NPL Commercial Services
Radioactive Standardised Solutions
2014 v3
Introducing NPL

Setting the standard
NPL is a world-leading centre for the development of measurement standards, technology and best practice. Quality of measurement is disseminated by collaborative research and development, licensing of intellectual property, consultancy, networking and through measurement services. Our capabilities underpin the UK National Measurement System (NMS), ensuring consistency and traceability of measurements in support of UK and overseas customer interests throughout the world.

Delivering service excellence
NPL’s reputation relies on the quality of support we provide, directly and indirectly, to hundreds of thousands of users worldwide for whom maintaining traceable and fit-for-purpose measurement is vital to their business. Our commitment to scientific excellence is coupled with a determination to offer high quality and affordable measurement services.

NPL’s commitment to quality
As the national measurement standards laboratory in the UK, NPL offers services at the highest available levels of accuracy. Customers depend on these to achieve direct traceability to nationally and internationally accepted standards. These services are operated within stringent quality and procedural requirements. To demonstrate this formally, it is NPL’s policy to seek accreditation for its measurement services.

ISO 9001
NPL’s quality management system has been registered for scientific R & D and the provision of internal services by LRQA to ISO 9001: 2000 and where appropriate in accordance with TickIT.

ISO 17025 and ISO Guide 34
Many of NPL’s standard calibration, measurement and testing services have been accredited by UKAS. The accredited capability of those services may be found in calibration and testing schedules issued by UKAS.

CIPM MRA
Many NPL certificates now display the CIPM MRA logo and statement, indicating that calibration and measurement certificates issued by NPL are recognised by other national metrology institutes (eg. PTB, NIST).
How to order

If you would like to discuss your radioactivity measurement issues with an expert in the field, or receive further information on the products and services in this brochure please contact Customer Services.

Customer Services: 020 8943 8695
E-mail: radioactivity@npl.co.uk

Lead times

Subject to availability and compliance with transport and export regulations, we aim to have stock products ready to be dispatched within 20 working days. Lead times for custom made standards will vary, depending on material availability.

Export Control

Depending on activity and delivery location the sale of some radioactive sources may be subject to UK Export Control Regulations. NPL must apply any restrictions enforced by these regulations. The time taken to process an application for an export licence is outside of our control, and is likely to impact on the delivery schedule.

Shelf life

The solutions are expected to be chemically stable in the ampoules for at least two years after dispatch.

Warranty

Radioactive sources naturally decay over time, each having a different "half-life" the period it takes for the material to half its activity. As such it is not possible to provide any warranty for radioactive material.

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Contact details

National Physical Laboratory
Hampton Road
Teddington
Middlesex
United Kingdom
TW11 0LW
Customer Services: 020 8943 8695
E-mail: radioactivity@npl.co.uk
## Product information

### $^{243}$Am

This product has exceptionally low levels of $^{241}$Am, which enables more accurate determination of Am isotopes.

#### Impurities

$^{241}$Am  
0.3 %

$^{242m}$Am  
<0.003 %

$^{242}$Cm and $^{244}$Cm  
<0.002 %

### $^{236}$Pu

The sources are standardised using liquid scintillation techniques. Impurities are assayed by high resolution gamma spectrometry and by alpha spectrometry.

#### Impurities

$^{232}$U  
0.4%

No other Pu isotopes detected

### $^{242}$Pu

Ultra pure with only $^{241}$Pu detectable, also available at a higher activity. Impurities are assayed by high resolution gamma spectrometry and by alpha spectrometry.

#### Impurities

$^{241}$Am  
0.3 %

$^{241}$Pu  
6 %

### $^{209}$Po

This product offers advantages over $^{208}$Po as a tracer, due to it being much longer lived and with a much larger energy separation, over $^{210}$Po. However we are currently unable to provide calibration standards of polonium-209 due to chemical stability difficulties.

