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EN-TRAP

The European Network of Testing Facilities for the Quality Checking of Radioactive Waste Packages

Pierre Van Iseghem

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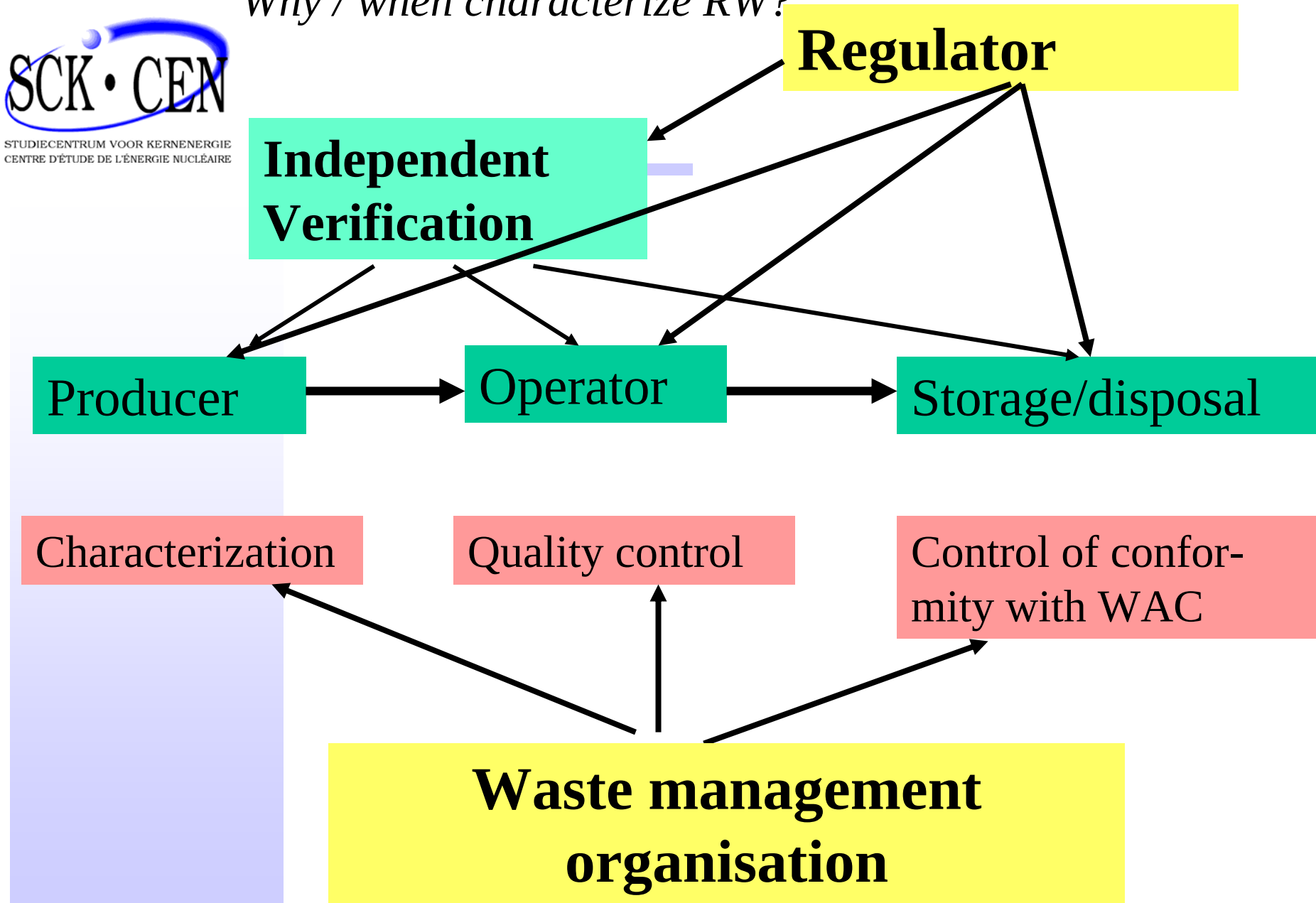
Why / when characterize RW?



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How to characterize conditioned radioactive waste?

