Evaluation of the radiological impact of building materials containing NORM residues

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In the last decade, the authors carried out studies to evaluate the building material contribution as source of gamma radiation. In this frame, a European database containing data on more than 23,000 samples of structural and superficial building materials, used in 26 Member States and 4 non-EU countries, was created. Here updated information about natural radionuclide content of NORM residues, used in standard building materials or as they are, are presented.

The ISS-INAIL database contains now data of ~7200 samples of by products from 20 EU_MS + 2 Non EU_MS.
Different types of by-product were considered (see Fig.1). For each type of by-product, average activity concentration of ^{226}Ra, ^{232}Th and ^{40}K are given in Fig.2.

Figure 1: number of samples of NORM residues in database

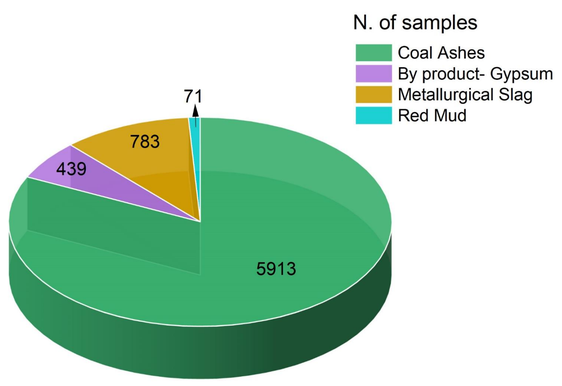
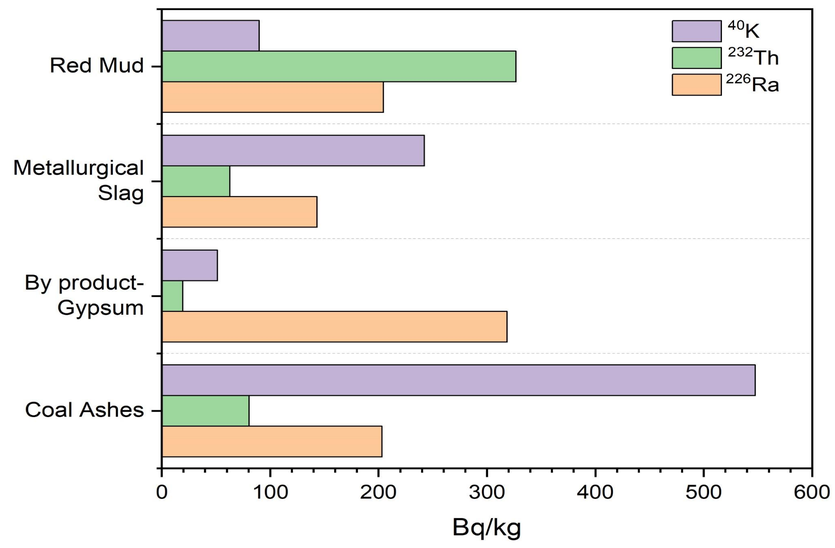


Figure 2: average activity concentration of ^{226}Ra, ^{232}Th and ^{40}K for different NORM residue



NORM RESIDUES IN BUILDING MATERIALS: EFFECT OF THE RED MUD ADDITION IN BRICKS

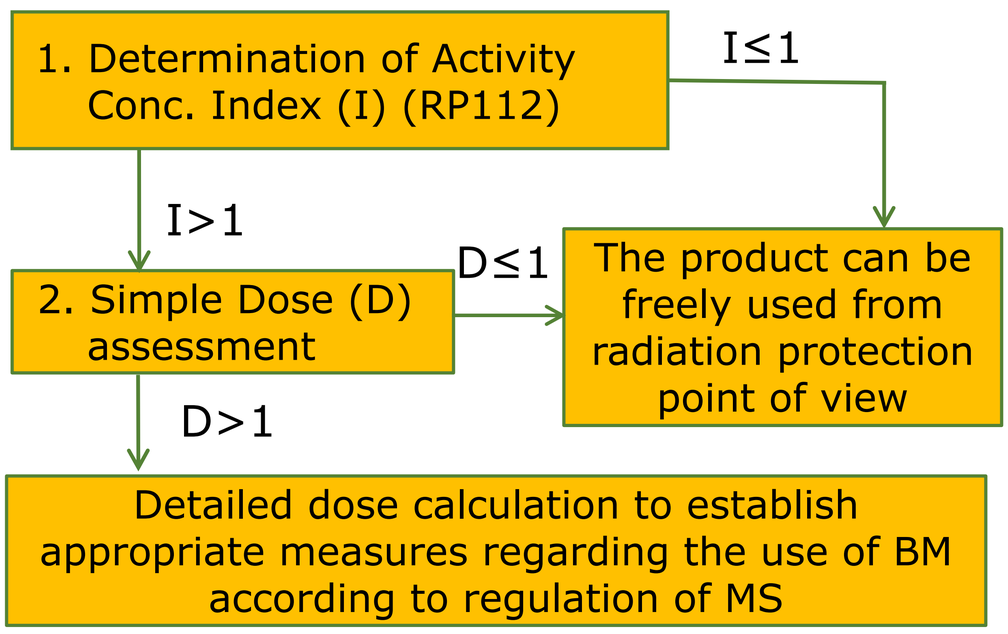


Figure 3: flowchart of a possible assessment of indoor gamma exposure due to building materials, according to 2013 EU BSS (from CEN/TR 17113:2017)

