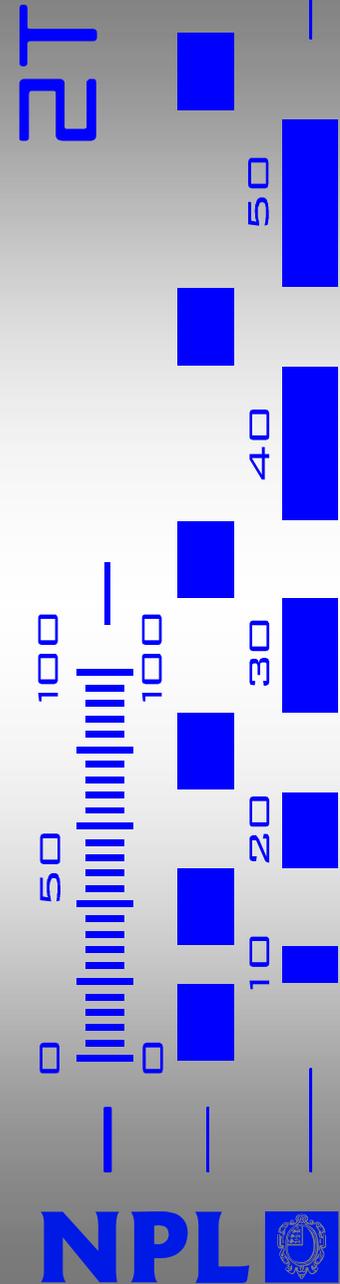


Environmental Radioactivity Comparison Exercise 2003 - Workshop

Selection and standardisation of the radionuclides

Arzu Arinc

27 September 2004



Overview

- ◆ Selection of the radionuclides
- ◆ Standardisation of the radionuclides
- ◆ Validation of the dilutions

Selection of the radionuclides

- ◆ User survey carried out to give NPL feedback on which radionuclides/radionuclide types and sample matrices users would like to analyse in future comparisons
- ◆ Suggested categories of emitters:
 - α and α/γ -emitters
 - ‘pure’ β -emitters
 - β/γ -emitters
- ◆ Participants allocated ‘priority ratings’ (high, medium or low) to any nuclides/matrices of interest

Suggested α - and α/γ -emitters

- ◆ Polonium-210
- ◆ Radium-226
- ◆ Thorium-232
- ◆ Uranium
- ◆ Neptunium-237
- ◆ Plutonium-238
- ◆ Plutonium-239
- ◆ Americium-241
- ◆ Curium-244
- ◆ Others?

Suggested 'pure' β -emitters

- ◆ Tritium
- ◆ Carbon-14
- ◆ Phosphorus-32
- ◆ Sulphur-35
- ◆ Calcium-45
- ◆ Strontium-89
- ◆ Strontium-90
- ◆ Technetium-99
- ◆ Lead-210
- ◆ Promethium-147
- ◆ Others?

