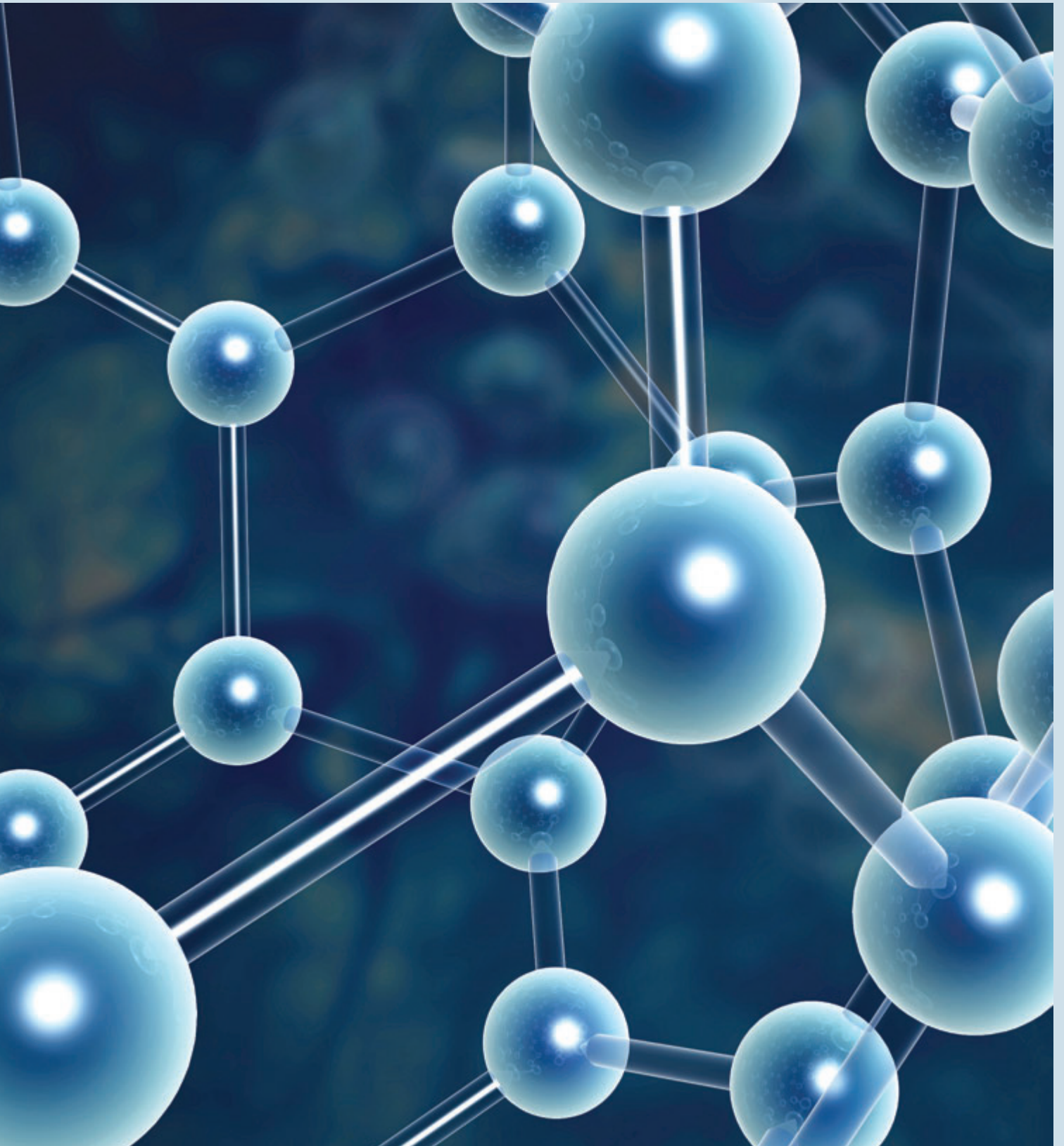


# Special Isotopes

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## Reference and Calibration Sources

The following isotopes may require consultation with Technical Support before ordering. The information in this table is meant to alert the end user of these isotopes to certain features and issues associated with them.

