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**EAN NORM Workshop
European ALARA Network for NORM
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Effluents in some Italian NORM industries

Flavio Trotti, Elena Caldognetto

*Regional Agency for the Environmental Protection of Veneto
(ARPAV)*



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PRESENTATION LAYOUT

1. **Framework:** Italian legislation and national project aimed at assessing environmental impact of NORM industries
2. Comparison of activity concentrations of **solid residues** from several NORM industries with international standards
3. Comparison of **discharged activity to atmosphere and water bodies** from several NORM industries with international standards



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IMPLEMENTATION OF EU BASIC SAFETY STANDARDS: LEGISLATIVE DECREE n.241/2000

- A first set of work activities with use or production of NORM is defined
- Management is requested to verify compliance with action levels in 2 years time
- Action levels are fixed in 1 mSv/y for workers and 0.3 mSv/y for reference group (effective doses)
- If action levels are exceeded, management should provide to reduce doses below them. If the reduction is not effective, exposure surveillance is mandatory
- Monitoring for selected activities started August 31st 2003



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IMPLEMENTATION OF EU BASIC SAFETY STANDARDS: LEGISLATIVE DECREE n.241/2000

Positive list of work activities

- phosphate industry and warehouses for fertilizers wholesale trade
- processing of ores in the extraction of tin, ferro-niobium from pyrochlore and aluminium from bauxite
- processing of zircon sands and refractory materials production
- manufacture of rare earths
- manufacture and use of thorium compounds
- titanium dioxide pigment industry
- oil extraction and refining industry and gas extraction industry



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NATIONAL SURVEY OF ENVIRONMENTAL AGENCIES ABOUT NORM (coordinated by ARPAV)

Purposes

Assessment of the radiological impact to the environment due to work activities with NORM on a national scale

Actions

- Inventory of the NORM involved industries in Italy (not always reflecting legislation positive list of work activities)
- Evaluation of the potential environmental radiological significance through the measure of concentrations of U-238 and Th-232 series radionuclides and of K-40 in various materials (especially residues, wastes, by-products)
- Dose to the public estimate due to work activities environmental impact by models (or comparison with derived reference levels)

GENERAL CLEARANCE LEVELS (RP 122, PART 2) - NORM



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- Residues and wastes accomplishing CL can be reused, recycled, delivered to disposal with no constraint from the radiological point of view
- CL refer to solid materials only (not air emissions nor liquid effluents)
- Radionuclide activity concentration of material in most conservative scenario delivering 300 $\mu\text{Sv/y}$ effective dose to individuals (population)
- Where several nuclides are involved, single concentrations are normalized to respective clearance levels and the sum of all ratios (Sum Index) must be less than 1, for compliance

Material	Usec(*)	Unat(**)	^{230}Th	$^{226}\text{Ra}+(\text{***})$	$^{210}\text{Pb}(\text{***})$	^{210}Po	$^{232}\text{Thsec}(\text{*})$	^{40}K
	Bq/kg							
All materials	500	5000	10000	500	5000	5000	500	5000
Wet sludge from oil/gas industry	5000	100000	100000	5000	100000	100000	5000	100000

(*) whole decay chain in secular equilibrium

(**) uranium isotopes in fixed natural ratio with respective short half-life daughters

