

**NORM characterization and  
applied metrology in daily routine  
in the Non-Nuclear Industry**

**-Analyze results? I Want It Now (I-WIN)-**

**Leo van Velzen**

(vanvelzen.eurssem@gmail.com)

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### **Content**

- Introduction
- Aim, I-WIN
- Intercomparison of instruments and methodologies for NORM
- Summary and discussion

### AIM

To provide an overview by means of an intercomparison a global overview of the applicability of instruments and methods for the characterization of NORM in the non-nuclear industry, to assess in daily routine:

- Elevated radiological health risks and to assist in the decision making process to take adequate measures in due time;
- The level of the radiological contamination of materials;
- The instruments and methods that can be applied to prove to be in compliance with National regulations.

### I-WIN (I Want It Now)

- Consumer trend: shopping on-line and delivery is next day, before ....
- Translated to NNI: I want *the analyze results now*, within ..... minutes

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

Criterion	Score				
	++	+	+/-	-	--
<b>Operational</b>					
H-H / Lab	Hand-Held	-	-	-	Laboratory
Operator / Specialist	Operator				Specialist
Avail. of results	Direct				> 21 days
Health physics	No other instrument of method needed				No added value
Costs	Cheap				Very expensive
<b>Regulatory</b>					
Regulations	No other instrument of method needed	-	-	-	No added value
<b>NORM specific</b>					
Equil corr	Accurate	-	-	-	Not possible
Nucl ident/indic	Accurate Identification				Not possible
Nucl interference	Accurate				Not possible
<b>Technical</b>					
NDA / DA	Non-Destructive Analysis	-	-	-	Destructive Analysis
Detec calib	Accurate				Not possible
Smpl calib corr	Accurate				Not possible
S-abs rho	Accurate				Not possible
S-abs chm comp	Accurate				Not possible

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

Criterion	Score				
	++	+	+/-	-	--
<b>Operational</b>					
H-H / Lab	Hand-Held	-	-	-	Laboratory
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Smpl calib corr	Accurate				Not possible
S-abs rho	Accurate				Not possible
S-abs chm comp	Accurate				Not possible

### Instruments and analyze methods

### Abbreviation

- **Laboratory**

- $\alpha$ -spectroscopy
- $\beta$ -spectroscopy
- Gross  $\alpha/\beta$  counting

$\alpha$ -spec

$\beta$ -spec

Gross  $\alpha/\beta$

- **Hand-held monitors**

- $\alpha/\beta$  contamination
- Dose rate
- $\gamma$ -spectroscopy low-resolution (e.g. NaI(Tl), CsI)
- $\gamma$ -spectroscopy intermediate-resolution  
(e.g. LaBr<sub>3</sub>, CeBr<sub>3</sub>, Srl<sub>2</sub>)

Gross  $\alpha/\beta$  cont

Dose rate

$\gamma$ -spec LR

$\gamma$ -spec IntR

- Dose rate &  $\gamma$ -spectroscopy intermediate-resolution

Dose R &  $\gamma$ -spec IntR

### Instruments and analyze methods

#### $\gamma$ -spectroscopy

- **Hand-held monitors**

- $\gamma$ -spectroscopy low-resolution (e.g. NaI(Tl), CsI)
- $\gamma$ -spectroscopy intermediate-resolution  
(e.g. LaBr<sub>3</sub>, CeBr<sub>3</sub> low background, Srl<sub>2</sub>, CdZn(Te))

- **Laboratory systems**

- $\gamma$ -spectroscopy Intermediate-Resolution
- $\gamma$ -spectroscopy high-resolution (e.g. HPGe N-type low Bg)  
including a density correction
- $\gamma$ -spect high-resolution incl. a transmission technique
- $\gamma$ -spect high-resolution incl. an “ $\mu$ -over- $\rho$ ” technique

