

NORM WASTE MANAGEMENT: IMPACT ON LANDFILL WORKERS

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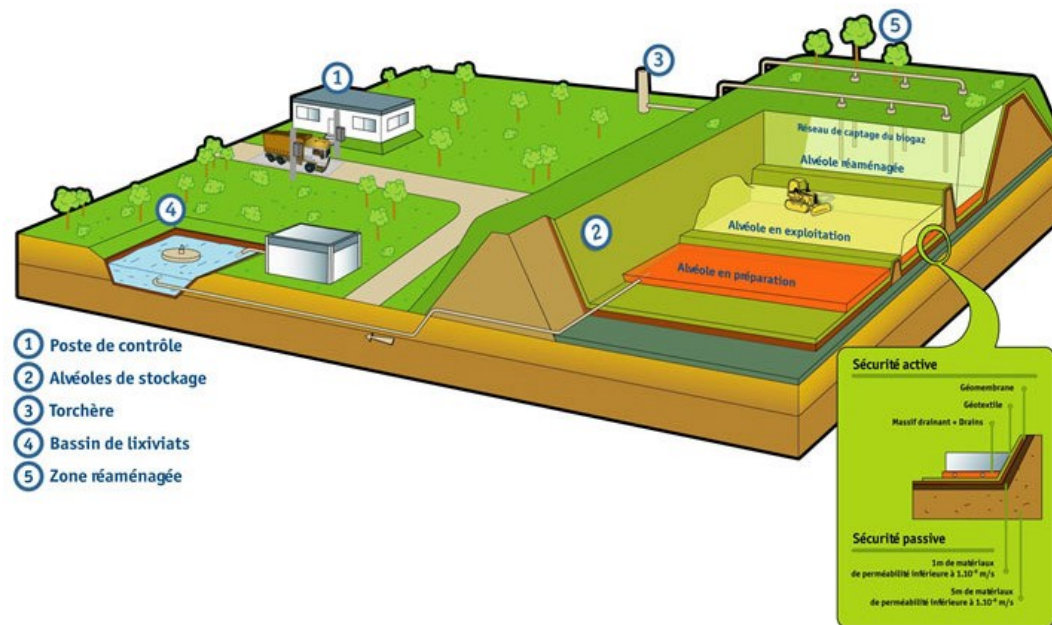
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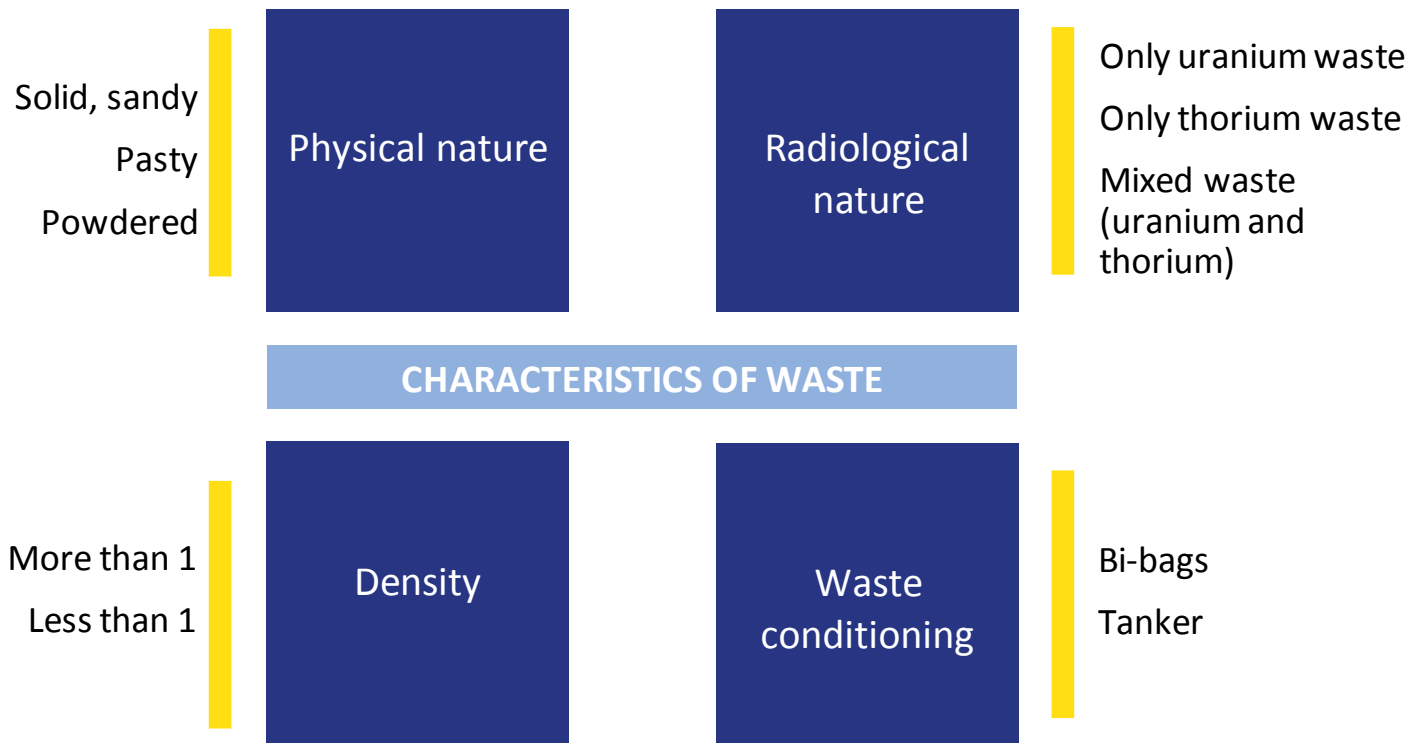
French context