- Inventory, distribution of radioactivity
  - non-destructive assay
  - destructive radiochemical analysis
  - calculation (scaling factors, ORIGEN code)
- Other properties: chemical, physical, mechanical, thermal, biological

IAEA reports offer good overviews, e.g.:

- *Characterization of radioactive waste forms and packages (TecRep Series No 383, 1997)*
- *Strategy and methodology for radioactive waste characterization (IAEA-TECDOC-1537, 2007)*

EN-TRAP was created in 1992, with the following objectives

- To promote European collaboration in the area of regulatory quality checking of radioactive waste packages
- This is to be achieved a.o. through
  - Information exchange
  - Identification of R&D requirements
  - Joint evaluation of test methods and proficiency testing
  - Co-ordination of national and international standardisation of test methods
  - Provision of training services
  - Promotion of the availability of testing and analytical services

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Organisation of EN-TRAP

EN-TRAP

THE EUROPEAN NETWORK OF TESTING FACILITIES FOR QUALITY CHECKING OF RADIOACTIVE WASTE PACKAGES

secretary

Steering Committee

WGA

WGB

WGC

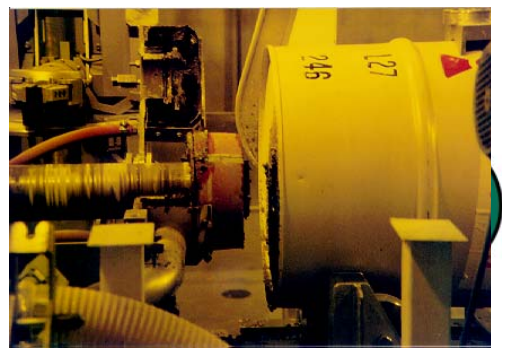
WGD

Non-destructive Methods

Destructive Methods

QA and QC

ILW / HLW



The members of EN-TRAP

CEA Cadarache
CIEMAT Madrid
ENEA Saluggia
ENRESA Madrid
FZ Jülich
FZ Seibersdorf
JRC Ispra
NRG Arnhem
NNC Winfrith
SCK•CEN Mol
TU München
VTT Espoo

+ associated laboratories

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EN-TRAP is operating as follows

- Steering Committee and Working Groups (they can create Task Groups)
- Full members, Regulatory bodies,
  Associated members
- SC meets twice a year. A chairman is elected for a one year period.
  WG's meet once a year (average)
- EC assumes the technical secretary of the Steering Committee

www.en-trap.eu

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Scientific Output of EN-TRAP

- Synopsis of gamma scanning systems (1998)
- Destructive analyses for the quality checking of radioactive waste packages (2001)
- Synopsis of neutron assay systems (2002)
- Non-destructive analyses for the quality checking of radioactive waste packages – Workshop Proceedings (2002)
- Leaching methods for conditioned radioactive waste (2004)

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EN-TRAP today (1 of 3)

- ENTRAP has been successful
  - Discussion forum, technical visits
  - Various R&D proposals were developed (resulted in EC-projects)
  - Many bi- or multilateral cooperations generated
  - Important scientific output
  - Networking (ISO, ASTM)
- Smaller output for the
  - implementation of regulatory checking
  - harmonisation of procedures

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EN-TRAP today (2 of 3)

- We prepare the extension with the new EU countries
- Quality control / quality checking is presently a lower priority at EC level
  - The analytical techniques achieved state-of-the-art
  - Round robin tests have been performed
- Possible actions for the future
  - Free release, ILW/HLW
  - Harmonisation of tests (liaison "A" member of ISO)
  - Specific problem wastes
  - Networking outside the EU
  - Training

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EN-TRAP today (3 of 3)

Two round robin tests are being prepared (to start 2008):

- Non-destructive assay of 220l waste package (γ spectroscopy analysis on drums with sources)
- Destructive analysis of a waste sample (Cs-137, Cl-36,Tc-99, I-129 doped resins)

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WG A on Non-Destructive Methods - Objectives

- Evaluate analytical data
- Improve the quality, efficiency and cost-effectiveness of NDT methods
- Exchange information on new developments
- Promote harmonisation of measurement procedures (e.g. determination of uncertainty)

WG A - R&D projects (EC FWP) initiated

- Improvement of Passive and Active Neutron Assay Techniques for the Characterization of Radioactive Waste Packages (EUR 19121)
- Optimization of Gamma Assay Techniques for the Standard Quality Checking of Radioactive Waste Packages and Samples (EUR 19127)
- Round Robin Test for Non-Destructive Assays of 220 Liters Radioactive Waste Packages (EUR 19779)
- Quality Control of Nuclear Waste Packages with a Compton Suppression and Ge-telescope Detection System
- Project on NDA of Large waste containers

