

# **NPL Environmental Proficiency Test Exercise 2007**

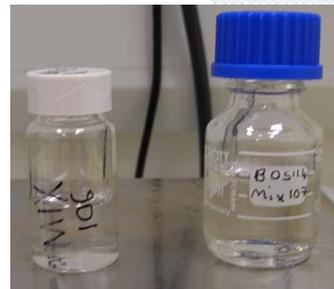
## **Source Preparation & Validation**

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19<sup>th</sup> September 2007

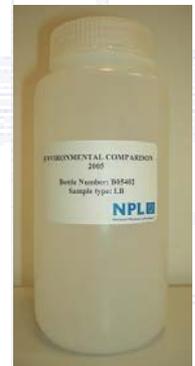
## Answer Three Questions

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

What did we make? +200 samples 26 nuclides



AH	$\alpha$	1 - 20 Bq g <sup>-1</sup>	(20g)
AL	$\alpha$	1 - 20 Bq kg <sup>-1</sup>	(500g)
GH	$\gamma$	1 - 20 Bq g <sup>-1</sup>	(100g)
GL	$\gamma$	1 - 20 Bq kg <sup>-1</sup>	(500g)
BH	$\beta^-$	1 - 20 Bq g <sup>-1</sup>	(100g)
BL	$\beta^-$	100 - 500 Bq kg <sup>-1</sup>	(100g)
B2	$\beta^-$	100 - 500 Bq kg <sup>-1</sup>	(500g)
Concrete		Bq/g	(50g)



## Alpha AH & AL

	Production	Major Decay	Standardisation
$^{226}\text{Ra}$	Primordial	$\alpha+\gamma$	NPL- Ion Chamber
$^{237}\text{Np}$	Activation ( $^{235}\text{U}$ )	$\alpha+\gamma$	NPL- Ion Chamber
$^{238}\text{U}$	Primordial	$\alpha$	NPL- $4\pi\alpha/\gamma$ tracing
$^{238}\text{Pu}$	Activation ( $^{237}\text{Np}$ )	$\alpha$	NPL- $4\pi\alpha$ LSC
$^{239}\text{Pu}$	Activation ( $^{238}\text{U}$ )	$\alpha$	NPL- $4\pi\alpha/\gamma$ tracing
$^{241}\text{Am}$	Beta Decay ( $^{241}\text{Pu}$ )	$\alpha+\gamma$	NPL- $4\pi\alpha/\gamma$
$^{244}\text{Cm}$	Activation	$\alpha+\gamma$	NPL- $4\pi\alpha/\gamma$ tracing

## Gamma GH & GL

	Production	Major Decay	Standardisation
$^{60}\text{Co}$	Activation	$\beta^-/\gamma$	NPL- $4\pi\beta^- \gamma$
$^{95}\text{Zr}$ $^{95}\text{Nb}$	Fission (6.5%)	$\beta^-/\gamma$	NPL- $\gamma$ -Spectrometry
$^{125}\text{Sb}$	Activation, Fission (0.3%)	$\beta^-/\gamma$	GE C.Counting
$^{133}\text{Ba}$	Activation	EC/ $\beta^+/\gamma$	NPL- Ion Chamber
$^{134}\text{Cs}$	Activation	$\beta^-/\gamma$	NPL- Ion Chamber
$^{137}\text{Cs}$	Fission (6.2%)	$\beta^-/\gamma$	NPL- Ion Chamber
$^{144}\text{Ce}$	Fission (5.5%)	$\beta^-/\gamma$	NPL- Ion Chamber
$^{152}\text{Eu}$	Activation	EC/ $\beta^+/\beta^-/\gamma$	NPL- Ion Chamber
$^{155}\text{Eu}$	Fission (0.03%)	$\beta^-/\gamma$	NPL- Ion Chamber

## Beta BH & BL

	Production	Major Decay	Standardisation
$^3\text{H}$	Activation Cosmogenic	$\beta^-$	NPL- Reduction to $\text{H-T}_{(g)}$ Gas proportional counting
$^{55}\text{Fe}$	Activation	EC	NPL- NIST CIEMAT
$^{63}\text{Ni}$	Activation	$\beta^-$	NPL- Ion Chamber
$^{89}\text{Sr}$	Fission (4.8 %)	$\beta^-$	NPL- Ion Chamber
$^{90}\text{Sr}$	Fission (5.8 %)	$\beta^-$	NPL- NIST CIEMAT
$^{99}\text{Tc}$	Fission (6.1 %)	$\beta^-$	NPL- NIST CIEMAT

## Beta Two B2

	Production	Major Decay	Standardisation
$^3\text{H}$	Activation Cosmogenic	$\beta^-$	NPL- Reduction to $\text{H-T}_{(g)}$ Gas proportional counting
OBT	Radiochem. $^3\text{H}$	$\beta^-$	NPL- NIST CIEMAT
$^{14}\text{C}$	Activation Cosmogenic	$\beta^-$	NPL- NIST CIEMAT
$^{36}\text{Cl}$	Activation	$\beta^-$	NPL- NIST CIEMAT
$^{129}\text{I}$	Fission (.%)	$\beta^-$	NPL- NIST CIEMAT

## How were the samples made? GL A Dilution $1.6 \times 10^7$ required ( $^{152}\text{Eu}$ )

1. Standardised single nuclide solutions. Ion chamber,  $\gamma$ -spec, LSC
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)

## Is the GDF correct?

Calibrated Weights (NPL)

Calibrated Balances (UKAS & NPL)

Uncertainty derived from difference between the two weights.

