Treatment of Radioactive Waste

Session 2

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RADIOACTIVE WASTE:
MEETING THE CHALLENGE
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Purpose of treatment

- Operations intended to benefit safety and/or economy by changing the characteristics of the waste
- Three basic objectives:
  - Volume reduction
  - Removal of radio-nuclides
  - Change of composition

Treatment of gases

- Gases from nuclear facilities contain aerosols (dust particles) and/or gaseous radioactive isotopes
- Common techniques for cleaning gases:
  - Filtration whether or not containing absorbing agents (e.g. active charcoal for capturing I-131, I-129)
  - Scrubbing units for washing the gases

- Comprehensive info: IAEA – TECDOC - 1744

Treatment of gases

Hepa filter bank and extraction fan

Hepa filter

-Common technique: Filtration of air from controlled nuclear areas before releasing to the atmosphere

-Radioactivity is transferred to filters or liquids and has to be treated as radioactive waste:

- -Used HEPA filters treated as solid waste
- -Scrubber liquids as liquid waste

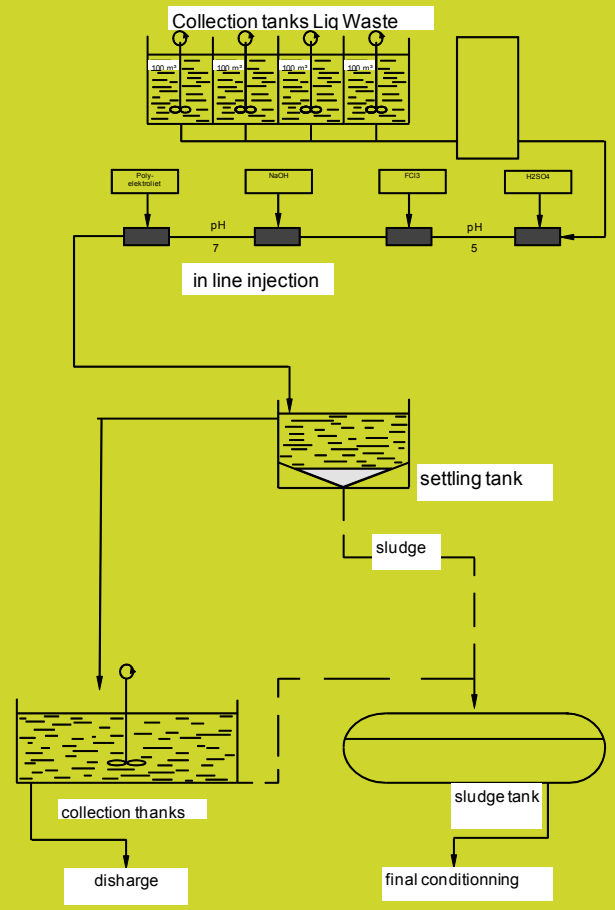
Treatment of liquid waste

Most applicable technologies give supernantant or purified water which can be directly released

- Chemical treatment: addition of different chemicals
- Evaporation gives a purified distillate and concentrate containing the radioactivity.
- Ion exchange
- Membrane methods often in combination with chemical treatment and ion exchange

Evaporation and ion exchange also used for ILW

Liquid Waste: Chemical Treatment LL Waste



Treatment of organic liquid waste

Typical organic liquid waste streams:

- spent oil from NPP's
- scintillation liquids, solvents from institutional waste producers

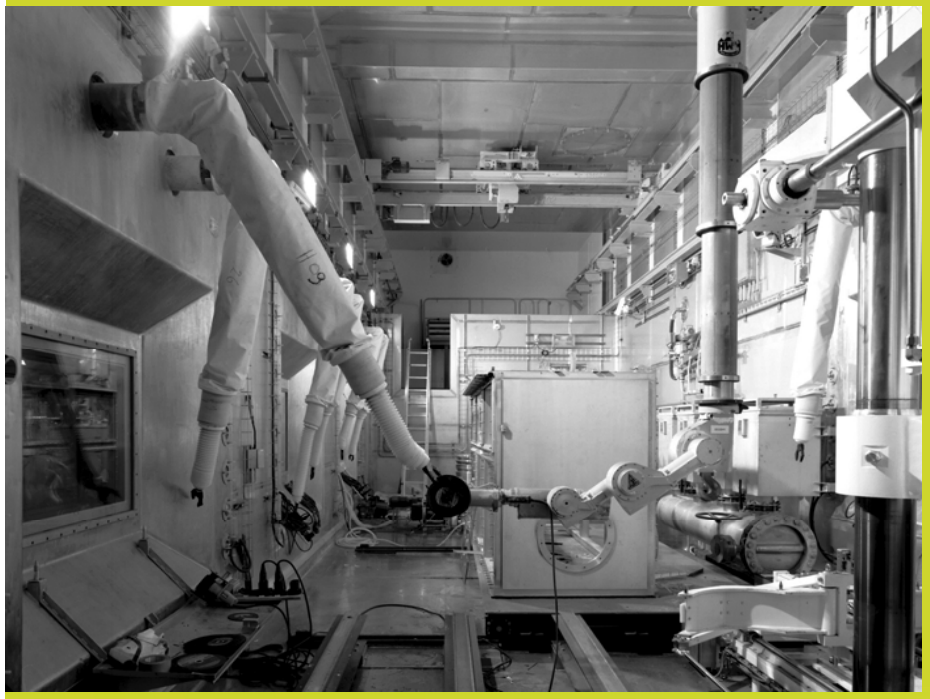
- Thermal treatment: incineration is common used; final product is ash
  - More used for LLW
- Wet oxidation using strong oxidising agents
- Absorbents to make a solid phase
  - Last two can be used for LLW and ILW

