Radiological study of transport and processing of naturally occurring radioactive materials.

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Outline

- NuTeC
- NORM projects
 - NuTeC-NORM
 - B-NORM
 - EUR-NORM
- · New research topic:
 - treatment of (NORM) contaminated waste



















- XIOS University College (Diepenbeek, Belgium)
 - Industrial Sciences: "Nuclear and environmental Engineering"
 - Environmental Technology-Radiochemistry
 - Medical Nuclear Technology























- Environmental and Energy related research
- Development and application of nuclear measurement aperture



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NuTeC -NORM project (15/12/08 - 14/12/10)

1. Construction of a NORM-database (Harbor of Antwerp)

















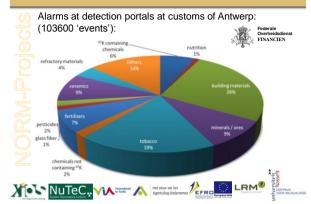




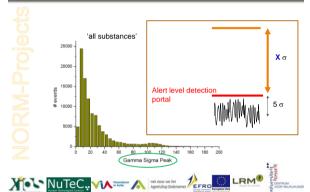




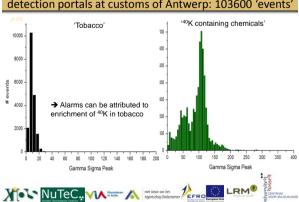
NORM Database [23/04/07 - 31/08/10]:



NORM Database [23/04/07 – 31/08/10]: Alarms at detection portals at customs of Antwerp: 103600 'events'



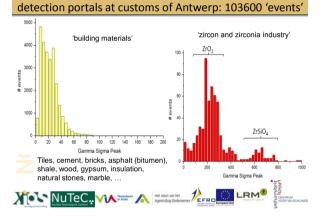
NORM Database [23/04/07 – 31/08/10]: Alarms at detection portals at customs of Antwerp: 103600 'events'



NORM Database [23/04/07 - 31/08/10]: Alarms at detection portals at customs of Antwerp: 103600 'events' '40K containing chemicals'

NORM Database [23/04/07 - 31/08/10]: Alarms at

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NuTeC -NORM project

2. Developing a tool to estimate the activity concentration of NORM For comparison:

- Nal and LaBr₃ experiments are benchmarked against a Laboratory experiment with high purity germanium detector after taking of sample
- Output = activity concentration radionuclide lies beneath, around or
- above the limits given by European Directives for NORM nuclides



NuTeC -NORM project 3. Case Studies at several NORM Companies Supplying information and training for companies in working with NORM Making an inventory of the presence and activity of NORM and propose measures for radiation protection.

NORM industries (New European Directives BSS)

- List of NORM industries which will require regulatory consideration:

 - Extraction of rare earth from monazite
 Production of thorium compounds and thorium containing products
 - Processing of niobium/tantalum ore

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- Oil and gas productionGeothermal energy production
- TiO₂ pigment production
- Thermal phosphorus production
 Zircon and zirconia industry
- Production of phosphate fertilisers
 Cement production, maintenance of clinker ovens
- Coal-fired power plants, maintenance of boilers
 Phosphoric acid production
- Primary iron production
- Tin/Lead/Copper smeltingGround water filtration facilities
- Mining of ores other than Uranium ore
- Including relevant secondary processes

 Member States should add other relevant activities







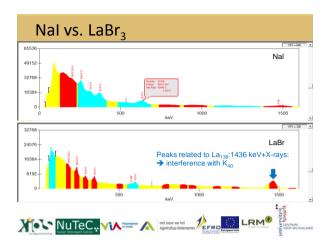




A new method for characterisation of NORM

*European list NORM-industries for strict regulation: NORM-nuclides: ²³⁸U > 1 Bq/g ²³²Th ⁴⁰K > 10 Bq/g





			Re	Results on fertilizers			
					⁴⁰ K > 10 Bq/g ?		
	Nal		LaBr₃		Labo (Ge)	Ec BSS (LaBr ₃)	
K-40	Act. Conc. (Bq/g)	Rel. Error (%)	Act. Conc. (Bq/g)	Rel. Error (%)	Act. Conc. (Bq/g)		
MAP	2.5 ±0.2	-	1.77 ±0.05	-	<mda 0.24<="" th=""><th></th></mda>		
MKP bedrijf1	7.4 ±0.1	17	11.14 ±0.09	77	6.3 ±0,4	•	
MKP bedrijf2		-	7.79 ±0.06	10	7.1 ±0,4		
KNO₃	6.3 ±0.1	-34	8.2 ±0.1	-14	9.5 ±0,4		
KCL	12.1 ±0.1	-8	13.73 ±0.04	5	13.1 ±0,4		
SOP	8.7 ±0.1	-18	10.5 ±0.1	-0.01	10.6 ±0,3	<u> </u>	
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Simplified dose-assessment workers in Zircon processing company

	Product	Activity concentration	Dust- concentration(*)	Exposure time
Handeling and storage zircon bags Maintenance warehouse		2 Bq/g U-238 + 0.5 Bq/g Th-232	2 mg/m ³	600 h/y

Assessment of external dose:

Operator spends 3 h/day at the warehouse (200 days a year) Zircon: → Maximal measured external doserate: 0.15 μSv/h Maximal external dose: 90 µSv/year

Assessment of inhalation dose?

