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Environmental Radioactivity Comparison Exercise

Source Preparation & Validation

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Answer Three Questions

1. What did we make?
   Sample types, nuclide selection

2. How did we prepare the sources?
   Source preparation, dispensing mixing & dilution

3. Have we got the ‘right values’?
   Validation measurements, calibration, traceability, UKAS accreditation

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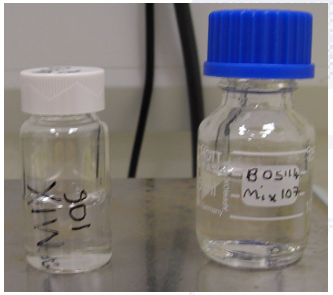
What did we make? 5 samples 20 nuclides



ABH	α/β^-	1 - 20 Bq g^{-1}	(20g)
ABL	α/β^-	1 - 20 Bq kg^{-1}	(500g)
GH	γ	1 - 20 Bq g^{-1}	(100g)
GL	γ	1 - 20 Bq kg^{-1}	(500g)
LB	β^-	100 - 500 Bq kg^{-1}	(500g)

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Low Energy Beta

	Production	Major Decay	Standardisation
^{3}H	Activation (n,γ) Cosmogenic	β–	NPL- Reduction to H-$T_{(g)}$ Gas proportional counting
^{14}C	Activation (n,γ) Cosmogenic	β–	NPL- NIST CIEMAT
^{35}S	Activation (n,γ)	β–	NPL- NIST CIEMAT

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Gamma

	Production	Major Decay	Standardisation
^{22}Na	Charged Particle (p,n)	EC/β^+/γ	NPL- Ion Chamber
^{60}Co	Activation (n,γ)	β^-/γ	NPL- 4$\pi\beta^-\gamma$
^{88}Y	Charged Particle (p,n)	EC/β^+/γ	NPL- Ion Chamber
^{95}Zr ^{95}Nb	Fission (6.5%)	β^-/γ	NPL- γ-Spectrometry
^{125}Sb	Activation (n,γ), Fission (0.3%)	β^-/γ	GE C.Counting
^{133}Ba	Activation (n,γ)	EC/β^+/γ	NPL- Ion Chamber
^{134}Cs	Activation (n,γ), Fission	β^-/γ	NPL- Ion Chamber
^{137}Cs	Fission (6.2%)	β^-/γ	NPL- Ion Chamber
^{152}Eu	Activation (n,γ)	EC/β^+/β^-/γ	NPL- Ion Chamber

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Alpha Beta

	Production	Major Decay	Standardisation
^{55}Fe	Activation (n,γ)	EC	NPL- NIST CIEMAT
^{89}Sr	Fission (4.8 %)	β^-	NPL- Ion Chamber
^{90}Sr	Fission (5.8 %)	β^-	NPL- NIST CIEMAT
^{238}U	Primordial	α	NPL- 4πα/γ tracing
^{238}Pu	Activation (n,γ)	α	NPL- 4πα/γ tracing
^{239}Pu	Activation (n,γ)	α	NPL- 4πα/γ tracing
^{241}Am	Activation (n,γ)	α+γ	NPL- 4πα/γ

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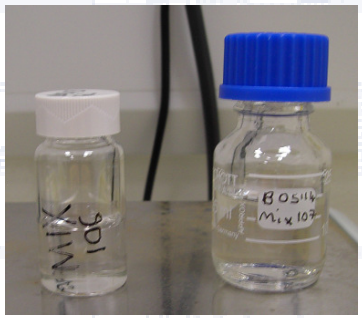
How were the samples made?
A Dilution >10^7 required (^{60}Co)

1. Standardised single nuclide solutions
2. Dispense solutions into a small bottle to make a mixed nuclide source
3. Dispense ‘mix’ into a larger bottle, dilute with carrier.

D.F.



D.F.

D.F.

G.D.F. = Total Mass/Active Mass (Gravimetric Dilution Factor)

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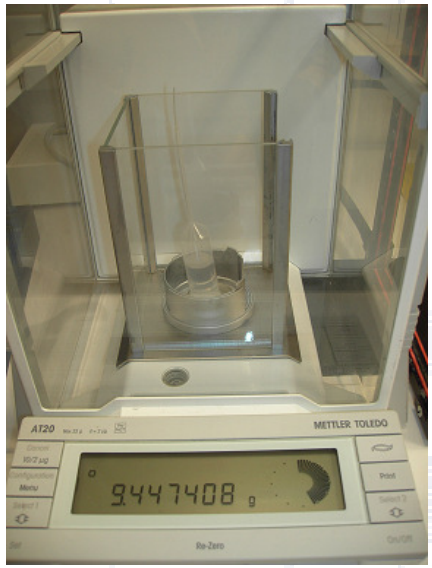
Is the GDF correct?

