CHOSING A STRATEGY FOR WASTE: RECYCLING? DISPOSAL?

EXPERIENCE FROM AN ITALIAN AGENCY

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ARPA Lombardia

- ARPA Lombardia (Environment Protection Agency of Lombardia) is a public Agency in charge of preventing and monitoring environmental pollution due to chemical and physical agents
- ARPA is based in Northern Italy (headquarter in Milano)
- Northern Italy is one of the first region at European scale for ferrous and nonferrous metal production
- In the last 30 years we had several cases of accidental melting of radioactive sources in metal foundries

Accidental melting of RA sources and waste management

First accident: 1989

- The first accidental melting of a radioactive source occurred in Italy in 1989 in an aluminum foundry. A Cs-137 radioactive source of several tens of GBq of activity was melted:

→ contamination was spread in 6 different companies;

→ liquid wastes contaminated river waters up to 100 km downstream of the factories;

→ source melting and the following decontamination work produced about 100,000 ton of solid wastes, most of them salt slags

→ activity concentration: 1 ÷ 1000 Bq/g

Regulation in force

- After that European and National legislation was enforced in order to prevent the accidental melting of orphan sources (DL 230/95, EU 2002, EU 2011, EU 2013)
- Specific guidance on monitoring for radioactive scrap metal was given by international (e.g. UNECE 2006, EC 2013) and national bodies (e.g. UNI 10897:2016)
- In most cases radiation detection systems are effective in detecting hidden radioactive sources
- Nonetheless, accidents remain to some extent unavoidable due to the shielding effect of scrap

Radiation detection systems in operation in metal foundries and scrap metal repositories

Source recovery from metal scrap

Accidental melting of radioactive sources

- Since 1989 11 companies (out of 140) melted radioactive sources (last accident: 2018)
- The activity of melted (unfound) sources has decreased from 1000 GBq (1989) to less than 1 GBq
- First alarm is usually triggered by radiometric control on loads leaving the foundry (off gas, slag, metal)
- First step to be undertaken:
  - → Dose assessment to workers and public (<< 1 mSv)
  - → Evaluation of environment contamination (negligible)
  - → Decontamination of the industrial plant
  - → Waste characterization and management

Industrial plant (de-)contamination

- Plant contamination depends on chemical behavior of nuclide with respect to metal process:

Nuclide	Metal	Plant contamination	Contaminated material (waste)
Cs-137	Steel	Gas cleaning system	Off-gas dust
Cs-137 Ra-226	Aluminum Lead	Melting furnace	Slag
Co-60	Steel	Melting furnace	Metal
Am-241	Brass	Gas cleaning system	Off-gas dust

- Decontamination work: mechanical removal of dust and scales
- Decontamination goal:
  - → residual metal and by-products contamination < (a fraction of) GCL ex RP89 – 122 P.I
  - → after decontamination: dose to “ordinary” worker < 10 microSv/h
- Dose to decontamination workers < 1 mSv

Wastes

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Sistema Nazionale per la Protezione dell'Ambiente

ID.	YEAR	METAL FACTORY	MATERIAL	NUCLIDE	m^3	GBq
BS 6	2001	BRASS	SLAG, OFF-GAS DUST	Am-241	29	0,014
BS	1997	STEEL	STEEL	Co-60	190	0,51
CO	1990	ALUMINUM	SALT SLAG, BUILDING RUBBLE, MIXED	Cs-137	250	100
VA	1990	ALUMINUM	ALUMINUM OXIDES	Cs-137	210	4
BS 1	1990	ALUMINUM	SALT SLAG	Cs-137	20	0,2
BS 2	1990	ALUMINUM	SALT SLAG	Cs-137	8	0,008
BS	1990	CONVENTIONAL WASTE	MIXED SLAG	Cs-137	1000	120
BS	1990	CONVENTIONAL WASTE	SALT SLAG	Cs-137	55000	1000
BS	1997	STEEL	OFF-GAS DUST	Cs-137	90	240
BS 7	2007	STEEL	OFF-GAS DUST	Cs-137	470	3,1
BS 8	2008	BRASS	OFF-GAS DUST, BUILDING RUBBLE, MIXED	Cs-137	100	2,2
BS	2011	STEEL	OFF-GAS DUST	Cs-137	118	0,22
BS 9	2018	STEEL	OFF-GAS DUST	Cs-137	305	0,47
PV 1	2011	ALUMINUM	SLAG	Ra-226	90	0,45
MI 1	2015	LEAD	SLAG (Pb FOUNDRY)	Ra-226	130	15

Waste management

- Wastes come from source melting (metal, slag, off-gas dust) and plant decontamination (by-products, scales, building rubble, etc.)
- Big volumes (10 ÷ 55000 tons)
- Low activity RA wastes (0,01 ÷ 1000 GBq; 0,1 ÷ 1000 Bq/g)
- Different radionuclides: Cs-137, Ra-226, Am-241, Co-60

- Two main constraints:
  - → Lack of a national waste repository
  - → Financial aspects and technical skill, in charge of the metal company