[TRANSPOSITION OF THE EUROPEAN DIRECTIVE 2013/59/EURATOM

- Update the regulation of the management of waste from industries involving NORM
- A graded approach

	Inert waste landfill	Non-hazardous waste landfill	Hazardous waste landfill	Radioactive waste storage
NORM < 1 Bq/g	X	X	X	X
1 Bq/g < NORM < 20 Bq/g		X (with radiological survey)	X (with radiological survey)	X
NORM > 20 Bq/g				X

Types of waste containing NORM



Choice of term-sources

RICH-URANIUM WASTE

Activity concentration:
20 Bq/g U238
0 Bq/g Th232
10 Bq/g K40

Secular equilibrium

Pasty waste (d=1.6)/
powdered waste (d=1)

Big-bags

RICH-THORIUM WASTE

Activity concentration:
0 Bq/g U238
20 Bq/g Th232
10 Bq/g K40

Secular equilibrium

Pasty waste (d=1.6)/
powdered waste (d=1)

Big-bags

MIXED WASTE

Activity concentration:
20 Bq/g U238
20 Bq/g Th232
10 Bq/g K40

Secular equilibrium

Pasty waste (d=1.6)/
powdered waste (d=1)

Big-bags

Considered workers and realized tasks

TRUCK DRIVER

- Waste loading
- Transport
- Waste unloading

LANDFILL WORKER

- Control of waste before reception on arrival at the landfill
- Waste unloading
- De-bagging of waste
- Mixing of waste (if pasty waste) or conditioning of waste (if powdered waste)
- Installation of waste in the storage cell
- Compacting the waste layer in the storage cell
- Covering the compacted waste layer

Considered workers and exposure pathways

TRUCK DRIVER

- External exposure (irradiation) during loading, transport and unloading
- Internal exposure by inhalation during loading and unloading
- Internal exposure by inadvertent ingestion during loading and unloading