This material is supplied without a calibration certificate and may still be used as a radiochemical yield tracer with an additional step of liquid scintillation counting, instructions for this can be supplied.

#### Impurities

None detected

---

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Nominal Activity Concentration</th>
<th>Container Size</th>
<th>Chemical Form</th>
<th>NPL Product Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{243}$Am</td>
<td>1 Bq/g</td>
<td>100 Bq/g</td>
<td>10 ml Ampoule</td>
<td>1 mol dm$^{-3}$ HNO$_3$</td>
</tr>
<tr>
<td>$^{236}$Pu</td>
<td>10 Bq/g</td>
<td>150 Bq/g</td>
<td>5 ml Ampoule</td>
<td>2 mol dm$^{-3}$ HNO$_3$</td>
</tr>
<tr>
<td>$^{241}$Pu</td>
<td>10 Bq/g</td>
<td>150 Bq/g</td>
<td>10 ml Ampoule</td>
<td>2 mol dm$^{-3}$ HNO$_3$</td>
</tr>
<tr>
<td>$^{241}$Pu</td>
<td>4 kBq/g</td>
<td>5 ml Ampoule</td>
<td>2 mol dm$^{-3}$ HNO$_3$</td>
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<td>$^{242}$Pu</td>
<td>1 Bq/g</td>
<td>12.5 Bq/g</td>
<td>10 ml Ampoule</td>
<td>2 mol dm$^{-3}$ HNO$_3$</td>
</tr>
<tr>
<td>$^{209}$Po</td>
<td>100 Bq/g</td>
<td></td>
<td>10 ml Ampoule</td>
<td>8 mol dm$^{-3}$ HCl</td>
</tr>
<tr>
<td>$^{229}$Th</td>
<td>1 Bq/g</td>
<td>10 Bq/g</td>
<td>100 Bq/g</td>
<td>10 ml Ampoule</td>
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<tr>
<td>$^{232}$U</td>
<td>1 Bq/g</td>
<td>10 Bq/g</td>
<td>100 Bq/g</td>
<td>5 kBq/g</td>
</tr>
</tbody>
</table>
229\textsuperscript{Th}

The solution is prepared by gravimetric dilution of a solution of standardised \textsuperscript{229}Th.

**Impurities**

Alpha Spectrometry indicated the presence of Th in stock solution. The activity concentrations of these impurities were determined to be:

\begin{align*}
\text{\textsuperscript{228}Th} & \quad 0.03 \% \\
\text{\textsuperscript{230}Th} & \quad 0.001 \% \\
\text{\textsuperscript{232}Th} & \quad 0.001 \%
\end{align*}

232\textsuperscript{U}

Available at three different activity concentrations. The solution is checked for \(\alpha\) and \(\gamma\) emitting contaminants by \(\alpha\)-spectrometry and by high-resolution \(\gamma\)-spectrometry.

**Impurities**

None detected
### Solutions for calibrating liquid scintillation counters

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Nominal Activity Concentration</th>
<th>Container Size</th>
<th>Chemical Form</th>
<th>NPL Product Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{36}$Cl</td>
<td>10 Bq/g 1 kBq/g</td>
<td>10 ml Ampoule</td>
<td>De-ionised water</td>
<td>R38-01 R38-03</td>
</tr>
<tr>
<td>$^{129}$I</td>
<td>100 Bq/g 1 kBq/g</td>
<td>10 ml Ampoule</td>
<td>0.001 mol dm$^{-3}$ NaOH</td>
<td>R14-02 R14-03</td>
</tr>
<tr>
<td>$^{90}$Sr</td>
<td>100 Bq/g 2 Bq/g</td>
<td>10 ml Ampoule</td>
<td>0.1 mol dm$^{-3}$ HCl</td>
<td>R01-03 R01-05</td>
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<tr>
<td>$^{90}$Sr</td>
<td>40 kBq/g</td>
<td>10 ml Ampoule</td>
<td>1 mol dm$^{-3}$ HNO$_3$</td>
<td>R01-04</td>
</tr>
<tr>
<td>$^{99}$Tc</td>
<td>100 Bq/g</td>
<td>10 ml Ampoule</td>
<td>0.1 mol dm$^{-3}$ NH$_4$OH</td>
<td>R11-02</td>
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<tr>
<td>$^3$H</td>
<td>10 Bq/g 100 Bq/g 5 kBq/g</td>
<td>10 ml Ampoule</td>
<td>De-ionised water</td>
<td>R30-01 R30-02 R30-04</td>
</tr>
<tr>
<td>$^{14}$C</td>
<td>100 Bq/g 2 kBq/g</td>
<td>10 ml Ampoule</td>
<td>0.1 mol dm$^{-3}$ NaOH</td>
<td>R19-02 R19-03</td>
</tr>
</tbody>
</table>
Solutions for gamma spectrometry