The round robin campaign on NDA of LLW packages (EC project)

- 17 drums were selected
- Drums were classified
  - Homogeneous/non-homogeneous
  - Uniform/non-uniform activity distribution
  - Apparent density (low/high) <1g/cm^3<
  - Internal shielding
- 3 drums contain fissile material
- Kind of matrix: cement, bitumen

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The NDA systems were classified as follows

C1: assay method assumes homogeneous matrix and uniform activity distributions for the whole drum;

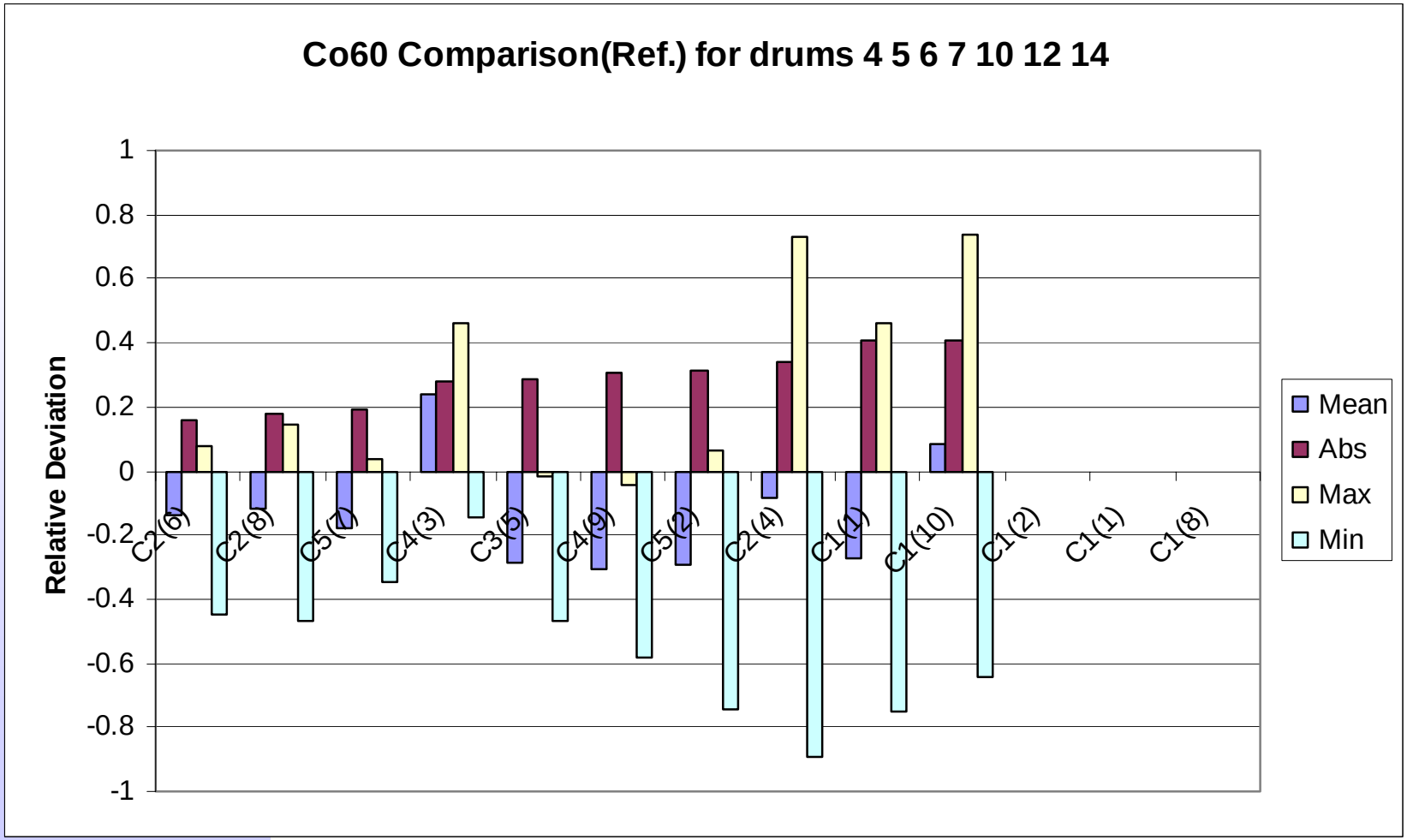
C2: assay method assumes homogeneous matrix for the whole drum and a uniform activity distribution within segments of the drum;

C3: assay method assumes homogeneous matrix for the whole drum and a uniform activity distribution within concentric rings in the drum;

C4: assay method assumes homogeneous matrix and uniform activity distribution only within segments of the drum;

C5: assay method uses complete spatial information on matrix and activity distribution.

