-235. |       |

Note: For purposes of 12VAC5-481-930, where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise

established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity").

#### Statutory Authority

§ 32.1-229 of the Code of Virginia.

#### Historical Notes

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008; amended, Virginia Register Volume 32, Issue 24, eff. August 25, 2016.

#### 12VAC5-481-3760. Limits for broad scopes.

| Radioactive material | Col. I curies | Col. II curies |
|----------------------|---------------|----------------|
| Antimony-122         | 1             | 0.01           |
| Antimony-124         | 1             | 0.01           |
| Antimony-125         | 1             | 0.01           |
| Arsenic-73           | 10            | 0.1            |
| Arsenic-74           | 1             | 0.01           |
| Arsenic-76           | 1             | 0.01           |
| Arsenic-77           | 10            | 0.1            |
| Barium-131           | 10            | 0.1            |
| Barium-140           | 1             | 0.01           |
| Beryllium-7          | 10            | 0.1            |
| Bismuth-210          | 0.1           | 0.001          |
| Bromine-82           | 10            | 0.1            |
| Cadmium-109          | 1             | 0.01           |
| Cadmium-115m         | 1             | 0.01           |
|                      |               |                |

|             |     |       |
|-------------|-----|-------|
| Cadmium-115 | 10  | 0.1   |
| Calcium-45  | 1   | 0.01  |
| Calcium-47  | 10  | 0.1   |
| Carbon-14   | 100 | 1     |
| Cerium-141  | 10  | 0.1   |
| Cerium-143  | 10  | 0.1   |
| Cerium-144  | 0.1 | 0.001 |
| Cesium-131  | 100 | 1     |
| Cesium-134m | 100 | 1     |
| Cesium-134  | 0.1 | 0.001 |
| Cesium-135  | 1   | 0.01  |
| Cesium-136  | 10  | 0.1   |
| Cesium-137  | 0.1 | 0.001 |
| Chlorine-36 | 1   | 0.01  |
| Chlorine-38 | 100 | 1     |
| Chromium-51 | 100 | 1     |
| Cobalt-57   | 10  | 0.1   |
| Cobalt-58m  | 100 | 1     |
| Cobalt-58   | 1   | 0.01  |
| Cobalt-60   | 0.1 | 0.001 |

|                    |     |       |
|--------------------|-----|-------|
| Copper-64          | 10  | 0.1   |
| Dysprosium-165     | 100 | 1     |
| Dysprosium-166     | 10  | 0.1   |
| Erbium-169         | 10  | 0.1   |
| Erbium-171         | 10  | 0.1   |
| Europium-152 9.2 h | 10  | 0.1   |
| Europium-152 13 y  | 0.1 | 0.001 |
| Europium-154       | 0.1 | 0.001 |
| Europium-155       | 1   | 0.01  |
| Fluorine-18        | 100 | 1     |
| Gadolinium-153     | 1   | 0.01  |
| Gadolinium-159     | 10  | 0.1   |
| Gallium-72         | 10  | 0.1   |
| Germanium-71       | 100 | 1     |
| Gold-198           | 10  | 0.1   |
| Gold-199           | 10  | 0.1   |
| Hafnium-181        | 1   | 0.01  |
| Holmium-166        | 10  | 0.1   |
| Hydrogen-3         | 100 | 1     |
|                    |     |       |

|               |     |       |
|---------------|-----|-------|
| Indium-113m   | 100 | 1     |
| Indium-114m   | 1   | 0.01  |
| Indium-115m   | 100 | 1     |
| Indium-115    | 1   | 0.01  |
| Iodine-125    | 0.1 | 0.001 |
| Iodine-126    | 0.1 | 0.001 |
| Iodine-129    | 0.1 | 0.001 |
| Iodine-131    | 0.1 | 0.001 |
| Iodine-132    | 10  | 0.1   |
| Iodine-133    | 1   | 0.01  |
| Iodine-134    | 10  | 0.1   |
| Iodine-135    | 1   | 0.01  |
| Iridium-192   | 1   | 0.01  |
| Iridium-194   | 10  | 0.1   |
| Iron-55       | 10  | 0.1   |
| Iron-59       | 1   | 0.01  |
| Krypton-85    | 100 | 1     |
| Krypton-87    | 10  | 0.1   |
| Lanthanum-140 | 1   | 0.01  |
| Lutetium-177  | 10  | 0.1   |



|               |     |      |
|---------------|-----|------|
| Manganese-52  | 1   | 0.01 |
| Manganese-54  | 1   | 0.01 |
| Manganese-56  | 10  | 0.1  |
| Mercury-197m  | 10  | 0.1  |
| Mercury-197   | 10  | 0.1  |
| Mercury-203   | 1   | 0.01 |
| Molybdenum-99 | 10  | 0.1  |
| Neodymium-147 | 10  | 0.1  |
| Neodymium-149 | 10  | 0.1  |
| Nickel-59     | 10  | 0.1  |
| Nickel-63     | 1   | 0.01 |
| Nickel-65     | 10  | 0.1  |
| Niobium-93m   | 1   | 0.01 |
| Niobium-95    | 1   | 0.01 |
| Niobium-97    | 100 | 1    |
| Osmium-185    | 1   | 0.01 |
| Osmium-191m   | 100 | 1    |
| Osmium-191    | 10  | 0.1  |
| Osmium-193    | 10  | 0.1  |
|               |     |      |

|                  |       |        |
|------------------|-------|--------|
| Palladium-103    | 10    | 0.1    |
| Palladium-109    | 10    | 0.1    |
| Phosphorus-32    | 1     | 0.01   |
| Platinum-191     | 10    | 0.1    |
| Platinum-193m    | 100   | 1      |
| Platinum-193     | 10    | 0.1    |
| Platinum-197m    | 100   | 1      |
| Platinum-197     | 100   | .1     |
| Polonium-210     | 0.01  | 0.0001 |
| Potassium-42     | 1     | 0.01   |
| Praseodymium-142 | 10    | 0.1    |
| Praseodymium-143 | 10    | 0.1    |
| Promethium-147   | 1     | 0.01   |
| Promethium-149   | 10    | 0.1    |
| Radium-226       | 0.01  | 0.0001 |
| Rhenium-186      | 10    | 0.1    |
| Rhenium-188      | 10    | 0.1    |
| Rhodium-103m     | 1,000 | 10     |
| Rhodium-105      | 10    | 0.1    |
| Rubidium-86      | 1     | 0.01   |

|               |       |       |
|---------------|-------|-------|
| Rubidium-87   | 1     | 0.01  |
| Ruthenium-97  | 100   | 1     |
| Ruthenium-103 | 1     | 0.01  |
| Ruthenium-105 | 10    | 0.1   |
| Ruthenium-106 | 0.1   | 0.001 |
| Samarium-151  | 1     | 0.01  |
| Samarium-153  | 10    | 0.1   |
| Scandium-46   | 1     | 0.01  |
| Scandium-47   | 10    | 0.1   |
| Scandium-48   | 1     | 0.01  |
| Selenium-75   | 1     | 0.01  |
| Silicon-31    | 10    | 0.1   |
| Silver-105    | 1     | 0.01  |
| Silver-110m   | 0.1   | 0.001 |
| Silver-111    | 10    | 0.1   |
| Sodium-22     | 0.1   | 0.001 |
| Sodium-24     | 1     | 0.01  |
| Strontium-85m | 1,000 | 10    |
| Strontium-85  | 1     | 0.01  |
|               |       |       |

|                |      |        |
|----------------|------|--------|
| Strontium-89   | 1    | 0.01   |
| Strontium-90   | 0.01 | 0.0001 |
| Strontium-91   | 10   | 0.1    |
| Strontium-92   | 10   | 0.1    |
| Sulphur-35     | 10   | 0.1    |
| Tantalum-182   | 1    | 0.01   |
| Technetium-96  | 10   | 0.1    |
| Technetium-97m | 10   | 0.1    |
| Technetium-97  | 10   | 0.1    |
| Technetium-99m | 100  | 1      |
| Technetium-99  | 1    | 0.01   |
| Tellurium-125m | 1    | 0.01   |
| Tellurium-127m | 1    | 0.01   |
| Tellurium-127  | 10   | 0.1    |
| Tellurium-129m | 1    | 0.01   |
| Tellurim-129   | 100  | 1      |
| Tellurium-131m | 10   | 0.1    |
| Tellurium-132  | 1    | 0.01   |
| Terbium-160    | 1    | 0.01   |
| Thallium-200   | 10   | 0.1    |

|               |       |      |
|---------------|-------|------|
| Thallium-201  | 10    | 0.1  |
| Thallium-202  | 10    | 0.1  |
| Thallium-204  | 1     | 0.01 |
| Thulium-170   | 1     | 0.01 |
| Thulium-171   | 1     | 0.01 |
| Tin-113       | 1     | 0.01 |
| Tin-125       | 1     | 0.01 |
| Tungsten-181  | 1     | 0.01 |
| Tungsten-185  | 1     | 0.01 |
| Tungsten-187  | 10    | 0.1  |
| Vandadium-48  | 1     | 0.01 |
| Xenon-131m    | 1,000 | 10   |
| Xenon-133     | 100   | 1    |
| Xenon-135     | 100   | 1    |
| Ytterbium-175 | 10    | 0.1  |
| Yttrium-90    | 1     | 0.01 |
| Yttrium-91    | 1     | 0.01 |
| Yttrium-92    | 10    | 0.1  |
| Yttrium-93    | 1     | 0.01 |
|               |       |      |

|                                                                                          |     |       |
|------------------------------------------------------------------------------------------|-----|-------|
| Zinc-65                                                                                  | 1   | 0.01  |
| Zinc-69m                                                                                 | 10  | 0.1   |
| Zinc-69                                                                                  | 100 | 1     |
| Zirconium-93                                                                             | 1   | 0.01  |
| Zirconium-95                                                                             | 1   | 0.01  |
| Zirconium-97                                                                             | 1   | 0.01  |
| Any radioactive material other than alpha emitting radioactive material not listed above | 0.1 | 0.001 |

**Statutory Authority**

§ 32.1-229 of the Code of Virginia.

**Historical Notes**

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008.

**12VAC5-481-3770. Determination of A<sub>1</sub> and A<sub>2</sub>.**

A. Values of A<sub>1</sub> and A<sub>2</sub> for individual radionuclides, which are the bases for many activity limits elsewhere in these regulations, are given in Table 1 of this section. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) value. The terabecquerel values are the regulatory standard. The curie values are for information only and are not intended to be the regulatory standard. Where values of A<sub>1</sub> and A<sub>2</sub> are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

B. For individual radionuclides whose identities are known, but that are not listed in Table 1 or Table 2 of this section, the A<sub>1</sub> and A<sub>2</sub> values or exempt material activity concentration and exempt consignment activity values contained in Table 3 of this section may be used. Otherwise, the licensee shall obtain prior agency approval for radionuclides not listed in Table 1 or Table 2 of this section, before shipping the material. The licensee shall submit requests for prior approval to the agency.

C. In the calculations of A<sub>1</sub> and A<sub>2</sub> for a radionuclide not in Table 1 of this section, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter radionuclide has a half-life either longer than 10 days, or longer than that of the parent radionuclide, shall be considered as a single radionuclide, and the activity to be taken into account, and the A<sub>1</sub> or A<sub>2</sub> value to be applied, shall be those corresponding to the parent radionuclide of that chain. In the case of radioactive decay chains in which any daughter radionuclide has a half-life either longer than 10 days or greater than that of the parent radionuclide, the parent and those daughter radionuclides shall be considered as mixtures of different radionuclides.

D. For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:

1. For special form radioactive material, the maximum quantity transported in a Type A package is as follows:

$$\sum_i \frac{B(i)}{A_1(i)} \leq 1$$

where B(i) is the activity of radionuclide (i) in special form, and A<sub>1</sub>(i) is the A<sub>1</sub> value for radionuclide (i).

2. For normal form radioactive material, the maximum quantity transported in a Type A package is as follows:

$$\sum B(i)/A_2(i) \leq 1$$

where B(i) is the activity of radionuclide (i) in normal form, and A<sub>2</sub>(i) is the A<sub>2</sub> value for radionuclide (i).

3. If the package contains both special and normal form radioactive material, the activity that may be transported in the Type A package is as follows:

$$\sum B(i)/A_1(i) + \sum C(j)/A_2(j) \leq 1$$

Where B(i) is the activity of radionuclide i (i) as special form radioactive material, A<sub>1</sub>(i) is the A<sub>1</sub> value for the radionuclide (i), C(j) is the activity of radionuclide (j) as normal form radioactive material, and A<sub>2</sub>(j) is the A<sub>2</sub> value for radionuclide (j).

4. Alternatively, the A<sub>1</sub> value for mixtures of special form material may be determined as follows:

$$A_1 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

where f(i) is the fraction of activity for radionuclide (i) in the mixture, and A<sub>1</sub>(i) is the appropriate A<sub>1</sub> value for radionuclide (i).

5. Alternatively, the A<sub>2</sub> value for mixtures of normal form material may be determined as follows:

$$A_2 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

where f(i) is the fraction of activity for radionuclide (i) in the mixture, and A<sub>2</sub>(i) is the appropriate A<sub>2</sub> value for radionuclide (i).

6. The exempt activity concentration for mixtures of nuclides may be determined as follows:

$$\text{Exempt activity concentration for mixture} = \frac{1}{\sum_i \frac{f(i)}{[A](i)}}$$

where  $f(i)$  is the fraction of activity concentration of radionuclide (i) in the mixture, and  $[A](i)$  is the activity concentration for exempt material containing radionuclide (i).

7. The activity limit for an exempt consignment for mixtures of radionuclides may be determined as follows:

$$\text{Exempt consignment activity limit for mixture} = \frac{1}{\sum_i \frac{f(i)}{A(i)}}$$

where  $f(i)$  is the fraction of activity of radionuclide (i) in the mixture, and  $[A](i)$  is the activity limit for exempt consignments for radionuclide (i).

