What happened to the Italian Radiochemists?

Enrico Rizzio
Coordinator of Spectrometric Analysis and Dosimetry Laboratory
RADI – Radiation Protection & Physical Risk Unit

Two critical dates:

April 26, 1986 → Chernobyl disaster

November 8-9, 1987 → Popular Referendum
(exit of Italy by the programs for the peaceful use of nuclear energy)

Ionizing Radiations: Italian Legislation

Chapter III bis – D.Lgs.230/95

Exposure from working activities with particular natural radiation sources

"ESPOSIZIONI DA ATTIVITA' LAVORATIVE CON PARTICOLARI SORGENTI NATURALI DI RADIAZIONI"

Article 10 bis

Work activities involving the use or storage of materials normally not considered radioactive, but which contain natural radionuclides and cause a significant increase in the exposure of workers and, in case, people"

"*Attività lavorative implicanti l'uso o lo stoccaggio di materiali abitualmente non considerati radioattivi, ma che contengono radionuclidi naturali e provocano un aumento significativo dell'esposizione dei lavoratori e, eventualmente, di persone del pubblico*"

Annex 1 bis – D.Lgs.230/95

Work activities to which the provisions of Chapter III must be applied (among others):

a) industry that uses phosphate minerals and deposits for the wholesale fertilizer trade

   "industria che utilizza minerali fosfatici e depositi per il commercio all'ingrosso di fertilizzanti"

.....

g) extraction and refining of oil and gas extraction, concerning the presence and removal of sludge and scales in pipes and containers.

   "estrazione e raffinazione di petrolio ed estrazione di gas, per quanto concerne presenza e rimozione di fanghi e incrostazioni in tubazioni e contenitori"

Decommissioning and remediation of old industrial plant

Decommissioning of former Phosphoric acid production plant owned by ISAF (Eni – Syndial)

Row material: Phosphate rock (Phosphorite) from North Africa and Togo

Typical NORM concentration:
^{238}U Series: ≅ 1000 Bq/kg
^{232}Th Series: ≅ 100 Bq/kg

Typical NORM concentration in “by-products”: ????

Phosphoric Acid Production by wet process

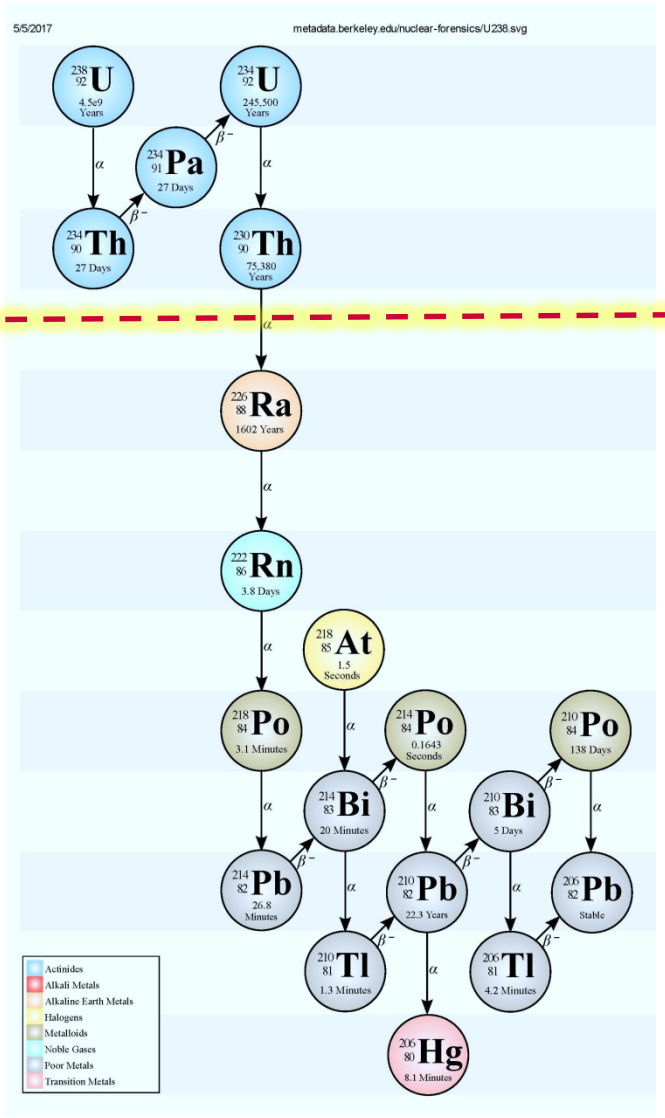
$$Ca_3(PO_4) + 3H_2SO_4 \longrightarrow 2H_3PO_4 + 3CaSO_4$$

