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# End-of-Waste criteria for NORM residues in Belgium: examples and challenges

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# NORM regulations in Belgium

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Belgian NORM regulations => Royal Decree of July, 20 2001

Art.4 : list "*work activities involving natural radiation sources*"
> initially based on restricted list of activities
> since 2020, = **any work activity dealing with material with AC >**
**Exemption levels**

Art.9 : industries are submitted to **declaration**

**Objective of declaration**: dose-impact assessment (workers and population)

⇒if possibility to exceed 1 mSv/a , **corrective measures** or **licensing**

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⇒ **Use of clearance/exemption levels of EC document "Radiation Protection 122 II"**

Derived from a dose criterion of **0.3 mSv/a**

| Radionuclide | Clearance/exemption levels (Bq/g) |
|---|---|
| U-238sec (incl. U-235sec) | 0.5 |
| | 0.1 (mono-landfill) |
| U nat | 5 |
| Th-230 | 10 |
| Ra-226+ | 0.5 |
| | 0.1 (mono-landfill) |
| Pb-210+ | 5 |
| Po-210 | 5 |
| Th-232sec | 0.5 |
| | 0.1 (mono-landfill) |
| Th-232 | 5 |
| Ra-228+ | 1 |
| Th-228+ | 0.5 |
| K-40 | 5 |

**If AC < clearance**: no additional constraints for residue management (**exception**: mono-landfill)

⇒clearance from further surveillance

**If AC > clearance:** follow-up necessary

⇒ NORM residues treatment facilities must notify FANC

(**NB: also applies to reuse/recycling activity**)

⇒ **Acceptance criteria** in function of type of treatment

# Reference values for acceptance criteria

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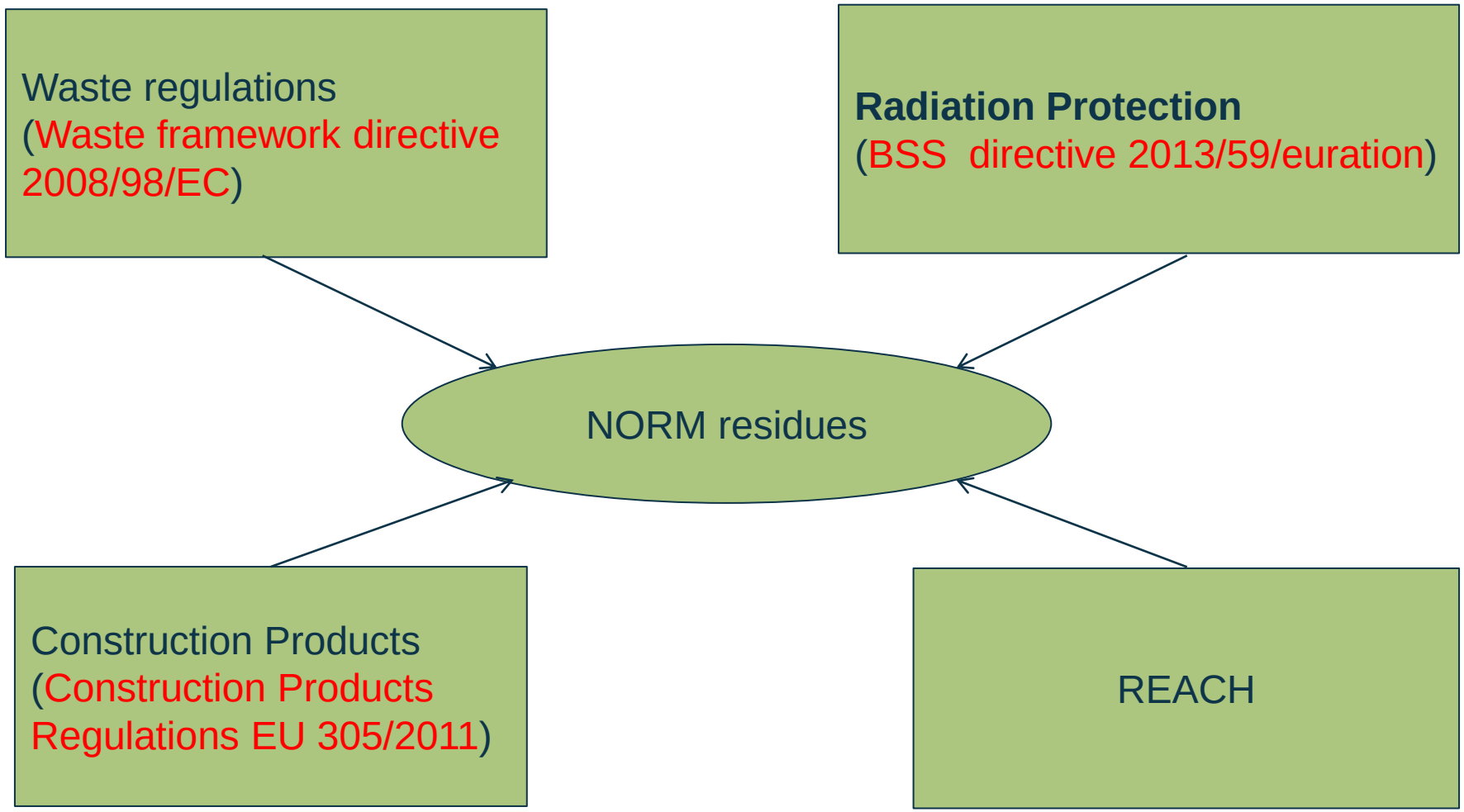
| Treatment | Activity concentration | | |
|---|---|---|---|
| | Input (single batch of residues) | | Output (after residue processing) |
| (Co-)incineration | $C_{exemption}$ | RP 122 II | - Activity index (building)<br>- RP 122 II (road construction) |
| | $C_{max}$ | 10 Bq/g | |
| Building materials | $C_{exemption}$ | RP 122 II | - Activity index (buildings)<br>- RP 122 II (road construction) |
| | $C_{max}$ | 10 Bq/g | |
| Other uses | Case by case (dose assessment < 0.3 mSv/y) | | |