### Abbreviation

H-H,  $\gamma$ -spec LR

H-H,  $\gamma$ -spec IntR

Lab,  $\gamma$ -spec IntR

Lab,  $\gamma$ -spect HR  $\rho$

Lab,  $\gamma$ -spect HR Tr

Lab,  $\gamma$ -spect  $\mu$ -over- $\rho$

### Assessment: $\alpha$ -spectroscopy

- Destructive; unlocking the sample
- Electrodeposition
- Sample geometry; thickness of a few atoms
- Vacuum (preferable  $< 1.10^{-3}$  mBar)
- Nuclide identification by analysis software or manually
- Specialist

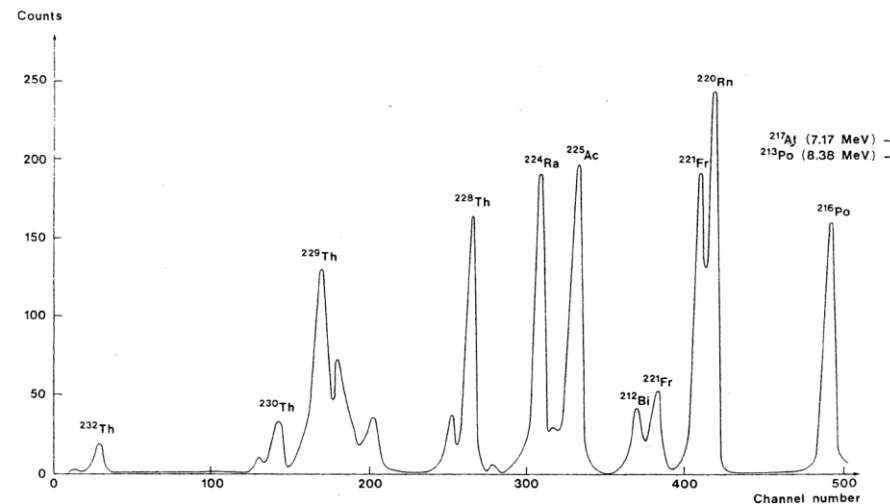


Fig. 3. Alpha spectrum after thorium separation from sea water and electrodeposition using  $^{229}\text{Th}$  as yield determinant, with a surface barrier Si-detector (From Holm, 1984).

Criterion	$\alpha$ -spec
<b>Operational</b>	
H-H / Lab	Lab
Opr / Spc	Spc
○ Avail of results	--
Health phys	--
Costs	--
<b>Regulatory</b>	
○ Regulations	-
<b>NORM specific</b>	
Equil corr	--
Nucl ident/indic	+
Nucl interf	+
<b>Technical</b>	
NDA / DA	DA
Detec calib	+
Smpl calib corr	n.a.
S-abs rho	n.a.
S-abs chm comp	n.a.



### Assessment: $\alpha$ -spectroscopy

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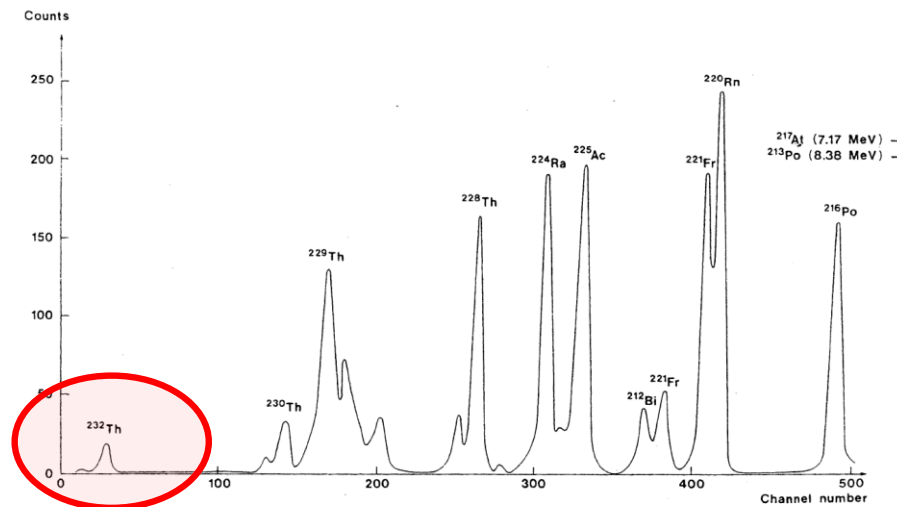


Fig. 3. Alpha spectrum after thorium separation from sea water and electrodeposition using  $^{229}\text{Th}$  as yield determinant, with a surface barrier Si-detector (From Holm, 1984).

