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

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NORM industries (New European Directives BSS)

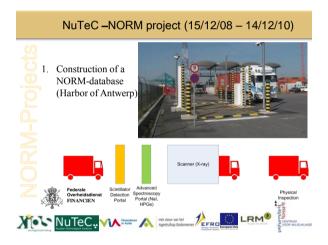
- List of NORM industries which will require regulatory consideration: Extraction of rare earth from monazite Production of thorium compounds and thorium containing products _
 - _ _ Processing of niobium/tantalum ore

 - Oil and gas production
 Geothermal energy production
 - TiO₂ pigment production
 Thermal phosphorus production

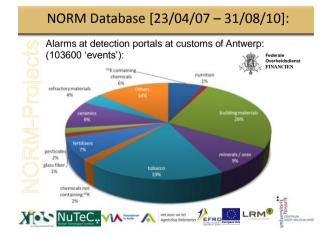
 - Zircon and zirconia industry
 - Production of phosphate fertilisers
 Cement production, maintenance of clinker ovens
 - Coal-fired power plants, maintenance of boilers
 Phosphoric acid production
 - _ Primary iron production

 - Tin/Lead/Copper smelting
 Ground water filtration facilities
 - Mining of ores other than Uranium ore
 - Including relevant secondary processes

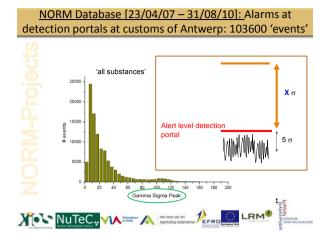
 Wember States sn 	iouid add oth	er relevant act	ivities	
XIII NuTeC. VI∧	Vicenderen	met stean van het Agentschap ûndernemer		LRM

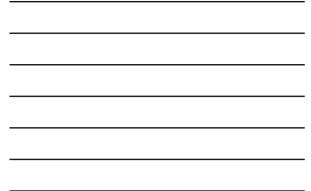


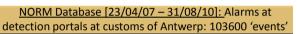


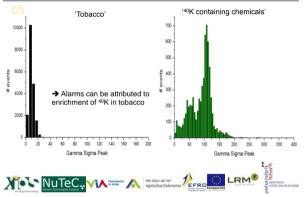




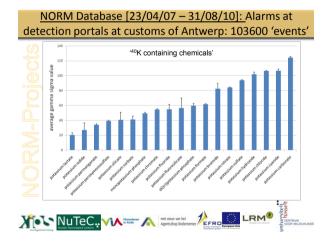




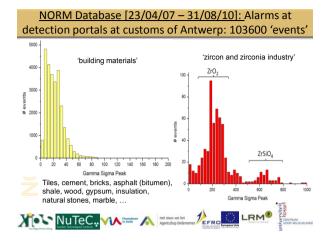




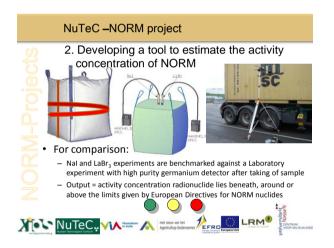




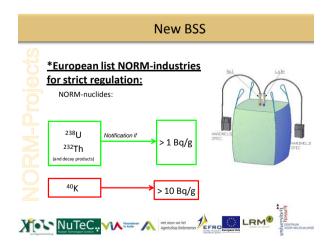








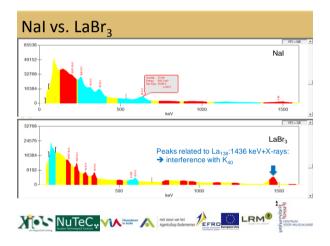






3. Case studies at severa NORM Companies						eral
Results on fertilizers						
					⁴⁰ K > 10 Bq/g ?	
10	Na					Ec BSS (LaBr ₃)
⁴⁰ K	Act. Conc. (Bq/g)	Rel. Error (%)	Act. Conc. (Bq/g)	Rel. Error (%)	Act. Conc. (Bq/g)	
NH ₄ H ₂ PO ₄ MAP	2.5 ±0.2	-	1.77 ±0.05	-	<mda 0.24<="" td=""><td>•</td></mda>	•
KH ₂ PO ₄ Company 1	7.4 ±0.1	17	11.14 ±0.09	77	6.3 ±0,4	•
KH ₂ PO ₄ Company 2		-	7.79 ±0.06	10	7.1 ±0,4	•
KNO ₃	6.3 ±0.1	-34	8.2 ±0.1	-14	9.5 ±0,4	9
KCI	12.1 ±0.1	-8 🤇	13.73 ±0.04	5	13.1 ±0,4	۲
K ₂ SO ₄	8.7 ±0.1	-18	10.5 ±0.1	-0.01	10.6 ±0,3	_
XII	\uTeC₊	VIA Visconter In Activ	met stean van he Agentschap Onde	FERD		ADDR WITERKONDE