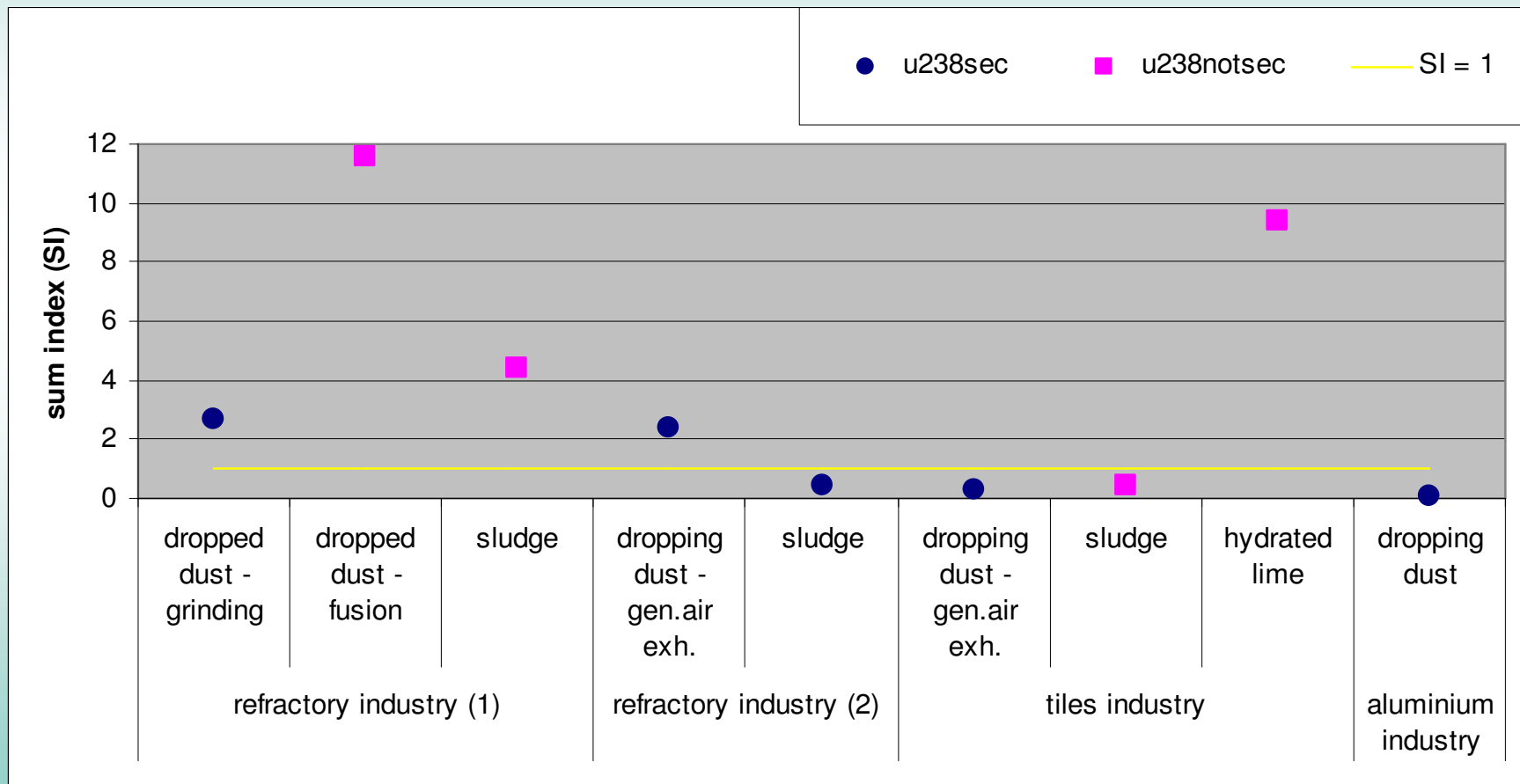
(***) short half-life daughters in secular equilibrium

COMPARISON BETWEEN RESIDUES ACTIVITY AND CLEARANCE LEVELS



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Sum Index (SI) as given in RP 122 for residues from several work activities
SI = sum of ratios of single radionuclides activity concentration to respective CL