⇨ **2022**: 11 sites authorized for **disposal** of NORM residues

**But only few notifications regarding recycling / reuse**

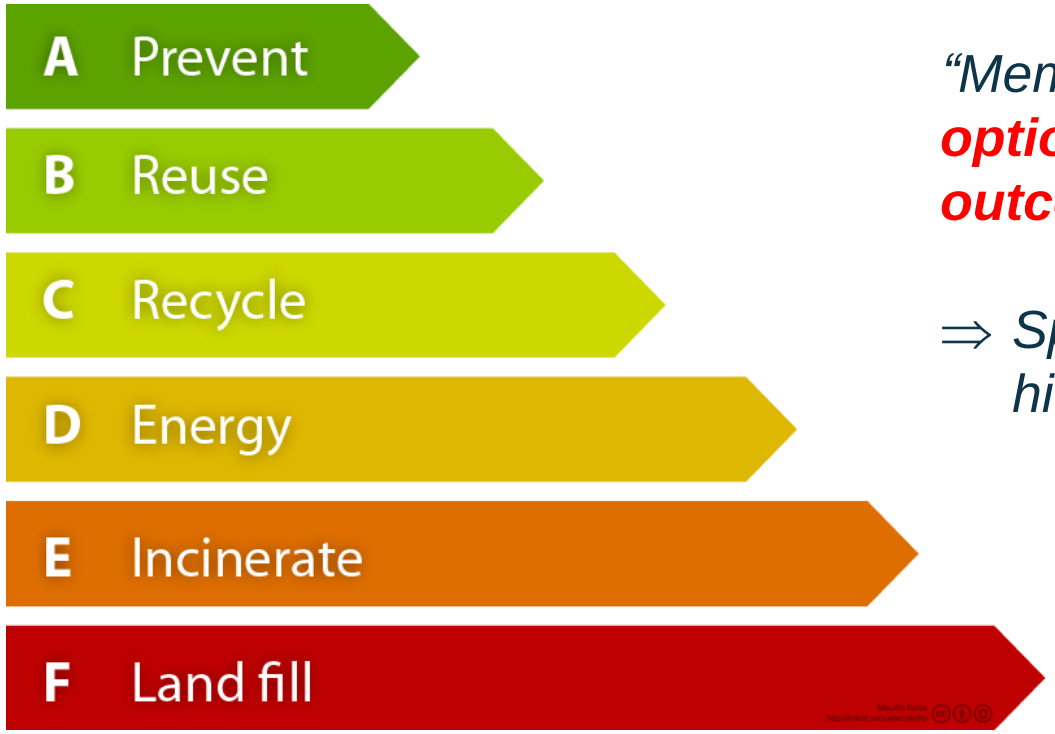
# Interface with other regulations



# Waste Framework Directive

*Waste Framework Directive 2008/98/EC*

**Art. 4** => *waste hierarchy* (ladder of Lansink)




*"Member States shall take measures to **encourage the options that deliver the best overall environmental outcome**"*

