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Review of Italian NORM industries with specific reference to their environmental impact

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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.

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
- manufacture of rare earths
- manufacture and use of thorium compounds
- titanium dioxide pigment industry



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INVOLVEMENT OF ENVIRONMENTAL AGENCIES IN INDUSTRIAL ACTIVITIES WITH NORM

- Environment control in Italy is accomplished on the basis of a network of Regional Environmental Protection Agencies (ARPA) and of the National Environmental Protection Agency (APAT)
- A project aimed at estimating environmental impact for some activities dealing with NORM is being carried out in the frame of the coordination of ARPA, as a support for APAT in collecting information about environmental radioactivity.
- ARPAV, Regional Agency for the Environmental Protection, is the leader agency in this NORM project.



THE ARPAV NORM PROJECT FRAMEWORK

Project working plans:

- the inventory of the NORM involved industries in Italy;
- the evaluation of the potential environmental radiological significance through the assessment of concentrations of U-238 and Th-232 series radionuclides and of K-40 in selected input and output materials;
- the estimate of the environmental impact (dose to the public) due to effluents, dusts, residues and products in selected working activities.

Project collaborations:

- sector associations (information on and access to factories), APAT and Urbino University (radiochemical analysis), ARPA of other Regions for general and analytical contribution

INVENTORY OF THE NORM INVOLVED INDUSTRY IN ITALY



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Work activity	N (*)	Radiological criticality	Notes
Processing of phosphate ores (fertilizers production)	~ 20	Elevated U-238 series content in ores (phosphorite)	3 factories produce superphosphate
Phosphogypsum disposal sites	5 sites	Elevated Ra-226 (Pb-210) content in by product (phosphogypsum)	Various grades of remediation
Coal fired power plants	13	Ash enrichment of natural radionuclides	
Integrated steelworks	4	Sintering and blast furnace dusts enrichment of natural radionuclides (Pb-210, Po-210)	
Oil and natural gas extraction	More than 7000 wells	Scales and sludge in plants with presence of Ra-226 and Pb-210	Main producer (AGIP) data
Oil refineries	18	Scales in plants with presence of natural radionuclides	
Alumina extraction from bauxite	1	U-238 above natural background in by products (red mud)	

(*) data from National Sector Associations/Industries personal communications or from specific internet site and reports (2002-2004)

INVENTORY OF THE NORM INVOLVED INDUSTRY IN ITALY (2)



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Work activity	N (*)	Radiological criticality	Notes
Refractory manufacture	~ 10	Fusion dust enrichment in Pb-210 e Po-210; zircon sands (and derivatives) use in the whole working cycle	Few factories use relevant amounts of zircon sands (or derivatives)
Tiles manufacture	~ 50 main factories	Enamels (sometimes the bulk itself) containing zircon sands (and derivatives)	Factories with relevant use of zircon sands (and derivatives) to be identified
Zircon sands grinding	~ 10	Zircon sands (and derivatives) use in the whole working cycle	
Ceramic glazes industry and metal oxides manufacture	-	Zircon sands use in frits destined for the ceramic inorganic pigments used as colorants for ceramics, as enamels for metal, or as compounds of paints	Sector not yet surveyed
Uranium mines	2	Extraction areas access and re-use	Dismantled in 70's

(*) data from National Sector Associations/Industries personal communications or from specific internet site and reports (2002-2004)

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	$^{226}\text{Ra}+$ (***)	$^{210}\text{Pb}+$ (***)	^{210}Po	$^{232}\text{Thsec}$ (*)	^{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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Activity concentrations (Bq/kg) in residues from several work activities and resulting Sum Index (SI) as given in RP 122. ^{238}U series in secular equilibrium.

Work activity	Materials	$^{238}\text{U}_{\text{sec}}$	$^{232}\text{Th}_{\text{sec}}$	^{40}K	SI
Refractory industry	Dropping system dust by refuse grinding (factory 1)	1141	178	255	2.7
	Dropping system dust by general air-exhauster (factory 2)	1000	170	36	2.4
	Sludge (factory 2)	160	37	31	0.4
Tile industry	Dropping system dust by general air-exhauster	61	38	526	0.3
	Sludge	111	34	317	0.4
Aluminium industry	Red mud	97	118	15	0.4
	Dropping system dust	9	0.5	3	<0.1



Activity concentrations (Bq/kg) in residues from several work activities and resulting Sum Index (SI) as given in RP 122. ^{238}U series not in secular equilibrium.