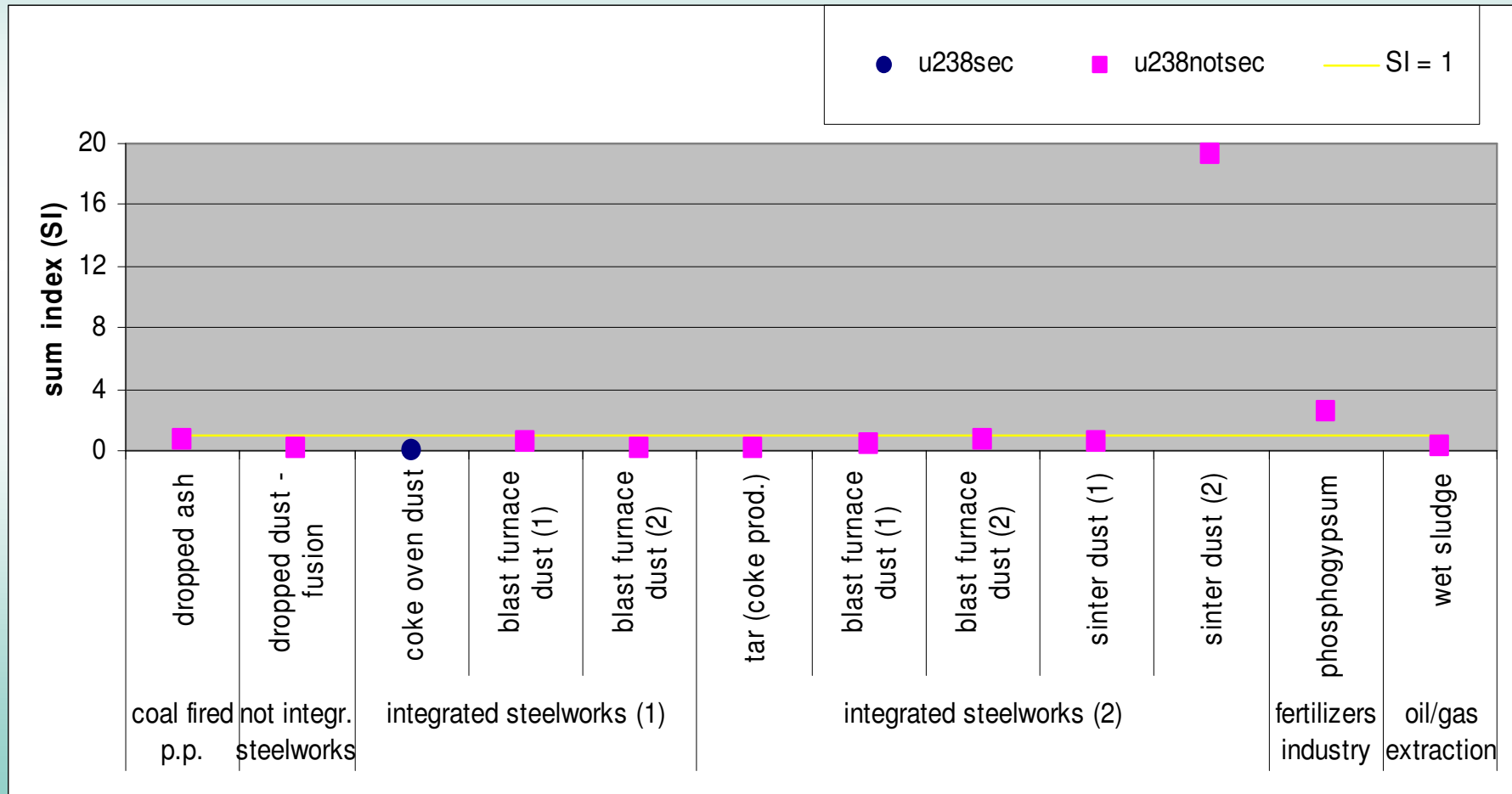


COMPARISON BETWEEN RESIDUES ACTIVITY AND CLEARANCE LEVELS



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Sum Index (SI) as given in RP 122 for residues from several work activities
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EFFLUENTS FROM ITALIAN NORM INDUSTRIES

International standards for atmospheric and aquatic discharges reference levels

- Radiation Protection 135 “Effluents and dose control from European NORM industries: assessment of current situation and proposal for a harmonised Community approach” (EU, 2003)
- “Generic models for use in assessing the impact of discharges of radioactive substances to the environment” IAEA Safety Report Series n. 19 (Vienna, 2001)
- “Generalised Derived Constraints for Radioisotopes of Polonium, Lead, Radium and Uranium” Documents of the NRPB vol. 13 n. 2 (UK, 2002)



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SCREENING LEVELS FROM RP 135 FOR DISCHARGES INTO ATMOSPHERE

Levels are given in Bq/y

They have different values according to different stack height

They are referred to an individual effective dose of 300 μ Sv/y

	10m	50m	100m	200m
U-238+	1,4E+11	2,3E+12	1,2E+13	2,3E+13
U-234	1,2E+11	2,0E+12	1,0E+13	2,0E+13
Th-230	2,7E+10	5,1E+11	7,3E+11	5,0E+12
Ra-226+	6,5E+10	7,3E+11	1,6E+12	5,5E+12
Rn-222	1,5E+14	2,7E+15	1,6E+16	2,7E+16
Pb-210+	1,6E+11	1,6E+12	3,1E+12	1,1E+13
Po-210	7,0E+10	7,9E+11	1,7E+12	5,8E+12
Th-232	1,4E+10	2,1E+11	7,3E+11	1,9E+12
Ra-228+	1,2E+11	1,5E+12	4,1E+12	1,3E+13
Th-228+	9,4E+09	1,7E+11	9,4E+11	1,7E+12
Rn-220	2,0E+12	3,7E+13	2,1E+14	3,7E+14
U-238sec	1,1E+10	1,6E+11	3,2E+11	1,4E+12
Th-232sec	5,4E+09	8,8E+10	3,7E+11	8,2E+11



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COMPARISON BETWEEN ACTIVITY DISCHARGE RATES TO AIR FOR SOME ITALIAN INDUSTRIES AND RP 135 SCREENING LEVELS

