# Standards of Radioactivity – A to Z of Batch Stock

Version 2.2 – September 2024

National Physical Laboratory

[1] Delivery of Plutonium-239 products outside the UK is subject to Export Control Regulations.
[2]. Delivery of Radium-226 products outside the UK is subject to Export Control Regulations.
[3]. Delivery of Thorium products outside the UK is subject to Export Control Regulations.
[4]. Delivery of natural Uranium products outside the UK is subject to Export Control Regulations.
[5]. Delivery of Uranium-232 products may be subject to UK Export Control Regulations.
[6]. Delivery of Uranium-233 products outside the UK is subject to Export Control Regulations.
[7]. Delivery of Zirconium-93 products outside of the UK is subject to Export Control Regulations.

| Radionuclide | Approximate activity per unit mass | Nominal Mass | Product Code | | | | Chemistry | Poison Act Regulated or Reportable | Detected impurities (≈ % of activity per unit mass at certificated reference time) |
|---|---|---|---|---|---|---|---|---|---|
| **$^{227}$Actinium** *(Ac-227)* | Research and development currently in progress – please register interest with radioactivity@npl.co.uk | | | | | | | | |
| **$^{241}$Americium** *(Am-241)* | 10 Bq $g^{-1}$ | 10 g nominal | R13-01 | | | | 0.5 M $HNO_3$ | Reportable | None detected |
| | 300 Bq $g^{-1}$ | 10 g nominal | R13-02 | | | | | | |
| | 4 kBq $g^{-1}$ | 10 g nominal | R13-03 | | | | | | |
| | 100 kBq $g^{-1}$* | 10 g nominal | R13-05 | | | | | | |
| **$^{243}$Americium** *(Am-243)* | 1 Bq $g^{-1}$ | 10 g nominal | R18-00 | | | | 1 M $HNO_3$ | Regulated | $^{241}$Am < 0.05 % |
| | 100 Bq $g^{-1}$ | 10 g nominal | R18-20 | | | | | | |
| **$^{137}$Caesium** *(Cs-137)* | 10 Bq $g^{-1}$ | 10 g nominal | R03-01 | | | | 0.1 M $HNO_3$ containing 50 µg $g^{-1}$ inactive Cs | N/A | None detected |
| | 100 Bq $g^{-1}$ | 10 g nominal | R03-02 | | | | | | |
| | 350 kBq $g^{-1}$ | 1 g or 3 g nominal | R03-05 | | | | 0.1 M HCl containing 10 µg $g^{-1}$ inactive Cs | N/A | |

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*Requires a Type A package

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|---|---|---|---|---|---|---|
| **$^{14}$Carbon** *(C-14)* | 100 Bq $g^{-1}$ | 10 g nominal | R19-02 | Aqueous sodium carbonate containing 5 mg $g^{-1}$ inactive $Na_2CO_3$ and 1 mg $g^{-1}$ formaldehyde | N/A | None detected |
| | 2 kBq $g^{-1}$ | 10 g nominal | R19-03 | | | |
| **$^{14}$Carbon in glucose** *(C-14)* | 100 Bq $g^{-1}$ | 10 g nominal | R43-02 | Aqueous D-[1-$^{14}$C]-glucose also containing 1 mg $g^{-1}$ inactive glucose and 1 mg $g^{-1}$ formaldehyde | N/A | None detected |
| | 2 kBq $g^{-1}$ | 10 g nominal | R43-03 | | | |
| | 100 kBq $g^{-1}$ | 10 g nominal | R43-05 | | | |
| **$^{36}$Chlorine** *(Cl-36)* | 1 kBq $g^{-1}$ | 10 g nominal | R38-03 | 0.001 M HCl containing 90 µg $g^{-1}$ sodium chloride | N/A | None detected |
| **$^{244}$Curium** *(Cm-244)* | 1 kBq $g^{-1}$ | 5 g nominal | R25-03 | 2 M $HNO_3$ | Regulated | $^{243}$Cm < 0.1 %<br>$^{243}$Am < 0.1 % |
| **$^{129}$Iodine** *(I-129)* | 100 Bq $g^{-1}$ | 10 g nominal | R14-02 | 0.001 M NaOH | N/A | None detected |
| | 1 kBq $g^{-1}$ | 10 g nominal | R14-03 | | | |