Example of results of the NDA-RRT (7 drums)



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WG B on Destructive Chemical and Radiochemical Techniques

Main Objectives

- ✓ Build and maintain an up-to-date list of chemical and radiochemical methods and physical techniques.
- ✓ Stimulate R&D programmes in the participating laboratories.
- ✓ Determine the reliability of measurements via detailed discussion and inter-laboratory measurement programmes
- ✓ Consider sampling problems and the representative and stability of the samples.
- ✓ Stimulate the co-operation and the exchange of information.
- ✓ Provide assistance for the harmonisation of methods used by laboratories.

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WGB on Destructive Chemical and Radiochemical Techniques

R&D Projects Developed in the Framework of EU Programmes

- ✓ Evaluation and Standardisation of Fast Analytical Techniques for Destructive Radwaste Control. 1994-1998.
- ✓ Qualification of Radiochemical Routines for the Decontamination of Alpha-emitting Nuclides in Conditioned Radioactive Waste. 1994-1998 (EUR 19111).
- ✓ Development and Automation of Chemical Analytical Procedures for Determination of Non-Gamma Emitting Radionuclides in Radioactive Waste (DACAPO). 1998-2002.
- ✓ Interlaboratory Radiochemical Analysis Comparison on a Primary Waste Flux (INTERLAB). 1998-2002 (EUR 20616).

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INTERLAB project (EC funded) – Objectives

- To determine the accuracy and reliability of the different analytical methods applied in the different participating laboratories belonging to "European Network of Testing Facilities for the Quality Checking of Radioactive Waste Packages",
- To compare and validate the analytical methods used at present,
- To detect discrepancies and shortcomings in routine analysis, which will help to identify whether a separation or measurement method need further improvement.

INTERLAB – Radionuclides analyzed

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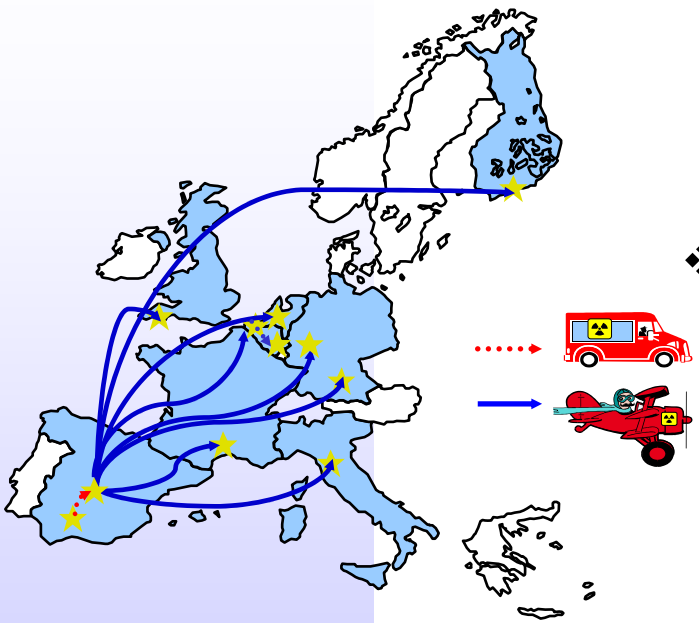
NUCLIDE	CIEMAT	ENRESA EL CABRIL	CEA[(1)]	SCK·CEN	NRG	FZJ	BELGO-PROCESS	HELSINKI UNIVERSITY	NNC	TUM	ENEA
^{3}H	X	X	X	X	X	X	X	X*	X	X	X
^{14}C	X	X	X	X		X			X	X	
^{55}Fe	X	X	X	X	X	X	X	X	X	X	X
^{63}Ni	X	X	X	X	X	X	X	X		X	X
$^{89/90}Sr$	X	X**	X	X**	X	X	X	X		X	X
^{99}Tc	X	X	X			X			X	X	X
^{129}I	X	X	X			X	X		X		
^{238}Pu	X	X	X	X	X	X	X	X	X	X	X
$^{239/40}Pu$	X	X	X	X	X	X	X	X	X	X	X
^{241}Pu	X	X	X	X	X		X [(2)]	X	X	X	X
^{241}Am	X	X	X	X	X	X	X	X	X	X	X
^{242}Cm	X	X	X	X [(2)]	X	X		X	X	X	X [(2)]
^{244}Cm	X	X	X	X	X	X		X	X	X	X
^{234}U	X		X	X	X	X	X	X	X	X	X
^{238}U	X		X	X	X	X	X	X	X	X	X