Special Isotopes	
Si-32	P-32 daughter is in equilibrium. Glass containers are not suitable for long-term storage of Si-32 solutions and solutions sold by EZIP are packaged in polypropylene v-vials.
Ni-63	Beta sources have no cover, and due to self-absorption within sources, they are certified for contained activity, and separately for surface emission rate.
Ge-68	Ga-68 daughter (half-life: 68 minutes) is in equilibrium; both the positrons and 1077 keV gamma rays come from Ga-68.
Sr-90	Y-90 daughter (half-life: 2.67 days) is in equilibrium. Users are urged to distinguish between orders for Sr-90 only and Sr-90/Y-90 taking into account activity of Y-90 present. The certified activity is generally for Sr-90 only. The surface emission rate for beta sources is for Sr-90, plus Y-90.
Zr-95	Nb-95 daughter is generally not in equilibrium. Glass containers are not suitable for long-term storage of Zr-95 solutions, and EZIP packages Zr-95 in polypropylene v-vials.
Ru-106	Rh-106 daughter (half-life: 29.8 seconds) is in equilibrium. All gamma rays come from the daughter Rh-106.
I-131Sim	Simulated I-131 is made from Ba-133 and Cs-137 to simulate I-131 in terms of gamma emissions. I-131 has gamma rays at 364 keV (81.2%) and at 636, 642, and 723 keV with branching ratios of 7.27, 0.220 and 1.80%, respectively. Ba-133 has gamma rays at 356 (61.94%) and 384 keV (8.905%). The gamma rays at 356 and 384 keV from Ba-133 are used to simulate the 364 keV gamma ray of I-131. The 662 keV gamma rays from Cs-137 are used to simulate the 636, 642, and 723 keV gamma rays of I-131. To produce the same number of gamma rays as 1 uCi of I-131 (at 364 keV), the amount of Ba-133 required will be $(81.2/61.94+8.90) = 1.146 \mu\text{Ci}$ and the amount of Cs-137 needed will be $(7.27+0.220+1.80)/85.1 = 0.1092 \mu\text{Ci}$ .
Pb-210	Bi-210 daughter is in equilibrium.
Ra-226	Daughters (Rn-222, Po-218, Pb-214, Bi-214, Po-214 Pb-210, Bi-210, Po-210) may not be in equilibrium. Radon is a noble gas and will diffuse from the surface of its source and contaminate exposed surfaces. Open sources must be handled with caution.
Th-228	Daughters (Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212, Tl-208) may not be in equilibrium. Radon is a noble gas and will diffuse from the surface of its source and contaminate exposed surfaces. Open sources must be handled with caution.
Th-232	Daughters (Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212, Tl-208) may not be in equilibrium. Due to its extremely low specific activity, only very small quantities of activity may be available.
Am-241	Type M source has a backing of 0.0254 mm platinum plus 9.23 mg/cm <sup>2</sup> kapton and a cover of 0.0254 mm aluminum.
Am-243	Np-239 (beta active, half-life: 2.35 days) daughter is in equilibrium. Gamma rays (from Np-239): 106.1 keV (27.2%), 228.2 keV (11.27%), 277.6 keV (14.38%).
Cf-252	Will have californium impurities and is supplied with a Technical Data Sheet. It is sold as a neutron source, fission source or alpha source, and calibrated accordingly.

# Special Isotopes

## Uranium

Uranium consists of a mixture of isotopes. All uranium sources, in general, are certified on the basis of specific activity and mass. EZIP calculates the activity percentages of the isotopes present using technical data provided by the vendor of the material, and writes a Technical Data Sheet. The Technical Data Sheet is a part of the Certificate of Calibration.

It is very difficult to separate U-234 from U-235. Since the specific activity of U-234 is 2867 times that of U-235, a 1% amount by mass of U-234 in U-235 will create an activity of U-234 28 times higher than that of U-235.

Since the amount of uranium mass itself in a solution could be substantial, the solution densities could be much higher than the diluent (as high as 1.5 g/cc). Uranium sources are generally electroplated on an aluminum surface.