⇒ *Specific waste streams **may depart** from the waste hierarchy*

# Waste Framework Directive: end-of-waste criteria

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Art. 6 : "**End-of-waste" criteria => specify when a waste become a secundary raw materials**

⇒"The criteria shall include **limit values for pollutants** where necessary and shall take into account any possible adverse environmental effects of the substance or object"

⇒ Methodology to derive end-of-waste criteria developed by **Joint Research Centre** (JRC) http://ec.europa.eu/environment/waste/framework/end_of_waste.htm

- For some specific waste streams (metal scrap, glass)

⇒ end-of-waste criteria fixed at European level

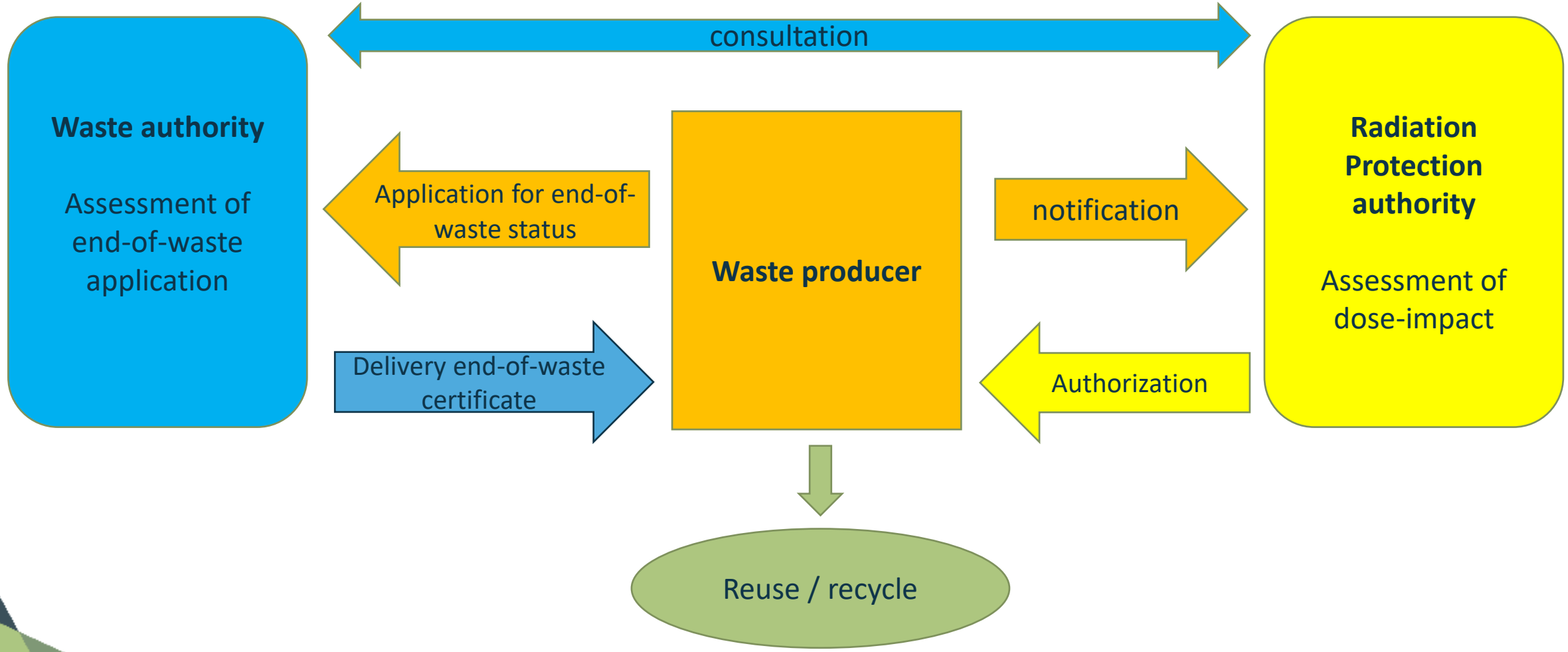
- Other streams

⇒ **«end-of-waste » certificate delivered by national/regional waste authority** upon application by waste producer