* Only from evaporator concentrate; possibilities for determination depend on sample composition.

** Only ^{90}Sr

(1) Only resin; (2) Foreseen but finally not performed

INTERLAB – Sampling and distribution



- Representative aliquots of the resin and concentrate samples were homogenised, sorted and prepared in ENRESA-LVCR under CIEMAT supervision.
- The procedure performed in order to test the homogeneity of the prepared samples was a Technical Report of **IUPAC** "The International Harmonised Protocol for the Proficiency Testing of Analytical Laboratories".
- The distribution was performed under the supervision and responsibility of ENRESA-El Cabril.

WG C on Quality Assurance / Quality Control

Objectives

- Identifying the requirements for quality checking
- Reviewing procedures, testing and control methods
- Evaluating uncertainties

Main achievements

- Document on QA/QC of LLW/ILW packages (EUR 19615)
- Discussion and promotion of accreditation / certification of the member laboratories

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WG D on ILW / HLW - Needs and Objectives

- Internationally accepted and demonstrated methods and procedures have to be developed and demonstrated

- A common approach in Quality control and Quality checking, and a common understanding of the techniques and procedures should be achieved

➢ Exchange information and discuss on harmonization of existing characterization systems

➢ Stimulate and coordinate ongoing R&D on characterization methods and procedures for HLW and ILW

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WG D on ILW / HLW - present status

- 4 meetings have been organized
- Topics discussed:
  - High-level radioactive waste (glass, spent fuel)
  - Intermediate level, long-living radioactive waste (cement, bitumen)
  - General problems, approaches

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Networking of ENTRAP

- ENTRAP is networking with
  - ISO ("liaison "A" member)
  - ASTM
- ENTRAP is present at international conferences (e.g. RADWAP, ICEM)
- ? networking with the Forum on design and assessment of radioactive waste packages (developed by JRC-IE)

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Reserve slides

WG A - a picture of the currently available gamma systems for quality checking (2001)

NDA Gamma Techniques	X of 14	% of laboratories
Segmented gamma scanning	**14**	**100**
Angular scanning	**5**	**36**
Swivel or Horizontal scanning	**3**	**20**
Transmission corrected scanning	**6**	**40**
Digital radiography	**3**	**20**
Digital tomography	**3**	**20**

