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Health impact assessment of recovery/disposal options of sewage sludge: methodology and critical parameters

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Summary

- Context
- Methodology of IRSN
- Critical parameters
- Application

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Context (1/2)

- More and more studies
  - Very various requests of the stakeholders of sewers and/or WWTPs
  - Several recovery options operated simultaneously

- Generic method developed by IRSN
  - No dose assessment for all sewage sludge recovery options (except land application)
  - No dose assessment for all exposed persons
  - Very – and even too – conservative hypotheses

Context (2/2)

- Overview of worldwide assessment models
  - No dose assessment for all exposed persons (only the age group of adults)
  - Some considered recovery options are not allowed in France
  - Some retained hypothesis do not comply with the French regulation

→ **Decision of IRSN to develop its own exhaustive model**

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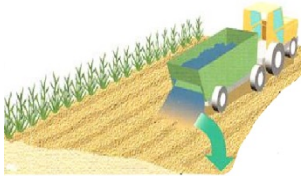
Recovery/disposal options (1/2)

- Agricultural recovery
  - Farmland application with or without a storage platform
  - Composting and amendment (agriculture or garden)
  - Mulching

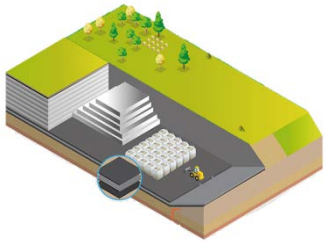


- Energy recovery
  - Incineration in the WWTP
  - Co-incineration in a cement facility
  - Co-incineration in a coal-fired plant
  - Co-incineration with household refuse
  - Wet-air oxidation
  - Gasification

Recovery/disposal options (1/2)

- Building materials recovery
  - Concrete
  - Bricks or ceramics

- Disposal in a landfill



Exposed persons and exposure pathways

- Workers
  - Potentially exposed persons
    - Driver, all the agents of facilities, users of building materials, farmer
  - Exposure pathways
    - Irradiation
    - Inhalation of resuspended dust (and radon when appropriate)
    - Inadvertent ingestion
  - Complementary information
    - All the operations achieved by each worker
    - Annual duration of exposure for each operation
    - Workers' positions relative to each source
    - Geometry and composition of each source
    - Nature, thickness and density of materials between sludge and the workers

→ **Sources of information : visits, workers interviews, literature**

Exposed persons and exposure pathways

- Public members
  - Potentially exposed persons
    - Residents, consumers
  - Exposure pathways
    - Irradiation
    - Inhalation of resuspended dust (and radon when appropriate)
    - Ingestion of contaminated foodstuff and water
    - Inadvertent ingestion of contaminated soil
  - Complementary information
    - Location of the exposed persons
    - Age groups
    - Food and water consumption for each age group
    - Distribution of weather conditions (in case of atmospheric releases)

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Critical parameters (1/2)

- Parameters impacting the source term
  - Fraction of the radionuclides that is not vented as part of the exhaust gas stream: range from 0.0 to 0.99
  - Dilution of sludge by municipal solid waste (co-incineration with household refuse) or by green waste (composting)
  - Dilution of ashes in concrete or in building materials

→ **Values of these parameters are in wide range or are not well-defined in the literature: the choice of relevant values of these parameters must be done with judgement or caution**

Critical parameters (2/2)

- Operational times

- Parameters for atmospheric releases
  - Conditions of releases (height and surrounding buildings)
  - Distribution of weather conditions

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As application (1/3)

- Recovery options: building materials
  - Concrete including cement with sludge ash
  - Bricks including sewage sludge
  - Ceramics including sewage sludge

- Source term (sludge)
  - Case 1: Iodine 131 – 1 Bq/g
  - Case 2: Caesium 137 – 1 Bq/g

As application (2/3)

- Same hypothesis for the different cases if possible
  - Sources dimension, positions in regard to sources
  - Dried sludge
  - Time budgets

- Radionuclides content in the building materials
  - Concrete : ≅ 13 % (based on technical data about content of ash in concrete)
  - Bricks and ceramics : ≅ 30 % (based on technical data)

As application (2/3)

