Intercomparison of the applicability of equipment and analysis methods for the assessment of NORM in daily routine

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Intercomparison of equipment and analysis methods for the assessment of NORM

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- Introduction
- Aim of this intercomparison
- Criteria
- Equipment and analysing methods
- Conclusion

Intercomparison of equipment and analysis methods for the assessment of NORM

INTRODUCTION

- 1970’s: Awareness of regulators
- Remains from non-nuclear industrial processes
- European Directives 1996/29 en 2013/59/Euratom
- National regulations
- Impact of actions and measures

Intercomparison of equipment and analysis methods for the assessment of NORM

AIM

To provide an overview of the applicability of instruments and methods in the non-nuclear industry in routine to assess:

- Elevated radiological health risks caused by NORM and to assist in the decision making process
- Instruments and methods can be applied to prove compliance with National regulations on NORM.

Intercomparison of equipment and analysis methods for the assessment of NORM

CRITERIA

- Technical
  1. Non-destructive versus destructive
  2. Correction for detector properties
  3. Correction for the density
  4. Correction for the chemical composition
  5. Correction for the size or geometry
- NORM specific
  6. The equilibrium status of primordial nuclides
  7. Nuclide identification and specific radioactivity

Intercomparison of equipment and analysis methods for the assessment of NORM

CRITERIA

- Operational
  8. Swiftness of availabity of analysis results
  9. Specialist versus operator
  10. Costs
  11. Health physics
- Regulatory
  12. National regulations

Intercomparison of equipment and analysis methods for the assessment of NORM

CRITERIA

	Criterion	Score				
		++	+	+/-	-	--
1	ND / D	Non-Destructive	-	-	-	Destructive
2	Corr. Detector	Accurate				Not possible
3	Corr. ρ	Accurate				Not possible
4	Corr. Chemical composition	Accurate				Not possible
5	Corr. Geometry	Accurate				Not possible
6	Corr. Equilibrium	Accurate				Not possible
7	Nucl. Identification & Activity	No other instrument or method needed				Not possible
8	Availability of Analysis results	Direct				> 2 weeks
9	Specialist - Operator	Operator	-	-	-	Specialist
10	Costs	Cheap				Very expensive
11	Health Physics	No other instrument or method needed				No added value
12	National Regulations	No other instrument or method needed				No added value

Intercomparison of equipment and analysis methods for the assessment of NORM

Equipment and analysis methods

- Alpha-spectroscopy
- Beta-spectroscopy
- Gross alpha and beta counting
- Hand-held equipment
  - Alpha and beta contamination monitor
  - Dose rate monitor
  - Dose rate monitor including isotope identifier

Intercomparison of equipment and analysis methods for the assessment of NORM

Equipment and analysis methods

- Gamma-spectroscopy including new developments
  - High resolution system
  - High resolution system combined with a transmission technique
  - High resolution system combined with a “μ-over-ρ” technique
  - Low resolution system used in screening method.

Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: α-spectroscopy

- Destructive; unlocking the sample
- Electrodeposition
- Sample geometry; thickness of a few atoms
- Vacuum
- Nuclide identification: Analysis software or manual
- Specialist

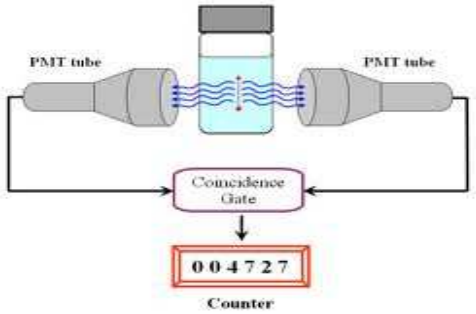
Criterion	α-spec
ND / D	D
Corr dtctr.	+
Corr φ	n.a.
Corr chem.	n.a.
Corr geo.	n.a.
Corr equil.	--
Nucl-ident	+
Avail. result	--
Specl/Oprtr	Sp
Costs	--
Health phys.	--
Nat. reg.	-

Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: β-spectroscopy

- Destructive; sample preparation
- Adding to scintillator
- Sample geometry depending on vial, quenching, etc.
- Sensitive for visible light
- Nuclide identification: Analysis software or manual
- Specialist

Criterion	β-spec
ND / D	D
Corr detctr.	+
Corr φ	n.a.
Corr chem.	n.a.
Corr geo.	n.a.
Corr equil.	--
Nucl-ident	+/-
Avail. result	--
Specl/Oprtr	Sp
Costs	--
Health phys.	--
Nat. reg.	-



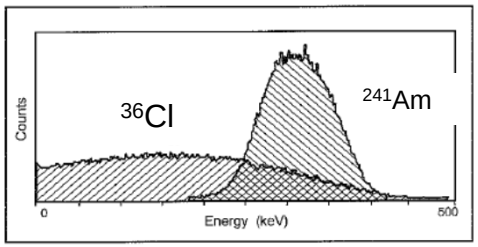


Figure 3-2.
Multichannel analyzer display, alpha/beta interferences.

Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: Gross α/β counting

- Destructive; sample preparation
- No correction for density and chemical composition
- Sample geometry equal to detector size
- Nuclide identification: not possible
- Specialist

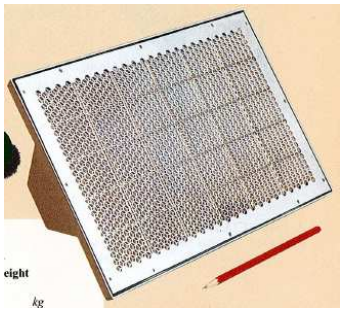
Criterion	α/β-total
ND / D	D
Corr dtctr.	+
Corr φ	n.a.
Corr chem.	-
Corr geo.	n.a.
Corr equil.	--
Nucl-ident	--
Avail. result	-
Specl/Oprtr	Sp
Costs	+/-
Health phys.	+/-
Nat. reg.	-

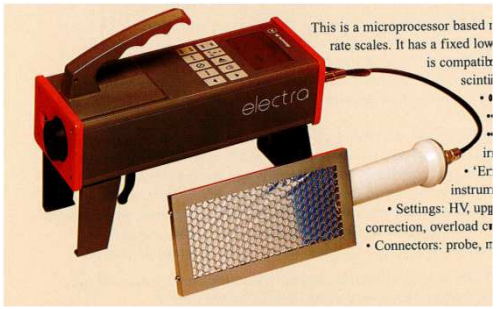
Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: Hand-held α/β contamination

- Non-destructive; no sample preparation
- No correction for density and chemical composition
- Sample geometry equal to detector size
- Equipment is vulnerable
- Nuclide identification: not possible
- Operator

Criterion	hand -α/β
ND / D	ND
Corr detctr.	+/-
Corr φ	--
Corr chem.	--
Corr geo.	--
Corr equil.	--
Nucl-ident	--
Avail. result	++
Specl/Oprtr	Op
Costs	+
Health phys.	+
Nat. reg.	+/-





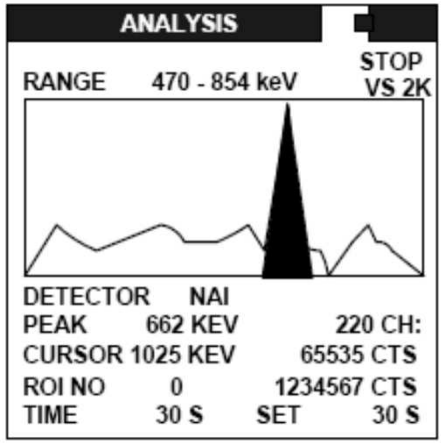
Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: Hand-held dose rate – γ low resolution

- Non-destructive; no sample preparation
- No correction for density, chemical composition and detector properties
- Sample geometry undefined
- Nuclide identification is possible
- Operator / specialist

Criterion	hand - γ_{LR}
ND / D	ND
Corr detctr.	+/-
Corr φ	--
Corr chem.	--
Corr geo.	--
Corr equil.	--
Nucl-ident	+/-
Avail. result	+
Specl/Oprtr	Op
Costs	+/-
Health phys.	+
Nat. reg.	+/-