Suggested β/γ -emitters

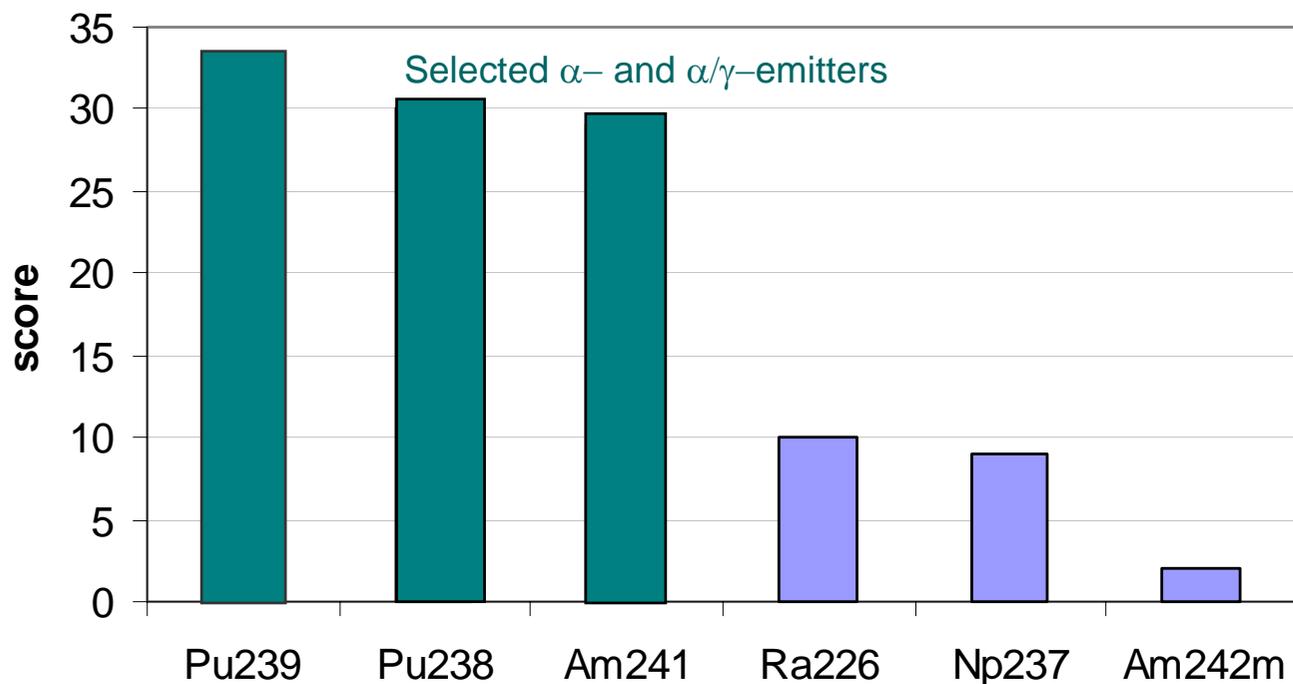
- ◆ Sodium-22
- ◆ Cobalt-57
- ◆ Cobalt-60
- ◆ Zinc-65
- ◆ Zirconium-95/Niobium-95
- ◆ Ruthenium-106/Rhodium-106
- ◆ Antimony-124
- ◆ Antimony-125
- ◆ Caesium-134
- ◆ Caesium-137
- ◆ Europium-152
- ◆ Europium-154
- ◆ Europium-155
- ◆ Others?

Suggested matrices

- ◆ Aqueous
- ◆ Milk
- ◆ Concrete
- ◆ Grass
- ◆ Aqueous (nitric form)
- ◆ Soil
- ◆ Others?