NPL mixed nuclides

The NPL ‘Mixed Nuclide’ solution contains a set of radionuclides with fourteen gamma lines between 60 keV and 1836 keV. The relative activities of the radionuclides in the mixtures have been adjusted so that the relative intensities of the peaks in the gamma-spectrum are optimum at the reference date. If dilution is required, the NPL inactive carrier solution should be used so that the radionuclides are not adsorbed on the walls of any vessels.

The ‘Mixed Nuclide’ is available at three activity concentrations including new large volume activity products, saving you time performing dilutions:

1. NPL Product Code R08-01: 500 g HDPE bottle, total activity 5 kBq
2. NPL Product Code R08-03: 10 g flame sealed glass ampoule, total activity 10 kBq
3. NPL Product Code R08-04: 10 g flame sealed glass ampoule, total activity 100 kBq

<table>
<thead>
<tr>
<th>Place order by end of</th>
<th>For delivery from</th>
<th>Reference date</th>
</tr>
</thead>
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<tr>
<td>February</td>
<td>April</td>
<td>1st June</td>
</tr>
<tr>
<td>September</td>
<td>November</td>
<td>1st January</td>
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</tbody>
</table>
Carrier Solution 500 g nominal of 4 mol dm$^{-3}$ HCl with 50 µg g$^{-1}$ of Cd, Co, Ce, Cr, Sn, Sr, Cs, Mn, Zn, Y.
# Single nuclides for gamma spectrometry

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Nominal Activity Concentration</th>
<th>Container Size</th>
<th>Chemical Form</th>
<th>NPL Product Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{241}$Am</td>
<td>10 Bq/g</td>
<td>300 Bq/g</td>
<td>10 ml Ampoule</td>
<td>0.5 mol dm$^{-3}$ HNO$_3$</td>
</tr>
<tr>
<td>$^{137}$Cs</td>
<td>10 Bq/g</td>
<td>100 Bq/g</td>
<td>10 ml Ampoule</td>
<td>0.1 mol dm$^{-3}$ HNO$_3$</td>
</tr>
<tr>
<td>$^{129}$I</td>
<td>100 Bq/g</td>
<td>1 kBq/g</td>
<td>10 ml Ampoule</td>
<td>0.001 mol dm$^{-3}$ NaOH</td>
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<tr>
<td>$^{210}$Pb</td>
<td>350 Bq/g</td>
<td>10 ml Ampoule</td>
<td>2 mol dm$^{-3}$ HNO$_3$</td>
<td>R22-02</td>
</tr>
<tr>
<td>$^{226}$Ra</td>
<td>37 kBq/g</td>
<td>5 ml Ampoule</td>
<td>2 mol dm$^{-3}$ HNO$_3$</td>
<td>R22-03</td>
</tr>
<tr>
<td>$^{226}$Ra</td>
<td>100 Bq/g</td>
<td>10 ml</td>
<td>1 mol dm$^{-3}$ HCL</td>
<td>R36-02</td>
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</table>
NPL can also supply custom made standards for a wide range of nuclides and activities.