E. When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped, and the lowest  $A_1$  or  $A_2$  value or lowest  $[A]$  (activity concentration for exempt material or  $A$  (activity limit for exempt consignment) value, as appropriate, for the radionuclides in each group may be used in applying the formulas in subsection D of this section. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest  $A_1$  or  $A_2$  values or the lowest  $[A]$  or  $A$  value, as appropriate, for the alpha emitters and beta/gamma emitters.

F. Table 1.  $A_1$  and  $A_2$  Values for Radionuclides.

| Symbol of radionuclide | Element and atomic number | $A_1$ (TBq)          | $A_1$ (Ci) <sup>b</sup> | $A_2$ (TBq)          | $A_2$ (Ci) <sup>b</sup> | Specific activity    |                      |
|------------------------|---------------------------|----------------------|-------------------------|----------------------|-------------------------|----------------------|----------------------|
|                        |                           |                      |                         |                      |                         | (TBq/g)              | (Ci/g)               |
| Ac-225 (a)             | Actinium (89)             | $8.0 \times 10^{-1}$ | $2.2 \times 10^{-1}$    | $6.0 \times 10^{-3}$ | $1.6 \times 10^{-1}$    | $2.1 \times 10^3$    | $5.8 \times 10^4$    |
| Ac-227 (a)             |                           | $9.0 \times 10^{-1}$ | $2.4 \times 10^1$       | $9.0 \times 10^{-5}$ | $2.4 \times 10^{-3}$    | 2.7                  | $7.2 \times 10^1$    |
| Ac-228                 |                           | $6.0 \times 10^{-1}$ | $1.6 \times 10^1$       | $5.0 \times 10^{-1}$ | $1.4 \times 10^1$       | $8.4 \times 10^4$    | $2.2 \times 10^6$    |
| Ag-105                 | Silver (47)               | 2.0                  | $5.4 \times 10^1$       | 2.0                  | $5.4 \times 10^1$       | $1.1 \times 10^3$    | $3.0 \times 10^4$    |
| Ag-108m (a)            |                           | $7.0 \times 10^{-1}$ | $1.9 \times 10^1$       | $7.0 \times 10^{-1}$ | $1.9 \times 10^1$       | $9.7 \times 10^{-1}$ | $2.6 \times 10^1$    |
| Ag-110m (a)            |                           | $4.0 \times 10^{-1}$ | $1.1 \times 10^1$       | $4.0 \times 10^{-1}$ | $1.1 \times 10^1$       | $1.8 \times 10^2$    | $4.7 \times 10^3$    |
| Ag-111                 |                           | 2.0                  | $5.4 \times 10^1$       | $6.0 \times 10^{-1}$ | $1.6 \times 10^1$       | $5.8 \times 10^3$    | $1.6 \times 10^5$    |
| Al-26                  | Aluminum (13)             | $1.0 \times 10^{-1}$ | 2.7                     | $1.0 \times 10^{-1}$ | 2.7                     | $7.0 \times 10^{-4}$ | $1.9 \times 10^{-2}$ |
| Am-241                 | Americium (95)            | $1.0 \times 10^1$    | $2.7 \times 10^2$       | $1.0 \times 10^{-3}$ | $2.7 \times 10^{-2}$    | $1.3 \times 10^{-1}$ | 3.4                  |



|             |               |                      |                     |                      |                      |                      |                      |
|-------------|---------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Am-242m (a) |               | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 3.6X10 <sup>-1</sup> | 1.0X10 <sup>1</sup>  |
| Am-243 (a)  |               | 5.0                  | 1.4X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 7.4X10 <sup>-3</sup> | 2.0X10 <sup>-1</sup> |
| Ar-37       | Argon (18)    | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 3.7X10 <sup>3</sup>  | 9.9X10 <sup>4</sup>  |
| Ar-39       |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 1.3                  | 3.4X10 <sup>1</sup>  |
| Ar-41       |               | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 1.5X10 <sup>6</sup>  | 4.2X10 <sup>7</sup>  |
| As-72       | Arsenic (33)  | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 6.2X10 <sup>4</sup>  | 1.7X10 <sup>6</sup>  |
| As-73       |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 8.2X10 <sup>2</sup>  | 2.2X10 <sup>4</sup>  |
| As-74       |               | 1.0                  | 2.7X10 <sup>1</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup>  | 3.7X10 <sup>3</sup>  | 9.9X10 <sup>4</sup>  |
| As-76       |               | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 5.8X10 <sup>4</sup>  | 1.6X10 <sup>6</sup>  |
| As-77       |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 3.9X10 <sup>4</sup>  | 1.0X10 <sup>6</sup>  |
| At-211 (a)  | Astatine (85) | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 7.6X10 <sup>4</sup>  | 2.1X10 <sup>6</sup>  |
| Au-193      | Gold (79)     | 7.0                  | 1.9X10 <sup>2</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 3.4X10 <sup>4</sup>  | 9.2X10 <sup>5</sup>  |
| Au-194      |               | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 1.5X10 <sup>4</sup>  | 4.1X10 <sup>5</sup>  |
| Au-195      |               | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 6.0                  | 1.6X10 <sup>2</sup>  | 1.4X10 <sup>2</sup>  | 3.7X10 <sup>3</sup>  |
| Au-198      |               | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 9.0X10 <sup>3</sup>  | 2.4X10 <sup>5</sup>  |
| Au-199      |               | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 7.7X10 <sup>3</sup>  | 2.1X10 <sup>5</sup>  |
| Ba-131 (a)  | Barium (56)   | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 3.1X10 <sup>3</sup>  | 8.4X10 <sup>4</sup>  |
| Ba-133      |               | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 9.4                  | 2.6X10 <sup>2</sup>  |
| Ba-133m     |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.2X10 <sup>4</sup>  | 6.1X10 <sup>5</sup>  |

|             |                |                      |                     |                      |                      |                      |                      |
|-------------|----------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Ba-140 (a)  |                | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 3.0X10 <sup>-1</sup> | 8.1                  | 2.7X10 <sup>3</sup>  | 7.3X10 <sup>4</sup>  |
| Be-7        | Beryllium (4)  | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 1.3X10 <sup>4</sup>  | 3.5X10 <sup>5</sup>  |
| Be-10       |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 8.3X10 <sup>-4</sup> | 2.2X10 <sup>-2</sup> |
| Bi-205      | Bismuth (83)   | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 1.5X10 <sup>3</sup>  | 4.2X10 <sup>4</sup>  |
| Bi-206      |                | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 3.8X10 <sup>3</sup>  | 1.0X10 <sup>5</sup>  |
| Bi-207      |                | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 1.9                  | 5.2X10 <sup>1</sup>  |
| Bi-210      |                | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 4.6X10 <sup>3</sup>  | 1.2X10 <sup>5</sup>  |
| Bi-210m (a) |                | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 2.1X10 <sup>-5</sup> | 5.7X10 <sup>-4</sup> |
| Bi-212 (a)  |                | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 5.4X10 <sup>5</sup>  | 1.5X10 <sup>7</sup>  |
| Bk-247      | Berkelium (97) | 8.0                  | 2.2X10 <sup>2</sup> | 8.0X10 <sup>-4</sup> | 2.2X10 <sup>-2</sup> | 3.8X10 <sup>-2</sup> | 1.0                  |
| Bk-249 (a)  |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0X10 <sup>-1</sup> | 8.1                  | 6.1X10 <sup>1</sup>  | 1.6X10 <sup>3</sup>  |
| Br-76       | Bromine (35)   | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 9.4X10 <sup>4</sup>  | 2.5X10 <sup>6</sup>  |
| Br-77       |                | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 2.6X10 <sup>4</sup>  | 7.1X10 <sup>5</sup>  |
| Br-82       |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 4.0X10 <sup>4</sup>  | 1.1X10 <sup>6</sup>  |
| C-11        | Carbon (6)     | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 3.1X10 <sup>7</sup>  | 8.4X10 <sup>8</sup>  |
| C-14        |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 1.6X10 <sup>-1</sup> | 4.5                  |
| Ca-41       | Calcium (20)   | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 3.1X10 <sup>-3</sup> | 8.5X10 <sup>-2</sup> |
| Ca-45       |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 6.6X10 <sup>2</sup>  | 1.8X10 <sup>4</sup>  |
| Ca-47 (a)   |                | 3.0                  | 8.1X10 <sup>1</sup> | 3.0X10 <sup>-1</sup> | 8.1                  | 2.3X10 <sup>4</sup>  | 6.1X10 <sup>5</sup>  |
|             |                |                      |                     |                      |                      |                      |                      |

|            |                  |                      |                      |                      |                      |                      |                      |
|------------|------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Cd-109     | Cadmium (48)     | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 2.0                  | 5.4X10 <sup>1</sup>  | 9.6X10 <sup>1</sup>  | 2.6X10 <sup>3</sup>  |
| Cd-113m    |                  | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 8.3                  | 2.2X10 <sup>2</sup>  |
| Cd-115 (a) |                  | 3.0                  | 8.1X10 <sup>1</sup>  | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 1.9X10 <sup>4</sup>  | 5.1X10 <sup>5</sup>  |
| Cd-115m    |                  | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 9.4X10 <sup>2</sup>  | 2.5X10 <sup>4</sup>  |
| Ce-139     | Cerium (58)      | 7.0                  | 1.9X10 <sup>2</sup>  | 2.0                  | 5.4X10 <sup>1</sup>  | 2.5X10 <sup>2</sup>  | 6.8X10 <sup>3</sup>  |
| Ce-141     |                  | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 2.8X10 <sup>4</sup>  |
| Ce-143     |                  | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup>  | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.5X10 <sup>4</sup>  | 6.6X10 <sup>5</sup>  |
| Ce-144 (a) |                  | 2.0X10 <sup>-1</sup> | 5.4                  | 2.0X10 <sup>-1</sup> | 5.4                  | 1.2X10 <sup>2</sup>  | 3.2X10 <sup>3</sup>  |
| Cf-248     | Californium (98) | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 6.0X10 <sup>-3</sup> | 1.6X10 <sup>-1</sup> | 5.8X10 <sup>1</sup>  | 1.6X10 <sup>3</sup>  |
| Cf-249     |                  | 3.0                  | 8.1X10 <sup>1</sup>  | 8.0X10 <sup>-4</sup> | 2.2X10 <sup>-2</sup> | 1.5X10 <sup>-1</sup> | 4.1                  |
| Cf-250     |                  | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 2.0X10 <sup>-3</sup> | 5.4X10 <sup>-2</sup> | 4.0                  | 1.1X10 <sup>2</sup>  |
| Cf-251     |                  | 7.0                  | 1.9X10 <sup>2</sup>  | 7.0X10 <sup>-4</sup> | 1.9X10 <sup>-2</sup> | 5.9X10 <sup>-2</sup> | 1.6                  |
| Cf-252     |                  | 1.0X10 <sup>-1</sup> | 2.7                  | 3.0X10 <sup>-3</sup> | 8.1X10 <sup>-2</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  |
| Cf-253 (a) |                  | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 4.0X10 <sup>-2</sup> | 1.1                  | 1.1X10 <sup>3</sup>  | 2.9X10 <sup>4</sup>  |
| Cf-254     |                  | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 3.1X10 <sup>2</sup>  | 8.5X10 <sup>3</sup>  |
| Cl-36      | Chlorine (17)    | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>  | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 1.2X10 <sup>-3</sup> | 3.3X10 <sup>-2</sup> |
| Cl-38      |                  | 2.0X10 <sup>-1</sup> | 5.4                  | 2.0X10 <sup>-1</sup> | 5.4                  | 4.9X10 <sup>6</sup>  | 1.3X10 <sup>8</sup>  |
| Cm-240     | Curium (96)      | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 7.5X10 <sup>2</sup>  | 2.0X10 <sup>4</sup>  |
| Cm-241     |                  | 2.0                  | 5.4X10 <sup>1</sup>  | 1.0                  | 2.7X10 <sup>1</sup>  | 6.1X10 <sup>2</sup>  | 1.7X10 <sup>4</sup>  |
|            |                  |                      |                      |                      |                      |                      |                      |

|            |               |                      |                      |                      |                      |                      |                      |
|------------|---------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Cm-242     |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 1.0X10 <sup>-2</sup> | 2.7X10 <sup>-1</sup> | 1.2X10 <sup>2</sup>  | 3.3X10 <sup>3</sup>  |
| Cm-243     |               | 9.0                  | 2.4X10 <sup>2</sup>  | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 1.9X10 <sup>-3</sup> | 5.2X10 <sup>4</sup>  |
| Cm-244     |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 2.0X10 <sup>-3</sup> | 5.4X10 <sup>-2</sup> | 3.0                  | 8.1X10 <sup>1</sup>  |
| Cm-245     |               | 9.0                  | 2.4X10 <sup>2</sup>  | 9.0X10 <sup>-4</sup> | 2.4X10 <sup>-2</sup> | 6.4X10 <sup>-3</sup> | 1.7X10 <sup>-1</sup> |
| Cm-246     |               | 9.0                  | 2.4X10 <sup>2</sup>  | 9.0X10 <sup>-4</sup> | 2.4X10 <sup>-2</sup> | 1.1X10 <sup>-2</sup> | 3.1X10 <sup>-1</sup> |
| Cm-247 (a) |               | 3.0                  | 8.1X10 <sup>1</sup>  | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 3.4X10 <sup>-6</sup> | 9.3X10 <sup>-5</sup> |
| Cm-248     |               | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 3.0X10 <sup>-4</sup> | 8.1X10 <sup>-3</sup> | 1.6X10 <sup>-4</sup> | 4.2X10 <sup>-3</sup> |
| Co-55      | Cobalt (27)   | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 1.1X10 <sup>5</sup>  | 3.1X10 <sup>6</sup>  |
| Co-56      |               | 3.0X10 <sup>-1</sup> | 8.1                  | 3.0X10 <sup>-1</sup> | 8.1                  | 1.1X10 <sup>3</sup>  | 3.0X10 <sup>4</sup>  |
| Co-57      |               | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>  | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>  | 3.1X10 <sup>2</sup>  | 8.4X10 <sup>3</sup>  |
| Co-58      |               | 1.0                  | 2.7X10 <sup>1</sup>  | 1.0                  | 2.7X10 <sup>1</sup>  | 1.2X10 <sup>3</sup>  | 3.2X10 <sup>4</sup>  |
| Co-58m     |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 2.2X10 <sup>5</sup>  | 5.9X10 <sup>6</sup>  |
| Co-60      |               | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 4.2X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  |
| Cr-51      | Chromium (24) | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 3.4X10 <sup>3</sup>  | 9.2X10 <sup>4</sup>  |
| Cs-129     | Cesium (55)   | 4.0                  | 1.1X10 <sup>2</sup>  | 4.0                  | 1.1X10 <sup>2</sup>  | 2.8X10 <sup>4</sup>  | 7.6X10 <sup>5</sup>  |
| Cs-131     |               | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 3.8X10 <sup>3</sup>  | 1.0X10 <sup>5</sup>  |
| Cs-132     |               | 1.0                  | 2.7X10 <sup>1</sup>  | 1.0                  | 2.7X10 <sup>1</sup>  | 5.7X10 <sup>3</sup>  | 1.5X10 <sup>5</sup>  |
| Cs-134     |               | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 4.8X10 <sup>1</sup>  | 1.3X10 <sup>3</sup>  |
| Cs-134m    |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 3.0X10 <sup>5</sup>  | 8.0X10 <sup>6</sup>  |