Criterion	$\alpha$ -spec
<b>Operational</b>	
H-H / Lab	Lab
Opr / Spc	Spc
○ Avail of results	--
Health phys	--
Costs	--
<b>Regulatory</b>	
○ Regulations	-
<b>NORM specific</b>	
Equil corr	--
Nucl ident/indic	+
Nucl interf	+
<b>Technical</b>	
NDA / DA	DA
Detec calib	+
Smpl calib corr	n.a.
S-abs rho	n.a.
S-abs chm comp	n.a.

# NORM characterization and applied metrology

## Intercomparison of instruments and methods for NORM

### Assessment: Hand-Held $\alpha/\beta$ -contamination

- Non-destructive; no sample preparation
- No correction for density and chemical composition
- Sample (measuring) geometry in principal equal to detector size
- Equipment is vulnerable, especially the foil
- Nuclide identification not possible
- Operator



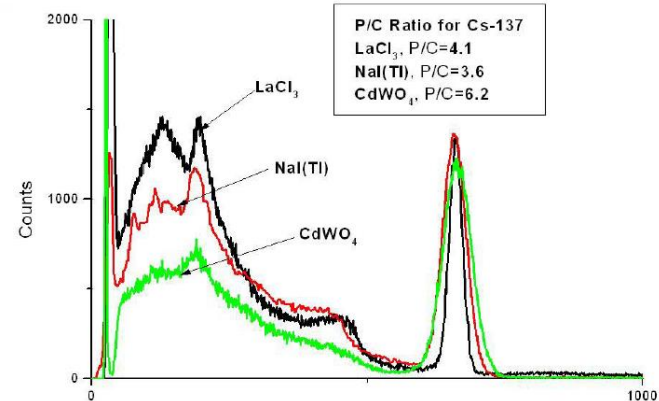
Criterion	Gross $\alpha/\beta$ cont
<b>Operational</b>	
H-H / Lab	H-H
Opr / Spc	Opr
○ Avail of results	++
Health phys	++
Costs	+
<b>Regulatory</b>	
○ Regulations	+/-
<b>NORM specific</b>	
Equil corr	--
Nucl ident/indic	--
Nucl interf	--
<b>Technical</b>	
NDA / DA	NDA
Detec calib	+/-
Smpl calib corr	--
S-abs rho	--
S-abs chm comp	--

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

### Assessment: Hand-Held Dose Rate – $\gamma$ spec interm. resolution

- Non-destructive; no sample preparation
- No correction for density, chemical composition and detector properties
- The “Dose rate” sample (measuring) geometry is in general not defined and thus the  $\gamma$ -detector might not be calibrated
- Nuclide identification/indication is possible
- Operator