# End-of-waste application

! *Radioactivity not integrated in end-of-waste criteria*

⇒ ***2 parallel regulations***



# Transboundary aspects

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**Calcium silicate slag** from thermal phosphorous production

⇒ Used in the Netherlands e.g. as **road bed or dykes** construction material

(see e.g. IAEA SRS 78 “Radiation Protection and management of NORM residues in the phosphate industry)

⇒ **But** “end-of-waste” certificate delivered at national level

⇒ “end-of-waste” has to be demanded in each country of use

⇒ **Dutch producer** of calcium silicate slag asked for “end-of-waste” certificate to **Belgian (Flemish) waste authority**

⇒ **Waste authority asked advice FANC** on radiation protection aspects

⇒ Favourable advice FANC

⇒ **Delivery of end-of-waste certificate for reuse of calcium silicate slag in Belgium**

# Example of reuse/recycling in Belgium: phosphogypsum

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## Active phosphate factory (sulfuric acid process)

⇒ **More than 80% of PG** is reused: most of it as **building material** (plaster) + additive for **cement-industry** and **soil amendment**

⇒ excess of PG disposed onto stack

⇒ Reporting radioactivity level to FANC

⇒ Use essentially magmatic phosphate

⇒ Low-content of radioactivity (I < 1)

Application for end-of-waste status to the local waste authority

⇒ **Positive advice FANC**

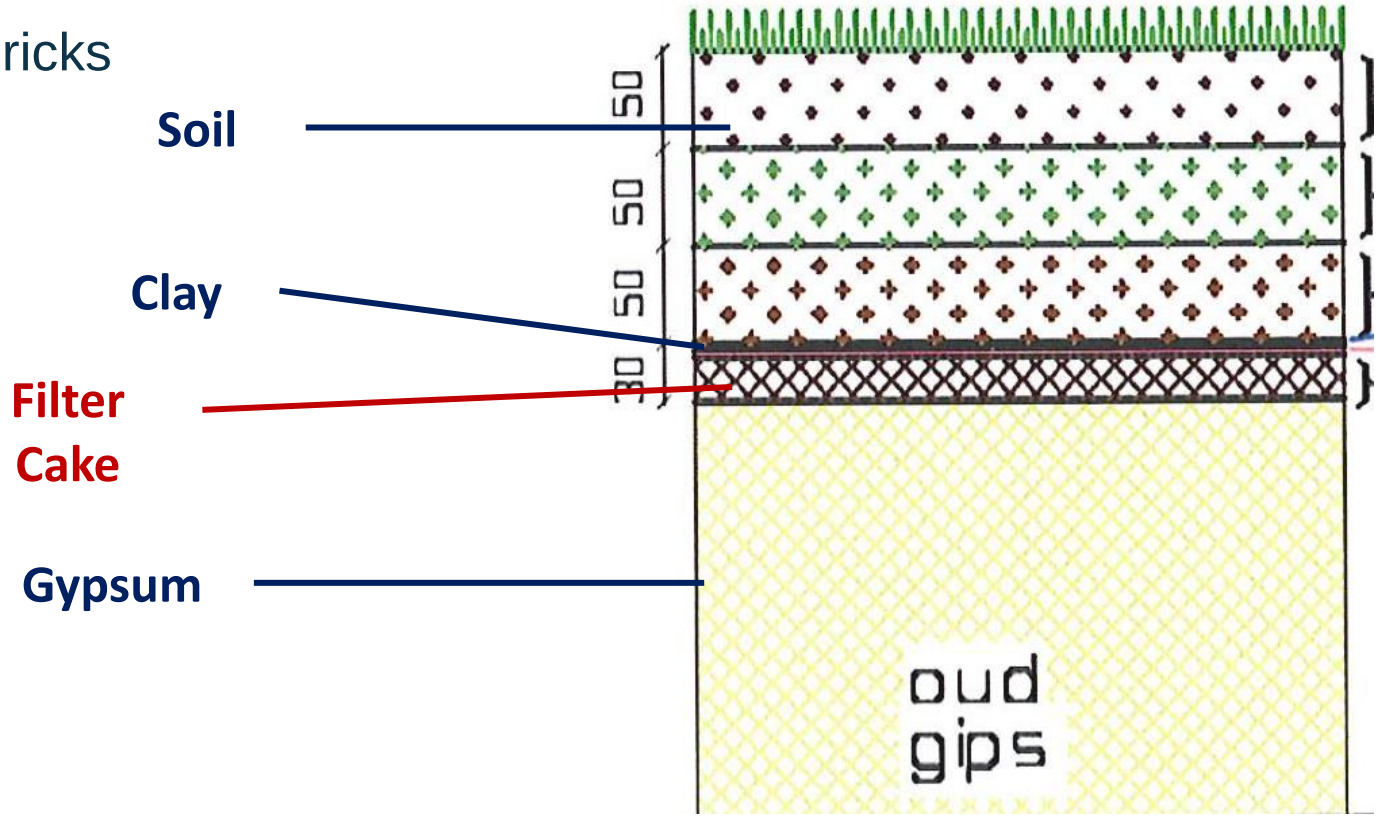
# Reuse of filter-cakes from $TiO_2$ production