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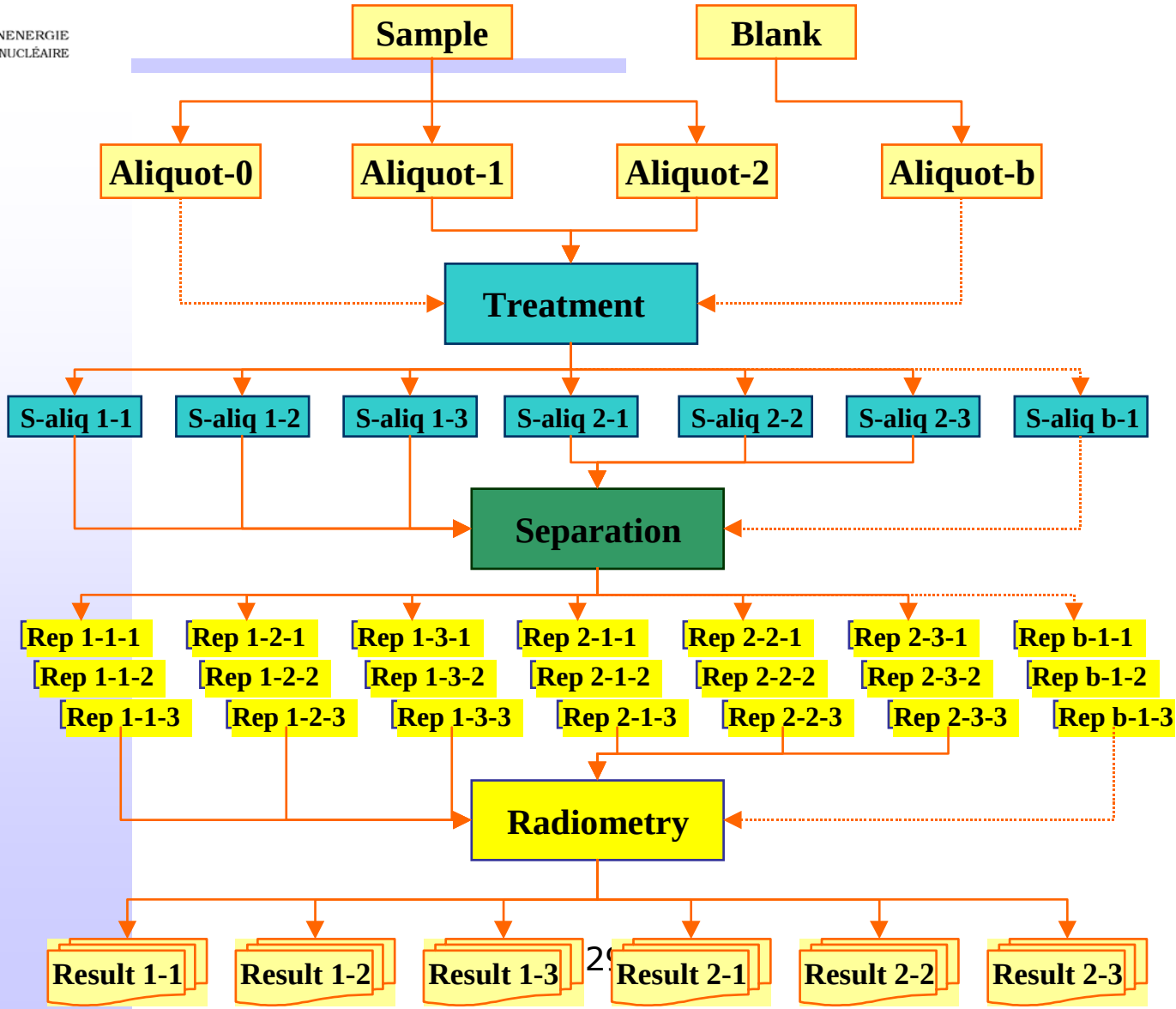
Conclusions from this NDA round robin test

- No data available on uncertainty of expected values (activity, homogeneity)
  - No conclusions possible on the measure-ment bias or precision of the methods or systems
- On average 3 to 4 systems report activities that deviate ~20% from the expected activity