|                      |                 |                      |                     |                      |                     |                      |                      |
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| Cs-135               |                 | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 4.3X10 <sup>-5</sup> | 1.2X10 <sup>-3</sup> |
| Cs-136               |                 | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 2.7X10 <sup>5</sup>  | 7.3X10 <sup>4</sup>  |
| Cs-137 (a)           |                 | 2.0                  | 5.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 3.2                  | 8.7X10 <sup>1</sup>  |
| Cu-64                | Copper (29)     | 6.0                  | 1.6X10 <sup>2</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 1.4X10 <sup>5</sup>  | 3.9X10 <sup>6</sup>  |
| Cu-67                |                 | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 2.8X10 <sup>4</sup>  | 7.6X10 <sup>5</sup>  |
| Dy-159               | Dysprosium (66) | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.1X10 <sup>2</sup>  | 5.7X10 <sup>3</sup>  |
| Dy-165               |                 | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 3.0X10 <sup>5</sup>  | 8.2X10 <sup>6</sup>  |
| Dy-166 (a)           |                 | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 3.0X10 <sup>-1</sup> | 8.1                 | 8.6X10 <sup>5</sup>  | 2.3X10 <sup>5</sup>  |
| Er-169               | Erbium (68)     | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 3.1X10 <sup>3</sup>  | 8.3X10 <sup>4</sup>  |
| Er-171               |                 | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 9.0X10 <sup>4</sup>  | 2.4X10 <sup>6</sup>  |
| Eu-147               | Europium (63)   | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 1.4X10 <sup>5</sup>  | 3.7X10 <sup>4</sup>  |
| Eu-148               |                 | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 6.0X10 <sup>2</sup>  | 1.6X10 <sup>4</sup>  |
| Eu-149               |                 | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 3.5X10 <sup>2</sup>  | 9.4X10 <sup>3</sup>  |
| Eu-150 (short lived) |                 | 2.0                  | 5.4X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 6.1X10 <sup>4</sup>  | 1.6X10 <sup>6</sup>  |
| Eu-150 (long lived)  |                 | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 6.1X10 <sup>4</sup>  | 1.6X10 <sup>6</sup>  |
| Eu-152               |                 | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 6.5                  | 1.8X10 <sup>2</sup>  |
| Eu-152m              |                 | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 8.2X10 <sup>4</sup>  | 2.2X10 <sup>6</sup>  |
| Eu-154               |                 | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 9.8                  | 2.6X10 <sup>2</sup>  |
|                      |                 |                      |                     |                      |                     |                      |                      |

|            |                 |                      |                     |                      |                      |                      |                      |
|------------|-----------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Eu-155     |                 | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 1.8X10 <sup>1</sup>  | 4.9X10 <sup>2</sup>  |
| Eu-156     |                 | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 2.0X10 <sup>5</sup>  | 5.5X10 <sup>4</sup>  |
| F-18       | Fluorine (9)    | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 3.5X10 <sup>6</sup>  | 9.5X10 <sup>7</sup>  |
| Fe-52 (a)  | Iron (26)       | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 2.7X10 <sup>5</sup>  | 7.3X10 <sup>6</sup>  |
| Fe-55      |                 | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup>  | 8.8X10 <sup>1</sup>  | 2.4X10 <sup>5</sup>  |
| Fe-59      |                 | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup>  | 1.8X10 <sup>5</sup>  | 5.0X10 <sup>4</sup>  |
| Fe-60 (a)  |                 | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 2.0X10 <sup>-1</sup> | 5.4                  | 7.4X10 <sup>-4</sup> | 2.0X10 <sup>-2</sup> |
| Ga-67      | Gallium (31)    | 7.0                  | 1.9X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 2.2X10 <sup>4</sup>  | 6.0X10 <sup>5</sup>  |
| Ga-68      |                 | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 1.5X10 <sup>6</sup>  | 4.1X10 <sup>7</sup>  |
| Ga-72      |                 | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 1.1X10 <sup>5</sup>  | 3.1X10 <sup>6</sup>  |
| Gd-146 (a) | Gadolinium (64) | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 6.9X10 <sup>2</sup>  | 1.9X10 <sup>4</sup>  |
| Gd-148     |                 | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0X10 <sup>-3</sup> | 5.4X10 <sup>-2</sup> | 1.2                  | 3.2X10 <sup>1</sup>  |
| Gd-153     |                 | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 9.0                  | 2.4X10 <sup>2</sup>  | 1.3X10 <sup>2</sup>  | 3.5X10 <sup>5</sup>  |
| Gd-159     |                 | 3.0                  | 8.1X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 3.9X10 <sup>4</sup>  | 1.1X10 <sup>6</sup>  |
| Ge-68 (a)  | Germanium (32)  | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 2.6X10 <sup>2</sup>  | 7.1X10 <sup>3</sup>  |
| Ge-71      |                 | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup>  | 5.8X10 <sup>5</sup>  | 1.6X10 <sup>5</sup>  |
| Ge-77      |                 | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 1.3X10 <sup>5</sup>  | 3.6X10 <sup>6</sup>  |
| Hf-172 (a) | Hafnium (72)    | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 4.1X10 <sup>1</sup>  | 1.1X10 <sup>5</sup>  |
| Hf-175     |                 | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 3.9X10 <sup>2</sup>  | 1.1X10 <sup>4</sup>  |
|            |                 |                      |                     |                      |                      |                      |                      |

|             |              |                      |                     |                      |                     |                      |                      |
|-------------|--------------|----------------------|---------------------|----------------------|---------------------|----------------------|----------------------|
| Hf-181      |              | 2.0                  | 5.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 6.3X10 <sup>2</sup>  | 1.7X10 <sup>4</sup>  |
| Hf-182      |              | Unlimited            | Unlimited           | Unlimited            | Unlimited           | 8.1X10 <sup>-6</sup> | 2.2X10 <sup>-4</sup> |
| Hg-194 (a)  | Mercury (80) | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 1.3X10 <sup>-1</sup> | 3.5                  |
| Hg-195m (a) |              | 3.0                  | 8.1X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 1.5X10 <sup>4</sup>  | 4.0X10 <sup>5</sup>  |
| Hg-197      |              | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 9.2X10 <sup>3</sup>  | 2.5X10 <sup>5</sup>  |
| Hg-197m     |              | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 2.5X10 <sup>4</sup>  | 6.7X10 <sup>5</sup>  |
| Hg-203      |              | 5.0                  | 1.4X10 <sup>2</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 5.1X10 <sup>2</sup>  | 1.4X10 <sup>4</sup>  |
| Ho-166      | Holmium (67) | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 2.6X10 <sup>4</sup>  | 7.0X10 <sup>5</sup>  |
| Ho-166m     |              | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 6.6X10 <sup>-2</sup> | 1.8                  |
| I-123       | Iodine (53)  | 6.0                  | 1.6X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup> | 7.1X10 <sup>4</sup>  | 1.9X10 <sup>6</sup>  |
| I-124       |              | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 9.3X10 <sup>3</sup>  | 2.5X10 <sup>5</sup>  |
| I-125       |              | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup> | 6.4X10 <sup>2</sup>  | 1.7X10 <sup>4</sup>  |
| I-126       |              | 2.0                  | 5.4X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 2.9X10 <sup>3</sup>  | 8.0X10 <sup>4</sup>  |
| I-129       |              | Unlimited            | Unlimited           | Unlimited            | Unlimited           | 6.5X10 <sup>-6</sup> | 1.8X10 <sup>-4</sup> |
| I-131       |              | 3.0                  | 8.1X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 4.6X10 <sup>3</sup>  | 1.2X10 <sup>5</sup>  |
| I-132       |              | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 3.8X10 <sup>5</sup>  | 1.0X10 <sup>7</sup>  |
| I-133       |              | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 4.2X10 <sup>4</sup>  | 1.1X10 <sup>6</sup>  |
| I-134       |              | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 9.9X10 <sup>5</sup>  | 2.7X10 <sup>7</sup>  |
| I-135 (a)   |              | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.3X10 <sup>5</sup>  | 3.5X10 <sup>6</sup>  |
|             |              |                      |                     |                      |                     |                      |                      |

|             |                |                      |                         |                      |                     |                      |                      |
|-------------|----------------|----------------------|-------------------------|----------------------|---------------------|----------------------|----------------------|
| In-111      | Indium (49)    | 3.0                  | 8.1X10 <sup>1</sup>     | 3.0                  | 8.1X10 <sup>1</sup> | 1.5X10 <sup>4</sup>  | 4.2X10 <sup>5</sup>  |
| In-113m     |                | 4.0                  | 1.1X10 <sup>2</sup>     | 2.0                  | 5.4X10 <sup>1</sup> | 6.2X10 <sup>5</sup>  | 1.7X10 <sup>7</sup>  |
| In-114m (a) |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>     | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 8.6X10 <sup>2</sup>  | 2.3X10 <sup>4</sup>  |
| In-115m     |                | 7.0                  | 1.9X10 <sup>2</sup>     | 1.0                  | 2.7X10 <sup>1</sup> | 2.2X10 <sup>5</sup>  | 6.1X10 <sup>6</sup>  |
| Ir-189 (a)  | Iridium (77)   | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>     | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.9X10 <sup>3</sup>  | 5.2X10 <sup>4</sup>  |
| Ir-190      |                | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>     | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 2.3X10 <sup>3</sup>  | 6.2X10 <sup>4</sup>  |
| Ir-192      |                | 1.0 (c)              | 2.7X10 <sup>1</sup> (c) | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 3.4X10 <sup>2</sup>  | 9.2X10 <sup>3</sup>  |
| Ir-194      |                | 3.0X10 <sup>-1</sup> | 8.1                     | 3.0X10 <sup>-1</sup> | 8.1                 | 3.1X10 <sup>4</sup>  | 8.4X10 <sup>5</sup>  |
| K-40        | Potassium (19) | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup>     | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 2.4X10 <sup>-7</sup> | 6.4X10 <sup>-6</sup> |
| K-42        |                | 2.0X10 <sup>-1</sup> | 5.4                     | 2.0X10 <sup>-1</sup> | 5.4                 | 2.2X10 <sup>5</sup>  | 6.0X10 <sup>6</sup>  |
| K-43        |                | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>     | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.2X10 <sup>5</sup>  | 3.3X10 <sup>6</sup>  |
| Kr-79       | Krypton (36)   | 4.0                  | 1.1X10 <sup>2</sup>     | 2.0                  | 5.4X10 <sup>1</sup> | 4.2X10 <sup>4</sup>  | 1.1X10 <sup>6</sup>  |
| Kr-81       |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>     | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 7.8X10 <sup>-4</sup> | 2.1X10 <sup>-2</sup> |
| Kr-85       |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>     | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.5X10 <sup>1</sup>  | 3.9X10 <sup>2</sup>  |
| Kr-85m      |                | 8.0                  | 2.2X10 <sup>2</sup>     | 3.0                  | 8.1X10 <sup>1</sup> | 3.0X10 <sup>5</sup>  | 8.2X10 <sup>6</sup>  |
| Kr-87       |                | 2.0X10 <sup>-1</sup> | 5.4                     | 2.0X10 <sup>-1</sup> | 5.4                 | 1.0X10 <sup>6</sup>  | 2.8X10 <sup>7</sup>  |
| La-137      | Lanthanum (57) | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>     | 6.0                  | 1.6X10 <sup>2</sup> | 1.6X10 <sup>-3</sup> | 4.4X10 <sup>-2</sup> |
| La-140      |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>     | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 2.1X10 <sup>4</sup>  | 5.6X10 <sup>5</sup>  |
| Lu-172      | Lutetium (71)  | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>     | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 4.2X10 <sup>3</sup>  | 1.1X10 <sup>5</sup>  |
|             |                |                      |                         |                      |                     |                      |                      |