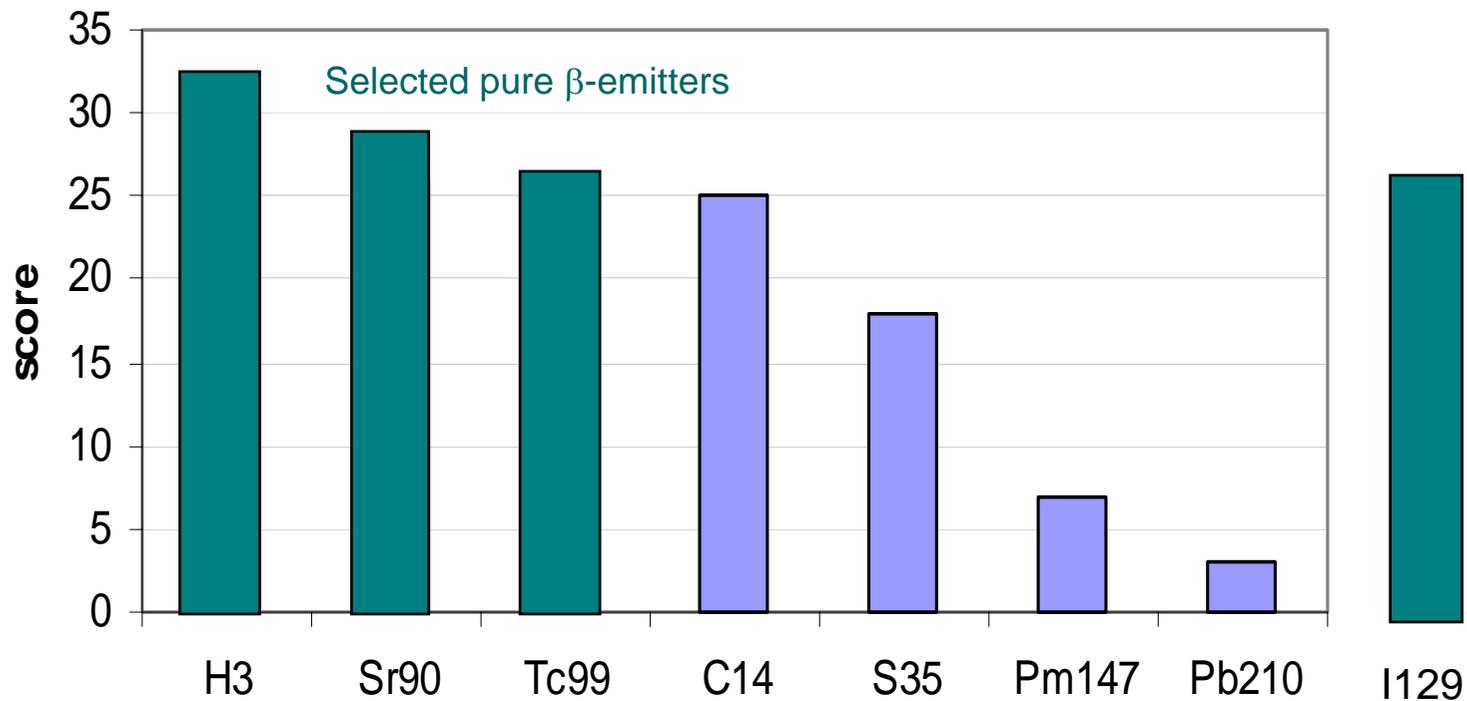
Results of the survey

Environmental radioactivity Comparison 2002 Workshop
