

# “Processing of zircon sands: the Italian inventory”

**Cristina Nuccetelli**

*National Institute of Health (ISS), Rome, Italy*

**Wouter Schroeyers**

*Universiteit Hasselt, Hasselt, Belgium*

**Flavio Trotti,**

*Environmental Protection Agency of Veneto (ARPAV), Verona, Italy*

## General aspects

- Zircon sands are widely used in industrial processes since provide specific physical properties to tiles and refractories
- In Italy there are many tile production plants, mostly located in Emilia Romagna, and many factories producing refractories and ceramic articles are present in all the country.
- Processing of zircon sands (and derivatives) is a work activity in the list of "NORM involving activities" present in Directive 2013/59/Euratom, now being transposed in Italian legislation
- This production sector is already subject to Italian regulation (Legislative Decree 230/95) due to its important role and impact in the Italian industrial scene
- Radiological concern on this industrial sector depends on the significant concentrations of radionuclides from  $^{238}\text{U}$  and  $^{232}\text{Th}$  series in the raw materials, potentially impacting also final products and residues/effluents

## General aspects (cont.)

- In the last 15 years, several initiatives have been carried out by scientific and public institutions to assess the radiological impact of zircon sand industrial sector in Italy.
- Preliminary inventories of companies have been developed together with processing cycle studies.
- Radiometric campaigns have been also performed in several plants (*in situ* measurements, laboratory analyses of representative samples and model calculations).
- Due to this consolidated experience, in 2017 Italy has been proposed to develop the case study concerning the zircon sand industry in drafting a

*"Guidance on how to establish a NORM Inventory"*

in the frame of the IAEA ENVIRONET network project *"Promoting Good Practices and Providing Knowledge Transfer Applicable to the Management of NORM Residues and Wastes"*.

## of operating NORM involving activities

The goal is the elaboration of a general approach to be adapted to build an inventory for any specific NORM industrial sector.

**Preparation phase:** a deep analysis of all data and information collected by previous surveys and on-site investigations, and study of the relevant scientific literature and reports of international institutions (e.g. IAEA, EC) and national bodies.

**Data Collection - Active informative phase:**

- contacting the industrial category associations to obtain information and help to create a collaboration between institutions and industrial sectors on new bases
- screening the list of the Integrated Environment Authorizations (IEAs), at least in the EU, periodically presented by large plants to issue or renew the authorization to operate.

## **Data Collection (cont.)**

- identification of “sentinel” products, i.e. goods characterized by a relatively high natural radioactivity content and/or by a well known production process of radiological impact for workers and/or members of the public (phosphorus/potassium fertilizers for fertilizer industry, clinker production for cement industry or electric energy production for geothermal plants).

**Administration of a standardised questionnaire phase:** crucial step for the NORM inventory setup. Its elaboration is in progress.

- Information collection already included in the questionnaire draft:
  - plant description and location,
  - amount and activity concentration of raw materials,
  - trace and record of all paths of radioactive distributions within the process,
  - residues, products and effluents shall be characterized and their fates should be accounted for.

## **questionnaire phase (cont.):**

- Questionnaire should not be too detailed, e.g. searching for mass/activity balances in the whole process; this approach risks to complicate the collection procedure and discourages an effective collaboration without giving really useful information.
- Small surveys of plants representative of a certain sector can help to select a list of industries eligible for receiving the questionnaire.

**Distribution strategy phase:** a very important phase is the elaboration of the distribution strategy following the individuation of the questionnaire receivers.

**Final phase**: based on the information collected by questionnaires, this phase will identify missing data and includes visits to representative plants to fill the data gaps. A strategy to keep updated the inventory is also to be elaborated.

**Legacy sites**: a special procedure should be developed because important tools of identification like category associations or IEAs are missing.

- important problem related to the NORM involving industries, generally characterized by huge amounts of by-products or residues.
- In many countries, e.g. in EU, past activities never subject to regulatory control during the operational time left disused plants and/or residue landfills as legacy sites (e.g. phosphate industries).

# Application of the IAEA General Methodology to the Italian zircon sand industry and lesson learned

## *Preparation Phase*

- The Italian experience is based on two general surveys on NORM involving activities carried out in 2004 and in 2014.
- Data collection and elaboration were limited to sectors using zircon sands in significant amount and in Italian areas with massive presence of these industries.
- Selected categories: zircon sands grinding, tile production, refractory production.
- A review of scientific literature and Italian reports has been carried out .