|               |                 |                      |                     |                      |                     |                      |                      |
|---------------|-----------------|----------------------|---------------------|----------------------|---------------------|----------------------|----------------------|
| Lu-173        |                 | 8.0                  | 2.2X10 <sup>2</sup> | 8.0                  | 2.2X10 <sup>2</sup> | 5.6X10 <sup>1</sup>  | 1.5X10 <sup>3</sup>  |
| Lu-174        |                 | 9.0                  | 2.4X10 <sup>2</sup> | 9.0                  | 2.4X10 <sup>2</sup> | 2.3X10 <sup>1</sup>  | 6.2X10 <sup>2</sup>  |
| Lu-174m       |                 | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 2.0X10 <sup>2</sup>  | 5.3X10 <sup>3</sup>  |
| Lu-177        |                 | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 4.1X10 <sup>3</sup>  | 1.1X10 <sup>5</sup>  |
| Mg-28 (a)     | Magnesium (12)  | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 2.0X10 <sup>5</sup>  | 5.4X10 <sup>6</sup>  |
| Mn-52         | Manganese (25)  | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 1.6X10 <sup>4</sup>  | 4.4X10 <sup>5</sup>  |
| Mn-53         |                 | Unlimited            | Unlimited           | Unlimited            | Unlimited           | 6.8X10 <sup>-5</sup> | 1.8X10 <sup>-3</sup> |
| Mn-54         |                 | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 2.9X10 <sup>2</sup>  | 7.7X10 <sup>3</sup>  |
| Mn-56         |                 | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 8.0X10 <sup>5</sup>  | 2.2X10 <sup>7</sup>  |
| Mo-93         | Molybdenum (42) | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 4.1X10 <sup>-2</sup> | 1.1                  |
| Mo-99 (a) (h) |                 | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.8X10 <sup>4</sup>  | 4.8X10 <sup>5</sup>  |
| N-13          | Nitrogen (7)    | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 5.4X10 <sup>7</sup>  | 1.5X10 <sup>9</sup>  |
| Na-22         | Sodium (11)     | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 2.3X10 <sup>2</sup>  | 6.3X10 <sup>3</sup>  |
| Na-24         |                 | 2.0X10 <sup>-1</sup> | 5.4                 | 2.0X10 <sup>-1</sup> | 5.4                 | 3.2X10 <sup>5</sup>  | 8.7X10 <sup>6</sup>  |
| Nb-93m        | Niobium (41)    | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 8.8                  | 2.4X10 <sup>2</sup>  |
| Nb-94         |                 | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 6.9X10 <sup>-3</sup> | 1.9X10 <sup>-1</sup> |
| Nb-95         |                 | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 1.5X10 <sup>3</sup>  | 3.9X10 <sup>4</sup>  |
| Nb-97         |                 | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 9.9X10 <sup>5</sup>  | 2.7X10 <sup>7</sup>  |
| Nd-147        | Neodymium (60)  | 6.0                  | 1.6X10 <sup>2</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 3.0X10 <sup>3</sup>  | 8.1X10 <sup>4</sup>  |
|               |                 |                      |                     |                      |                     |                      |                      |

|                      |                   |                      |                     |                      |                      |                      |                      |
|----------------------|-------------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Nd-149               |                   | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 4.5X10 <sup>5</sup>  | 1.2X10 <sup>7</sup>  |
| Ni-59                | Nickel (28)       | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 3.0X10 <sup>-3</sup> | 8.0X10 <sup>-2</sup> |
| Ni-63                |                   | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 2.1                  | 5.7X10 <sup>1</sup>  |
| Ni-65                |                   | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 7.1X10 <sup>5</sup>  | 1.9X10 <sup>7</sup>  |
| Np-235               | Neptunium (93)    | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 5.2X10 <sup>1</sup>  | 1.4X10 <sup>3</sup>  |
| Np-236 (short-lived) |                   | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 4.7X10 <sup>-4</sup> | 1.3X10 <sup>-2</sup> |
| Np-236 (long-lived)  |                   | 9.0X100              | 2.4X10 <sup>2</sup> | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 4.7X10 <sup>-4</sup> | 1.3X10 <sup>-2</sup> |
| Np-237               |                   | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0X10 <sup>-3</sup> | 5.4X10 <sup>-2</sup> | 2.6X10 <sup>-5</sup> | 7.1X10 <sup>-4</sup> |
| Np-239               |                   | 7.0                  | 1.9X10 <sup>2</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 8.6X10 <sup>3</sup>  | 2.3X10 <sup>5</sup>  |
| Os-185               | Osmium (76)       | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 2.8X10 <sup>2</sup>  | 7.5X10 <sup>3</sup>  |
| Os-191               |                   | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 1.6X10 <sup>3</sup>  | 4.4X10 <sup>4</sup>  |
| Os-191m              |                   | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup>  | 4.6X10 <sup>4</sup>  | 1.3X10 <sup>6</sup>  |
| Os-193               |                   | 2.0                  | 5.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.0X10 <sup>4</sup>  | 5.3X10 <sup>5</sup>  |
| Os-194 (a)           |                   | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 1.1X10 <sup>1</sup>  | 3.1X10 <sup>2</sup>  |
| P-32                 | Phosphorus (15)   | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 1.1X10 <sup>4</sup>  | 2.9X10 <sup>5</sup>  |
| P-33                 |                   | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 5.8X10 <sup>3</sup>  | 1.6X10 <sup>5</sup>  |
| Pa-230 (a)           | Protactinium (91) | 2.0                  | 5.4X10 <sup>1</sup> | 7.0X10 <sup>-2</sup> | 1.9                  | 1.2X10 <sup>3</sup>  | 3.3X10 <sup>4</sup>  |
| Pa-231               |                   | 4.0                  | 1.1X10 <sup>2</sup> | 4.0X10 <sup>-4</sup> | 1.1X10 <sup>-2</sup> | 1.7X10 <sup>-3</sup> | 4.7X10 <sup>-2</sup> |
|                      |                   |                      |                     |                      |                      |                      |                      |

|             |                   |                      |                     |                      |                      |                      |                      |
|-------------|-------------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Pa-233      |                   | 5.0                  | 1.4X10 <sup>2</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 7.7X10 <sup>2</sup>  | 2.1X10 <sup>4</sup>  |
| Pb-201      | Lead (82)         | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 6.2X10 <sup>4</sup>  | 1.7X10 <sup>6</sup>  |
| Pb-202      |                   | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 1.2X10 <sup>-4</sup> | 3.4X10 <sup>-3</sup> |
| Pb-203      |                   | 4.0                  | 1.1X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 1.1X10 <sup>4</sup>  | 3.0X10 <sup>5</sup>  |
| Pb-205      |                   | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 4.5X10 <sup>-6</sup> | 1.2X10 <sup>-4</sup> |
| Pb-210 (a)  |                   | 1.0                  | 2.7X10 <sup>1</sup> | 5.0X10 <sup>-2</sup> | 1.4                  | 2.8                  | 7.6X10 <sup>1</sup>  |
| Pb-212 (a)  |                   | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 2.0X10 <sup>-1</sup> | 5.4                  | 5.1X10 <sup>4</sup>  | 1.4X10 <sup>6</sup>  |
| Pd-103 (a)  | Palladium (46)    | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup>  | 2.8X10 <sup>5</sup>  | 7.5X10 <sup>4</sup>  |
| Pd-107      |                   | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 1.9X10 <sup>-5</sup> | 5.1X10 <sup>-4</sup> |
| Pd-109      |                   | 2.0                  | 5.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 7.9X10 <sup>4</sup>  | 2.1X10 <sup>6</sup>  |
| Pm-143      | Promethium (61)   | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 1.3X10 <sup>2</sup>  | 3.4X10 <sup>5</sup>  |
| Pm-144      |                   | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 9.2X10 <sup>1</sup>  | 2.5X10 <sup>5</sup>  |
| Pm-145      |                   | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>  | 5.2                  | 1.4X10 <sup>2</sup>  |
| Pm-147      |                   | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 3.4X10 <sup>1</sup>  | 9.3X10 <sup>2</sup>  |
| Pm-148m (a) |                   | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 7.9X10 <sup>2</sup>  | 2.1X10 <sup>4</sup>  |
| Pm-149      |                   | 2.0                  | 5.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 1.5X10 <sup>4</sup>  | 4.0X10 <sup>5</sup>  |
| Pm-151      |                   | 2.0                  | 5.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.7X10 <sup>4</sup>  | 7.3X10 <sup>5</sup>  |
| Po-210      | Polonium (84)     | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>5</sup> | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 1.7X10 <sup>2</sup>  | 4.5X10 <sup>5</sup>  |
| Pr-142      | Praseodymium (59) | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 4.3X10 <sup>4</sup>  | 1.2X10 <sup>6</sup>  |
|             |                   |                      |                     |                      |                      |                      |                      |

|            |                |                      |                     |                      |                      |                      |                      |
|------------|----------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Pr-143     |                | 3.0                  | 8.1X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.5X10 <sup>3</sup>  | 6.7X10 <sup>4</sup>  |
| Pt-188 (a) | Platinum (78)  | 1.0                  | 2.7X10 <sup>1</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup>  | 2.5X10 <sup>3</sup>  | 6.8X10 <sup>4</sup>  |
| Pt-191     |                | 4.0                  | 1.1X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 8.7X10 <sup>3</sup>  | 2.4X10 <sup>5</sup>  |
| Pt-193     |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 1.4                  | 3.7X10 <sup>1</sup>  |
| Pt-193m    |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 5.8X10 <sup>3</sup>  | 1.6X10 <sup>5</sup>  |
| Pt-195m    |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 6.2X10 <sup>3</sup>  | 1.7X10 <sup>5</sup>  |
| Pt-197     |                | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 3.2X10 <sup>4</sup>  | 8.7X10 <sup>5</sup>  |
| Pt-197m    |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 3.7X10 <sup>5</sup>  | 1.0X10 <sup>7</sup>  |
| Pu-236     | Plutonium (94) | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 3.0X10 <sup>-3</sup> | 8.1X10 <sup>-2</sup> | 2.0X10 <sup>1</sup>  | 5.3X10 <sup>2</sup>  |
| Pu-237     |                | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 4.5X10 <sup>2</sup>  | 1.2X10 <sup>4</sup>  |
| Pu-238     |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 6.3X10 <sup>-1</sup> | 1.7X10 <sup>1</sup>  |
| Pu-239     |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 2.3X10 <sup>-3</sup> | 6.2X10 <sup>-2</sup> |
| Pu-240     |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 8.4X10 <sup>-3</sup> | 2.3X10 <sup>-1</sup> |
| Pu-241 (a) |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 6.0X10 <sup>-2</sup> | 1.6                  | 3.8                  | 1.0X10 <sup>2</sup>  |
| Pu-242     |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 1.5X10 <sup>-4</sup> | 3.9X10 <sup>-3</sup> |
| Pu-244 (a) |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 6.7X10 <sup>-7</sup> | 1.8X10 <sup>-5</sup> |
| Ra-223 (a) | Radium (88)    | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 7.0X10 <sup>-3</sup> | 1.9X10 <sup>-1</sup> | 1.9X10 <sup>3</sup>  | 5.1X10 <sup>4</sup>  |
| Ra-224 (a) |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 5.9X10 <sup>3</sup>  | 1.6X10 <sup>5</sup>  |
| Ra-225 (a) |                | 2.0X10 <sup>-1</sup> | 5.4                 | 4.0X10 <sup>-3</sup> | 1.1X10 <sup>-1</sup> | 1.5X10 <sup>3</sup>  | 3.9X10 <sup>4</sup>  |
|            |                |                      |                     |                      |                      |                      |                      |

|            |               |                      |                     |                      |                      |                      |                      |
|------------|---------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Ra-226 (a) |               | 2.0X10 <sup>-1</sup> | 5.4                 | 3.0X10 <sup>-3</sup> | 8.1X10 <sup>-2</sup> | 3.7X10 <sup>-2</sup> | 1.0                  |
| Ra-228 (a) |               | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup>  |
| Rb-81      | Rubidium (37) | 2.0                  | 5.4X10 <sup>1</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup>  | 3.1X10 <sup>5</sup>  | 8.4X10 <sup>6</sup>  |
| Rb-83 (a)  |               | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 6.8X10 <sup>2</sup>  | 1.8X10 <sup>4</sup>  |
| Rb-84      |               | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 1.8X10 <sup>3</sup>  | 4.7X10 <sup>4</sup>  |
| Rb-86      |               | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 3.0X10 <sup>3</sup>  | 8.1X10 <sup>4</sup>  |
| Rb-87      |               | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 3.2X10 <sup>-9</sup> | 8.6X10 <sup>-8</sup> |
| Rb(nat)    |               | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 6.7X10 <sup>6</sup>  | 1.8X10 <sup>8</sup>  |
| Re-184     | Rhenium (75)  | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 6.9X10 <sup>2</sup>  | 1.9X10 <sup>4</sup>  |
| Re-184m    |               | 3.0                  | 8.1X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 1.6X10 <sup>2</sup>  | 4.3X10 <sup>3</sup>  |
| Re-186     |               | 2.0                  | 5.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 6.9X10 <sup>3</sup>  | 1.9X10 <sup>5</sup>  |
| Re-187     |               | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 1.4X10 <sup>-9</sup> | 3.8X10 <sup>-8</sup> |
| Re-188     |               | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 3.6X10 <sup>4</sup>  | 9.8X10 <sup>5</sup>  |
| Re-189 (a) |               | 3.0                  | 8.1X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.5X10 <sup>4</sup>  | 6.8X10 <sup>5</sup>  |
| Re(nat)    |               | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 0.0                  | 2.4X10 <sup>-8</sup> |
| Rh-99      | Rhodium (45)  | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 3.0X10 <sup>3</sup>  | 8.2X10 <sup>4</sup>  |
| Rh-101     |               | 4.0                  | 1.1X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 4.1X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  |
| Rh-102     |               | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 4.5X10 <sup>1</sup>  | 1.2X10 <sup>3</sup>  |
| Rh-102m    |               | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 2.3X10 <sup>2</sup>  | 6.2X10 <sup>3</sup>  |