**HCl process**: two successive filtration / neutralization steps
⇒ **Two filter cakes** (AC: 100 – 700 Bq/kg U-238, Ra-226)

**First filter cake**:
- Used as additive in production of bricks
- ACI filter-cake > 1 but less than 5% in bricks

(=> no issue for RP)

**Second filter-cake**:
- Used in layer of capping of nearby phosphogypsum stack and other landfill
- Reuse of **60 000 tons** of filter-cake each year



# Recycling of NORM in non-ferrous metal production

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Non-ferrous metal production in Belgium: Sn, Pb, Cu, Zn
+ Cr, Sb, Mo, Bi, Co, Ge, noble metals,…

Examples of secondary raw materials with significant NOR content:

| | Raw material | Main nuclide of concern | Range of activity concentration (kBq/kg) |
|---|---|---|---|
| **Sn/Pb production** | Sn/Pb ingot from primay tin extraction | Pb-210<br>Po-210 | Up to 600 |
| **Co production** | Co concentrate | U-238 (without progenies) | 0.1 up to 10 |
| **Cu production** | Copper / cobalt cement (from Zn or Co production) | U-238 (without progenies) | 1 up to 50 |
| **Zn and Pb production** | Flue dust from primary Zn production | (Pb-210) | Up to 0.6 |
| | | Po-210 | Up to 4 |
| | Leaching residues of flue dust from waste incineration | Pb-210 | 15 |
| | | Po-210 | 80 |

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**No secular equilibrium** in most of secondary raw materials

- Po-210 up to ~10 X Pb-210 (*flue dust*)
- uranium present without any progenies (copper cement)

Residues of one process are raw materials for another:
e.g. copper cement = residue from Zn or Co production
⇒ used as raw material for Cu production

Also *non-NORM issues* (orphan sources or its consequences)
⇒Several cases reported of Cs-137 contamination in some secondary raw material (e.g. flue dust)

# Recycling / reuse of scrap metals

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**NORM contaminated scrap metals**

- Significant quantities of scrap decontaminated in the context of major **decommissioning projects**
- High-pressure water-jetting and acid-bath technique


Decontamination and further recycling of small quantities (scrap yard) remains challenging

- *Not cost-efficient*
- *Smelting of trivial quantities of contaminated scrap not accepted by operator from perception point of view*

# Conclusions

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- *Regulatory process for reuse/recycling of NORM is the same as for use of NORM as raw material (e.g. zirconia in tiles)*
- *Reuse / recycling involves parallel regulatory processes*
- *Delivery of **« end-of-waste »** certificate*
- *Several successful examples (phosphogypsum, TiO2 filter-cakes, secondary raw material metal industry)*
- *Reuse/recycling = balance between many factors*
  - technical feasibility;
  - specifications by end-user;
  - cost efficiency;
  - acceptability by companies and public opinion;
  - regulations & administrative burden.