LANDFILL WORKER

- External exposure (irradiation) during all his tasks
- Internal exposure by inhalation during all his tasks (except the covering of the compacted waste layer)
- Internal exposure by inadvertent ingestion during all his tasks (except the covering of the compacted waste layer)

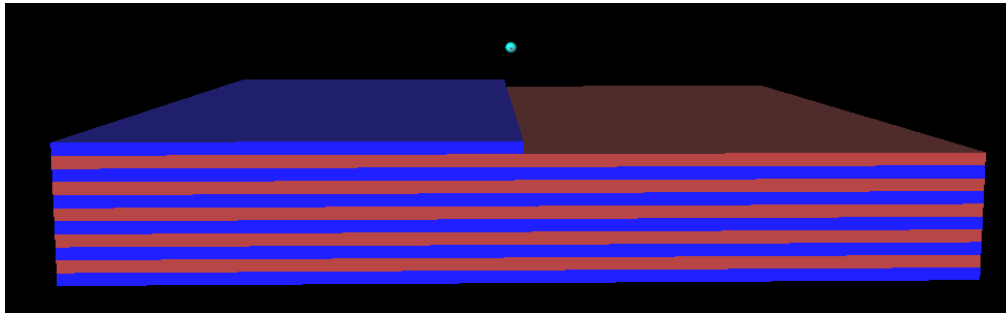
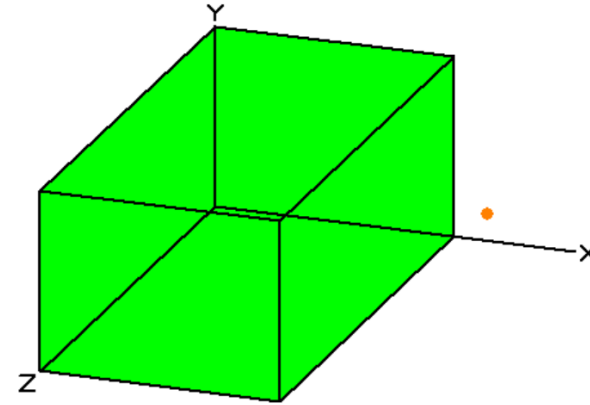
Radon exposure: In an outdoor atmosphere, it is generally negligible. This exposure pathway is therefore not considered in this study.

Skin exposure: not considered in the effective dose (specific regulatory limit)

Exposure pathways

[EXTERNAL EXPOSURE (IRRADIATION)

- Identification of each radiation sources
 - Geometry
 - Distance between sources and workers
 - Exposure time to each source
- Calculation tools
 - MicroShield
 - Mercurad



Exposure pathways

[INTERNAL EXPOSURE BY INHALATION

- Identification of each dust sources
 - Exposure time to each source
- Dust levels
 - Pasty waste: 0.1 mg/m^3
 - Powdered waste:
 - 10 mg/m^3 (regulatory limit) for waste loading and unloading, control of waste before reception, de-bagging of waste and conditioning of waste
 - 0.1 mg/m^3 for installation, compacting and covering in storage cell
- Inhalation rate
- Dose coefficients for workers (particles diameter: $5 \text{ }\mu\text{m}$)

Exposure pathways

[INTERNAL EXPOSURE BY INADVERTENT INGESTION

- Identification of each relevant sources
 - Contact time to deposits over the hands
- Ingested quantities → model “hand-to-mouth contact”
 - transfer factor by hand-to-mouth contact (%)
 - frequency of hand-to-mouth contact (event/h)
 - Quantity deposited over the hands:
 - Pasty waste: estimated on the basis of hands surface (cm^2) and adhesion factor waste-skin (g/cm^2)
 - Powdered waste: generic value of 5 g
- Dose coefficients for workers