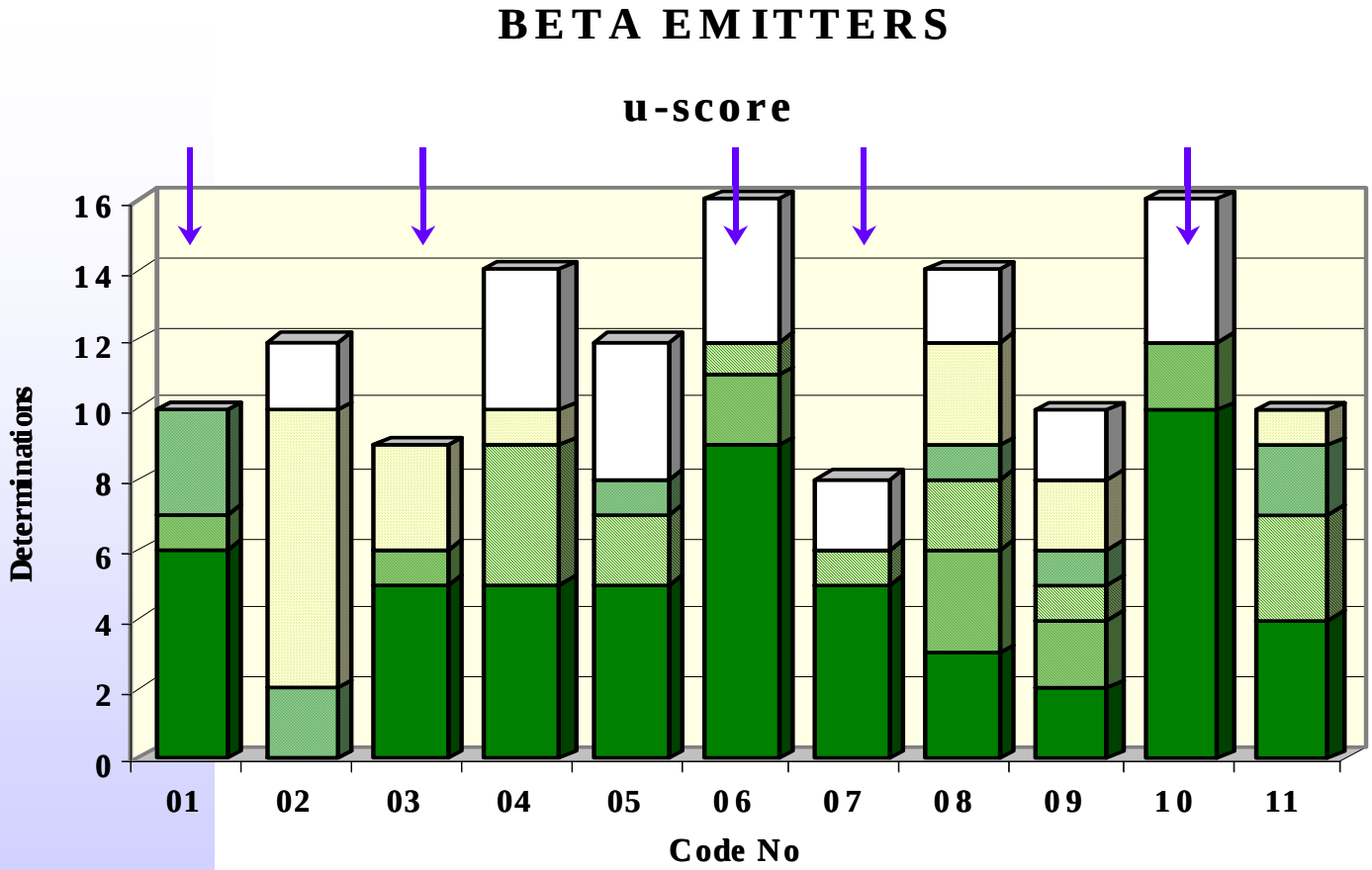
INTERLAB – Analyses of samples



Statistical evaluation of results

- **1579 results** and their uncertainties were managed: **754** from **concentrate** sample and **825** from **resin** sample.
- **Reference values** and the target uncertainty were evaluated by consensus of all participants in order to apply the statistical methods already existing. Results significantly deviating from the corresponding reference values were recognised as outliers by tests described in the **IUPAC** "Protocol for the design, conduct and interpretation of collaborative studies“: **Cochran and Grubbs tests**.
- Data treatment was performed by:
  - **Q-score** that only allows qualitative evaluations.
  - **U-score** follows a Student distribution and is sensitive to the outliers in order to detect inconsistencies in the declaration of activity and uncertainties. The u-score follows a Student distribution and can be defined with the criterion for evaluation by just defining the degrees of freedom (ν) (5 in this case).