Solutions are normally supplied as 1-10 ml in a flame sealed glass ampoule; larger volumes up to 1000 ml can be supplied in an HDPE bottle.

Below is a list of isotopes which have been standardised by NPL for customers. Other isotopes may be available on request:

<table>
<thead>
<tr>
<th>Element</th>
<th>Isotopes</th>
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<tbody>
<tr>
<td>Americium</td>
<td>241, 242m, 243</td>
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<tr>
<td>Antimony</td>
<td>124, 125</td>
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<tr>
<td>Barium</td>
<td>133, 140</td>
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<td>Beryllium</td>
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<tr>
<td>Bismuth</td>
<td>210</td>
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<tr>
<td>Cadmium</td>
<td>109</td>
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<tr>
<td>Caesium</td>
<td>134, 137</td>
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<tr>
<td>Calcium</td>
<td>41, 45</td>
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<tr>
<td>Californium</td>
<td>249</td>
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<tr>
<td>Carbon</td>
<td>11, 14</td>
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<tr>
<td>Cerium</td>
<td>139, 141, 144</td>
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<tr>
<td>Chlorine</td>
<td>36</td>
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<tr>
<td>Chromium</td>
<td>51</td>
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<tr>
<td>Cobalt</td>
<td>57, 58, 60</td>
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<tr>
<td>Copper</td>
<td>64</td>
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<tr>
<td>Curium</td>
<td>244</td>
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<tr>
<td>Europium</td>
<td>152, 154, 155</td>
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<tr>
<td>Fluorine</td>
<td>18</td>
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<tr>
<td>Gadolinium</td>
<td>153</td>
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<tr>
<td>Holmium</td>
<td>166m</td>
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<tr>
<td>Hydrogen</td>
<td>3</td>
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<tr>
<td>Iodine</td>
<td>123, 125, 129, 131</td>
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<tr>
<td>Iridium</td>
<td>192</td>
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<tr>
<td>Iron</td>
<td>55, 59</td>
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<tr>
<td>Lead</td>
<td>210</td>
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<tr>
<td>Manganese</td>
<td>54, 56</td>
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<tr>
<td>Mercury</td>
<td>203</td>
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<tr>
<td>Molybdenum</td>
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<tr>
<td>Neodymium</td>
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<tr>
<td>Neptunium</td>
<td>237, 239</td>
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<tr>
<td>Nickel</td>
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<tr>
<td>Niobium</td>
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<tr>
<td>Phosphorus</td>
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<tr>
<td>Plutonium</td>
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<tr>
<td>Polonium</td>
<td>208, 209, 210</td>
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<tr>
<td>Potassium</td>
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<tr>
<td>Protactinium</td>
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<tr>
<td>Radium</td>
<td>223, 226</td>
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<tr>
<td>Rubidium</td>
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<tr>
<td>Ruthenium</td>
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<tr>
<td>Samarium</td>
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<td>Selenium</td>
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<td>Silver</td>
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<td>Sodium</td>
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<td>Strontium</td>
<td>85, 89, 90</td>
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<tr>
<td>Sulphur</td>
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<tr>
<td>Technetium</td>
<td>99, 99m</td>
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<tr>
<td>Thallium</td>
<td>201, 204</td>
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<tr>
<td>Thorium</td>
<td>228, 229, 232</td>
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<tr>
<td>Tin</td>
<td>113</td>
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<tr>
<td>Uranium</td>
<td>232, 233, 234, 235, 236, 238</td>
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<tr>
<td>Yttrium</td>
<td>88, 90</td>
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<tr>
<td>Zinc</td>
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</tr>
<tr>
<td>Zirconium</td>
<td>95</td>
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</table>
A-Z of nuclides 2014 v3
Available from stock as aqueous solutions