Results for truck driver

RICH-URANIUM WASTE

Pasty waste

Effective dose: 3.31 mSv/y

Powdered waste

Effective dose: 8.53 mSv/y

RICH-THORIUM WASTE

Pasty waste

Effective dose: 3.68 mSv/y

Powdered waste

Effective dose: 8.22 mSv/y

MIXED WASTE

Pasty waste

Effective dose: 6.90 mSv/y

Powdered waste

Effective dose: 16.66 mSv/y

Results for landfill worker

RICH-URANIUM WASTE

Pasty waste

Effective dose: 5.32 mSv/y

Powdered waste

Effective dose: 8.85 mSv/y

RICH-THORIUM WASTE

Pasty waste

Effective dose: 5.63 mSv/y

Powdered waste

Effective dose: 9.15 mSv/y

MIXED WASTE

Pasty waste

Effective dose: 10.82 mSv/y

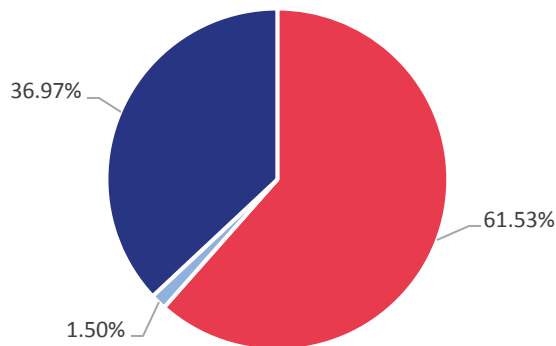
Powdered waste

Effective dose: 17.87 mSv/y

Results

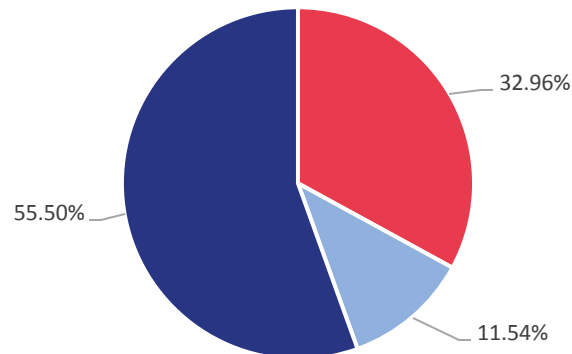
[EXAMPLE FOR RICH-URANIUM WASTE / EFFECTIVE DOSE FOR LANDFILL WORKER

Pasty waste



- external exposure
- internal exposure - inhalation
- internal exposure - ingestion