Calibrated Weights (NPL)
Calibrated Balances (UKAS & NPL)



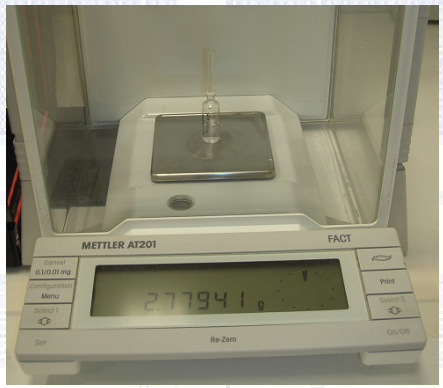
Uncertainty derived from difference between the two weights.

Typically <0.1 %

GL GDF2

-0.0004 g active

-0.004 g total



Active Mass 1.112968 g
Total Mass 57.167578 g

Active Mass 1.112339 g
Total Mass 57.16320 g

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Validation Measurements, GL GDF1

^{22}Na | ^{60}Co | ^{88}Y | ^{95}Zr | ^{125}Sb | ^{133}Ba | ^{134}Cs | ^{137}Cs | ^{152}Eu

GDF compared with RDF for each nuclide γ-spectrometer

1 g | 1 g | 1 g | 1 g

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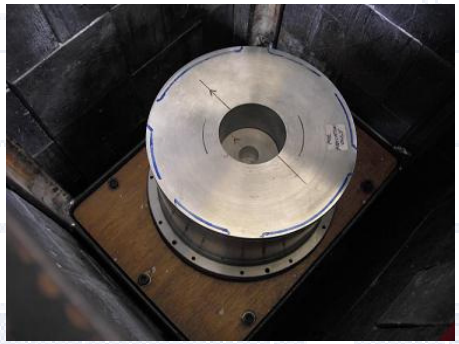
Validation Measurements, GL GDF2

GDF2 51.361(6) compared with

RDF2 51.48(12)

Using a ‘well’ type NaI(Tl) detector

‘u’ test 0.96



0.2g 0.2g 0.2g 0.2g

10g 10g 10g 10 g

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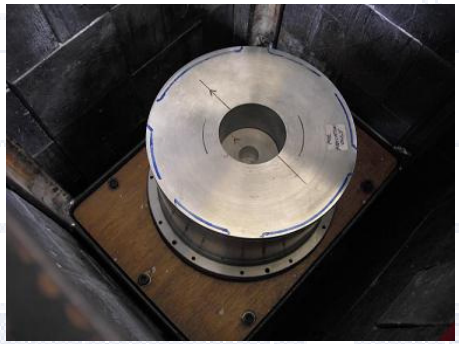
Validation Measurements, GL GDF3

GDF3 51.69(3) compared with

RDF3 52.1(7)

Using a ‘well’ type NaI(Tl) detector

‘u’ test 0.64



0.2g 0.2g 0.2g 0.2g

10g 10g 10g 10 g

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Validation Measurements, GL GDF4

GDF4 52.050(18) compared with

RDF4 52.1(7) (^{60}Co)

Using high purity γ-spectrometer
Relative efficiency of 104 %

'u' test 0.64

9.6g 9.6g 9.6g 9.2g

500g 500g 500g 500 g

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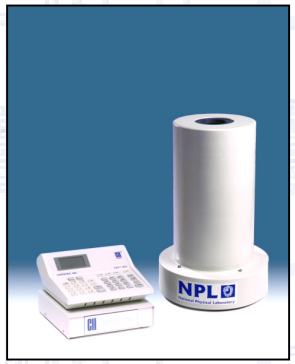
Activity Traceable to National & International Standards?

NIST ⟷ NPL ⟷ PTB ⟷ IRMM

$4\pi\beta^{-}\gamma$ Coincidence Counting

HT Gas Proportional Counting

γ-Spectrometer



Ion Chamber

Liquid scintillation counting

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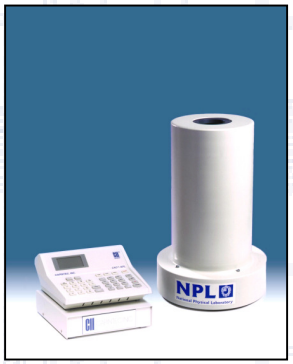
BIPM

Bureau International des Poids et Mesures

NIST ⟷ **NPL** ⟷ **PTB** ⟷ **IRMM**

$4\pi\beta^{-}\gamma$ Coincidence Counting

HT Gas proportional counting



γ-spectrometer

Ion Chamber

Liquid scintillation counting

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Has NPL got the Right Values?

Standardised Solutions	(Traceable to NPL and BIPM)
Double Weighing	(Mass Dispensed and Mass Received)
Calibrated Balances	(UKAS Accredited Lab or NPL)
Calibrated Check Weights	(NPL)
>160 Dilution Check Measurement	(LSC, NaI, γ-Spectrometry, Cerenkov)

ISO 17025:2005

General Requirements for the Competence of Calibration and Testing Laboratories

ISO Guide 43 Part 1

Proficiency Testing by Laboratory Comparisons – Development and Operation of Proficiency Testing Schemes

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Does anyone have any Questions?