GR-135 – THE IDENTIFIER

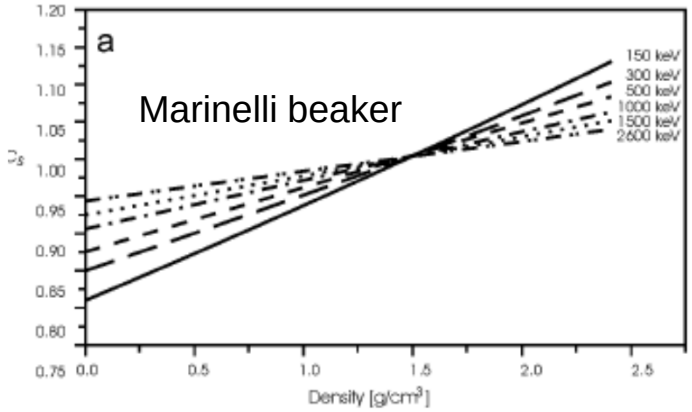


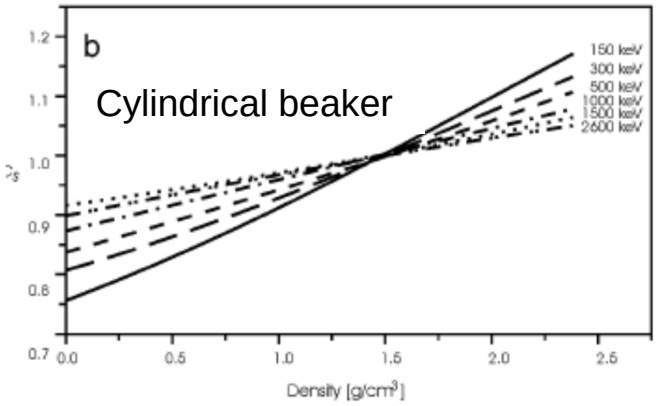
Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: γ-spectroscopy high resolution – density correction

- Non-destructive; no sample preparation
- Correction for density (by formula)
- No correction for chemical composition and detector properties
- Sample geometry defined
- Nuclide identification
- Specialist

Criterion	γ - $spec_{HR}$ φ
ND / D	ND
Corr detctr.	+
Corr φ	+/-
Corr chem.	+/-
Corr geo.	+/-
Corr equil.	+/-
Nucl-ident	+
Avail. result	-
Specl/Oprtr	Sp
Costs	--
Health phys.	-
Nat. reg.	+/-



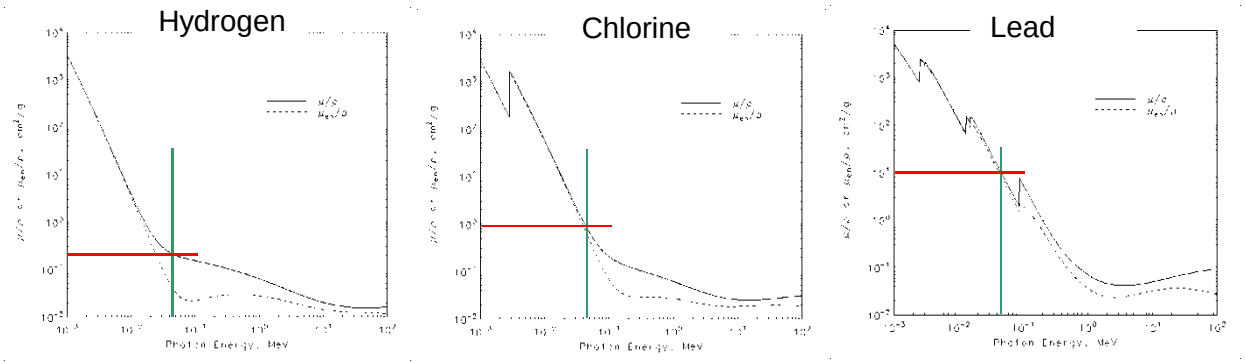


Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: γ-spectroscopy high resolution – Transmission correction

- Non-destructive; no sample preparation
- Correction for density
- Limited correction for chemical composition
- No correction for detector properties
- Sample geometry defined
- Nuclide identification
- Specialist

Criterion	γ - $spec_{HR}$ Transm
ND / D	ND
Corr detctr.	+
Corr φ	+
Corr chem.	+/-
Corr geo.	+/-
Corr equil.	+
Nucl-ident	+
Avail. result	-
Specl/Oprtr	Sp
Costs	--
Health phys.	-
Nat. reg.	+/-



Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: γ-spectroscopy high resolution – "μ-over-ρ" correction

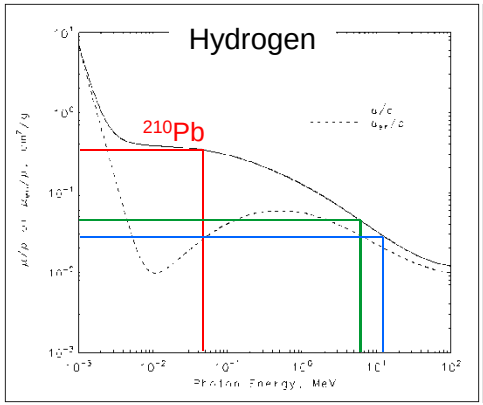
- Non-destructive; no sample preparation
- Correction for density
- Correction for chemical composition
- Correction for detector properties
- Sample geometry defined
- Nuclide identification
- Specialist