- Hypothesis for the room models

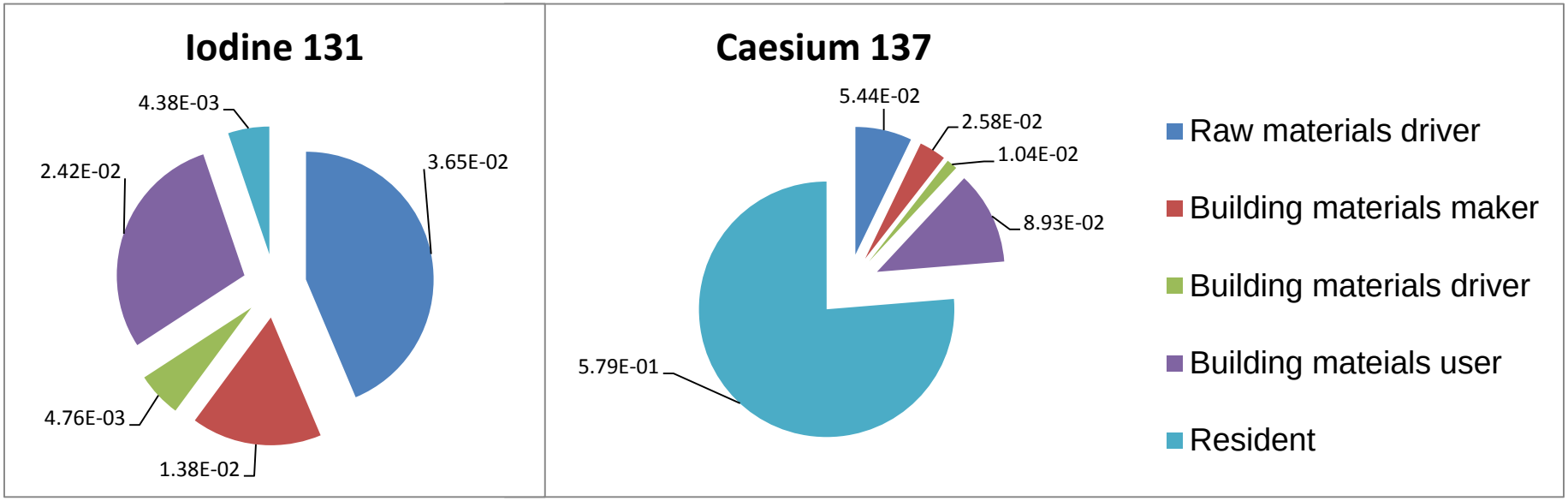
Parameters	Concrete	Bricks	Ceramics
Dimension of the model room	4 m x 5 m x 2.8 m (a)		
Room structures causing irradiation	Walls Floor Ceiling	Walls	Walls
Thickness	20 cm	7 cm	3 cm
Density	2.35	1.2	0.5

(a) From RP112 « Radiological protection principles concerning the natural radioactivity of building materials »

Results (1/3)

- Concrete

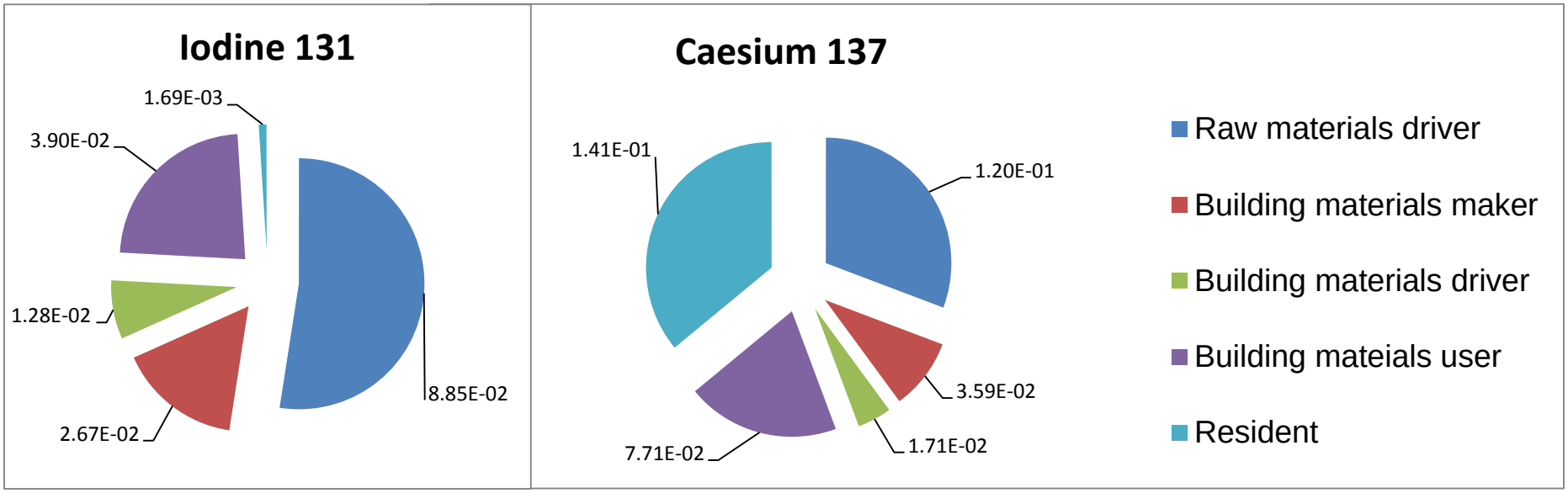
Effective doses (mSv/year)