## Application of the IAEA General Methodology to the Italian zircon sand industry... (cont.)

### *Data collection*

Zircon sands: in Italy are imported mainly from Australia and, to a lesser extent, from South Africa.

Ranges (Bq/kg): 2000 - 13000 for  $^{238}\text{U}$ , 400 – 2600 for  $^{232}\text{Th}$  and 30-300 for  $^{40}\text{K}$

Identification of industries in Italy: fundamental sources of information are

- Confindustria ceramica. It represents many companies (130 of 145 tile manufacturers and 14 of 34 refractory producers) and publishes annual sector studies.
- List of IEAs on the Ministry of Environment website; in 2014 the list, limited to the largest plants, included 82 tile production plants.
- At the moment in Italy there are no legacy sites of past zircon sand work activities.

## Application of the IAEA General Methodology to the Italian zircon sand industry... (cont. I)

### *Data collection (cont.)*

A screening method: selecting companies using sentinel products

- *porcelain stoneware* (tile sector): it typically contains zirconium silicates as bulk ingredient and represents the 86% of the tile production.
- *electro-cast* refractories generally contain zirconium silicates.

Sample surveys in companies allow the identification of materials and phases significant from the radiological point of view

# Application of the IAEA General Methodology to the Italian zircon sand industry... (cont. II)

## *Identification of potential critical phases for RP*

Process	Ceramic industry	Refractory industry
Raw material preparation	Zircon flour	Zircon sand and zircon flour
Baking process	Hydrated lime	
Fusion process		Fusion furnace dust
Scrap recovery		Scrap grinding dust
Products	Some types of tiles	Refractory materials
Process water depuration	Sludges	Sludges

Selecting criterion: exemption - clearance level of EU and International BSS (1 kBq/kg for  $^{238}\text{U}$  and  $^{232}\text{Th}$  series and 10 kBq/kg for  $^{40}\text{K}$ )

## Application of the IAEA General Methodology to the Italian zircon sand industry... (cont.III)

### *Identification of relevant aspects in radiological terms*

- From the data collected in the Italian surveys dose estimates were performed for workers and, limited to effluent release, for members of the public. Assessment of the exposure to effluents was based on Radiation Protection 135.

Effective dose ( $\mu\text{Sv}/\text{year}$ )	Ceramic industry	Refractory industry
Workers*	200	300-2200
Air effluents	< 1	< 1
Water release		< 1

- \*Workers' estimates are conservative, especially concerning radon exposure assumptions in refractory industry

## Application of the IAEA General Methodology to the Italian zircon sand industry... (cont. IV)

### *Questionnaire*

- The inventory finalization process needs a systematic approach
- The questionnaire to be administered to preselected industries is part of the process.
- A very useful collaboration with Confindustria Ceramica aimed to discriminate industries using zircon sands and to individuate new information is in progress.
- This collaboration can help and support dose estimates, in particular for workers.

# Conclusions and perspectives (1)

- The elaboration of the IAEA "Guidance on how to establish a NORM Inventory" to build inventory of the NORM involving industries can take advantage from past survey activities carried out in Member States.
- Italian experiences on zircon sand industries is contributing to the identification of radiological information which is significant for building inventory of this industrial sector.
- Proposed tool to facilitate individuation of zircon sand industries of radiological concern is the analysis of the sentinel products: this approach can be effectively applied to other industrial sectors.
- A collaboration with the category association 'Confindustria Ceramica' is in progress to get also new information useful to estimate doses, in particular for workers. This procedure can be generally useful for all the other NORM industrial sectors.

## Conclusions and perspectives (2)

- Member of public doses from effluents evaluated by the Italian zircon sand surveys suggest a scarce radiological impact and importance of the relevant information difficult and expensive to be measured (activity concentration).
- An effective procedure to individuate the NORM involving industries of radiological concern and build the relevant inventory can be considered an **ALARA tool** which facilitates optimization
  - concentrating attention and resources on reduction of doses in selected plants with particular radiological criticalities;
  - making more effective the industry-institution interaction and consequently leading to a general improvement of the radiation protection level.

## Conclusions and perspectives (3)

- A collaboration is planned with some countries that have decided to set up their inventory following the Italian experience. This may represent a sort of validation of the method.
- On national scale, it will be necessary to proceed with the inventory of all the other NORM processes, accounting for the IAEA Guidance general approach and the specific case study procedures.

*Thank you for your attention!*