 α - and α/γ -emitters priority



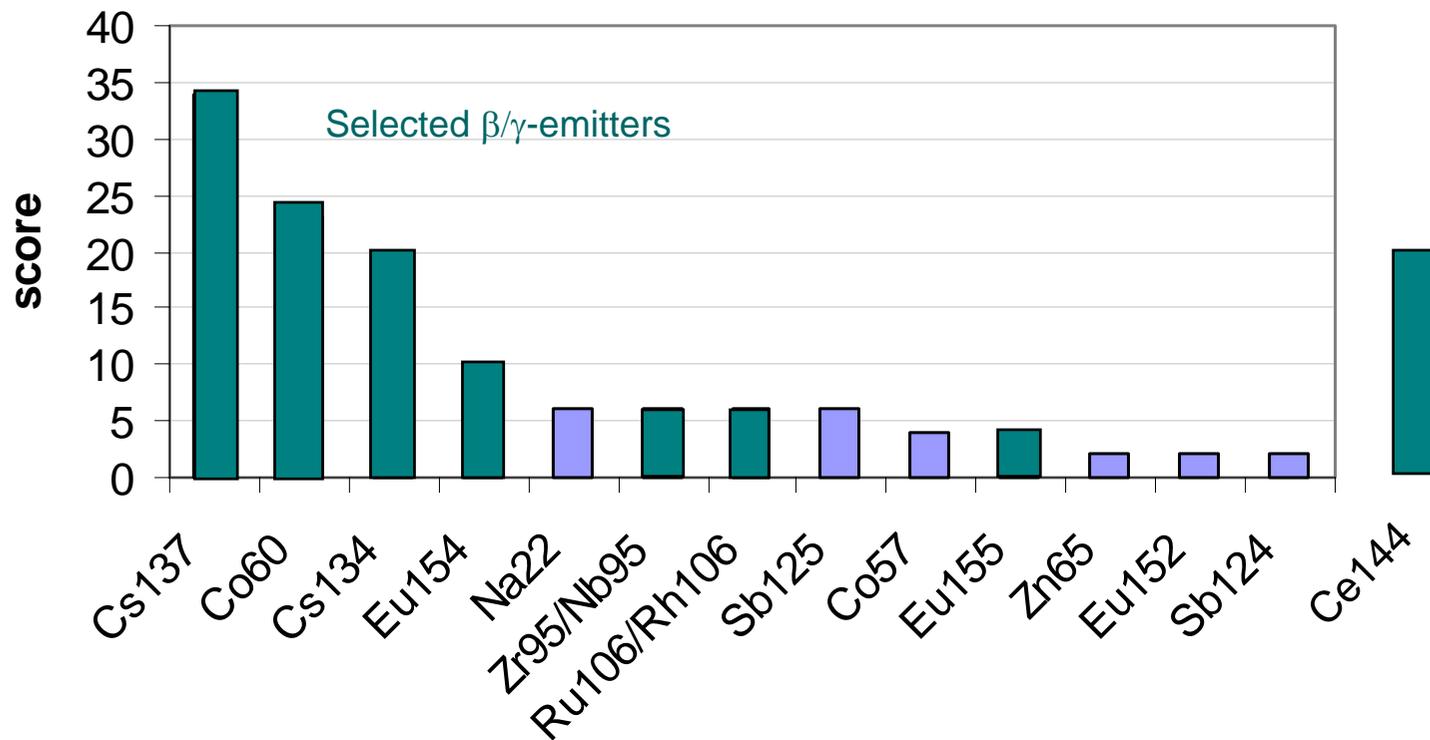
Environmental Radioactivity Comparison Exercise 2002 Workshop