Waste management

Characterization:

- Off-gas dust and metal:

  →contamination is homogeneous

  →representative samples can be taken and then analyzed in lab

- Slag:

  →incoherent mix of different chemical compounds

  →contamination is not homogeneous

  →mechanical operation (e.g. crushing) should be avoided

Waste management – An example

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- A Ra-226 source (0,5 GBq) was melted in an aluminum foundry
- 90 m^3 of slag was contaminated (0,5 ÷ 10 Bq/g)
- CL was set to a very low value: 0,1 Bq/g ex RP 122 P.I (lower than Ra-226 in "blank" slag!)
- A tentative was made for in-situ slag characterization, not successful due to:

→ the (very low) value of CL set by National Authorities

→ cost (each slag had to be measured by HPGe)

"Coarse" characterization

→ the lack of a "final solution" for contaminated material

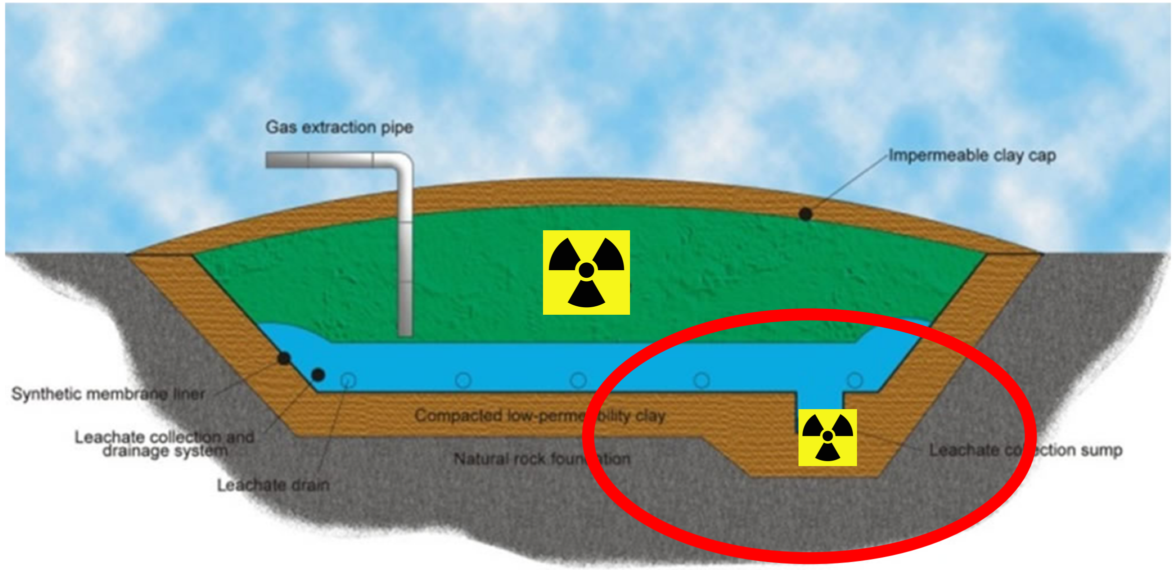
"Temporary" storage at foundry factory

Waste decontamination

- In one case a new method was patented to decontaminate off-gas dust (1350 m^3) from a steel factory that melted a Cs-137 source (Cianchi 2015)
- Dose to workers < 0,1 mSv
- Adv: the volume of radioactive waste was highly reduced (1:1000)
- Disadv: decontamination plant has to be “custom tailored” (different from the plants meant to decontaminate metal)

Clearance

- Clearance was applied to waste water from a waste quarry contaminated by Cs-137 (1990)



- The quarry was secured, but in the meantime contaminated leachate was produced (30 m^3 per month)

- Clearance levels were needed

- Exposure scenario: waste water sent to an ordinary sewage which was allowed to use sludge in agriculture (public acceptance!)

Cs-137: 100 Bq/kg

Contaminated
waste water
1000 ton/year

10^2 Bq/kg * 10^6 kg/y
= 10^8 Bq/y

10^8 Bq/y

«Clean»
Waste water

Sewage
treatment plant

Clean
water

River

Agriculture

Sludge
2000 ton/y

10^8 Bq/y / 2*10^6 kg/y
= 500 Bq/kg

Cs-137: 100 Bq/kg

Resulting dose: 1 μSv/a

CL = 1000 Bq/kg

Final remarks

- Radiometric surveillance in scrap repositories can be improved (not only at the entrance of the site but also during processing)
- The lack of national waste repository forces to look for alternative solutions
- Temporary storage at metal making companies is a threat for the future
- The effort we can ask to metal making companies for waste characterization is limited due to financial aspect (no profit at all from the whole story) and lack of technical skill (not their job)
- In some case cleaning of contaminated material is possible: whenever feasible, it should be applied
- General or specific CL have been applied in few cases, disposal to a conventional landfill for hazardous waste should be encouraged (public acceptance?!??)

Thank you for your attention

References

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- RP122 - Practical Use of the Concepts of Clearance and Exemption. Part I: Guidance on General Clearance Levels for Practices(2015