Side reactions with calcium fluoride and calcium carbonate present in the rock:

$$3CaF_2 + SiO_2 + 3H_2SO_4 \longrightarrow 2H_2SiF_6 + 3CaSO_4 + 2H_2O$$

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

Radionuclides behavior



Product – Acid solution

From ^{238}U to ^{230}Th – chain componets dissolved in acid solution; 80 ÷ 90% in the final product

(Tipical concentration of ^{234m}Pa = 1600 Bq /kg)

Phosphogypsum/residues

The chain breaks, ^{226}Ra precipitates in the gypsum or in scales and in the muds

Tipical concentration of ^{226}Ra and ^{210}Pb = 1600 Bq /kg

Tipical concentration of ^{238}U = 40 Bq/Kg

Products and By-products characterization

Liquid matrices:

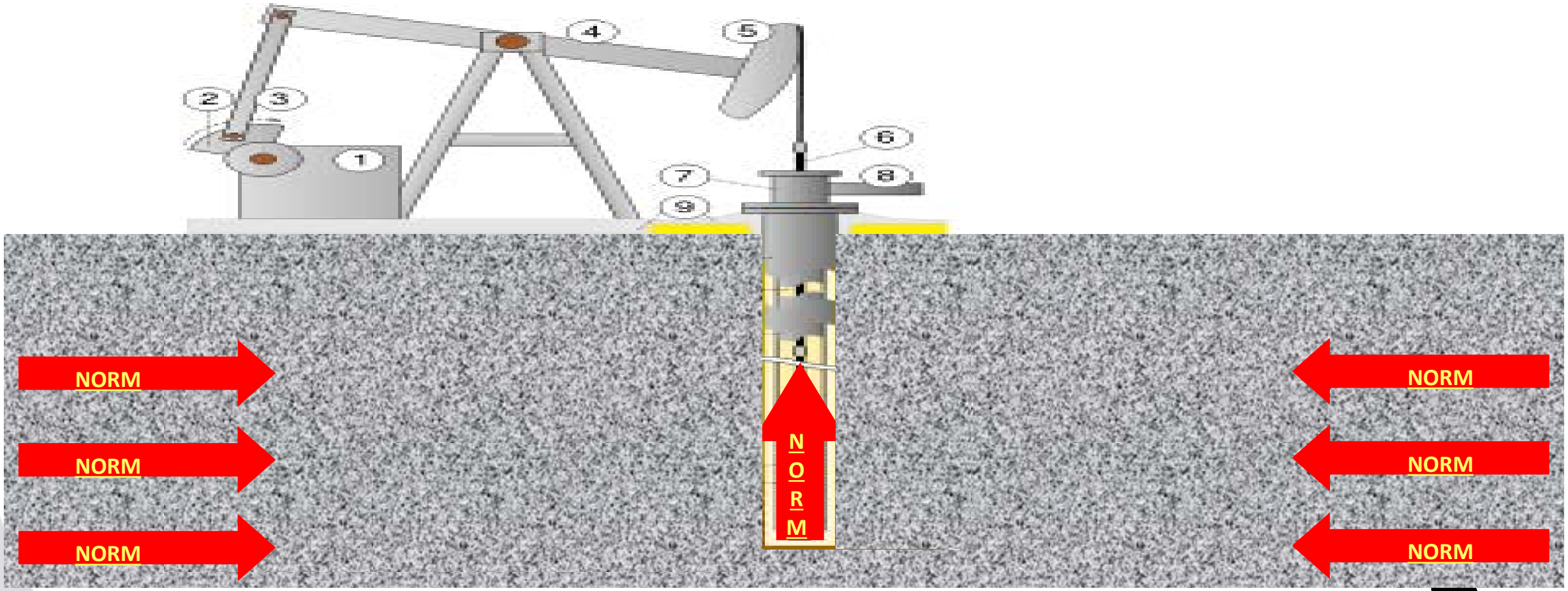
- Phosphoric acid (residues in the old tanks)