Typically <0.1 %



Active Mass 0.215008 g  
Total Mass 15.198326 g

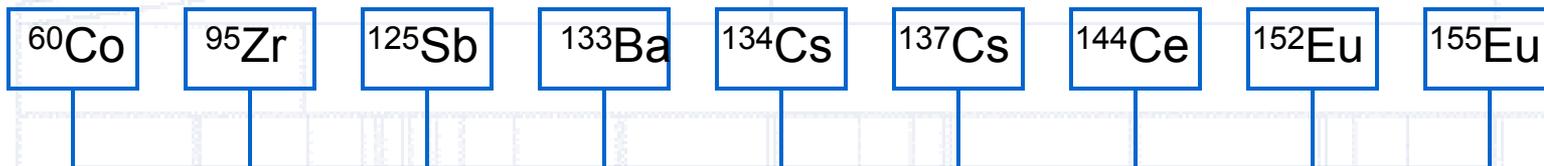
GL  $^{152}\text{Eu}$  GDF<sub>1</sub>  
0.00013 g active  
0.00445 g total  
GDF<sub>1</sub> 70.66 ± 0.02%



Active Mass 0.21488 g  
Total Mass 15.19388 g



## Validation Measurements, GL GDF<sub>1</sub>



GDF compared with RDF for each nuclide  $\gamma$ -spectrometer



## Validation Measurements, GL GDF2

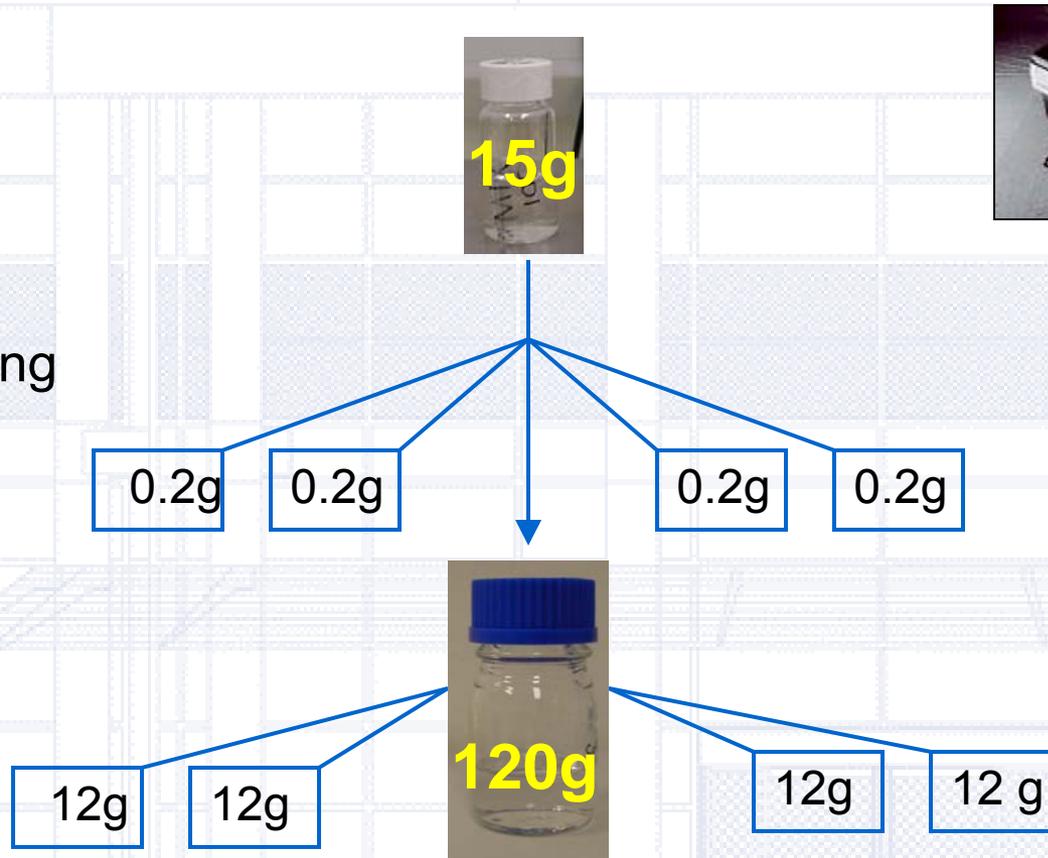
GDF2 60.79(4)