**Natural** uranium has the following atom % composition:

U-234 = 0.0055 atom %

U-235 = 0.720 atom %

U-238 = 99.2745 atom %

**Enriched** means higher atom % of U-235 than natural uranium.

**Depleted** means lower atom % of U-235 than natural uranium.

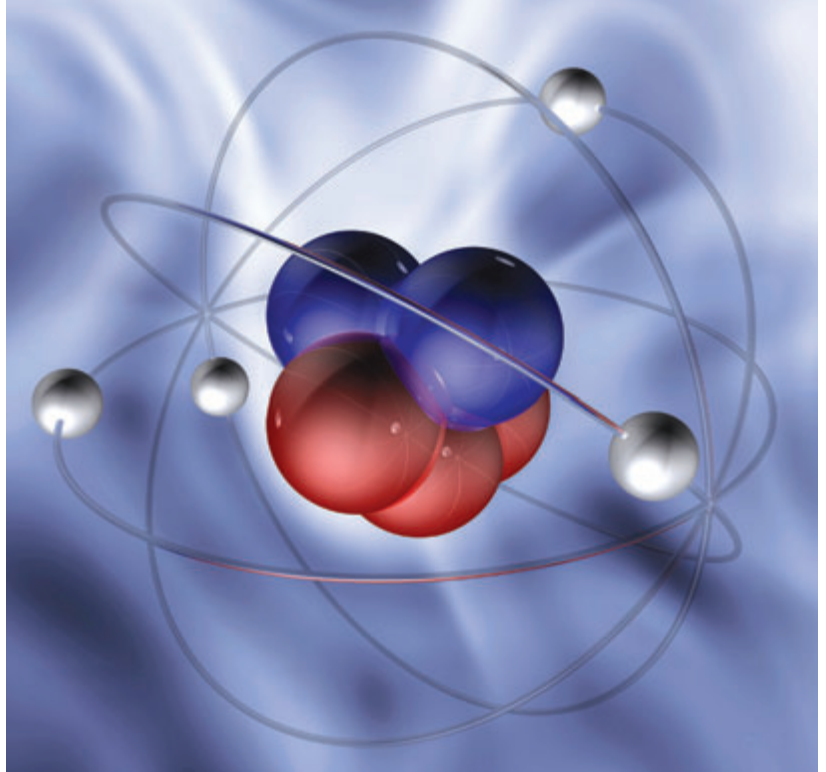
## Uranium Isotopes

U-232	Due to relatively short half-life, this isotope is generally free from other uranium isotopes. Daughters (Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212, Tl-208) may not be in equilibrium. When this isotope is available, sources and solutions are sold as: <ol style="list-style-type: none"><li>1. <i>Purified with no daughters</i>: If this kind is ordered, the daughters have to be separated, the solution calibrated (using LSC) and the solution shipped within 72 hours.</li><li>2. <i>As is</i>: (amount of daughters to be calculated).</li><li>3. <i>Daughters in equilibrium</i>: In this case the right amount of Th-228 (in equilibrium with its daughters) is added.</li></ol> Please contact customer service for availability of this isotope.
U-233	Technical Data Sheet, and EZIP will specify the activity for the primary isotope or the total activity.
U-235	Technical Data Sheet, and EZIP will specify the activity for the total uranium activity. Please contact customer service for specific requirements.
U-236	Technical Data Sheet, and EZIP will specify the activity for the primary isotope or the total uranium activity.
U-238	Technical Data Sheet, and EZIP will specify the activity for the total uranium activity. Please specify natural or depleted. U-238 will be in equilibrium with Th-234 and Pa-234m (both beta active). Please contact customer service for specific requirements.

## Plutonium

Plutonium consists of a mixture of isotopes. EZIP calculates the activity percentages of the isotopes present using technical data provided by the vendor of the material, and writes a Technical Data Sheet. The Technical Data Sheet is a part of the Certificate of Calibration.

Plutonium isotopes are complicated by the presence of Pu-241, which is beta active, and has a relatively short half-life of 14.4 years. Its daughter is Am-241, which is alpha active with significant gamma rays.



### Plutonium Isotopes

Pu-238	Technical Data Sheet, and EZIP will specify the activity for the primary isotope or the total activity.
Pu-239	Technical Data Sheet, and EZIP will specify the activity for the primary isotope or the total activity.
Pu-240	Technical Data Sheet, and EZIP will specify the activity for the primary isotope or the total activity.
Pu-241	Beta active. Technical Data Sheet, and EZIP will specify the activity for the Pu-241 isotope.
Pu-242	Technical Data Sheet, and EZIP will specify the activity for the primary isotope or the total activity.