Solid/wet matrices:

- Solid residues-deposits in the old tanks
- Sludge
- Solid coming from chemical treatment of liquid matrices and sludge (from acid neutralization)
- Wreckage (and different material) from demolition of plant buildings
- Other materials (soil surrounding the area, biomarkers, etc.)

NORM in oil and gas industry

The production water acts as a transport vehicle for radionuclides (NORM) from the reservoir to the surface

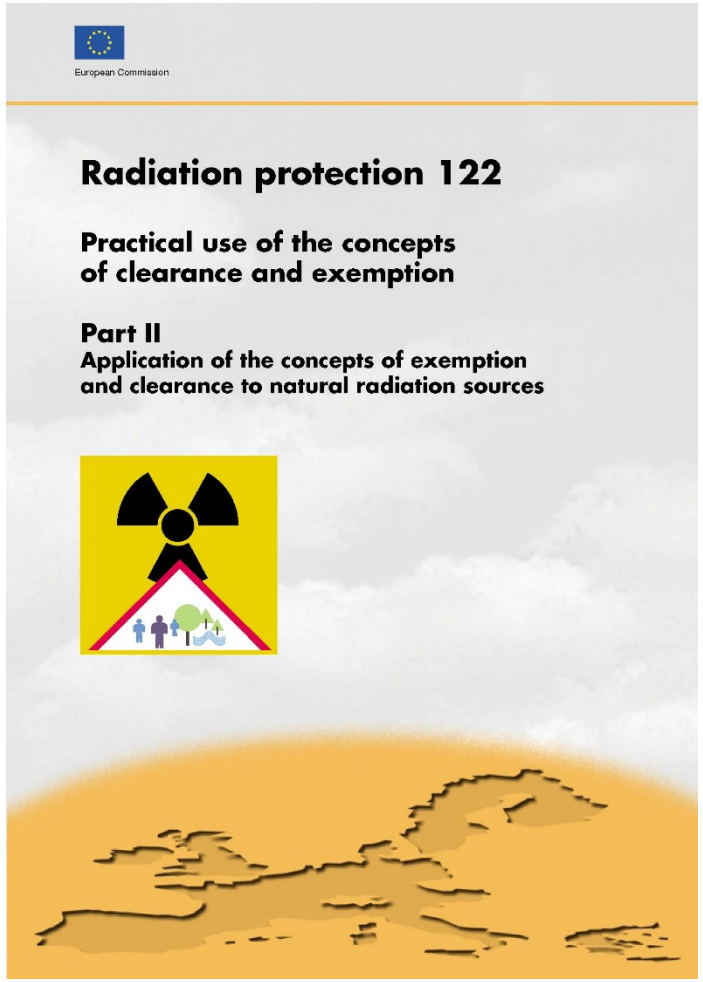


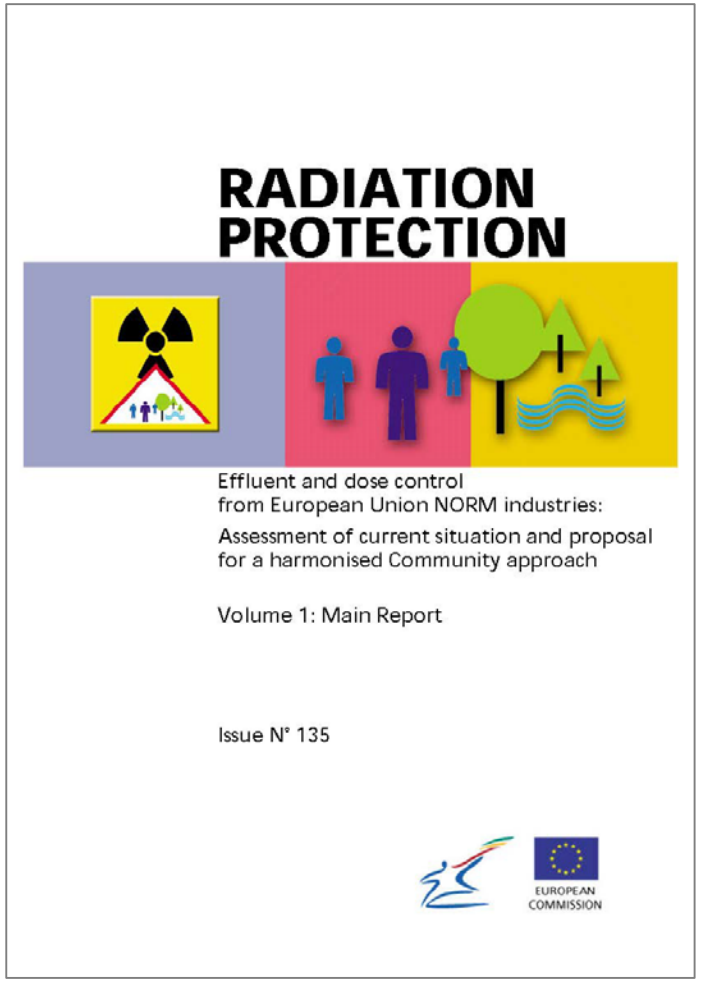
Production water

Solid Scale

Wet Sludge

Ionizing Radiations: European Union (reference documents)





Characterization

What happened to the Italian Radiochemists?

Nuclides	All Materials (Bq/kg)	Wet sludges from oil and gas industry (Bq/Kg)
U 238sec incl. U 235sec*	500	5000
U nat*	5000	100000
Th 230	10000	100000
Ra 226+	500	5000
Pb 210+	5000	100000
Po 210	5000	100000
U 235sec**	1000	10000
U 235+**	5000	50000
Pa 231	5000	50000
Ac 227+	1000	10000
Th 232sec	500	5000
Th 232	5000	100000
Ra 228+	1000	10000
Th 228+	500	5000
K 40	5000	100000

^{238}U; ^{235}U; (^{234}U) → instrumental gamma spectrometry; (ICP-MS) or better α spectrometry (with radiochemical separation)

^{228}Th; ^{230}Th; ^{232}Th → instrumental gamma spectrometry; or better α spectrometry (with radiochemical separation)

^{232}Th → ICP-MS; X-RF; instrumental gamma spectrometry

^{210}Pb → instrumental gamma spectrometry; or better ß spectrometry (with radiochemical separation)

^{210}Po → only α spectrometry (with radiochemical separation)

^{226}Ra → instrumental gamma spectrometry; or better liquid scintillation (with radiochemical separation)