M.Swoboda e.a.; Spectral gamma detector RID; 2004 IEEE

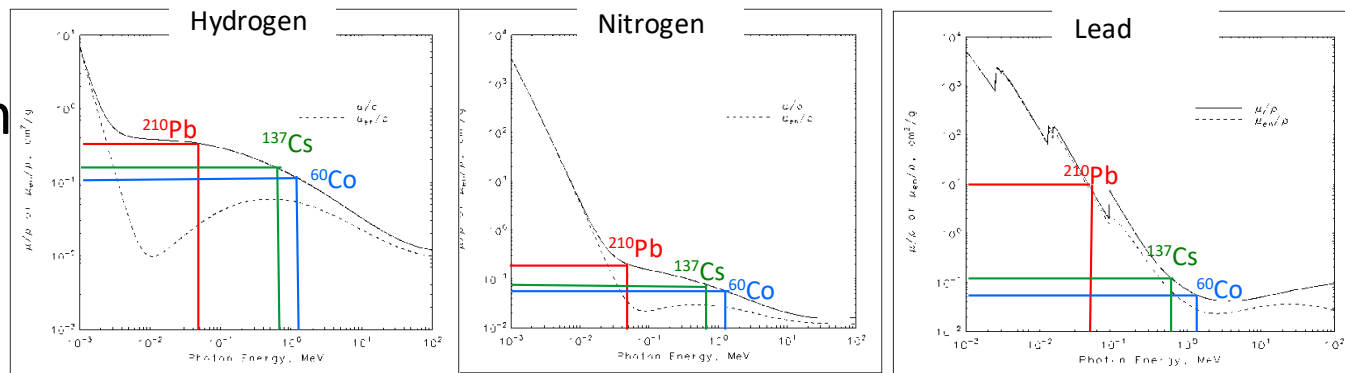
Criterion	Dose R & $\gamma$ -spec IntR
<b>Operational</b>	
H-H / Lab	H-H
Opr / Spc	Opr
○ Avail of results	++ & +
Health phys	++ & +
Costs	+/-
<b>Regulatory</b>	
○ Regulations	+/-
<b>NORM specific</b>	
Equil corr	--
Nucl ident/indic	+
Nucl interf	--
<b>Technical</b>	
NDA / DA	NDA
Detec calib	+/-
Smpl calib corr	+/-
S-abs rho	--
S-abs chm comp	--

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

### Assessment: Lab $\gamma$ spectroscopy high resolution – “ $\mu$ -over- $\rho$ ” correction

- Non-destructive; sample preparation for sample holder
- Self absorption correction: density and chemical composition
- Correction for detector properties
- Sample geometry is defined, equal to a calibration geometry or by simulation
- Nuclide identification
- Specialist



Criterion	$\gamma$ -spec HR $\mu$ -over- $\rho$
<b>Operational</b>	
H-H / Lab	Lab
Opr / Spc	Spc
○ Avail of results	-
Health phys	-
Costs	--
<b>Regulatory</b>	
○ Regulations	+
<b>NORM specific</b>	
Equil corr	++
Nucl ident/indic	++
Nucl interf	+
<b>Technical</b>	
NDA / DA	NDA
Detec calib	++
Smpl calib corr	+
S-abs rho	++
S-abs chm comp	++

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

### Overview:

### Lab systems

### & methods

Criterion	$\alpha$ -spec	$\beta$ -spec	Gross $\alpha/\beta$
<b>Operational</b>			
H-H / Lab	Lab	Lab	Lab
Opr / Spe	Spe	Spe	Spe/Opr
Avail of results	--	--	-
Health phys	--	--	+/-
Costs	--	--	+/-
<b>Regulatory</b>			
Regulations	-	-	-
<b>NORM specific</b>			
Equil corr	--	--	--
Nucl ident/indic	+	+/-	--
Nucl interf	+	+/-	+/-
<b>Technical</b>			
NDA / DA	DA	DA	DA
Detec calib	+	+	+
Smpl calib corr	n.a.	n.a.	n.a.
S-abs rho	n.a.	n.a.	n.a.
S-abs chm comp	n.a.	n.a.	n.a.

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

**Overview:**  
**Hand-Held**  
**systems**  
**& methods**

Criterion	Gross $\alpha/\beta$ cont	Dose rate	$\gamma$ -spec LR	$\gamma$ -spec IntR	Dose R & $\gamma$ -spec IntR
<b>Operational</b>					
H-H / Lab	H-H	H-H	H-H	H-H	H-H
Opr / Spe	Opr	Opr	Opr	Opr	Opr
Avail of results	++	++	+	+	++ & +
Health phys	++	++	+	+	++ & +
Costs	+	+	+/-	+/-	+/-
<b>Regulatory</b>					
Regulations	+/-	+/-	-	-	+/-
<b>NORM specific</b>					
Equil corr	--	--	--	--	--
Nucl ident/indic	--	--	+/-	+	+
Nucl interf	--	--	--	--	--
<b>Technical</b>					
NDA / DA	NDA	NDA	NDA	NDA	NDA
Detec calib	+/-	+	+/-	+/-	+/-
Smpl calib corr	--	--	+/-	+/-	+/-
S-abs rho	--	--	--	--	--
S-abs chm comp	--	--	--	--	--