Results (2/3)

- Bricks

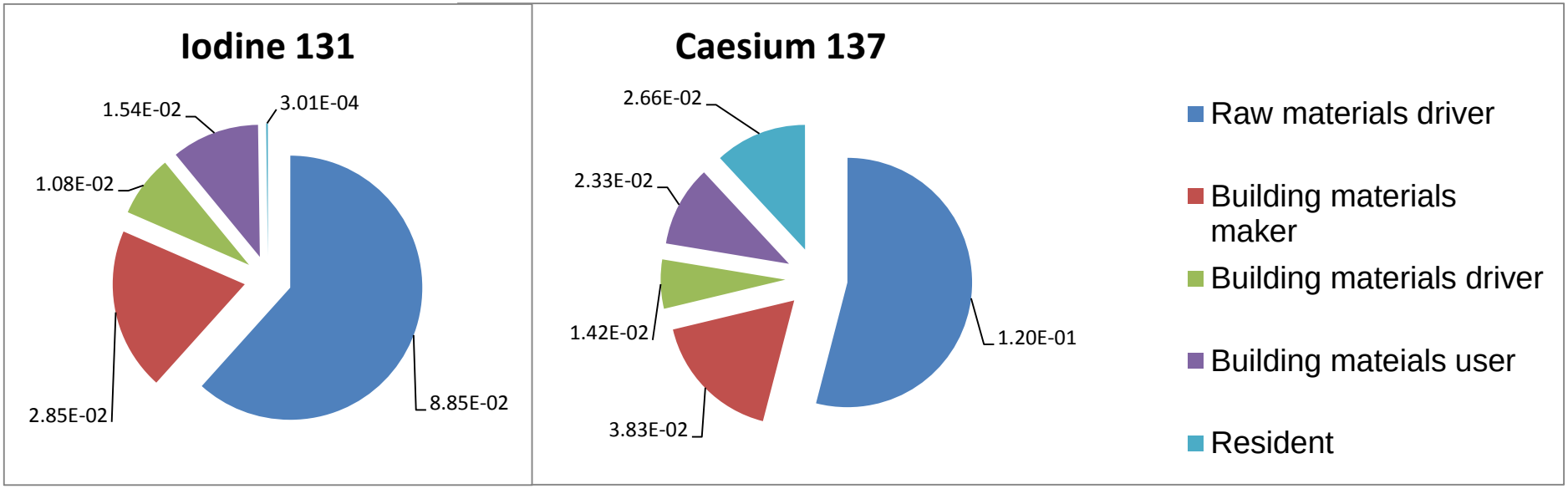
Effective doses (mSv/year)



Results (3/3)

- Ceramics

Effective doses (mSv/year)



Conclusions

- The most exposed persons depend on the radionuclide
  - A long half-life allows pathways concerned by longer duration (linked to occupation) to become significant
  - A short half-life doesn't permit to pathways concerned by longer duration to be significant
- As the most exposed persons cannot be predicted *a priori*, it is necessary to assess doses for all potentially exposed persons
- Overall, no health impact but an important social issue

Thanks for your attention