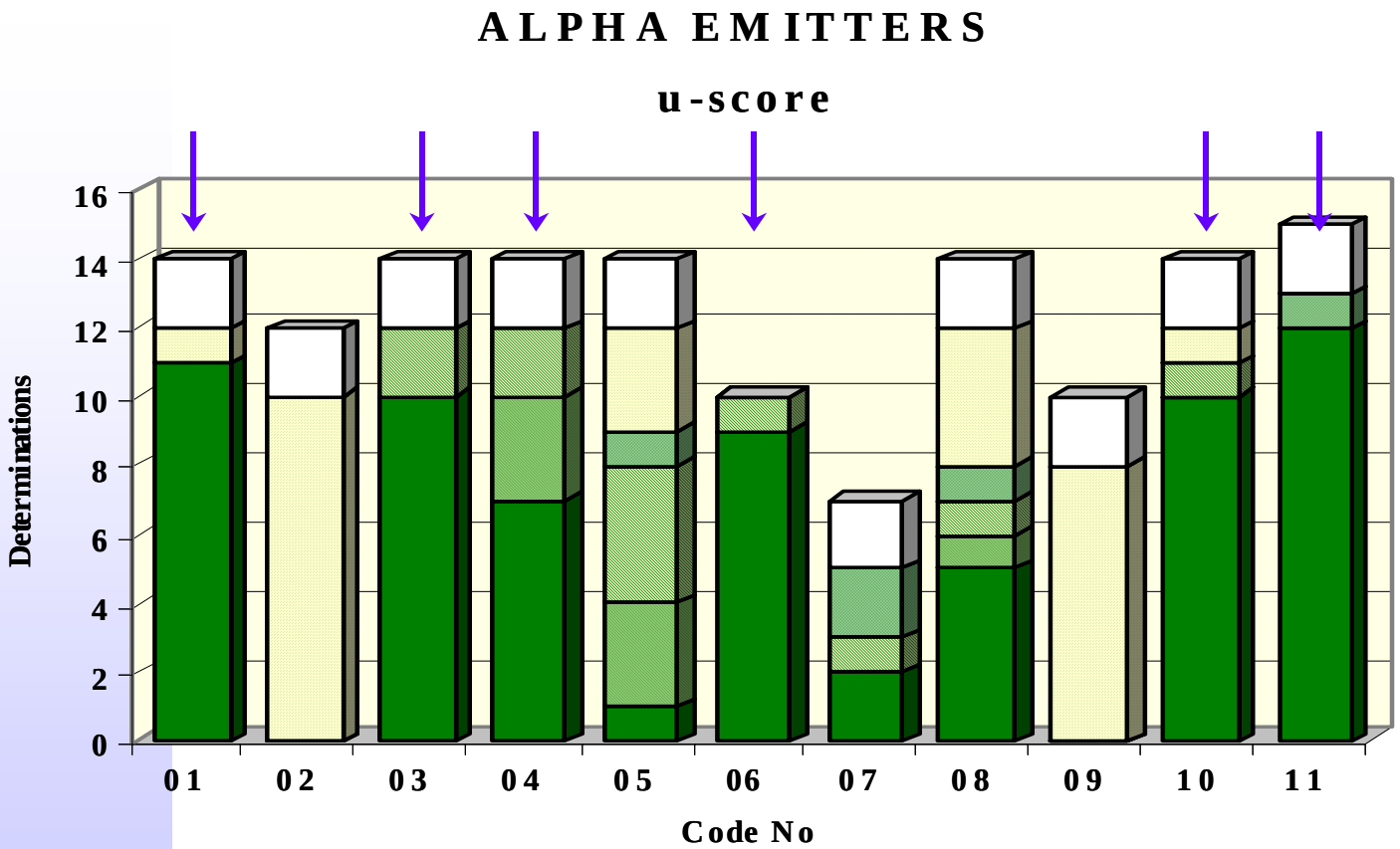
Evaluation of the results based on the u-score, using the rating shown previously (I)



S = satisfactorily NS = non-satisfactorily

A1-A3 = acceptable

Evaluation of the results based on the u-score, using the rating shown previously (II)



S = satisfactorily NS = non-satisfactorily

A1-A3 = acceptable

INTERLAB project - Conclusions (I)

- The evaluation of **beta emitting radionuclides** in resin and concentrate by lab of u-score test shows:
  - Excellent results for **CN1, CN3, CN6, CN7** and **CN10:** >60% of submitted results quoted satisfactory or acceptable at level 1.
  - Very good results for **CN4** and **CN5** with more than 85% of results quoted acceptable at level 2 or satisfactory.
  - Labs with good results are **CN8, CN9** and **CN11:** >60% of data better than acceptable at level 2.
  - Only one lab **CN2** has no results better than acceptable at level 3.
- The evaluation of **alpha emitting radionuclides** in resin and concentrate by lab of u-score test shows:
  - Excellent results for **CN1, CN3, CN4, CN6, CN10** and **CN11:** >80% of submitted results quoted satisfactory or acceptable at level 1.
  - Very good results for **CN5, CN7** and **CN8** with more than 55% of results quoted acceptable at level 2 or satisfactory.
  - Two labs **CN2** and **CN9** present results non-satisfactory for all alpha emitting

INTERLAB project – Conclusions (II)

- In general, the results of the evaporator concentrate are less satisfactory than the results of the ion exchange resin.
- The procedures used give results that are sufficiently accurate and precise for the purposes of the radioactive waste management
- A **"Procedures report"** with a full description of all destructive techniques used for the analyses of the different alpha, beta and gamma emitting radionuclides has been prepared.