- ~ 10% of dust made of zircon
- $D_{inh, U-238} + D_{inh, Th-232} = [(600 \text{ h}).(2 \text{ mg/m}^3).(0.1).(1.2 \text{ m}^3/h).(2 \text{ Bq/g}).(29,1\mu\text{Sv/Bq})]$
 - + [(600 h).(2 mg/m³).(0.1).(1.2 m³/h).(0.5 Bq/g).(48,2 μ Sv/Bq)]
 - = $[8 \mu Sv/y] + [4 \mu Sv/y] = 12 \mu Sv/jaar$





























Simplified dose-assessment workers in Zircon processing company

Assessment of dose related to Radon?

- radon emanation coefficient zircon: very low (~0,008 0,034) (compared to other uranium-containing materials)
- escape of radon is inhibited: ²²⁶Ra (²³⁸U) is bound within the crystal lattice 'Open' warehouse: no radon accumulation in the warehouse
- Radon release from zircon constitutes in this case a minor problem

Radon exhalation coefficient: $J = \rho \cdot R \cdot E \cdot \sqrt{\lambda \cdot D} \cdot \tanh\left(\sqrt{\lambda / D} \cdot H\right) = 0.4 \text{ Bq/(m}^2\text{s})$

- •Density
 •radium specific activity ρ = 2800 kg/m3 R = 2000 Bg / kg
- •Emanation coefficient E = 0,034 (zircon sands = 0.008)
- •Decay coefficient •Diffusion coefficient $\lambda = 2,1 .10^{-6} \text{ s-1}$ D = 2 . 10⁶ m²/s
- •Height of the emanating object H = 1 m



















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NORM in building materials (New European Directives - BSS)

- Materials including by-products or residues from NORM industries such as
 - fly ash
 - phosphogypsum
 - phosphorous slag
 - tin slag
 - copper slag
 - red mud (residue from alumina production)
 - residues from steel production
- · Natural materials



B-NORM (15/12/10 - 14/12/12): Goals

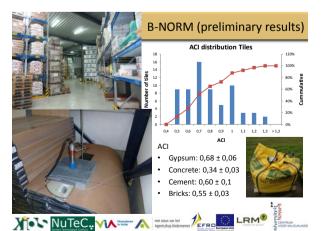
1-Projects





- 1. Create an inventory of building materials: Determination of **activity index** $I = \frac{C_{\it ka226}}{300} \frac{\it Bq}{\it kg} + \frac{C_{\it m232}}{200} \frac{\it Bq}{\it kg} + \frac{C_{\it K40}}{3000} \frac{\it Bq}{\it kg}$
- 2. Radon measurements in ('passive') buildings + correlation with the
- technical properties of the dwelling
 3. Increasing awareness of industry regarding NORM in building materials





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EUR-NORM: 4th EAN-NORM workshop

- ROUND TABLE
- Duo presentations
- Exhibition







NORM Measurements and Strategies, **Building Materials**" Second Announcement

Nov. 29th - Dec. 1st 2011,

















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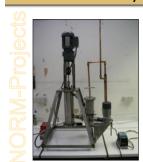








Pyrolysis



- O Input: Biomass / waste:
 - Rapeseed cake
 - Metal contaminated willow
 - Domestic waste
 - Sludge from water treatment



 NORM contaminated biomass or waste?



















Pyrolysis



- Output → validation
 - O Pyrolysis liquid
 - O Pyrolysis gas
 - O Char
 - O Valorisation activated carbon: Adsorbens for metals, radionuclides?



















New research topics:

Bio- and/or phytoremediation for the treatment of the radiological contaminated soils.

• Conversion of (Contaminated) biomass to char, liquid and gasses by means of pyrolysis.

• Study of (activated) char carbon is for the treatment of the waste water at contaminated sites.

Collaboration: XIOS – UHasselt – KULeuven - KHLim



















Treatment contaminated soils and waste water

Acknowledgement

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 - Flemish Community (Hermesfonds, 45%),
 - European Funds for Regional Development (EFRO-support, 40%)
 - XIOS University College Limburg (15%).
- · New research 'treatment contaminated soils and waste water sponsored by:
- -LRM













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