RP122, Part II – Radiation Protection Part II *"Practical use of the concepts of clearance and exemption – Part II, Application of the concepts of exemption and clearance to natural radiation sources"* Directorate General Environment - EU 2001

Actual situation in Italy (in our experience)

- Only few laboratories, even if they guarantee a very high quality level in the analysis of conventional chemistry, are able to perform radiometric analyzes with the required quality analytical requirements.

- Only some of these are able to perform measurements employing radiochemical analysis techniques

- All the laboratories that perform radiometric analyzes are well equipped with excellent instrumentation, but it is evident the lack of experience in this type of measurements

Snow Leopard (endangered species)

… in conclusion, since the referendum did not eliminate the “radioactivity”, and so that the endangered species of the Italian Radiochemist do not definitively disappear it is necessary that:

- Universities, Research Institutions and Control Agencies for Environmental and Health protection take an active part in sensitizing, guiding and supporting young students, especially in Chemical Sciences applied to radiometric measurements

- Media must inform correctly the public opinion so that the phenomenon of “radioactivity” can be properly controlled and managed and does not represent only something terrifying (humanity coexists with natural radioactivity from the creation of the world)

- Big Companies (like Eni) need specialists in radiation protection and radiometric measurements *(not only “Radiation Protection Expert”)* for different kind of activities.

Thanks for the attention!

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