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

**Overview:**  
**γ spectroscopy**  
**systems**  
**& methods**

Criterion	γ-spec LR	γ-spec IntR	Dose R & γ-spec IntR	γ-spec IntR	γ-spec HR φ	γ-spec HR Tr	γ-spec HR μ-over-φ
<b>Operational</b>							
H-H / Lab	H-H	H-H	H-H	Lab	Lab	Lab	Lab
Opr / Spc	Opr	Opr	Opr	Opr	Spc	Spc	Spc
Avail of results	+	+	++ & +	+	-	-	-
Health phys	+	+	++ & +	+	-	-	-
Costs	+/-	+/-	+/-	-	--	--	--
<b>Regulatory</b>							
Regulations	-	-	+/-	+	+	+	+
<b>NORM specific</b>							
Equil corr	--	--	--	+/-	+/-	+	++
Nucl ident/indic	+/-	+	+	+	+	+	++
Nucl interf	--	--	--	+	+	+	+
<b>Technical</b>							
NDA / DA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Detec calib	+/-	+/-	+/-	+	+	+	++
Smpl calib corr	+/-	+/-	+/-	+	+	+	+
S-abs rho	--	--	--	+/-	+	+	++
S-abs chm comp	--	--	--	+/-	-	+	++

# NORM characterization and applied metrology in NNI

## Intercomparison of instruments and methods for NORM

**Overview:**  
 **$\gamma$  spectroscopy**  
**systems**  
**& methods**

Criterion	$\gamma$ -spec LR	$\gamma$ -spec IntR	Dose R & $\gamma$ -spec IntR	$\gamma$ -spec IntR	$\gamma$ -spec HR $\varphi$	$\gamma$ -spec HR Tr	$\gamma$ -spec HR $\mu$ -over- $\varphi$
<b>Operational</b>							
H-H / Lab	H-H	H-H	H-H	Lab	Lab	Lab	Lab
Opr / Spc	Opr	Opr	Opr	Opr	Spc	Spc	Spc
Avail of results	+	-	++ & +	+	-	-	-
Health phys	+	+	++ & +	+	-	-	-
Costs	+/-	+/-	+/-	-	--	--	--
<b>Regulatory</b>							
Regulations	-	-	+/-	+	+	+	+
<b>NORM specific</b>							
Equil corr	--	--	--	+/-	+/-	+	++
Nucl ident/indic	+/-	+	+	+	+	+	++
Nucl interf	--	--	--	+	+	+	+
<b>Technical</b>							
NDA / DA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Detec calib	+/-	+/-	+/-	+	+	+	++
Smpl calib corr	+/-	+/-	+/-	+	+	+	+
S-abs rho	--	--	--	+/-	+	+	++
S-abs chm comp	--	--	--	+/-	-	+	++



### Summary and discussion

- No single instrument & method covers adequate all health protection and regulatory compliances.
- Dealing with the best practices with NORM in the non-nuclear industry a combination of:
  - Hand held  $\alpha/\beta$  contamination monitor
  - Hand held dose rate monitor or a hand-held dose rate including an isotope identifier
  - Lab gamma-spectroscopy intermediate resolution

may be applied to cover all radiological aspects for health physics and regulatory control compliances in the non-nuclear industry, e.g. assessing the radiological contamination -, dose rate -, the total activity – and the nuclide specific activity concentration of NORM.

# Questions ?

Contact information:

[vanvelzen.eurssem@gmail.com](mailto:vanvelzen.eurssem@gmail.com)