Comparison is performed through the Sum Index (SI), that is the sum of ratios of single radionuclides activity concentration to respective screening level. SI must be less or equal to 1 for compliance

work activity	stack height (m)	U-238sec (Bq/y)	Th-238sec (Bq/y)	U-238+, U-234, Th-230 (Bq/y)	Ra-226+ (Bq/y)	Rn-222 (Bq/y)	Pb-210+ (Bq/y)	Po-210 (Bq/y)	Ra-228+ (Bq/y)	SI
coal fired power plant	300		1,0E+08	1,3E+08	1,3E+08	3,2E+10	3,9E+08	3,9E+08		2,9E-04
refractory (fusion and grinding) 1	22 and 15		4,0E+04	3,0E+05	2,4E+05	7,5E+09	4,2E+06	6,9E+06		2,0E-04
refractory (general air exhauster) 2	10	1,2E+05	2,0E+04							1,4E-05
tiles	20						7,5E+05	8,2E+07		1,2E-03
primary steel (sintering)	210						2,4E+10	5,7E+10		1,2E-02
oil sludge incineration	40				4,6E+04	4,6E+08			8,8E+02	2,3E-07

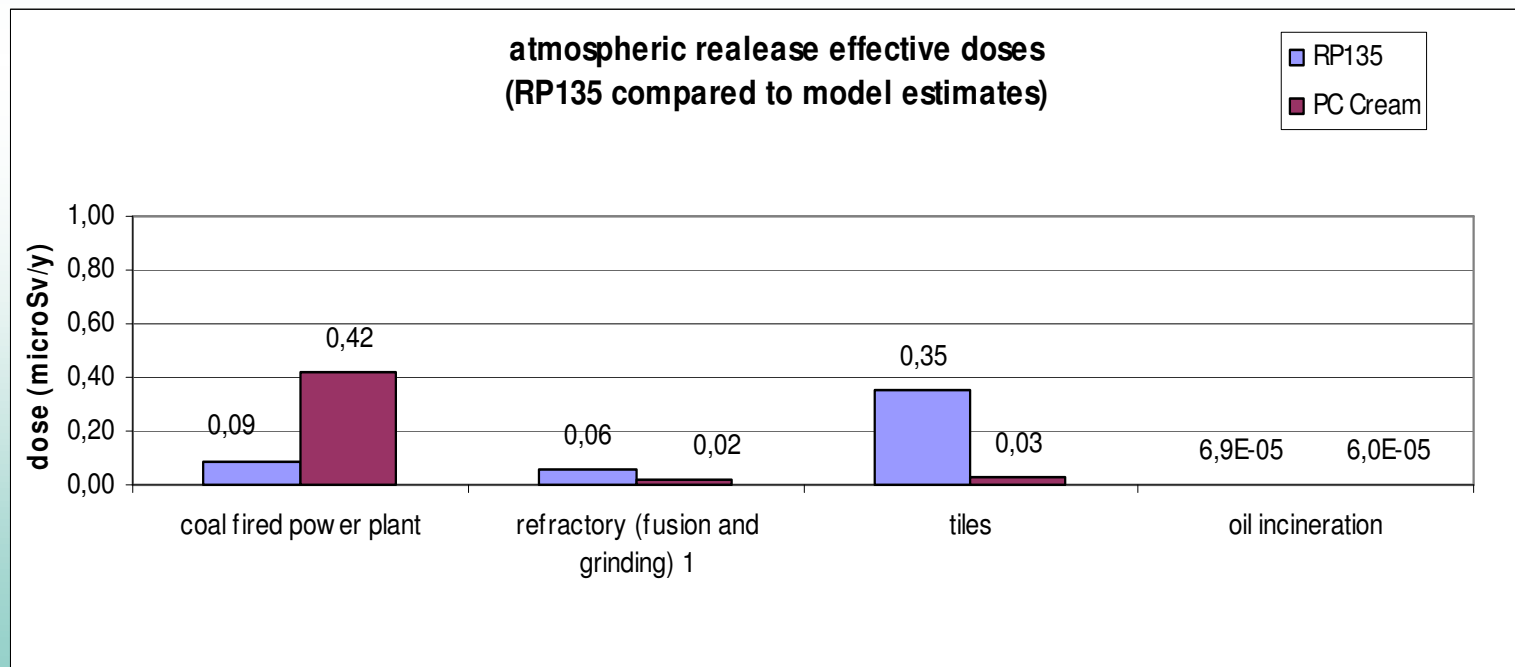
Primary steel data recently assessed by ISPRA (National Environmental Protection Agency)