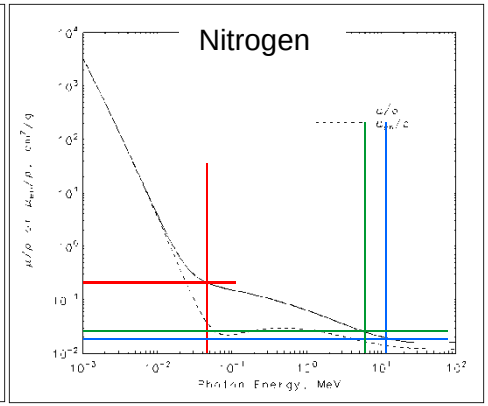
Criterion	γ - spec$_{HR}$ μ-over-φ
ND / D	ND
Corr detctr.	+
Corr φ	++
Corr chem.	++
Corr geo.	+
Corr equil.	++
Nucl-ident	++
Avail. result	-
Specl/Oprtr	Sp
Costs	--
Health phys.	-
Nat. reg.	+

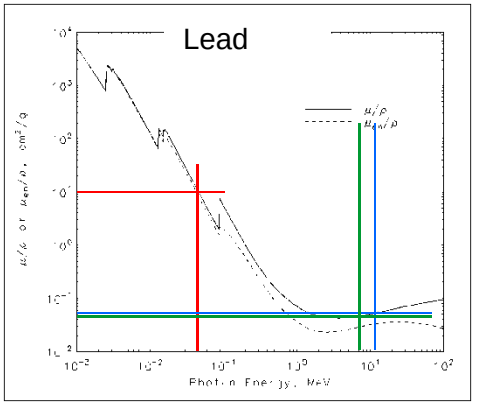
Hydrogen

Nitrogen

Lead







Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: γ-spectroscopy low resolution screening

- Non-destructive; no sample preparation
- Correction for density
- Correction for chemical composition
- Correction for detector properties
- Sample geometry defined
- Nuclide identification (limited)
- Operator / specialist

Criterion	γ - spec$_{HR}$ screening
ND / D	ND
Corr detctr.	+
Corr φ	+/-
Corr chem.	+/-
Corr geo.	+/-
Corr equil.	+/-
Nucl-ident	+
Avail. result	+
Specl/Oprtr	Op / Sp
Costs	+/-
Health phys.	+
Nat. reg.	+

Intercomparison of equipment and analysis methods for the assessment of NORM

Assessment: Overview

	Criterion	Score									
		α - spectroscopy	β - spectroscopy	Gross α/β counting	Hand held - α/β contamination	Hand held - Dose rate	Hand held- Dose rate and isotope identifier	γ - spectroscopy high resolution	γ - spectroscopy high resolution & Transmission	γ - spectroscopy high resolution & μ-over-ρ transmission	γ - spectroscopy low resolution & screening
1	ND / D	D	D	D	ND	ND	ND	ND	ND	ND	ND
2	Corr. Detector	+	+	+	+/-	+/-	+/-	+	+	+	+
3	Corr. ρ	n.a.	n.a.	n.a.	--	--	--	+/-	+	++	+/-
4	Corr. Chemical composition	n.a.	n.a.	-	--	--	--	+/-	+/-	++	+/-
5	Corr. Geometry	n.a.	n.a.	n.a.	--	--	--	+/-	+/-	+	+/-
6	Corr. Equilibrium	--	--	--	--	--	--	+/-	+	++	+/-
7	Nucl. Identification & Activity	+	+/-	--	--	--	+/-	+	+	++	+
8	Availability of Analysis results	--	-	-	++	++	+	-	-	-	+
9	Specialist - Operator	Sp	Sp	Sp	Op	Op	Op	Sp	Sp	Sp	Op/Sp
10	Costs	--	--	+/-	+	+	+/-	--	--	--	+/-
11	Health Physics	--	--	+/-	+	+	+	-	-	-	+
12	National Regulations	-	-	-	+/-	+/-	+/-	+/-	+/-	+	+

Note: n.a. = not applicable

Intercomparison of equipment and analysis methods for the assessment of NORM

Conclusion

- No single instrument/method covers adequate health protection and regulatory compliances.
- Dealing with NORM according to best practices, a combination of:
  - Hand held α/β contamination monitor
  - Hand held dose rate monitor or a hand-held dose rate including an isotope identifier
  - Gamma-spectroscopy low resolution for screening

  may be applied to cover all radiological aspects for health physics and regulatory control.

Intercomparison of equipment and analysis methods for the assessment of NORM

Conclusion (continued)

- Future developments can be expected in the evolution of:
  - “The hand held dose rate monitor including an isotope identifier” towards a “gamma-spectroscopy low resolution system”.
  - A “gamma-spectroscopy low resolution system” towards a “gamma-spectroscopy high resolution system”.


Thank for your attention