Work activity	Materials	Unat	$^{226}\text{Ra}+$	$^{210}\text{Pb}+$	^{210}Po	^{232}Th	^{40}K	SI
Fertilizers industry	Phosphogypsum	n.a.	1300-4000	n.a.	n.a.	n.a.	n.a.	2.6
Refractory Industry	Dropping system dust in fusion furnace (factory 1)	358	147	21050	35000	27	10	11.6
	Sludge (factory 1)	1635	1496	1167	1177	238	27	4.4
Tiles industry	Hydrated lime	9	10	425	46100	3	369	9.4
Coal-fired power plants	Ash	126	126	400	400	97	458	0.7
Not integrated Steelwork	Dropping system dust by fusion	n.a.	n.a.	360	422	n.a.	n.a.	0.2
Integrated Steelwork	Tar (coke production)	3	<0.3	181	177	1	<3.0	<0.1
	blast furnace dust	18-20	22-26	665-1583	632-1544	11	83-242	0.3-0.8
	sinter dust traditional	27	32	1167	1058	5	180	0.1
	sinter dust weep	<15	24	47249	42867	7	6219	19.3
Oil/gas extraction	Wet sludge	0	600-1600	140	140	n.a.	0	0.3

DOSE TO THE PUBLIC FROM STACK EMISSIONS



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Action level for individuals of reference group: 300 $\mu\text{Sv}/\text{y}$ (national law)

Work activity	Plant information	Effective dose ref. Group, adults ($\mu\text{Sv}/\text{y}$)	Simulation tool	Notes
Coal fired power plants	Power station situated in south Italy producing 7600 GWh per year	0.4	PC-Cream deterministic model (HPA-UK)	Site/plant specific data used. Ref. Group 500 m to the stack
Refractory industry	Northern Italy factory processing 2320 t of zircon sands per year	< 0.1	PC-Cream deterministic model (HPA-UK)	Site/plant specific data used. Ref. Group 900 m to the stack
Tile production	Factory situated in "ceramic district" (Northern Italy) processing 2976 t of zircon sands/silicates per year	< 0.1*	UnscEAR 1982 (simplified model)	Not specific data used. Ref. Group is the municipality where the plant is
Oil extraction	Incineration (Northern Italy) of 230 m ³ of sludge from dismantled oil center	0.6 (most conservative assumptions)	PC-Cream deterministic model (HPA-UK)	Site/plant specific data used. Ref. Group live in most critical site 1000 m to the stack

* Age average



THE NATIONAL BOARD ON PHOSPHOGYPSUM DISPOSAL SITES

The Ministry of Environment and Protection of the Territory and the Sea is the leader authority for the remediation of chemically and biologically contaminated waste disposal sites

For radiation protection aspects it relies on

- APAT (Agency for Environmental Protection and Technological Services)
- ISPESL (National Institute for Occupational Prevention and Safety)
- ISS (National Institute of Health)



In the last years the Ministry of the Environment involved the three institutes in the remediation of **phosphogypsum disposal sites**, a legacy of past plants for phosphoric acid production

This activity was presented at the **NORM V Conference** in Seville (Spain), in March 2007



The main conclusion of the paper were:

at the national and international level

the harmonisation of legislation regarding conventional and NORM contaminations is the most urgent problem to be solved

at the national level

the authorities should be made aware that a radiological remediation intervention must be a global, justified and optimised plan

- Importance of cooperation between Regional Environmental Protection Agencies and Central Institutes in view of stating coherent approaches and sharing specific knowledges
- Much has to be done to adequately trace NORM frame in Italy: development of specific analytical methods, surveys and data collection to better assessing workers exposures, ...
- Population exposure (impact on the environment) is not always negligible, so that care has to be taken in managing residues/by-products/effluents of some work activities
- Provisions to put National legislation into effect are needed: clearance levels have to be adopted to ensure uniform behaviour on waste management; authorities and procedures for clearing permissions should be identified, ...



- Trotti F. and Zampieri C., *The inventory and radiological impact of Naturally Occurring Radionuclides Materials in some Italian non-nuclear industries*, Proceedings of the NORM IV Conference - Szczyrk 2004, May 16th - 21th
- Trotti F. and Zampieri C., *Environmental aspects of NORM industry in Italy*, Proceedings of the 2nd International Conference on Radioactivity in the Environment - Nice 2005, October 2nd - 6th
- Zampieri C. and Trotti F., *NORM in Italian tiles and refractories industries*, Proceedings of the NORM V Conference - Seville 2007, March 19th - 22th