INDIVIDUAL EFFECTIVE DOSE DUE TO ATMOSPHERIC RELEASE FOR SOME ITALIAN INDUSTRIES



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- Doses are derived on the basis of the proportion between discharged activity and RP 135 screening level
- These estimates have been compared to site/plant specific model assessments, where available
- PC-Cream suite of models for discharge into the atmosphere have been used for site/plant specific assessments

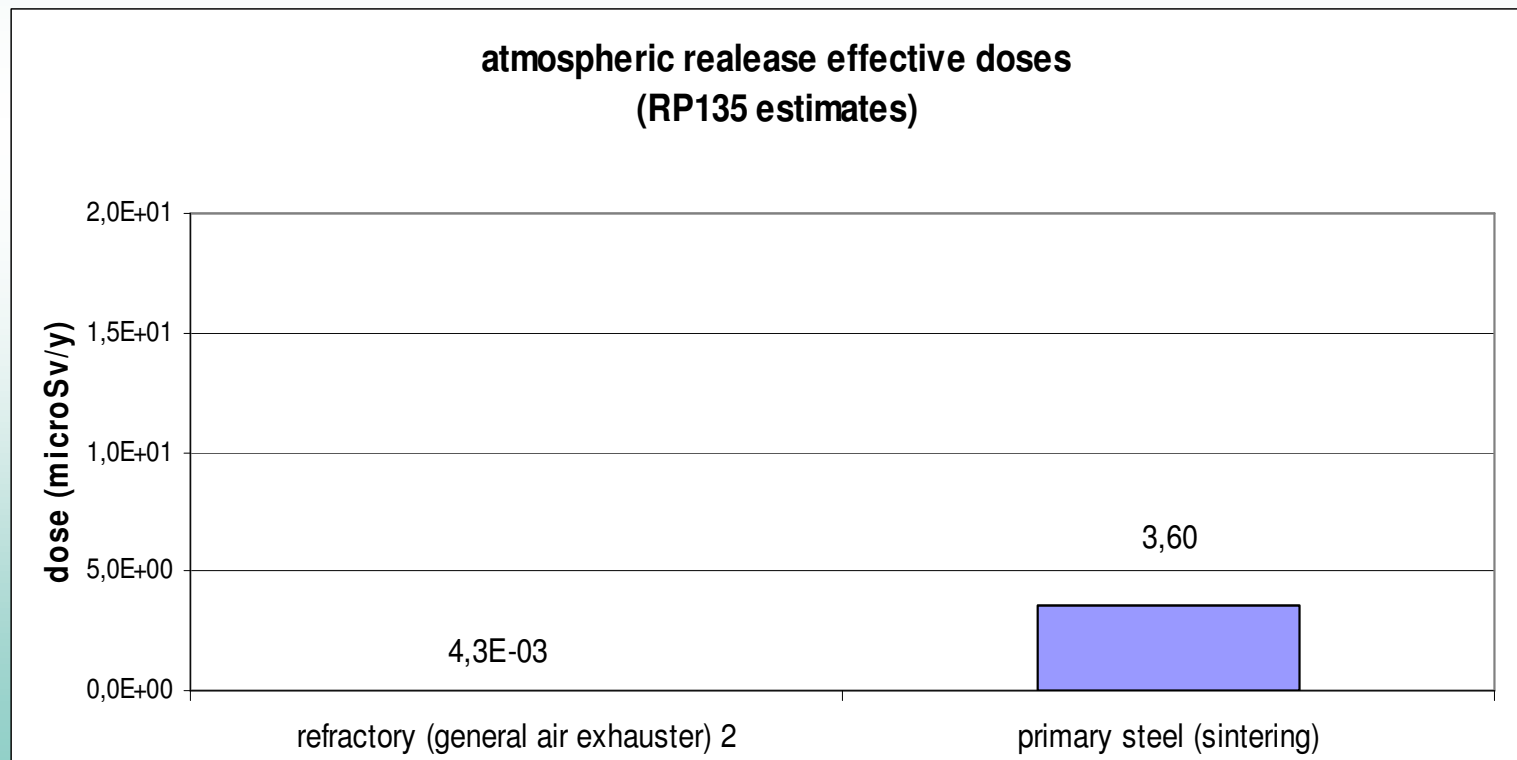


INDIVIDUAL EFFECTIVE DOSE DUE TO ATMOSPHERIC RELEASE FOR SOME ITALIAN INDUSTRIES