|            |                |                      |                     |                      |                      |                      |                      |
|------------|----------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Rh-103m    |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 1.2X10 <sup>6</sup>  | 3.3X10 <sup>7</sup>  |
| Rh-105     |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup>  | 3.1X10 <sup>4</sup>  | 8.4X10 <sup>5</sup>  |
| Rn-222 (a) | Radon (86)     | 3.0X10 <sup>-1</sup> | 8.1                 | 4.0X10 <sup>-3</sup> | 1.1X10 <sup>-1</sup> | 5.7X10 <sup>5</sup>  | 1.5X10 <sup>5</sup>  |
| Ru-97      | Ruthenium (44) | 5.0                  | 1.4X10 <sup>2</sup> | 5.0                  | 1.4X10 <sup>2</sup>  | 1.7X10 <sup>4</sup>  | 4.6X10 <sup>5</sup>  |
| Ru-103 (a) |                | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 1.2X10 <sup>3</sup>  | 3.2X10 <sup>4</sup>  |
| Ru-105     |                | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 2.5X10 <sup>5</sup>  | 6.7X10 <sup>6</sup>  |
| Ru-106 (a) |                | 2.0X10 <sup>-1</sup> | 5.4                 | 2.0X10 <sup>-1</sup> | 5.4                  | 1.2X10 <sup>2</sup>  | 3.3X10 <sup>3</sup>  |
| S-35       | Sulphur (16)   | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 1.6X10 <sup>3</sup>  | 4.3X10 <sup>4</sup>  |
| Sb-122     | Antimony (51)  | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 1.5X10 <sup>4</sup>  | 4.0X10 <sup>5</sup>  |
| Sb-124     |                | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 6.5X10 <sup>2</sup>  | 1.7X10 <sup>4</sup>  |
| Sb-125     |                | 2.0                  | 5.4X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup>  | 3.9X10 <sup>1</sup>  | 1.0X10 <sup>3</sup>  |
| Sb-126     |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 3.1X10 <sup>3</sup>  | 8.4X10 <sup>4</sup>  |
| Sc-44      | Scandium (21)  | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 6.7X10 <sup>5</sup>  | 1.8X10 <sup>7</sup>  |
| Sc-46      |                | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 1.3X10 <sup>3</sup>  | 3.4X10 <sup>4</sup>  |
| Sc-47      |                | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 3.1X10 <sup>4</sup>  | 8.3X10 <sup>5</sup>  |
| Sc-48      |                | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 5.5X10 <sup>4</sup>  | 1.5X10 <sup>6</sup>  |
| Se-75      | Selenium (34)  | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup>  | 5.4X10 <sup>2</sup>  | 1.5X10 <sup>4</sup>  |
| Se-79      |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 2.6X10 <sup>-3</sup> | 7.0X10 <sup>-2</sup> |
| Si-31      | Silicon (14)   | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 1.4X10 <sup>6</sup>  | 3.9X10 <sup>7</sup>  |
|            |                |                      |                     |                      |                      |                      |                      |

|             |                |                      |                     |                      |                     |                      |                      |
|-------------|----------------|----------------------|---------------------|----------------------|---------------------|----------------------|----------------------|
| Si-32       |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 3.9                  | 1.1X10 <sup>2</sup>  |
| Sm-145      | Samarium (62)  | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 9.8X10 <sup>1</sup>  | 2.6X10 <sup>3</sup>  |
| Sm-147      |                | Unlimited            | Unlimited           | Unlimited            | Unlimited           | 8.5X10 <sup>-1</sup> | 2.3X10 <sup>-8</sup> |
| Sm-151      |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 9.7X10 <sup>-1</sup> | 2.6X10 <sup>1</sup>  |
| Sm-153      |                | 9.0                  | 2.4X10 <sup>2</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.6X10 <sup>4</sup>  | 4.4X10 <sup>5</sup>  |
| Sn-113 (a)  | Tin (50)       | 4.0                  | 1.1X10 <sup>2</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 3.7X10 <sup>2</sup>  | 1.0X10 <sup>4</sup>  |
| Sn-117m     |                | 7.0                  | 1.9X10 <sup>2</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 3.0X10 <sup>3</sup>  | 8.2X10 <sup>4</sup>  |
| Sn-119m     |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 1.4X10 <sup>2</sup>  | 3.7X10 <sup>3</sup>  |
| Sn-121m (a) |                | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  |
| Sn-123      |                | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 3.0X10 <sup>2</sup>  | 8.2X10 <sup>3</sup>  |
| Sn-125      |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>3</sup>  | 1.1X10 <sup>5</sup>  |
| Sn-126 (a)  |                | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 1.0X10 <sup>-3</sup> | 2.8X10 <sup>-2</sup> |
| Sr-82 (a)   | Strontium (38) | 2.0X10 <sup>-1</sup> | 5.4                 | 2.0X10 <sup>-1</sup> | 5.4                 | 2.3X10 <sup>3</sup>  | 6.2X10 <sup>4</sup>  |
| Sr-85       |                | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 8.8X10 <sup>2</sup>  | 2.4X10 <sup>4</sup>  |
| Sr-85m      |                | 5.0                  | 1.4X10 <sup>2</sup> | 5.0                  | 1.4X10 <sup>2</sup> | 1.2X10 <sup>6</sup>  | 3.3X10 <sup>7</sup>  |
| Sr-87m      |                | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup> | 4.8X10 <sup>5</sup>  | 1.3X10 <sup>7</sup>  |
| Sr-89       |                | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.1X10 <sup>3</sup>  | 2.9X10 <sup>4</sup>  |
| Sr-90 (a)   |                | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 5.1                  | 1.4X10 <sup>2</sup>  |
| Sr-91 (a)   |                | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 1.3X10 <sup>5</sup>  | 3.6X10 <sup>6</sup>  |
|             |                |                      |                     |                      |                     |                      |                      |

|                     |                 |                      |                     |                      |                     |                      |                      |
|---------------------|-----------------|----------------------|---------------------|----------------------|---------------------|----------------------|----------------------|
| Sr-92 (a)           |                 | 1.0                  | 2.7X10 <sup>1</sup> | 3.0X10 <sup>-1</sup> | 8.1                 | 4.7X10 <sup>5</sup>  | 1.3X10 <sup>7</sup>  |
| T(H-3)              | Tritium (1)     | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.6X10 <sup>2</sup>  | 9.7X10 <sup>3</sup>  |
| Ta-178 (long-lived) | Tantalum (73)   | 1.0                  | 2.7X10 <sup>1</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 4.2X10 <sup>6</sup>  | 1.1X10 <sup>8</sup>  |
| Ta-179              |                 | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 4.1X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  |
| Ta-182              |                 | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 2.3X10 <sup>2</sup>  | 6.2X10 <sup>3</sup>  |
| Tb-157              | Terbium (65)    | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 5.6X10 <sup>-1</sup> | 1.5X10 <sup>1</sup>  |
| Tb-158              |                 | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 5.6X10 <sup>-1</sup> | 1.5X10 <sup>1</sup>  |
| Tb-160              |                 | 1.0                  | 2.7X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 4.2X10 <sup>2</sup>  | 1.1X10 <sup>4</sup>  |
| Tc-95m (a)          | Technetium (43) | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 8.3X10 <sup>2</sup>  | 2.2X10 <sup>4</sup>  |
| Tc-96               |                 | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 1.2X10 <sup>4</sup>  | 3.2X10 <sup>5</sup>  |
| Tc-96m (a)          |                 | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 1.4X10 <sup>6</sup>  | 3.8X10 <sup>7</sup>  |
| Tc-97               |                 | Unlimited            | Unlimited           | Unlimited            | Unlimited           | 5.2X10 <sup>-5</sup> | 1.4X10 <sup>-3</sup> |
| Tc-97m              |                 | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 5.6X10 <sup>2</sup>  | 1.5X10 <sup>4</sup>  |
| Tc-98               |                 | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 3.2X10 <sup>-5</sup> | 8.7X10 <sup>-4</sup> |
| Tc-99               |                 | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 6.3X10 <sup>-4</sup> | 1.7X10 <sup>-2</sup> |
| Tc-99m              |                 | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 4.0                  | 1.1X10 <sup>2</sup> | 1.9X10 <sup>5</sup>  | 5.3X10 <sup>6</sup>  |
| Te-121              | Tellurium (52)  | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 2.4X10 <sup>3</sup>  | 6.4X10 <sup>4</sup>  |
| Te-121m             |                 | 5.0                  | 1.4X10 <sup>2</sup> | 3.0                  | 8.1X10 <sup>1</sup> | 2.6X10 <sup>2</sup>  | 7.0X10 <sup>3</sup>  |
| Te-123m             |                 | 8.0                  | 2.2X10 <sup>2</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 3.3X10 <sup>2</sup>  | 8.9X10 <sup>3</sup>  |



|             |               |                      |                     |                      |                      |                      |                      |
|-------------|---------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Te-125m     |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup>  | 6.7X10 <sup>2</sup>  | 1.8X10 <sup>4</sup>  |
| Te-127      |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup>  | 9.8X10 <sup>4</sup>  | 2.6X10 <sup>6</sup>  |
| Te-127m (a) |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 3.5X10 <sup>2</sup>  | 9.4X10 <sup>3</sup>  |
| Te-129      |               | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup>  | 7.7X10 <sup>5</sup>  | 2.1X10 <sup>7</sup>  |
| Te-129m (a) |               | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 1.1X10 <sup>3</sup>  | 3.0X10 <sup>4</sup>  |
| Te-131m (a) |               | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup>  | 3.0X10 <sup>4</sup>  | 8.0X10 <sup>5</sup>  |
| Te-132 (a)  |               | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 1.1X10 <sup>4</sup>  | 3.0X10 <sup>5</sup>  |
| Th-227      | Thorium (90)  | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 5.0X10 <sup>-3</sup> | 1.4X10 <sup>-1</sup> | 1.1X10 <sup>3</sup>  | 3.1X10 <sup>4</sup>  |
| Th-228 (a)  |               | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 3.0X10 <sup>1</sup>  | 8.2X10 <sup>2</sup>  |
| Th-229      |               | 5.0                  | 1.4X10 <sup>2</sup> | 5.0X10 <sup>-4</sup> | 1.4X10 <sup>-2</sup> | 7.9X10 <sup>-3</sup> | 2.1X10 <sup>-1</sup> |
| Th-230      |               | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 1.0X10 <sup>-3</sup> | 2.7X10 <sup>-2</sup> | 7.6X10 <sup>-4</sup> | 2.1X10 <sup>-2</sup> |
| Th-231      |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 2.0X10 <sup>-2</sup> | 5.4X10 <sup>-1</sup> | 2.0X10 <sup>4</sup>  | 5.3X10 <sup>5</sup>  |
| Th-232      |               | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 4.0X10 <sup>-9</sup> | 1.1X10 <sup>-7</sup> |
| Th-234 (a)  |               | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                  | 8.6X10 <sup>2</sup>  | 2.3X10 <sup>4</sup>  |
| Th(nat)     |               | Unlimited            | Unlimited           | Unlimited            | Unlimited            | 8.1X10 <sup>-9</sup> | 2.2X10 <sup>-7</sup> |
| Ti-44 (a)   | Titanium (22) | 5.0X10 <sup>-1</sup> | 1.4X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup>  | 6.4                  | 1.7X10 <sup>2</sup>  |
| Tl-200      | Thallium (81) | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup>  | 2.2X10 <sup>4</sup>  | 6.0X10 <sup>5</sup>  |
| Tl-201      |               | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 4.0                  | 1.1X10 <sup>2</sup>  | 7.9X10 <sup>3</sup>  | 2.1X10 <sup>5</sup>  |
| Tl-202      |               | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup>  | 2.0X10 <sup>3</sup>  | 5.3X10 <sup>4</sup>  |

|                                       |              |                   |                   |                      |                      |                      |                      |
|---------------------------------------|--------------|-------------------|-------------------|----------------------|----------------------|----------------------|----------------------|
| Tl-204                                |              | $1.0 \times 10^1$ | $2.7 \times 10^2$ | $7.0 \times 10^{-1}$ | $1.9 \times 10^1$    | $1.7 \times 10^1$    | $4.6 \times 10^2$    |
| Tm-167                                | Thulium (69) | 7.0               | $1.9 \times 10^2$ | $8.0 \times 10^{-1}$ | $2.2 \times 10^1$    | $3.1 \times 10^5$    | $8.5 \times 10^4$    |
| Tm-170                                |              | 3.0               | $8.1 \times 10^1$ | $6.0 \times 10^{-1}$ | $1.6 \times 10^1$    | $2.2 \times 10^2$    | $6.0 \times 10^5$    |
| Tm-171                                |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $4.0 \times 10^1$    | $1.1 \times 10^3$    | $4.0 \times 10^1$    | $1.1 \times 10^3$    |
| U-230 (fast lung absorption) (a)(d)   | Uranium (92) | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $1.0 \times 10^{-1}$ | 2.7                  | $1.0 \times 10^3$    | $2.7 \times 10^4$    |
| U-230 (medium lung absorption) (a)(e) |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $4.0 \times 10^{-3}$ | $1.1 \times 10^{-1}$ | $1.0 \times 10^3$    | $2.7 \times 10^4$    |
| U-230 (slow lung absorption) (a)(f)   |              | $3.0 \times 10^1$ | $8.1 \times 10^2$ | $3.0 \times 10^{-3}$ | $8.1 \times 10^{-2}$ | $1.0 \times 10^3$    | $2.7 \times 10^4$    |
| U-232 (fast lung absorption) (d)      |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $1.0 \times 10^{-2}$ | $2.7 \times 10^{-1}$ | $8.3 \times 10^{-1}$ | $2.2 \times 10^1$    |
| U-232 (medium lung absorption) (e)    |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $7.0 \times 10^{-3}$ | $1.9 \times 10^{-1}$ | $8.3 \times 10^{-1}$ | $2.2 \times 10^1$    |
| U-232 (slow lung absorption) (f)      |              | $1.0 \times 10^1$ | $2.7 \times 10^2$ | $1.0 \times 10^{-3}$ | $2.7 \times 10^{-2}$ | $8.3 \times 10^{-1}$ | $2.2 \times 10^1$    |
| U-233 (fast lung absorption) (d)      |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $9.0 \times 10^{-2}$ | 2.4                  | $3.6 \times 10^{-4}$ | $9.7 \times 10^{-3}$ |
| U-233 (medium lung absorption) (e)    |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $2.0 \times 10^{-2}$ | $5.4 \times 10^{-1}$ | $3.6 \times 10^{-4}$ | $9.7 \times 10^{-3}$ |
| U-233 (slow lung absorption) (f)      |              | $4.0 \times 10^1$ | $1.1 \times 10^3$ | $6.0 \times 10^{-3}$ | $1.6 \times 10^{-1}$ | $3.6 \times 10^{-4}$ | $9.7 \times 10^{-3}$ |