Powdered waste



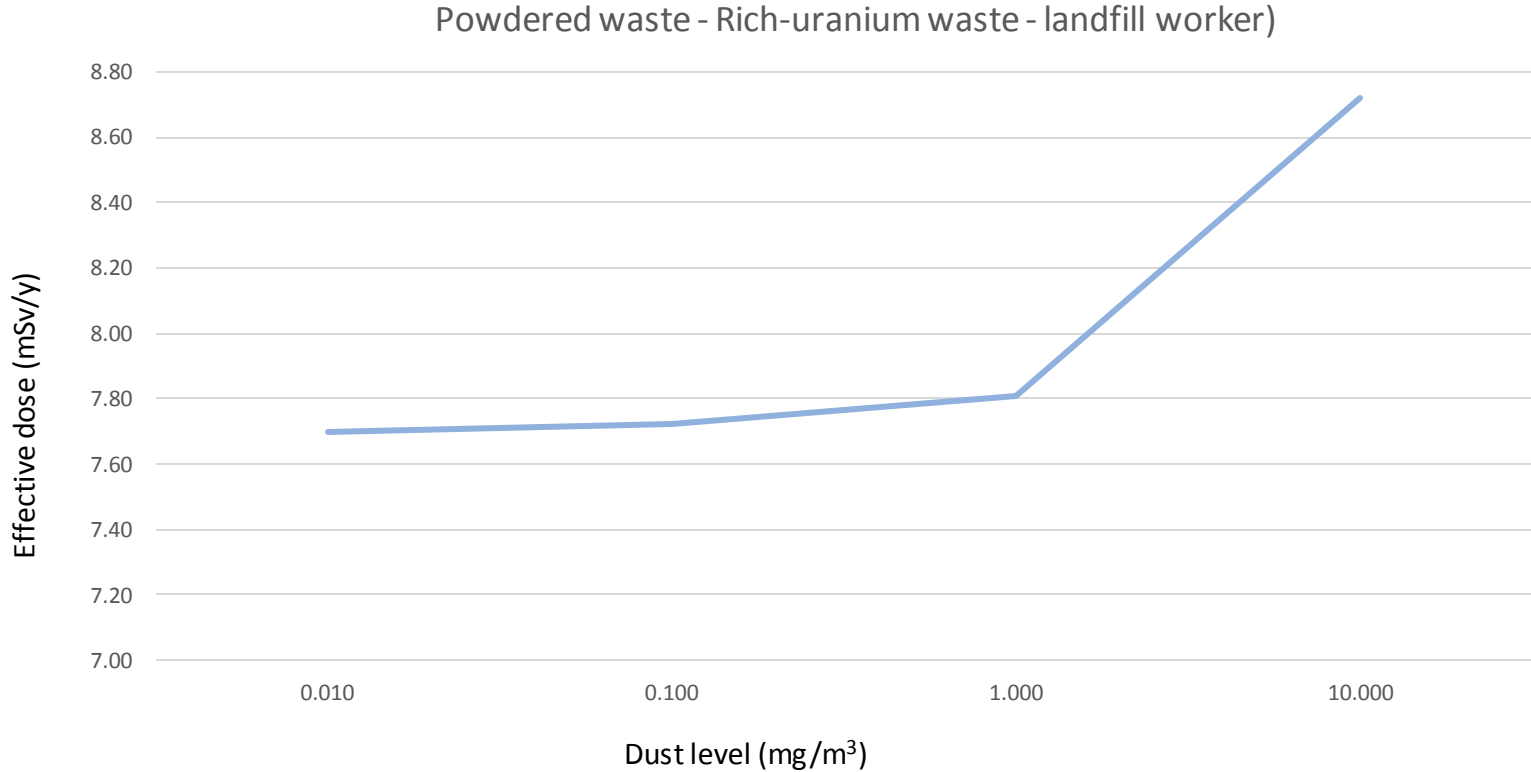
- external exposure
- internal exposure - inhalation
- internal exposure - ingestion



The physical nature, the dust level and the ingested quantity are very important hypothesis because their values have a significant impact on the effective dose