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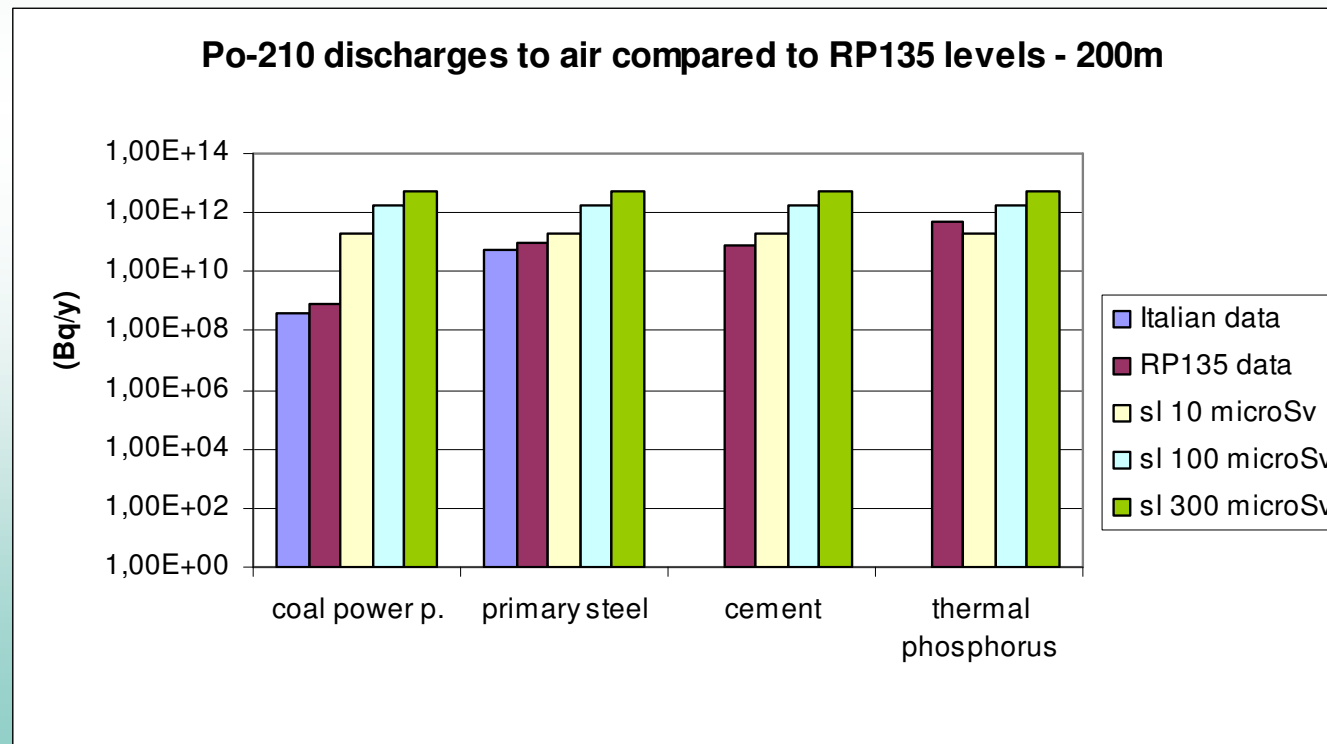
- Doses are derived on the basis of the proportion between discharged activity and RP 135 screening level





COMPARISON BETWEEN Po-210 DISCHARGE RATES TO AIR FOR SOME ITALIAN INDUSTRIES AND RP 135

- Comparison is performed with literature data as reported in RP 135 and with screening levels in the same document based on different dose criteria (10 $\mu\text{Sv}/\text{y}$, 100 $\mu\text{Sv}/\text{y}$ and 300 $\mu\text{Sv}/\text{y}$)