Results on sands 238U > 1 Bq/g ?						
	Na		LaBr ₃		Labo (Ge)	Ec BSS
U - 238	Act. Conc. (Bq/g)	Rel. Error (%)	Act. Conc. (Bq/g)	Rel. Error (%)	Act. Conc. (Bq/g)	
Zirkonium coarse grade	1.7 ±0.2	-11	2.19 ±0,05	15	1.9 ±0,8	•
Zirkonium stand. Gr	0.86 ±0.04	-57	2.36±0,06	18	2.0 ±0.8	•
Ilmeniet	~mda (0.04)	-	~mda (0.05)	-	<mda (0.31)<="" th=""><th></th></mda>	
Rutiel	<mda (0.05)<="" th=""><th>-</th><th>0.33 ±0.01</th><th>-34</th><th>0.5 ±0.4</th><th></th></mda>	-	0.33 ±0.01	-34	0.5 ±0.4	
GMA garnet	0.04 ±0.02	-	0.03 ±0.01 - <mda (0.32)<="" th=""><th><mda (0.32)<="" th=""><th>•</th></mda></th></mda>		<mda (0.32)<="" th=""><th>•</th></mda>	•
X[•\`	NuTeC _*	Viconderer In Actie	met steun van het Agentschap Onde			Hiversite

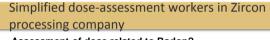
Simplified dose-assessment workers in Zircon

processing company

	processing company						
		Product	Activity concentration	Dust- concentration(*)	Exposure time		
	Handeling and storage zircon bags Maintenance warehouse	Zircon flour and sand	2 Bq/g ²³⁸ U + 0.5 Bq/g ²³² Th	2 mg/m ³	600 h/y		
Õ	Assessment of ex	ternal do	ose:				
	 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 h).(2 mg/m³).(0.1).(1.2 m³/h).(2 Bq/g).(29,1µSv/Bq)] 						
	+ [(600 h).(2 mg/m ³).(0.1).(1.2 m ³ /h).(0.5 Bq/g).(48,2 µSv/Bq)]						
	= [8 μSv/y] + [4 μSv/y] = 12 μSv/jaar						

*Safety report series No.51, IAEA Ra *RP122, European Commission on and NORM Residue Ma ent in the Zircon and Zir

	met stean van het Agentschap ûndernemer		
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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: $J = \rho \cdot R \cdot E \cdot \sqrt{\lambda \cdot D} \cdot tanh(\sqrt{\lambda / D} \cdot H) = 0.4$ Bq/(m²s)

 $\rho = 2800 \text{ kg/m3}$ R = 2000 Bg / kg $\begin{aligned} \mathbf{E} &= \mathbf{0.034} \text{ (zircon sands} = \mathbf{0.008})\\ \lambda &= 2,1 \ .10^{-6} \ \text{s-1}\\ \mathbf{D} &= 2 \ .10^6 \ \text{m}^2\text{/s} \end{aligned}$

H = 1 m

on and Zi

•Height of the emanating object eries No.51 IAEA Radiation Protection and NORM Residu radioprotection vol 44, n 5, 2009, 445-451 Management in the Zir *Safety report s

•Density •radium specific activity

•Emanation coefficient Decay coefficient
 Diffusion coefficient



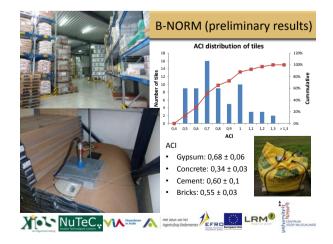


NORM in building materials (New European Directives - BSS)

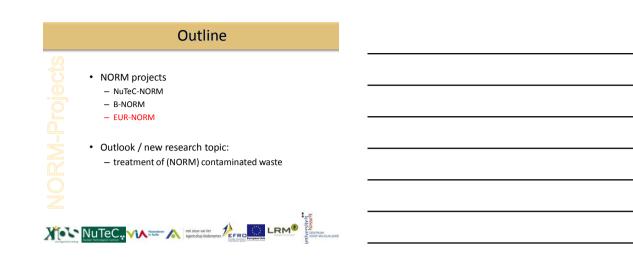
Materials including by-products or residues from NORM industries such as

 fly ash
 phosphogypsum
 phosphorous slag
 tin slag
 copper slag
 red mud (residue from alumina production)
 residues from steel production





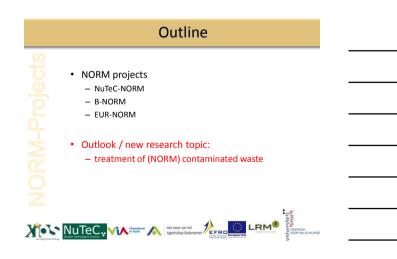


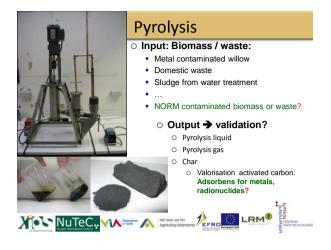


EUR-NORM: 4th EAN-NORM workshop









New research topics: Treatment contaminated soils and waste water

 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 - SCK-CEN

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 - LRM