pure β -emitters priority

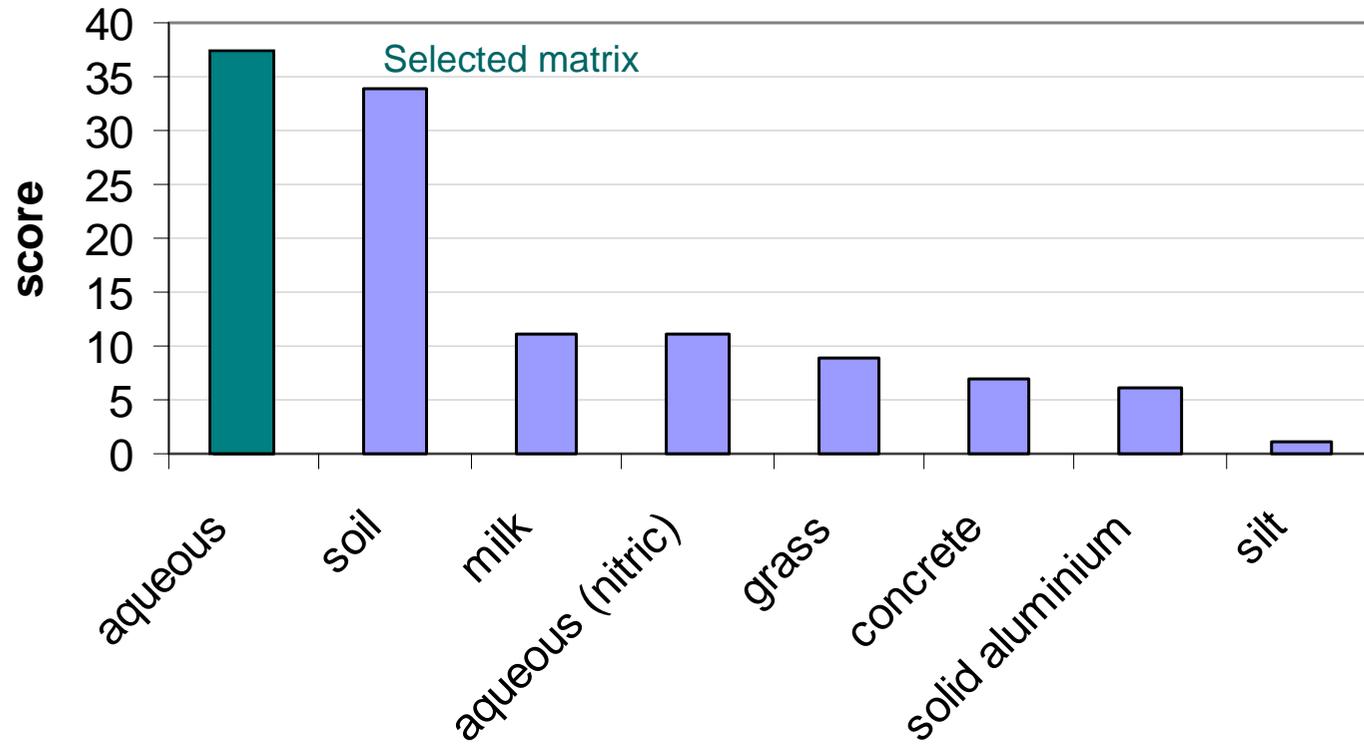


Environmental Comparison Exercise Workshop 2002

β/γ -emitters priority



Environmental Comparison Exercise Workshop 2002 matrix priority



Chosen radionuclide mixtures and activity levels

- ◆ α - β mixture:

Sr-90, Tc-99, Pu-238, Pu-239 and Am-241

~ 2 – 4 Bq/g for high level sample (10 Bq/g for Sr-90)

~ 2 – 5 Bq/kg for low level sample (12 Bq/kg for Sr-90)

- ◆ Low energy β mixture:

H-3 and I-129

One level ~ 500 Bq/kg

◆ β/γ mixture:

Co-60, Zr-95/Nb-95, Ru-106/Rh-106, Cs-134, Cs-137,
Ce-144, Eu-154 and Eu-155

~ 2 – 10 Bq/g for high level sample

~ 2 – 12 Bq/kg for low level sample

Note: Activity concentrations for β/γ emitters chosen function of:

- 1) Emission probabilities of nuclide
- 2) Energy and interferences of the main γ lines
- 3) To a certain extent, performance from last exercise

Standardisation of the nuclides

Five different techniques used to standardise 15 nuclides included in the environmental samples.

- ◆ Ionisation chambers:

- Co-60, Ru-106/Rh-106, Cs-134, Cs-137, Ce-144, Eu-154, Eu-155 and Am-241.

- ◆ Liquid scintillation techniques:

- Alpha counting: Pu-238
- CIEMAT/NIST: Sr-90/Y-90, Tc-99 and I-129.

- ◆ γ -ray spectrometry:
 - Zr-95/Nb-95
- ◆ $4\pi\beta\text{-}\gamma$ coincidence counting :
 - Pu-239
- ◆ Internal proportional gas counting:
 - H-3

The activity concentrations of Pu-239 and H-3 standardised beforehand were checked by liquid scintillation counting.

- ◆ Ionisation chambers (and liquid scintillation counting) used when possible:
 - Good accuracy (traceable to national standards)
 - Good precision (uncertainty less than 1%)
 - Sample preparation easy
 - Time of measurement short
 - Low cost (staff time)

Validation of the dilutions

- ◆ Set of sources were prepared at each dilution stage in order to derive radiometric dilution factors to confirm those derived gravimetrically.
- ◆ The radiometric factors were determined either by γ -ray spectrometry when possible or by liquid scintillation counting
- ◆ The u-statistic test was used to compare the gravimetric and radiometric factors

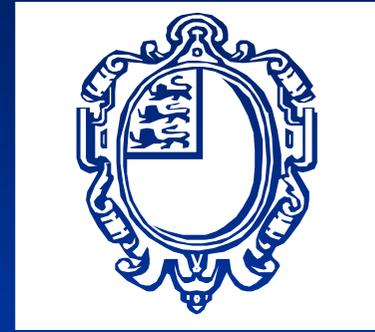
- ◆ Dilution checks of α - β mixture
 - Am-241 component checked by γ -ray spectrometry
 - All nuclides checked by liquid scintillation counting

- ◆ Dilution checks of low energy β mixture
 - I-129 component checked by γ -ray spectrometry

- ◆ Dilution checks of β/γ mixture
 - All nuclides checked individually by γ -ray spectrometry

- ◆ The results showed a good agreement between the gravimetric and the radiometric dilution factors.
- ◆ In all the cases, the u-statistic tests were lower than 1.64.

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