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|---|---|---|---|---|---|---|
| $^{210}$**Lead** *(Pb-210)* | 1 Bq $g^{-1}$ | 10 g nominal | R22-00 | 2 M $HNO_3$ containing 50 µg $g^{-1}$ inactive Pb and 50 µg $g^{-1}$ inactive Bi | Regulated | None detected |
| | 40 Bq $g^{-1}$ | 10 g nominal | R22-01 | | | |
| | 350 Bq $g^{-1}$ | 10 g nominal | R22-02 (D) | | | |
| | 37 kBq $g^{-1}$ | 5 g nominal | R22-03 (D) | 1 M $HNO_3$ containing 50 µg $g^{-1}$ inactive Pb and 50 µg $g^{-1}$ inactive Bi | Regulated | |
| $^{63}$**Nickel** *(Ni-63)* | 2 kBq $g^{-1}$ | 10 g nominal | R48-03 | 0.1 M HCl containing 100 µg $g^{-1}$ inactive Ni | N/A | None detected |
| $^{237}$**Neptunium** *(Np-237)* | 1 kBq $g^{-1}$ | 5 g nominal | R21-03 | 3 M $HNO_3$ | Regulated | $^{239}Pu/^{240}Pu$ < 0.01 %<br>$^{229}Th$ < 0.01 % |
| | 10 kBq $g^{-1}$ | 3 g nominal | R21-04 | | | |
| $^{236}$**Plutonium** *(Pu-236)* | Research and development in progress – please register interest with radioactivity@npl.co.uk | | | | | |
| $^{238}$**Plutonium** *(Pu-238)* | 10 Bq $g^{-1}$ | 10 g nominal | R45-01 | 2 M $HNO_3$ | Regulated | None detected |
| | 100 Bq $g^{-1}$ | 10 g nominal | R45-02 | | | |
| | 1 kBq $g^{-1}$ | 10 g nominal | R45-03 | | | |
| $^{239}$**Plutonium** *(Pu-239) [1].* | 50 Bq $g^{-1}$ | 10 g nominal | R24-01 | 2 M $HNO_3$ | Regulated | $^{240}Pu$ < 0.5 %<br>$^{241}Pu$ < 0.2 % |
| | 1 kBq $g^{-1}$ | 10 g nominal | R24-03 | | | |
| $^{240}$**Plutonium** *(Pu-240)* | Research and development in progress – please register interest with radioactivity@npl.co.uk | | | | | |

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| Radionuclide | Approximate activity per unit mass | Nominal Mass | Product Code | | | | Chemistry | Poison Act Regulated or Reportable | Detected impurities (≈ % of activity per unit mass at certificated reference time) |
|---|---|---|---|---|---|---|---|---|---|
| **$^{241}$Plutonium** *(Pu-241)* | 10 Bq g$^{-1}$ | 10 g nominal | R35-01 (D) | | | | 2 M $HNO_3$ | Regulated | $^{238}$Pu < 0.02 %<br>$^{239}$Pu < 0.01 %<br>$^{240}$Pu < 0.05 %<br>$^{242}$Pu < 6 × 10$^{-4}$ %<br>$^{244}$Pu < 3 × 10$^{-9}$ %<br>$^{241}$Am – Decay product |
| | 150 Bq g$^{-1}$ | 10 g nominal | R35-02 | | | | | | |
| | 4 kBq g$^{-1}$ | 5 g nominal | R35-03 (D) | | | | | | |
| **$^{242}$Plutonium** *(Pu-242)* | 1 Bq g$^{-1}$ | 10 g nominal | R15-00 | | | | 2 M $HNO_3$ | Regulated | $^{241}$Am < 0.3 %<br>$^{241}$Pu < 5 % |
| | 12.5 Bq g$^{-1}$ | 10 g nominal | R15-20 | | | | | Regulated | |
| **$^{209}$Polonium** *(Po-209)* | 100 Bq g$^{-1}$ | 5 g nominal | R33-02 | | | | 6 M HCl | Regulated | None detected |
| | 10 Bq g$^{-1}$ | 5 g nominal | R33-01 | | | | | | |
| **$^{231}$Protactinium** *(Pa-231)* | 100 Bq g$^{-1}$ | 5 g nominal | R49-02 | | | | 7 M HCl | Regulated | None detected |
| **$^{226}$Radium** *(Ra-226)* *[2].* | 100 Bq g$^{-1}$ | 10 g nominal | R36-02 | | | | 1 M HCl | Reportable | None detected |
| | 2 kBq g$^{-1}$ | 10 g nominal | R36-03 | | | | | | |
| | 40 kBq g$^{-1}$ | 5 g nominal | R36-04 | | | | | | |
| **$^{228}$Radium** *(Ra-228)* | 10 Bq g$^{-1}$ | 5 g nominal | R42-01 (D) | | | | 2 M $HNO_3$ | Regulated | $^{226}$Ra < 0.3 % |