|                                                   |               |                      |                   |                      |                      |                      |                      |
|---------------------------------------------------|---------------|----------------------|-------------------|----------------------|----------------------|----------------------|----------------------|
| U-234 (fast lung absorption) (d)                  |               | $4.0 \times 10^1$    | $1.1 \times 10^3$ | $9.0 \times 10^{-2}$ | 2.4                  | $2.3 \times 10^{-4}$ | $6.2 \times 10^{-3}$ |
| U-234 (medium lung absorption) (e)                |               | $4.0 \times 10^1$    | $1.1 \times 10^3$ | $2.0 \times 10^{-2}$ | $5.4 \times 10^{-1}$ | $2.3 \times 10^{-4}$ | $6.2 \times 10^{-3}$ |
| U-234 (slow lung absorption) (f)                  |               | $4.0 \times 10^1$    | $1.1 \times 10^3$ | $6.0 \times 10^{-3}$ | $1.6 \times 10^{-1}$ | $2.3 \times 10^{-4}$ | $6.2 \times 10^{-3}$ |
| U-235 (all lung absorption types) (a),(d),(e),(f) |               | Unlimited            | Unlimited         | Unlimited            | Unlimited            | $8.0 \times 10^{-8}$ | $2.2 \times 10^{-6}$ |
| U-236 (fast lung absorption) (d)                  |               | Unlimited            | Unlimited         | Unlimited            | Unlimited            | $2.4 \times 10^{-6}$ | $6.5 \times 10^{-5}$ |
| U-236 (medium lung absorption) (e)                |               | $4.0 \times 10^1$    | $1.1 \times 10^3$ | $2.0 \times 10^{-2}$ | $5.4 \times 10^{-1}$ | $2.4 \times 10^{-6}$ | $6.5 \times 10^{-5}$ |
| U-236 (slow lung absorption) (f)                  |               | $4.0 \times 10^1$    | $1.1 \times 10^3$ | $6.0 \times 10^{-3}$ | $1.6 \times 10^{-1}$ | $2.4 \times 10^{-6}$ | $6.5 \times 10^{-5}$ |
| U-238 (all lung absorption types) (d),(e),(f)     |               | Unlimited            | Unlimited         | Unlimited            | Unlimited            | $1.2 \times 10^{-8}$ | $3.4 \times 10^{-7}$ |
| U (nat)                                           |               | Unlimited            | Unlimited         | Unlimited            | Unlimited            | $2.6 \times 10^{-8}$ | $7.1 \times 10^{-7}$ |
| U (enriched to 20% or less) (g)                   |               | Unlimited            | Unlimited         | Unlimited            | Unlimited            | See Table A-4        | See Table A-4        |
| U (dep)                                           |               | Unlimited            | Unlimited         | Unlimited            | Unlimited            | See Table A-4        | See Table A-3        |
| V-48                                              | Vanadium (23) | $4.0 \times 10^{-1}$ | $1.1 \times 10^1$ | $4.0 \times 10^{-1}$ | $1.1 \times 10^1$    | $6.3 \times 10^3$    | $1.7 \times 10^5$    |

|            |               |                      |                     |                      |                     |                     |                     |
|------------|---------------|----------------------|---------------------|----------------------|---------------------|---------------------|---------------------|
| V-49       |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.0X10 <sup>2</sup> | 8.1X10 <sup>3</sup> |
| W-178 (a)  | Tungsten (74) | 9.0                  | 2.4X10 <sup>2</sup> | 5.0                  | 1.4X10 <sup>2</sup> | 1.3X10 <sup>5</sup> | 3.4X10 <sup>4</sup> |
| W-181      |               | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 2.2X10 <sup>2</sup> | 6.0X10 <sup>5</sup> |
| W-185      |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 3.5X10 <sup>2</sup> | 9.4X10 <sup>3</sup> |
| W-187      |               | 2.0                  | 5.4X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 2.6X10 <sup>4</sup> | 7.0X10 <sup>5</sup> |
| W-188 (a)  |               | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 3.0X10 <sup>-1</sup> | 8.1                 | 3.7X10 <sup>2</sup> | 1.0X10 <sup>4</sup> |
| Xe-122 (a) | Xenon (54)    | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.8X10 <sup>4</sup> | 1.3X10 <sup>6</sup> |
| Xe-123     |               | 2.0                  | 5.4X10 <sup>1</sup> | 7.0X10 <sup>-1</sup> | 1.9X10 <sup>1</sup> | 4.4X10 <sup>5</sup> | 1.2X10              |
| Xe-127     |               | 4.0                  | 1.1X10 <sup>2</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 1.0X10 <sup>3</sup> | 2.8X10 <sup>4</sup> |
| Xe-131m    |               | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 4.0X10 <sup>1</sup>  | 1.1X10 <sup>3</sup> | 3.1X10 <sup>3</sup> | 8.4X10 <sup>4</sup> |
| Xe-133     |               | 2.0X10 <sup>1</sup>  | 5.4X10 <sup>2</sup> | 1.0X10 <sup>1</sup>  | 2.7X10 <sup>2</sup> | 6.9X10 <sup>5</sup> | 1.9X10 <sup>5</sup> |
| Xe-135     |               | 3.0                  | 8.1X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 9.5X10 <sup>4</sup> | 2.6X10 <sup>6</sup> |
| Y-87 (a)   | Yttrium (39)  | 1.0                  | 2.7X10 <sup>1</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 1.7X10 <sup>4</sup> | 4.5X10 <sup>5</sup> |
| Y-88       |               | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 5.2X10 <sup>2</sup> | 1.4X10 <sup>4</sup> |
| Y-90       |               | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 2.0X10 <sup>4</sup> | 5.4X10 <sup>5</sup> |
| Y-91       |               | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 9.1X10 <sup>2</sup> | 2.5X10 <sup>4</sup> |
| Y-91m      |               | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 1.5X10 <sup>6</sup> | 4.2X10              |
| Y-92       |               | 2.0X10 <sup>-1</sup> | 5.4                 | 2.0X10 <sup>-1</sup> | 5.4                 | 3.6X10 <sup>5</sup> | 9.6X10 <sup>6</sup> |
| Y-93       |               | 3.0X10 <sup>-1</sup> | 8.1                 | 3.0X10 <sup>-1</sup> | 8.1                 | 1.2X10 <sup>5</sup> | 3.3X10 <sup>6</sup> |

|            |                |                      |                     |                      |                     |                     |                     |
|------------|----------------|----------------------|---------------------|----------------------|---------------------|---------------------|---------------------|
| Yb-169     | Ytterbium (70) | 4.0                  | 1.1X10 <sup>2</sup> | 1.0                  | 2.7X10 <sup>1</sup> | 8.9X10 <sup>2</sup> | 2.4X10 <sup>4</sup> |
| Yb-175     |                | 3.0X10 <sup>1</sup>  | 8.1X10 <sup>2</sup> | 9.0X10 <sup>-1</sup> | 2.4X10 <sup>1</sup> | 6.6X10 <sup>5</sup> | 1.8X10 <sup>5</sup> |
| Zn-65      | Zinc (30)      | 2.0                  | 5.4X10 <sup>1</sup> | 2.0                  | 5.4X10 <sup>1</sup> | 3.0X10 <sup>2</sup> | 8.2X10 <sup>5</sup> |
| Zn-69      |                | 3.0                  | 8.1X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.8X10 <sup>6</sup> | 4.9X10              |
| Zn-69m (a) |                | 3.0                  | 8.1X10 <sup>1</sup> | 6.0X10 <sup>-1</sup> | 1.6X10 <sup>1</sup> | 1.2X10 <sup>5</sup> | 3.3X10 <sup>6</sup> |
| Zr-88      | Zirconium (40) | 3.0                  | 8.1X10 <sup>1</sup> | 3.0                  | 8.1X10 <sup>1</sup> | 6.6X10 <sup>2</sup> | 1.8X10 <sup>4</sup> |
| Zr-93      |                | Unlimited            | Unlimited           | Unlimited            | Unlimited           | 9.3X10              | 2.5X10              |
| Zr-95 (a)  |                | 2.0                  | 5.4X10 <sup>1</sup> | 8.0X10 <sup>-1</sup> | 2.2X10 <sup>1</sup> | 7.9X10 <sup>2</sup> | 2.1X10 <sup>4</sup> |
| Zr-97 (a)  |                | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 4.0X10 <sup>-1</sup> | 1.1X10 <sup>1</sup> | 7.1X10 <sup>4</sup> | 1.9X10 <sup>6</sup> |

<sup>a</sup>A<sub>1</sub> and/or A<sub>2</sub> values include contributions from daughter nuclides with half-lives less than 10 days, as listed in the following:

|        |               |
|--------|---------------|
| Mg-28  | Al-28         |
| Ca-47  | Sc-47         |
| Ti-44  | Sc-44         |
| Fe-52  | Mn-52m        |
| Fe-60  | Co-60m        |
| Zn-69m | Zn-69         |
| Ge-68  | Ga-68         |
| Rb-83  | Kr-83m        |
| Sr-82  | Rb-82         |
| Sr-90  | Y-90          |
| Sr-91  | Y-91m         |
| Sr-92  | Y-92          |
| Y-87   | Sr-87m        |
| Zr-95  | Nb-95m        |
| Zr-97  | Nb-97m, Nb-97 |
| Mo-99  | Tc-99m        |
| Tc-95m | Tc-95         |

|         |                        |
|---------|------------------------|
| Tc-96m  | Tc-96                  |
| Ru-103  | Rh-103m                |
| Ru-106  | Rh-106                 |
| Pd-103  | Rh-103m                |
| Ag-108m | Ag-108                 |
| Ag-110m | Ag-110                 |
| Cd-115  | In-115m                |
| In-114m | In-114                 |
| Sn-113  | In-113m                |
| Sn-121m | Sn-121                 |
| Sn-126  | Sb-126m                |
| Te-127m | Te-127                 |
| Te-129m | Te-129                 |
| Te-131m | Te-131                 |
| Te-132  | I-132                  |
| I-135   | Xe-135m                |
| Xe-122  | I-122                  |
| Cs-137  | Ba-137m                |
| Ba-131  | Cs-131                 |
| Ba-140  | La-140                 |
| Ce-144  | Pr-144m, Pr-144        |
| Pm-148m | Pm-148                 |
| Gd-146  | Eu-146                 |
| Dy-166  | Ho-166                 |
| Hf-172  | Lu-172                 |
| W-178   | Ta-178                 |
| W-188   | Re-188                 |
| Re-189  | Os-189m                |
| Os-194  | Ir-194                 |
| Ir-189  | Os-189m                |
| Pt-188  | Ir-188                 |
| Hg-194  | Au-194                 |
| Hg-195m | Hg-195                 |
| Pb-210  | Bi-210                 |
| Pb-212  | Bi-212, Po-212, Tl-208 |
| Bi-210m | Tl-206                 |

|         |                                                        |
|---------|--------------------------------------------------------|
| Bi-212  | Tl-208, Po-212                                         |
| At-211  | Po-211                                                 |
| Rn-222  | Po-218, Pb-214, At-218, Bi-214, Po-214                 |
| Ra-223  | Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207         |
| Ra-224  | Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212         |
| Ra-225  | Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209 |
| Ra-228  | Ac-228                                                 |
| Ac-225  | Fr-221, At-217, Bi-213, Po-213, Pb-209, Tl-209         |
| Ac-227  | Fr-223                                                 |
| Th-228  | Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212 |
| Th-234  | Pa-234m, Pa-234                                        |
| Pa-230  | Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214         |
| U-230   | Th-226, Ra-222, Rn-218, Po-214                         |
| U-235   | Th-231                                                 |
| Pu-241  | U-237                                                  |
| Pu-244  | U-240, Np-240m                                         |
| Am-242m | Am-242, Np-238                                         |
| Am-243  | Np-239                                                 |
| Cm-247  | Pu-243                                                 |
| Bk-249  | Am-245                                                 |
| Cf-253  | Cm-249                                                 |

<sup>b</sup>The values of  $A_1$  and  $A_2$  in Curies (Ci) are approximate and for information only; the regulatory standard units are terabecquerels (TBq).

<sup>c</sup>The activity of Ir-192 in special form may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

<sup>d</sup>These values apply only to compounds of uranium that take the chemical form of  $UF_6$ ,  $UO_2F_2$  and  $UO_2(NO_3)_2$  in both normal and accident conditions of transport.

<sup>e</sup>These values apply only to compounds of uranium that take the chemical form of  $UO_3$ ,  $UF_4$ ,  $UCl_4$  and hexavalent compounds in both normal and accident conditions of transport.

<sup>f</sup>These values apply to all compounds of uranium other than those specified in notes d and e of this table.

<sup>g</sup>These values apply to unirradiated uranium only.

<sup>h</sup>  $A_2 = 0.74$  TBq (20 Ci) for Mo-99 for domestic use.