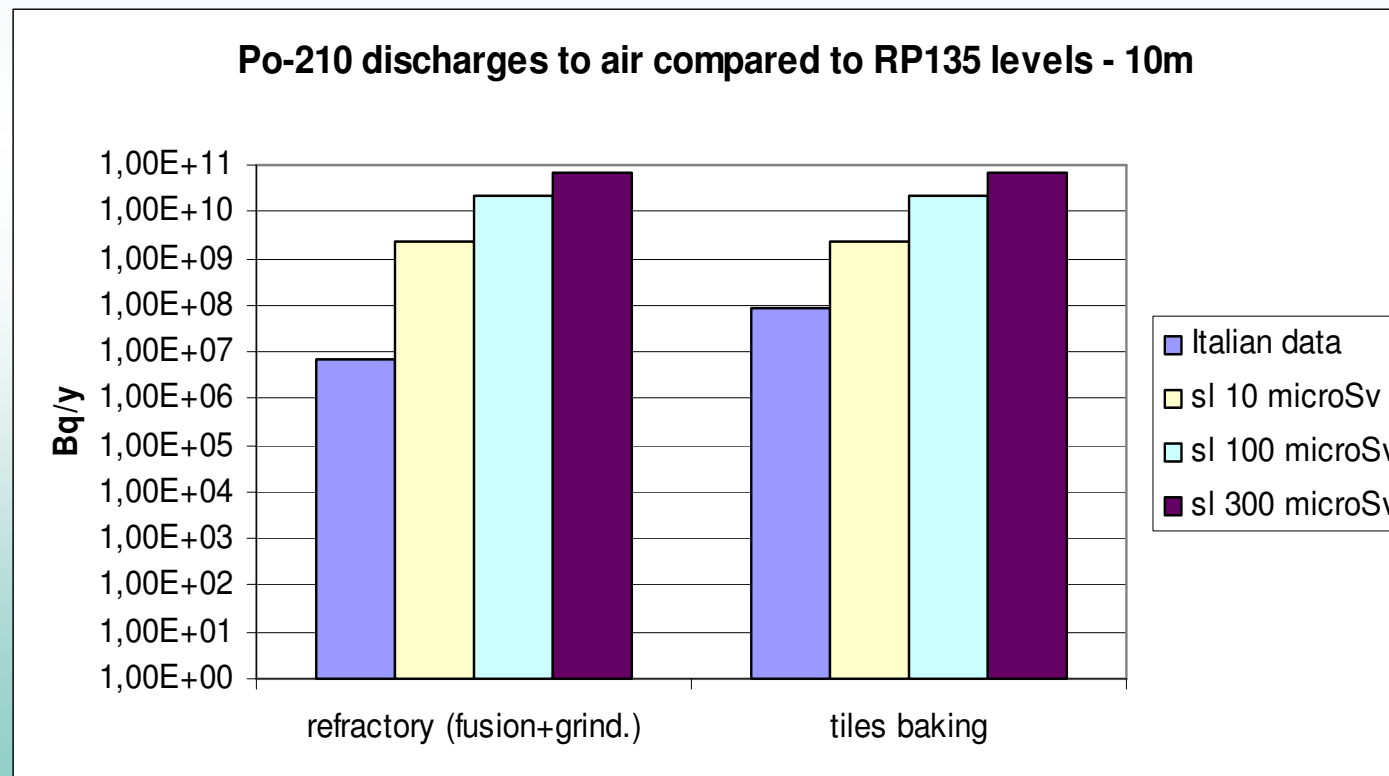




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COMPARISON BETWEEN Po-210 DISCHARGE RATES TO AIR FOR SOME ITALIAN INDUSTRIES AND RP 135

- Comparison is performed with screening levels in RP 135 based on different dose criteria (10 $\mu\text{Sv}/\text{y}$, 100 $\mu\text{Sv}/\text{y}$ and 300 $\mu\text{Sv}/\text{y}$)





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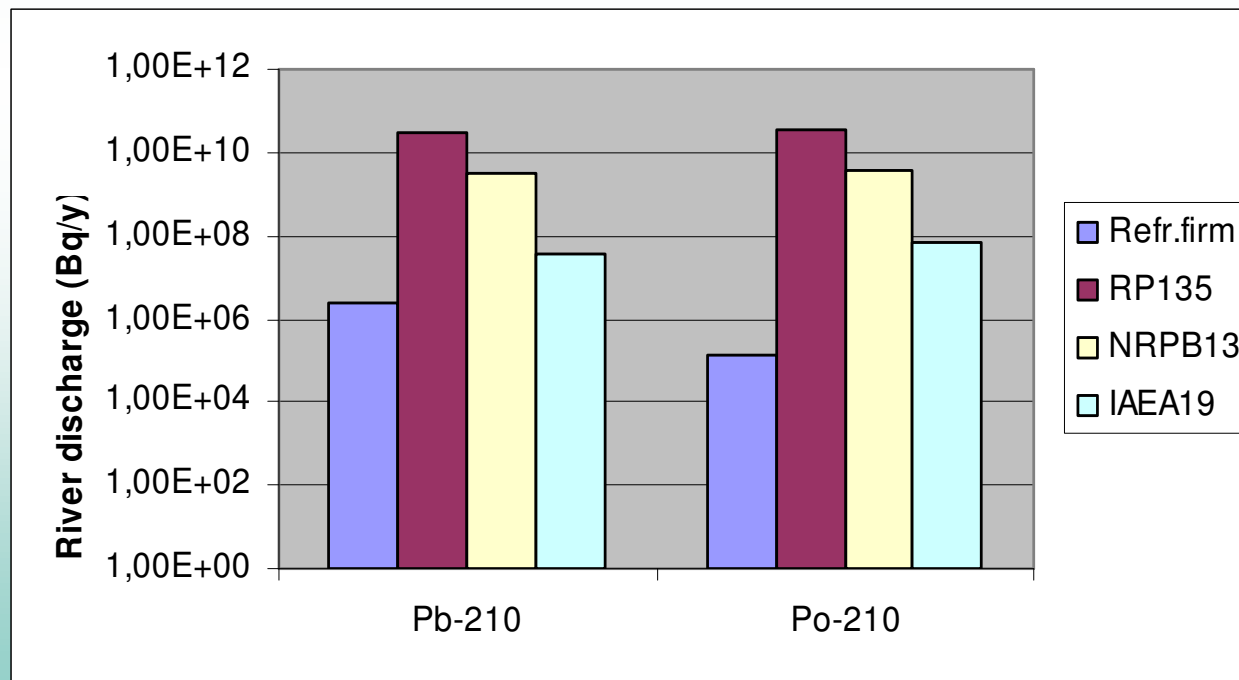
DOSE CRITERION SELECTION FOR DERIVING SCREENING LEVELS IN EFFLUENTS (AIR, WATER)