1. Analysis of the effects of the addition of different percentage of red mud (RM) (10%-30%) to bricks mixture in the European countries - Index (I)

Country	Index (I)			
	0% RM	10% RM	20% RM	30% RM
Austria	0.6	0.9	**1.3**	**1.6**
Belgium	0.5	0.9	**1.3**	**1.6**
Bulgaria	0.6	0.9	**1.3**	**1.6**
Cyprus	0.1	0.5	0.9	**1.3**
Czech Republic	0.7	**1.1**	**1.4**	**1.7**
Denmark	0.4	0.7	**1.1**	**1.5**
Estonia	0.3	0.6	**1.0**	**1.4**
Finland	0.7	**1.0**	**1.3**	**1.7**
France	0.6	0.9	**1.3**	**1.7**
Germany	0.7	**1.0**	**1.4**	**1.7**
Greece	0.5	0.6	**1.2**	**1.6**
Hungary	0.7	**1.0**	**1.4**	**1.7**
Ireland	0.5	0.8	**1.2**	**1.6**
Italy	0.5	0.9	**1.2**	**1.6**
Lithuania	0.5	0.8	**1.2**	**1.6**
Luxembourg	**1.0**	**1.3**	**1.6**	**1.9**
Netherlands	0.5	0.9	**1.3**	**1.6**
Poland	0.3	0.7	**1.1**	**1.5**
Portugal	0.7	**1.1**	**1.4**	**1.8**
Romania	0.6	0.9	**1.3**	**1.7**
Slovakia	0.9	**1.2**	**1.6**	**1.9**
Slovenia	0.9	**1.3**	**1.6**	**1.9**
Spain	0.7	**1.1**	**1.4**	**1.7**
Sweden	**1.0**	0.9	**1.2**	**1.4**
UK	0.5	0.7	**1.0**	**1.3**
Norway	**1.0**	**1.0**	**1.3**	**1.5**
Switzerland	0.2	0.7	**1.0**	**1.3**
Turkey	0.5	0.6	0.9	**1.2**

2. Assessment of dose from bricks incorporating RM when Index (I)>1.

Comparisons between ISS room model (RP 112 room size) [1] and CEN/TR 17113:2017 procedure [2] (fig. 4)

Hypothesis

- Room made of bricks (4 walls) (mass per unit area - ρd=200 kg/m^2).
- Floor (F) and ceiling (C) always made of concrete (mass per unit area - ρd=470 kg/m^2).

Parameters	ISS room model	CEN/TR 17113
Room dimensions	4m x 5m x 2.8 m	4m x 3m x 2.5 m
γ Background	50 nGy/h	60 nGy/h
Conversion factor	0.7 Sv/Gy	0.7 Sv/Gy
Occupancy time	7000 h per year	7000 h per year

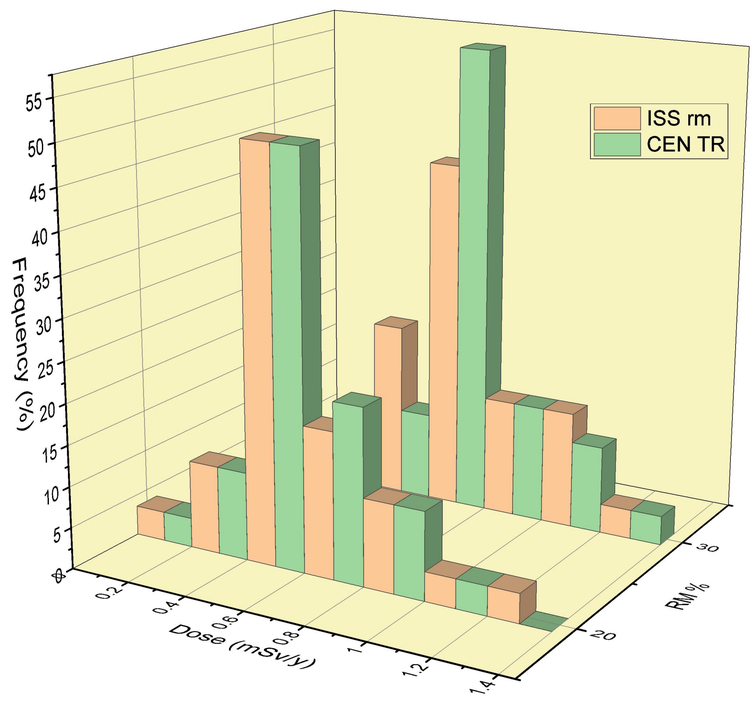


Figure 4. Comparison of distribution (%) of doses calculated for bricks with 20%-30% of RM with ISS room model and CEN approach

Where the addition of 20% or 30% of RM to the bricks mixture leads to an I_{RP112}>1, the assessment by both ISS room model and the CEN/TR17113:2017 procedure highlights that, with few exceptions, dose is below the reference level of 1 mSv/y (2013 EU BSS).

Moreover, results achieved by ISS room model are in good agreement with those get by the CEN/TR 17113:2017. Typically, assessment by ISS room model seems to be more conservative.

References

[1] C. Nuccetelli, F. Leonardi, R. Trevisi 2015 *"A new accurate and flexible index to assess the contribution of building materials to indoor gamma exposure".* J. Env. Rad. 143, 70-75

[2] CEN/TR 17113:2017- Construction products - Assessment of release of dangerous substances - Radiation from construction products - Dose assessment of emitted gamma radiation, October 2017