G. Table 2. Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides.

| Symbol of | Element and atomic number | Activity | Activity | Activity limit | Activity limit |
|-----------|---------------------------|----------|----------|----------------|----------------|
|-----------|---------------------------|----------|----------|----------------|----------------|

| radionuclide |                | concentration<br>for exempt<br>material (Bq/g) | concentration<br>for exempt<br>material (Ci/g) | for exempt<br>consignment<br>(Bq) | for exempt<br>consignment<br>(Ci) |
|--------------|----------------|------------------------------------------------|------------------------------------------------|-----------------------------------|-----------------------------------|
| Ac-225       | Actinium (89)  | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^4$                 | $2.7 \times 10^{-7}$              |
| Ac-227       |                | $1.0 \times 10^{-1}$                           | $2.7 \times 10^{-12}$                          | $1.0 \times 10^3$                 | $2.7 \times 10^{-8}$              |
| Ac-228       |                | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^6$                 | $2.7 \times 10^{-5}$              |
| Ag-105       | Silver (47)    | $1.0 \times 10^2$                              | $2.7 \times 10^{-9}$                           | $1.0 \times 10^6$                 | $2.7 \times 10^{-5}$              |
| Ag-108m (b)  |                | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^6$                 | $2.7 \times 10^{-5}$              |
| Ag-110m      |                | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^6$                 | $2.7 \times 10^{-5}$              |
| Ag-111       |                | $1.0 \times 10^3$                              | $2.7 \times 10^{-8}$                           | $1.0 \times 10^6$                 | $2.7 \times 10^{-5}$              |
| Al-26        | Aluminum (13)  | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^5$                 | $2.7 \times 10^{-6}$              |
| Am-241       | Americium (95) | 1.0                                            | $2.7 \times 10^{-11}$                          | $1.0 \times 10^4$                 | $2.7 \times 10^{-7}$              |
| Am-242m (b)  |                | 1.0                                            | $2.7 \times 10^{-11}$                          | $1.0 \times 10^4$                 | $2.7 \times 10^{-7}$              |
| Am-243 (b)   |                | 1.0                                            | $2.7 \times 10^{-11}$                          | $1.0 \times 10^3$                 | $2.7 \times 10^{-8}$              |
| Ar-37        | Argon (18)     | $1.0 \times 10^6$                              | $2.7 \times 10^{-5}$                           | $1.0 \times 10^8$                 | $2.7 \times 10^{-3}$              |
| Ar-39        |                | $1.0 \times 10^7$                              | $2.7 \times 10^{-4}$                           | $1.0 \times 10^4$                 | $2.7 \times 10^{-7}$              |
| Ar-41        |                | $1.0 \times 10^2$                              | $2.7 \times 10^{-9}$                           | $1.0 \times 10^9$                 | $2.7 \times 10^{-2}$              |
| As-72        | Arsenic (33)   | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^5$                 | $2.7 \times 10^{-6}$              |
| As-73        |                | $1.0 \times 10^3$                              | $2.7 \times 10^{-8}$                           | $1.0 \times 10^7$                 | $2.7 \times 10^{-4}$              |
| As-74        |                | $1.0 \times 10^1$                              | $2.7 \times 10^{-10}$                          | $1.0 \times 10^6$                 | $2.7 \times 10^{-5}$              |
|              |                |                                                |                                                |                                   |                                   |



|            |               |                   |                       |                   |                      |
|------------|---------------|-------------------|-----------------------|-------------------|----------------------|
| As-76      |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| As-77      |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| At-211     | Astatine (85) | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Au-193     | Gold (79)     | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Au-194     |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Au-195     |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Au-198     |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Au-199     |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ba-131     | Barium (56)   | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ba-133     |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ba-133m    |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ba-140 (b) |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Be-7       | Beryllium (4) | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Be-10      |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Bi-205     | Bismuth (83)  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Bi-206     |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Bi-207     |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Bi-210     |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Bi-210m    |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
|            |               |                   |                       |                   |                      |

|            |                |                     |                       |                     |                      |
|------------|----------------|---------------------|-----------------------|---------------------|----------------------|
| Bi-212 (b) |                | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Bk-247     | Berkelium (97) | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Bk-249     |                | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Br-76      | Bromine (35)   | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Br-77      |                | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Br-82      |                | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| C-11       | Carbon (6)     | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| C-14       |                | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Ca-41      | Calcium (20)   | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Ca-45      |                | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Ca-47      |                | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Cd-109     | Cadmium (48)   | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Cd-113m    |                | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Cd-115     |                | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Cd-115m    |                | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ce-139     | Cerium (58)    | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ce-141     |                | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Ce-143     |                | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ce-144 (b) |                | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
|            |                |                     |                       |                     |                      |

|        |                  |                     |                       |                     |                      |
|--------|------------------|---------------------|-----------------------|---------------------|----------------------|
| Cf-248 | Californium (98) | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Cf-249 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Cf-250 |                  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Cf-251 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Cf-252 |                  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Cf-253 |                  | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Cf-254 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Cl-36  | Chlorine (17)    | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Cl-38  |                  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Cm-240 | Curium (96)      | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Cm-241 |                  | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Cm-242 |                  | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Cm-243 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Cm-244 |                  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Cm-245 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Cm-246 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Cm-247 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Cm-248 |                  | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Co-55  | Cobalt (27)      | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
|        |                  |                     |                       |                     |                      |

|            |                 |                   |                       |                   |                      |
|------------|-----------------|-------------------|-----------------------|-------------------|----------------------|
| Co-56      |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Co-57      |                 | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Co-58      |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Co-58m     |                 | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Co-60      |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Cr-51      | Chromium (24)   | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Cs-129     | Cesium (55)     | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Cs-131     |                 | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Cs-132     |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Cs-134     |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Cs-134m    |                 | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Cs-135     |                 | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Cs-136     |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Cs-137 (b) |                 | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Cu-64      | Copper (29)     | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Cu-67      |                 | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Dy-159     | Dysprosium (66) | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Dy-165     |                 | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Dy-166     |                 | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
|            |                 |                   |                       |                   |                      |

|                      |               |                     |                       |                     |                      |
|----------------------|---------------|---------------------|-----------------------|---------------------|----------------------|
| Er-169               | Erbium (68)   | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Er-171               |               | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-147               | Europium (63) | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-148               |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-149               |               | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Eu-150 (short lived) |               | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-150 (long lived)  |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-152               |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-152m              |               | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-154               |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Eu-155               |               | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Eu-156               |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| F-18                 | Fluorine (9)  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Fe-52                | Iron (26)     | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Fe-55                |               | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Fe-59                |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Fe-60                |               | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Ga-67                | Gallium (31)  | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ga-68                |               | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
|                      |               |                     |                       |                     |                      |

|         |                 |                     |                       |                     |                      |
|---------|-----------------|---------------------|-----------------------|---------------------|----------------------|
| Ga-72   |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Gd-146  | Gadolinium (64) | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Gd-148  |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Gd-153  |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Gd-159  |                 | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ge-68   | Germanium (32)  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Ge-71   |                 | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Ge-77   |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Hf-172  | Hafnium (72)    | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hf-175  |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hf-181  |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hf-182  |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hg-194  | Mercury (80)    | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hg-195m |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hg-197  |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Hg-197m |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Hg-203  |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Ho-166  | Holmium (67)    | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Ho-166m |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
|         |                 |                     |                       |                     |                      |

|         |                |                   |                       |                   |                      |
|---------|----------------|-------------------|-----------------------|-------------------|----------------------|
| I-123   | Iodine (53)    | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| I-124   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| I-125   |                | $1.0 \times 10^5$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| I-126   |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| I-129   |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| I-131   |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| I-132   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| I-133   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| I-134   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| I-135   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| In-111  | Indium (49)    | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| In-113m |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| In-114m |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| In-115m |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ir-189  | Iridium (77)   | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Ir-190  |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ir-192  |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Ir-194  |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| K-40    | Potassium (19) | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
|         |                |                   |                       |                   |                      |

|         |                |                   |                       |                      |                      |
|---------|----------------|-------------------|-----------------------|----------------------|----------------------|
| K-42    |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
| K-43    |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
| Kr-79   | Krypton (36)   | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| Kr-81   |                | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| Kr-85   |                | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$  | $1.0 \times 10^4$    | $2.7 \times 10^{-7}$ |
| Kr-85m  |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^{10}$ | $2.7 \times 10^{-1}$ |
| Kr-87   |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^9$    | $2.7 \times 10^{-2}$ |
| La-137  | Lanthanum (57) | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| La-140  |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| Lu-172  | Lutetium (71)  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
| Lu-173  |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| Lu-174  |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| Lu-174m |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| Lu-177  |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| Mg-28   | Magnesium (12) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| Mn-52   | Manganese (25) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| Mn-53   |                | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^9$    | $2.7 \times 10^{-2}$ |
| Mn-54   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
| Mn-56   |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
|         |                |                   |                       |                      |                      |



|                      |                 |                     |                       |                     |                      |
|----------------------|-----------------|---------------------|-----------------------|---------------------|----------------------|
| Mo-93                | Molybdenum (42) | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Mo-99                |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| N-13                 | Nitrogen (7)    | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>9</sup> | 2.7X10 <sup>-2</sup> |
| Na-22                | Sodium (11)     | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Na-24                |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Nb-93m               | Niobium (41)    | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Nb-94                |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Nb-95                |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Nb-97                |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Nd-147               | Neodymium (60)  | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Nd-149               |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ni-59                | Nickel (28)     | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Ni-63                |                 | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Ni-65                |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Np-235               | Neptunium (93)  | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Np-236 (short-lived) |                 | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Np-236 (long-lived)  |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Np-237 (b)           |                 | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Np-239               |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
|                      |                 |                     |                       |                     |                      |

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| Os-185     | Osmium (76)       | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Os-191     |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Os-191m    |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Os-193     |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Os-194     |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| P-32       | Phosphorus (15)   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| P-33       |                   | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Pa-230     | Protactinium (91) | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pa-231     |                   | 1.0                 | 2.7X10 <sup>-11</sup> | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup> |
| Pa-233     |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Pb-201     | Lead (82)         | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pb-202     |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pb-203     |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pb-205     |                   | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Pb-210 (b) |                   | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Pb-212 (b) |                   | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Pd-103     | Palladium (46)    | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Pd-107     |                   | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup>  | 1.0X10 <sup>8</sup> | 2.7X10 <sup>-3</sup> |
| Pd-109     |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
|            |                   |                     |                       |                     |                      |

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| Pm-143  | Promethium (61)   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pm-144  |                   | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pm-145  |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Pm-147  |                   | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Pm-148m |                   | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pm-149  |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pm-151  |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Po-210  | Polonium (84)     | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Pr-142  | Praseodymium (59) | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Pr-143  |                   | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pt-188  | Platinum (78)     | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pt-191  |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pt-193  |                   | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Pt-193m |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Pt-195m |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pt-197  |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pt-197m |                   | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Pu-236  | Plutonium (94)    | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Pu-237  |                   | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
|         |                   |                     |                       |                     |                      |

|            |               |                   |                       |                   |                      |
|------------|---------------|-------------------|-----------------------|-------------------|----------------------|
| Pu-238     |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Pu-239     |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Pu-240     |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$ |
| Pu-241     |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Pu-242     |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Pu-244     |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Ra-223 (b) | Radium (88)   | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Ra-224 (b) |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Ra-225     |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Ra-226 (b) |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Ra-228 (b) |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Rb-81      | Rubidium (37) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Rb-83      |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Rb-84      |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Rb-86      |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Rb-87      |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Rb(nat)    |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Re-184     | Rhenium (75)  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Re-184m    |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
|            |               |                   |                       |                   |                      |

|            |                |                   |                       |                   |                      |
|------------|----------------|-------------------|-----------------------|-------------------|----------------------|
| Re-186     |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Re-187     |                | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$  | $1.0 \times 10^9$ | $2.7 \times 10^{-2}$ |
| Re-188     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Re-189     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Re(nat)    |                | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$  | $1.0 \times 10^9$ | $2.7 \times 10^{-2}$ |
| Rh-99      | Rhodium (45)   | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Rh-101     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Rh-102     |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Rh-102m    |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Rh-103m    |                | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^8$ | $2.7 \times 10^{-3}$ |
| Rh-105     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Rn-222 (b) | Radon (86)     | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^8$ | $2.7 \times 10^{-3}$ |
| Ru-97      | Ruthenium (44) | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Ru-103     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ru-105     |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Ru-106 (b) |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| S-35       | Sulphur (16)   | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$  | $1.0 \times 10^8$ | $2.7 \times 10^{-3}$ |
| Sb-122     | Antimony (51)  | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Sb-124     |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
|            |                |                   |                       |                   |                      |

|         |               |                   |                       |                   |                      |
|---------|---------------|-------------------|-----------------------|-------------------|----------------------|
| Sb-125  |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Sb-126  |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Sc-44   | Scandium (21) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Sc-46   |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Sc-47   |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Sc-48   |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Se-75   | Selenium (34) | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Se-79   |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Si-31   | Silicon (14)  | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Si-32   |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Sm-145  | Samarium (62) | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Sm-147  |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Sm-151  |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^8$ | $2.7 \times 10^{-3}$ |
| Sm-153  |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Sn-113  | Tin (50)      | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Sn-117m |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Sn-119m |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Sn-121m |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Sn-123  |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
|         |               |                   |                       |                   |                      |

|                     |                 |                     |                       |                     |                      |
|---------------------|-----------------|---------------------|-----------------------|---------------------|----------------------|
| Sn-125              |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Sn-126              |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Sr-82               | Strontium (38)  | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Sr-85               |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Sr-85m              |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Sr-87m              |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Sr-89               |                 | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Sr-90 (b)           |                 | 1.0X10 <sup>2</sup> | 2.7X10 <sup>-9</sup>  | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Sr-91               |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>5</sup> | 2.7X10 <sup>-6</sup> |
| Sr-92               |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| T(H-3)              | Tritium (1)     | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup>  | 1.0X10 <sup>9</sup> | 2.7X10 <sup>-2</sup> |
| Ta-178 (long-lived) | Tantalum (73)   | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Ta-179              |                 | 1.0X10 <sup>3</sup> | 2.7X10 <sup>-8</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Ta-182              |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup> |
| Tb-157              | Terbium (65)    | 1.0X10 <sup>4</sup> | 2.7X10 <sup>-7</sup>  | 1.0X10 <sup>7</sup> | 2.7X10 <sup>-4</sup> |
| Tb-158              |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Tb-160              |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Tc-95m              | Technetium (43) | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
| Tc-96               |                 | 1.0X10 <sup>1</sup> | 2.7X10 <sup>-10</sup> | 1.0X10 <sup>6</sup> | 2.7X10 <sup>-5</sup> |
|                     |                 |                     |                       |                     |                      |