- Radiation Protection 135 gives screening levels for aerial and liquid releases from NORM industries based on a dose criterion of $300 \mu\text{Sv/y}$
- A discussion is nevertheless advanced in the document concluding to suggest a dose criterion in the range $10 - 100 \mu\text{Sv/y}$
- RP 122, that considers reuse/disposal of solid material, is justified adopting a dose criterion of $300 \mu\text{Sv/y}$, because this incremental value is comparable with the variation of the total dose from natural radiation background (ext.irr.) and because exposure to multiple sources for described scenarios is unlikely
- RP 135, that considers discharges to atmosphere and water, is perplexed in adopting the same dose criterion, because the variation in natural exposures to airborne (Rn excluded) and waterborne activity is smaller than $300 \mu\text{Sv/y}$ and because discharges to air and water will very likely involve exposures to multiple sources



COMPARISON BETWEEN Pb-210 and Po-210 RIVER DISCHARGE RATE FROM AN ITALIAN REFRACTORY FIRM AND INTERNATIONAL STANDARDS

- Liquid discharge from the refractory firm is conveyed to a low flow river
- Comparison is performed with screening levels (according to a dose criterion of 300 $\mu\text{Sv/y}$) from RP 135 (small river), IAEA 19, NRPB 13





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CONSISTENCY OF INTERNATIONAL STANDARDS PROPOSING SCREENING LEVELS FOR EFFLUENTS

- Relevant differences appear for radionuclides screening levels due to different methodologies and parameters values adopted, particularly for releases to atmosphere
- RP 135 shows several advantages
 1. Comparison for airborne releases with site/plant specific model estimates is quite fair (orders of magnitude deviations are observed for the other documents, in conservative perspective)
 2. Different levels are proposed according to different stack heights (atmosphere) and river flow (water bodies)
 3. Methodologies expressly fit NORM industries effluents



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CONSISTENCY OF INTERNATIONAL STANDARDS PROPOSING SCREENING LEVELS FOR EFFLUENTS

- Effluents actual destination knowledge is essential for correctly selecting screening levels
 1. Collection of wastewaters in urban sewer is considered only by IAEA and NRPB documents, the first adopting the sewer worker exposure to sludge as limiting scenario, the second focusing on the criticality of using sludge for farmland treatment. Actually, wastewaters from drinking water treatment plants are often collected in urban sewer
 2. Sea discharge (coastal and off-shore) is considered only by RP 135

CONCLUSIONS



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- Potential critical cases are outlined when comparing activity concentrations of solid residues from NORM industry with General Clearance Levels (RP 122)
- Individual doses to the public arising from activity discharge to air and water appear to be generally low, through both model assessments and derived levels (such as RP 135 screening levels) comparison
- However, many of such estimates have to be refined; for airborne releases, for instance, activity concentrations of dust from collection system have often been used in the place of missing emitted dust data, sometimes, as in the case of the tiles production district, many factories simultaneously discharge radionuclides from chimneys, etc.
- International standards for effluents screening levels are not always consistent and care has to be used in selecting those more appropriate for actual scenarios. RP 135 seems to offer a sound base for airborne emissions compliance test
- RP 135 invites to discuss the preferable dose criterion (10 $\mu\text{Sv}/\text{y}$, 100 $\mu\text{Sv}/\text{y}$ and 300 $\mu\text{Sv}/\text{y}$) to be selected as far as NORM industry discharges to air and water bodies are concerned