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Product description</th>
<th>NPL Product Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>241Americium</td>
<td>10 Bq/g, 10 g nominal</td>
<td>R13-01</td>
<td>£579</td>
</tr>
<tr>
<td></td>
<td>300 Bq/g, 10 g nominal</td>
<td>R13-02</td>
<td>£1077</td>
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<tr>
<td>241Americium</td>
<td>1 Bq/g, 10 g nominal</td>
<td>R18-00</td>
<td>£579</td>
</tr>
<tr>
<td></td>
<td>100 Bq/g, 10 g nominal</td>
<td>R18-20</td>
<td>£1517</td>
</tr>
<tr>
<td>133Caesium</td>
<td>10 Bq/g, 10 g nominal</td>
<td>R03-01</td>
<td>£579</td>
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<td></td>
<td>100 Bq/g, 10 g nominal</td>
<td>R03-02</td>
<td>£1174</td>
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<tr>
<td>14Carbon</td>
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<td>R19-02</td>
<td>£689</td>
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<tr>
<td></td>
<td>2 kBq/g, 10 g nominal</td>
<td>R19-03</td>
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<td></td>
<td>40 kBq/g, 10 g nominal</td>
<td>R19-04</td>
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<tr>
<td>24Chlorine</td>
<td>10 Bq/g, 10 g nominal</td>
<td>R38-01</td>
<td>†††</td>
</tr>
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<td></td>
<td>1 kBq/g, 10 g nominal</td>
<td>R38-03</td>
<td>£1077</td>
</tr>
<tr>
<td>244Curium</td>
<td>1 kBq/g, 1 g nominal</td>
<td>R25-13</td>
<td>£1,103</td>
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<td></td>
<td>20 kBq/g, 1 g nominal</td>
<td>R25-14</td>
<td>£1,654</td>
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<td>135Iodine</td>
<td>100 Bq/g, 10 g nominal</td>
<td>R14-02</td>
<td>£689</td>
</tr>
<tr>
<td></td>
<td>1 kBq/g, 10 g nominal</td>
<td>R14-03</td>
<td>£1999</td>
</tr>
<tr>
<td>210Lead</td>
<td>350 Bq/g, 10 g nominal</td>
<td>R22-02</td>
<td>£877</td>
</tr>
<tr>
<td></td>
<td>37 kBq/g, 5 g nominal</td>
<td>R22-03</td>
<td>£1654</td>
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<tr>
<td>Mixed Nuclide</td>
<td>10 Bq/g in 500ml HDPE bottle</td>
<td>R08-01</td>
<td>£712</td>
</tr>
<tr>
<td>Mixed Nuclide</td>
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<td>R08-03</td>
<td>£767</td>
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<td>R08-04</td>
<td>£1650</td>
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<td>Mixed Nuclide</td>
<td>500 g nominal</td>
<td>R08-CS</td>
<td>£164</td>
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<td>237Neptunium</td>
<td>1 kBq/g, 10 g nominal</td>
<td>R21-03</td>
<td>£1256</td>
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<td>9 kBq/g, 10 g nominal</td>
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<td>£2096</td>
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<td>239Plutonium**</td>
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<td></td>
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<td>R37-02</td>
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<td>232Thorium**</td>
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<td>R11-02</td>
<td>†††</td>
</tr>
<tr>
<td>239Thorium**</td>
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<td>5 kBq/g, 10 g nominal</td>
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<td>226Radium</td>
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<tr>
<td>232Uranium</td>
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<td>£636</td>
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Prices valid for 2014 and do not include despatch costs and tax if applicable. Other nuclides are available as custom. See overleaf for further details.
††† Refer to NPL for pricing and availability. Where the price is in orange text we are low on stock.
Supply of Mixed Nuclides is subject to receipt of purchase order by: end February for the Spring batch (Reference Date 1st June), despatch April onwards; end September for the Autumn batch (Reference Date 1st January), despatch November onwards
* Delivery of Pu-239 products outside of the UK is subject to Export Control Regulations
** Delivery of Thorium products outside of the EU is subject to Export Control Regulations