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| Radionuclide | Approximate activity per unit mass | Nominal Mass | Product Code | | | | Chemistry | Poison Act Regulated or Reportable | Detected impurities (≈ % of activity per unit mass at certificated reference time) |
|---|---|---|---|---|---|---|---|---|---|
| **$^{90}$Strontium** *(Sr-90)* | 100 Bq $g^{-1}$ | 10 g nominal | R01-03 | | | | 1 M $HNO_3$ containing 50 µg $g^{-1}$ inactive Sr and inactive 50 µg $g^{-1}$ Y | Regulated | None detected |
| | 2 kBq $g^{-1}$ | 10 g nominal | R01-05 | | | | | | |
| | 40 kBq $g^{-1}$ | 10 g nominal | R01-04 | | | | | | |
| **$^{99}$Technetium** *(Tc-99)* | 100 Bq $g^{-1}$ | 10 g nominal | R11-02 | | | | 0.1 M $NH_4OH$ (ammonium hydroxide) | N/A | None detected |
| | 1 kBq $g^{-1}$ | 10 g nominal | R11-03 | | | | | | |
| **$^{229}$Thorium** *(Th-229) [3].* | 1 Bq $g^{-1}$ | 10 g nominal | R26-00 | | | | 2 $HNO_3$ containing 10 µg $g^{-1}$ $(NH_4)_2[Ce(NO_3)_6]$ (ammonium cerium nitrate) | Regulated | None detected |
| | 10 Bq $g^{-1}$ | 10 g nominal | R26-01 | | | | | | |
| | 100 Bq $g^{-1}$ | 10 g nominal | R26-02 | | | | | | |
| **Tritium** *(H-3)* | 10 Bq $g^{-1}$ | 10 g nominal | R30-01 | | | | Tritiated water | N/A | None detected |
| | 100 Bq $g^{-1}$ | 10 g nominal | R30-02 | | | | | | |
| | 5 kBq $g^{-1}$ | 10 g nominal | R30-04 | | | | | | |
| **Tritium in Glucose** *(H-3)* | 1 kBq $g^{-1}$ | 10 g nominal | R44-03 | | | | D-[3-$^3$H]-glucose containing 1 mg $g^{-1}$ inactive glucose and 1 mg $g^{-1}$ formaldehyde | N/A | None detected |