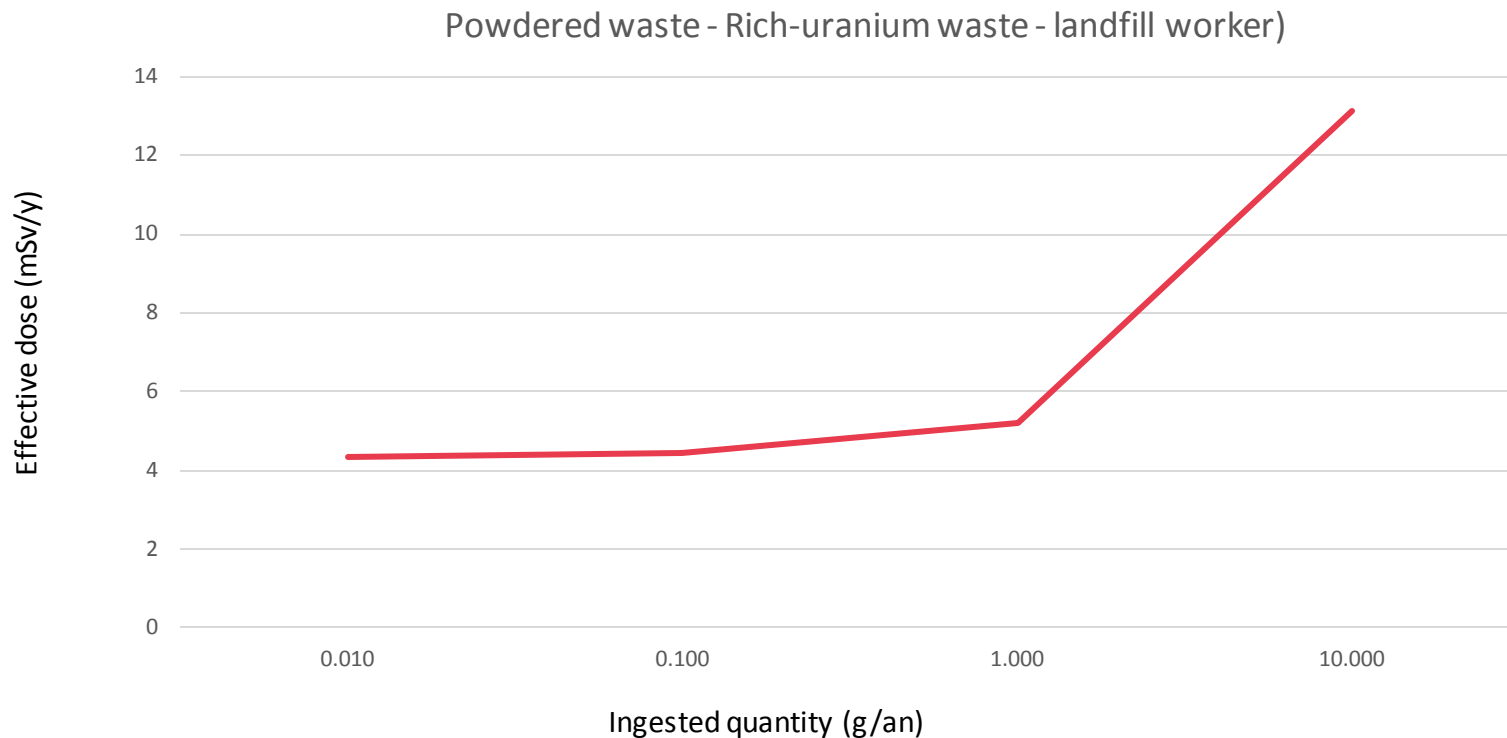
Sensitivity studies

[DUST LEVEL



Sensitivity studies

[INGESTED QUANTITY



Sensitivity studies

[WASTE CONDITIONING FOR TRANSPORT

- Only for powdered waste
- Transportation in tanker rather than in big-bags
 - Geometry of sources
 - Exposure time during loading and unloading of waste
 - Dust levels

[RICH-URANIUM WASTE]

Truck driver
Effective dose: 7.09 mSv/y

Landfill worker
Effective dose: 8.00 mSv/y

[RICH-THORIUM WASTE]

Truck driver
Effective dose: 5.86 mSv/y

Landfill worker
Effective dose: 8.03 mSv/y

[MIXED WASTE]

Truck driver
Effective dose: 12.90 mSv/y

Landfill worker
Effective dose: 15.94 mSv/y

Degraded operating situations

■ Considered situations

- Breakage or fall of a big-bag
- Sleeve breakage during silo-tank transfer or overflow of powdered waste

■ Impacted hypotheses

- Dust levels
- Exposure time



Estimate the frequency of the degraded situation
Put in place procedures to avoid these situations
Define procedures in the event that such situation arises

Conclusions

Landfill operators

- Ensure that the radiological characteristics of the waste are respected
- Optimize ventilation, hygienic requirements
- Wear mask and gloves, optimize the external exposure
- Degraded situations:
 - Well identify these situations
 - Put in place procedures to avoid these situations
 - Define procedures in the event that such situation arises
- Well inform and train the workers

Authorities

- Ensure that the radiological characteristics of the waste are respected
- Ensure the specific provisions put in place by the landfill operators are relevant

**THANK YOU FOR YOUR
ATTENTION**