|            |                |                   |                       |                   |                      |
|------------|----------------|-------------------|-----------------------|-------------------|----------------------|
| Tc-96m     |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Tc-97      |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^8$ | $2.7 \times 10^{-3}$ |
| Tc-97m     |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Tc-98      |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Tc-99      |                | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Tc-99m     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Te-121     | Tellurium (52) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Te-121m    |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Te-123m    |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Te-125m    |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Te-127     |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Te-127m    |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Te-129     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Te-129m    |                | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Te-131m    |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Te-132     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Th-227     | Thorium (90)   | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Th-228 (b) |                | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Th-229 (b) |                | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$ |



|                                      |               |                   |                       |                   |                      |
|--------------------------------------|---------------|-------------------|-----------------------|-------------------|----------------------|
| Th-230                               |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Th-231                               |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Th-232                               |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Th-234 (b)                           |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Th (nat) (b)                         |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$ |
| Ti-44                                | Titanium (22) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Tl-200                               | Thallium (81) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Tl-201                               |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Tl-202                               |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Tl-204                               |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| Tm-167                               | Thulium (69)  | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Tm-170                               |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Tm-171                               |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^8$ | $2.7 \times 10^{-3}$ |
| U-230 (fast lung absorption) (b),(d) | Uranium (92)  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| U-230 (medium lung absorption) (e)   |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-230 (slow lung absorption) (f)     |               | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-232 (fast lung absorption) (b),(d) |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$ |
|                                      |               |                   |                       |                   |                      |

|                                                    |  |                   |                       |                   |                      |
|----------------------------------------------------|--|-------------------|-----------------------|-------------------|----------------------|
| U-232 (medium lung absorption) (e)                 |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-232 (slow lung absorption) (f)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-233 (fast lung absorption) (d)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-233 (medium lung absorption) (e)                 |  | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| U-233 (slow lung absorption) (f)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| U-234 (fast lung absorption) (d)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-234 (medium lung absorption) (e)                 |  | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| U-234 (slow lung absorption) (f)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| U-235 (all lung absorption types) (b), (d),(e),(f) |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-236 (fast lung absorption) (d)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-236 (medium lung absorption) (e)                 |  | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| U-236 (slow lung absorption) (f)                   |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |
| U-238 (all lung                                    |  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$ |

|                                       |               |                   |                       |                      |                      |
|---------------------------------------|---------------|-------------------|-----------------------|----------------------|----------------------|
| absorption types) (b),<br>(d),(e),(f) |               |                   |                       |                      |                      |
| U (nat) (b)                           |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$    | $2.7 \times 10^{-8}$ |
| U (enriched to 20% or<br>less) (g)    |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$    | $2.7 \times 10^{-8}$ |
| U (dep)                               |               | 1.0               | $2.7 \times 10^{-11}$ | $1.0 \times 10^3$    | $2.7 \times 10^{-8}$ |
| V-48                                  | Vanadium (23) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| V-49                                  |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| W-178                                 | Tungsten (74) | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
| W-181                                 |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| W-185                                 |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^7$    | $2.7 \times 10^{-4}$ |
| W-187                                 |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
| W-188                                 |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| Xe-122                                | Xenon (54)    | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^9$    | $2.7 \times 10^{-2}$ |
| Xe-123                                |               | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^9$    | $2.7 \times 10^{-2}$ |
| Xe-127                                |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^5$    | $2.7 \times 10^{-6}$ |
| Xe-131m                               |               | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^4$    | $2.7 \times 10^{-7}$ |
| Xe-133                                |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^4$    | $2.7 \times 10^{-7}$ |
| Xe-135                                |               | $1.0 \times 10^3$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^{10}$ | $2.7 \times 10^{-1}$ |
| Y-87                                  | Yttrium (39)  | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$    | $2.7 \times 10^{-5}$ |
|                                       |               |                   |                       |                      |                      |

|           |                |                   |                       |                   |                      |
|-----------|----------------|-------------------|-----------------------|-------------------|----------------------|
| Y-88      |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Y-90      |                | $1.0 \times 10^5$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Y-91      |                | $1.0 \times 10^5$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Y-91m     |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Y-92      |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Y-93      |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |
| Yb-169    | Ytterbium (70) | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Yb-175    |                | $1.0 \times 10^5$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Zn-65     | Zinc (30)      | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Zn-69     |                | $1.0 \times 10^4$ | $2.7 \times 10^{-7}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Zn-69m    |                | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Zr-88     | Zirconium (40) | $1.0 \times 10^2$ | $2.7 \times 10^{-9}$  | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Zr-93 (b) |                | $1.0 \times 10^5$ | $2.7 \times 10^{-8}$  | $1.0 \times 10^7$ | $2.7 \times 10^{-4}$ |
| Zr-95     |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^6$ | $2.7 \times 10^{-5}$ |
| Zr-97 (b) |                | $1.0 \times 10^1$ | $2.7 \times 10^{-10}$ | $1.0 \times 10^5$ | $2.7 \times 10^{-6}$ |

<sup>a</sup>(Reserved)

<sup>b</sup>Parent nuclides and their progeny included in secular equilibrium are listed in the following:

|       |        |
|-------|--------|
| Sr-90 | Y-90   |
| Zr-93 | Nb-93m |
| Zr-97 | Nb-97  |

|         |                                                                                                        |
|---------|--------------------------------------------------------------------------------------------------------|
| Ru-106  | Rh-106                                                                                                 |
| Cs-137  | Ba-137m                                                                                                |
| Ce-144  | Pr-144                                                                                                 |
| Ba-140  | La-140                                                                                                 |
| Bi-212  | Tl-208 (0.36), Po-212 (0.64)                                                                           |
| Pb-210  | Bi-210, Po-210                                                                                         |
| Pb-212  | Bi-212, Tl-208 (0.36), Po-212 (0.64)                                                                   |
| Rn-222  | Po-218, Pb-214, Bi-214, Po-214                                                                         |
| Ra-223  | Rn-219, Po-215, Pb-211, Bi-211, Tl-207                                                                 |
| Ra-224  | Rn-220, Po-216, Pb-212, Bi-212, Tl-208(0.36), Po-212 (0.64)                                            |
| Ra-226  | Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210                                         |
| Ra-228  | Ac-228                                                                                                 |
| Th-228  | Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)                                   |
| Th-229  | Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209                                                 |
| Th-nat  | Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)           |
| Th-234  | Pa-234m                                                                                                |
| U-230   | Th-226, Ra-222, Rn-218, Po-214                                                                         |
| U-232   | Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)                           |
| U-235   | Th-231                                                                                                 |
| U-238   | Th-234, Pa-234m                                                                                        |
| U-nat   | Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 |
| Np-237  | Pa-233                                                                                                 |
| Am-242m | Am-242                                                                                                 |

Am-243

Np-239

<sup>c</sup>(Reserved)

<sup>d</sup>These values apply only to compounds of uranium that take the chemical form of  $UF_6$ ,  $UO_2F_2$  and  $UO_2(NO_3)_2$  in both normal and accident conditions of transport.

<sup>e</sup>These values apply only to compounds of uranium that take the chemical form of  $UO_3$ ,  $UF_4$ ,  $UCl_4$  and hexavalent compounds in both normal and accident conditions of transport.

<sup>f</sup>These values apply to all compounds of uranium other than those specified in notes (d) and (e) of this table.

<sup>g</sup>These values apply to unirradiated uranium only.

H. Table 3. General Values for  $A_1$  and  $A_2$ .

| Contents                                                                                                                     | $A_1$              |                      | $A_2$              |                      | Activity concentration for exempt material (Bq/g) | Activity concentration for exempt material (Ci/g) | Activity limits for exempt consignments (Bq) | Activity limits for exempt consignments (Ci) |
|------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------|--------------------|----------------------|---------------------------------------------------|---------------------------------------------------|----------------------------------------------|----------------------------------------------|
|                                                                                                                              | (TBq)              | (Ci)                 | (TBq)              | (Ci)                 |                                                   |                                                   |                                              |                                              |
| Only beta or gamma emitting radionuclides are known to be present                                                            | $1 \times 10^{-1}$ | $2.7 \times 10^0$    | $2 \times 10^{-2}$ | $5.4 \times 10^{-1}$ | $1 \times 10^1$                                   | $2.7 \times 10^{-10}$                             | $1 \times 10^4$                              | $2.7 \times 10^{-7}$                         |
| Alpha emitting radionuclides, but no neutron emitters, are known to be present (a)                                           | $2 \times 10^{-1}$ | $5.4 \times 10^0$    | $9 \times 10^{-5}$ | $2.4 \times 10^{-3}$ | $1 \times 10^{-1}$                                | $2.7 \times 10^{-12}$                             | $1 \times 10^3$                              | $2.7 \times 10^{-8}$                         |
| Neutron emitting nuclides are known to be present or no relevant data are available                                          | $1 \times 10^{-3}$ | $2.7 \times 10^{-2}$ | $9 \times 10^{-5}$ | $2.4 \times 10^{-3}$ | $1 \times 10^{-1}$                                | $2.7 \times 10^{-12}$                             | $1 \times 10^3$                              | $2.7 \times 10^{-8}$                         |
| <sup>a</sup> If beta or gamma emitting nuclides are known to be present, the $A_1$ value of 0.1 TBq (2.7 Ci) should be used. |                    |                      |                    |                      |                                                   |                                                   |                                              |                                              |

I. Table 4. Activity-Mass Relationships for Uranium.

| Uranium Enrichment <sup>1</sup><br>wt % U-235 present | Specific Activity |      |
|-------------------------------------------------------|-------------------|------|
|                                                       | TBq/g             | Ci/g |
|                                                       |                   |      |

|                                                                                                                                                            |                      |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
| 0.45                                                                                                                                                       | $1.8 \times 10^{-8}$ | $5.0 \times 10^{-7}$ |
| 0.72                                                                                                                                                       | $2.6 \times 10^{-8}$ | $7.1 \times 10^{-7}$ |
| 1                                                                                                                                                          | $2.8 \times 10^{-8}$ | $7.6 \times 10^{-7}$ |
| 1.5                                                                                                                                                        | $3.7 \times 10^{-8}$ | $1.0 \times 10^{-6}$ |
| 5                                                                                                                                                          | $1.0 \times 10^{-7}$ | $2.7 \times 10^{-6}$ |
| 10                                                                                                                                                         | $1.8 \times 10^{-7}$ | $4.8 \times 10^{-6}$ |
| 20                                                                                                                                                         | $3.7 \times 10^{-7}$ | $1.0 \times 10^{-5}$ |
| 35                                                                                                                                                         | $7.4 \times 10^{-7}$ | $2.0 \times 10^{-5}$ |
| 50                                                                                                                                                         | $9.3 \times 10^{-7}$ | $2.5 \times 10^{-5}$ |
| 90                                                                                                                                                         | $2.2 \times 10^{-6}$ | $5.8 \times 10^{-5}$ |
| 93                                                                                                                                                         | $2.6 \times 10^{-6}$ | $7.0 \times 10^{-5}$ |
| 95                                                                                                                                                         | $3.4 \times 10^{-6}$ | $9.1 \times 10^{-5}$ |
| <sup>1</sup> The figures for uranium include representative values for the activity of the uranium-234 that is concentrated during the enrichment process. |                      |                      |

**Statutory Authority**

§ 32.1-229 of the Code of Virginia.

**Historical Notes**

Derived from Virginia Register Volume 24, Issue 18, eff. June 12, 2008; amended, Virginia Register Volume 32, Issue 24, eff. August 25, 2016; Volume 34, Issue 2, eff. October 18, 2017.

**12VAC5-481-3780. Nationally tracked source thresholds.**

The terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values are provided for practical usefulness only and are rounded after conversion.

| Radioactive material | Category 1 (TBq) | Category 1 (Ci) | Category 2 (TBq) | Category 2 (Ci) |
|----------------------|------------------|-----------------|------------------|-----------------|
| Actinium-227         | 20               | 540             | 0.2              | 5.4             |
| Americium-241        | 60               | 1,600           | 0.6              | 16              |
| Americium-241/Be     | 60               | 1,600           | 0.6              | 16              |
| Californium-252      | 20               | 540             | 0.2              | 5.4             |
| Cobalt-60            | 30               | 810             | 0.3              | 8.1             |
| Curium-244           | 50               | 1,400           | 0.5              | 14              |
| Cesium-137           | 100              | 2,700           | 1                | 27              |
| Gadolinium-153       | 1,000            | 27,000          | 10               | 270             |
| Iridium-192          | 80               | 2,200           | 0.8              | 22              |
| Plutonium-238        | 60               | 1,600           | 0.6              | 16              |
| Plutonium-239/Be     | 60               | 1,600           | 0.6              | 16              |
| Polonium-210         | 60               | 1,600           | 0.6              | 16              |
| Promethium-147       | 40,000           | 1,100,000       | 400              | 11,000          |
| Radium-226           | 40               | 1,100           | 0.4              | 11              |
| Selenium-75          | 200              | 5,400           | 2                | 54              |
| Strontium-90         | 1,000            | 27,000          | 10               | 270             |
| Thorium-228          | 20               | 540             | 0.2              | 5.4             |
| Thorium-229          | 20               | 540             | 0.2              | 5.4             |
| Thulium-170          | 20,000           | 540,000         | 200              | 5,400           |



|               |     |       |   |    |
|---------------|-----|-------|---|----|
| Ytterbium-169 | 300 | 8,100 | 3 | 81 |
|---------------|-----|-------|---|----|

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