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| Radionuclide | Approximate activity per unit mass | Nominal Mass | Product Code | | | | Chemistry | Poison Act Regulated or Reportable | Detected impurities (≈ % of activity per unit mass at certificated reference time) |
|---|---|---|---|---|---|---|---|---|---|
| **Natural Uranium** *(U-234, U-235 & U-238) [4].* | 100 Bq $g^{-1}$<br>~50 Bq $g^{-1}$ $^{234}U$<br>~50 Bq $g^{-1}$ $^{238}U$<br>~2.5 Bq $g^{-1}$ $^{235}U$ | 10 g nominal | R47-02 | | | | 2 M $HNO_3$ | Regulated | None detected |
| | 200 Bq $g^{-1}$<br>~100 Bq $g^{-1}$ $^{234}U$<br>~100 Bq $g^{-1}$ $^{238}U$<br>~5 Bq $g^{-1}$ $^{234}U$ | 10 g nominal | R47-03 | | | | | | |
| **$^{232}$Uranium** *(U-232) [5].* | 1 Bq $g^{-1}$ | 10 g nominal | R20-00 | | | | 2 M $HNO_3$ | Regulated | None detected |
| | 10 Bq $g^{-1}$ | 10 g nominal | R20-15 | | | | | | |
| | 100 Bq $g^{-1}$ | 10 g nominal | R20-02 | | | | | | |
| | 5 kBq $g^{-1}$ | 5 g nominal | R20-03 | | | | | | |
| **$^{233}$Uranium** *(U-233) [6].* | 1 Bq $g^{-1}$ | 10 g nominal | R46-00 | | | | 2 M $HNO_3$ | Regulated | $^{229}Th$ < 0.3 % |
| | 10 Bq $g^{-1}$ | 10 g nominal | R46-01 | | | | | | |
| | 100 Bq $g^{-1}$ | 10 g nominal | R46-02 | | | | | | $^{229}Th$ < 0.2 %<br>$^{232}U$ < 0.4 % |
| | 1 kBq $g^{-1}$ | 10 g nominal | R46-03 | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|
| **$^{234}$Uranium** *(U-234)* | 10 Bq $g^{-1}$ | 10 g nominal | R50-01 | | | | 2 M $HNO_3$ | Regulated | $^{232}U < 1.5$ % |
| | 100 Bq $g^{-1}$ | 10 g nominal | R50-02 | | | | | | |
| **$^{236}$Uranium** *(U-236)* | 10 Bq $g^{-1}$ | 10 g nominal | R41-01 | | | | 2 M $HNO_3$ | Regulated | $^{235}U < 0.005$ % |
| | 100 Bq $g^{-1}$ | 10 g nominal | R41-02 | | | | | | |
| **$^{93}$Zirconium** *(Zr-93)* *[7].* | Research and development in progress – please register interest with radioactivity@npl.co.uk | | | | | | | | |

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[2]. Delivery of Radium-226 products outside the UK is subject to Export Control Regulations.
[3]. Delivery of Thorium products outside the UK is subject to Export Control Regulations.
[4]. Delivery of natural Uranium products outside the UK is subject to Export Control Regulations.
[5]. Delivery of Uranium-232 products may be subject to UK Export Control Regulations.
[6]. Delivery of Uranium-233 products outside the UK is subject to Export Control Regulations.
[7]. Delivery of Zirconium-93 products outside of the UK is subject to Export Control Regulations.

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**NPL Mixed Nuclide:** Our NPL Mixed Nuclide is produced annually. Please enquire for further details.

| Radionuclides | Approximate activity per unit mass | Nominal Mass | Product Code | | | | Chemistry | Poison Act Regulated or Reportable |
|---|---|---|---|---|---|---|---|---|
| **$^{241}$Americium, $^{109}$Cadmium, $^{57}$Colbalt, $^{139}$Cerium, $^{51}$Chromium, $^{113}$Tin, $^{85}$Strontium, $^{137}$Caesium, $^{54}$Manganese, $^{88}$Yttrium, $^{65}$Zinc and $^{60}$Colbalt** *(Am-241, Cd-109, Co-57, Ce-139, Cr-51, Sn-113, Sr-85, Cs-137, Mn-54, Y-88. Zn-65 & Co-60)* | 10 kBq $g^{-1}$ | 10 g nominal | R08-04 | | | | 4 M HCl with 10 µg $g^{-1}$ of appropriate carrier elements | Regulated |
| | | 1 g nominal | R08-02 | | | | | |
| **Mixed Carrier Solution** | N/A | 500 g nominal | R08-Carrier | | | | | |

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