RDF2 60.89(18)

'zeta' test 0.95

Čerenkov Counting

$^{144}\text{Pr}$  3 MeV  $\beta^-$



## Validation Measurements, GL GDF3

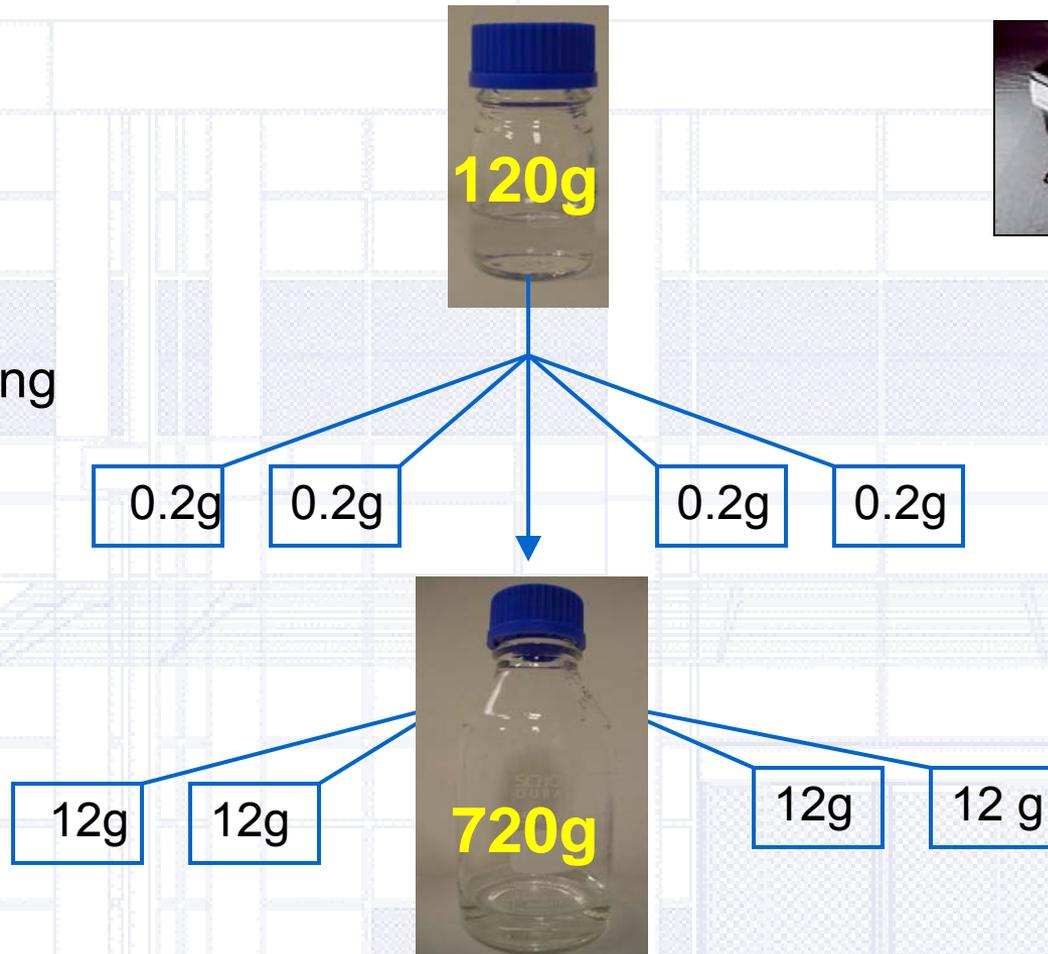
GDF2 60.1(3)

RDF2 60.80(19)

'zeta' test 1.9

Čerenkov Counting

$^{144}\text{Pr}$  3 MeV  $\beta^-$



## Validation Measurements, GL GDF4

GDF4 59.78(3)

RDF4 58.4(9)

Using  $\gamma$ -spectrometer  
Relative efficiency of 104 %

'zeta' test 1.6



# Activity Traceable to National & International Standards?

**NIST**

**NPL**

**PTB**

**IRMM**

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



HT Gas  
Proportional  
Counting



$\gamma$ -Spectrometer



Ion Chamber



Liquid scintillation counting



**BIPM**

Bureau International des Poids et Mesures



**NIST**

**NPL**

**PTB**

**IRMM**

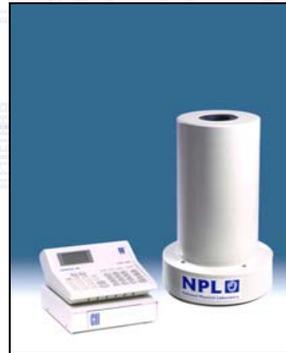
$4\pi\beta^- \gamma$   
Coincidence  
Counting



HT Gas  
proportional  
counting



$\gamma$ -spectrometer



Ion Chamber



Liquid scintillation counting

## 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)

>200 Dilution Check Measurement (LSC,  $\gamma$ -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

Does anyone have any  
Questions?