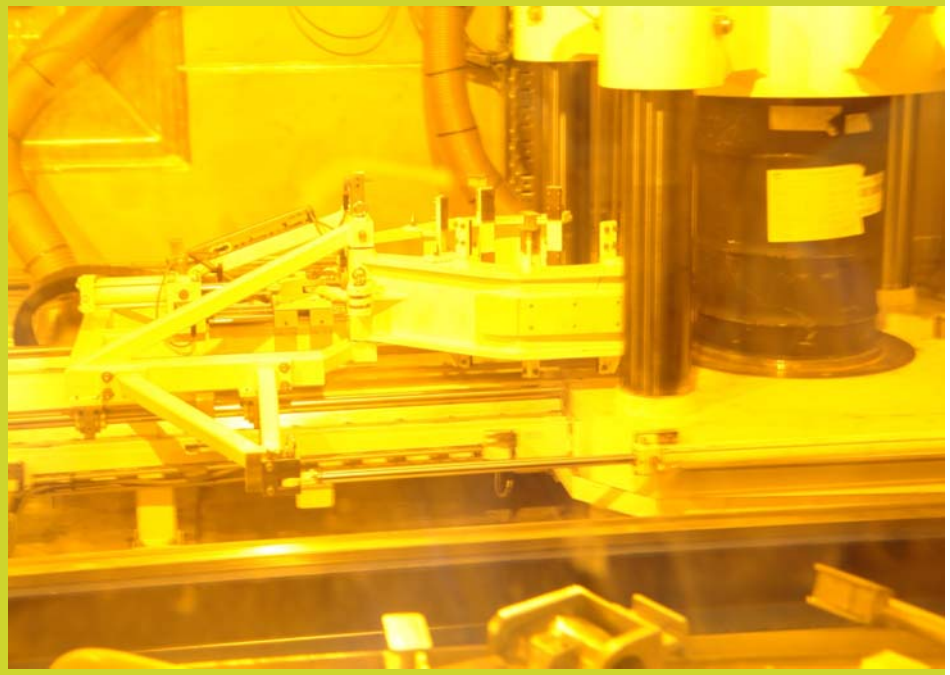
Treatment of liquid waste

- Radioactivity is transferred to the sludge, the concentrate or the spent ion exchange resins and has to be further treated or conditioned as radioactive waste.
- Treatment of sludge, concentrates and ion exchange resins by:
  - Mixing with grout
  - Drying and supercompaction or
  - Thermal technologies if dealing with LLW

Treatment of solid waste ILW

- Treatment of intermediate and even high level waste (ILW and HLW) in shielded infrastructures
- Most common techniques: cutting, sorting and supercompaction
- Final destination is mostly geological disposal





Treatment of solid waste: LLW

- Most used technologies for treatment of low level solid waste (LLW):
  - Compaction (Low force compaction and Supercompaction)
  - Incineration

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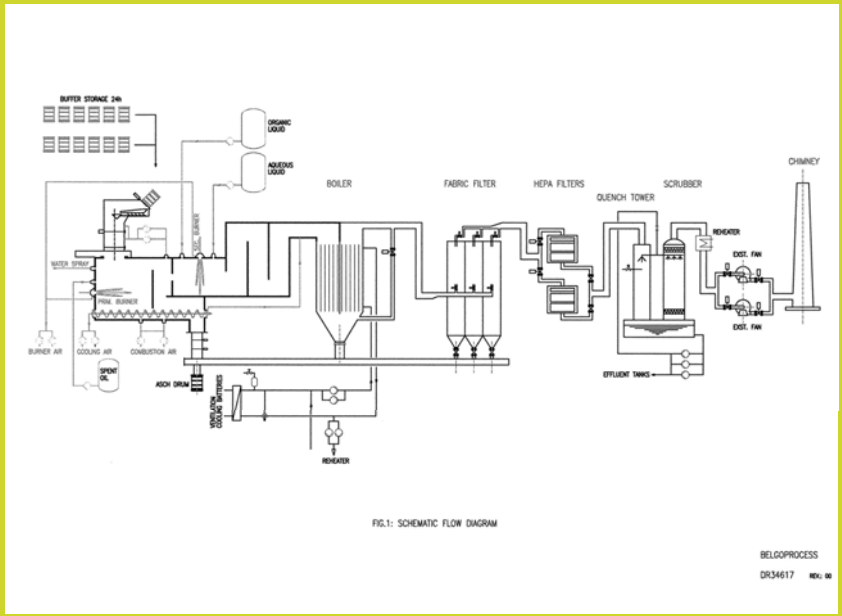
Treatment of solid waste:LLW

Supercompaction (typical 2000ton; 8drums per hour):

- -HEPA filters, insulation material ,concrete debries, metal pieces, granulates such as dried sludge
- -Mixtures of organic (burnable) and inorganic (non burnable) waste
- -Waste has to be packed in drums (e.g. 200l drums)

Treatment of solid waste:LLW



Incineration (typical 50 to 100kg/h; biggest units 500kg/h

-Waste has to be sorted out or collected as packages with burnable waste (wood, paper, rags, clothing, gloves, synthetic material, etc)

-Most incinerators can also treat liquids (organic and aqueuos liquids, spent oil) and spent resins

Treatment of solid waste: LLW

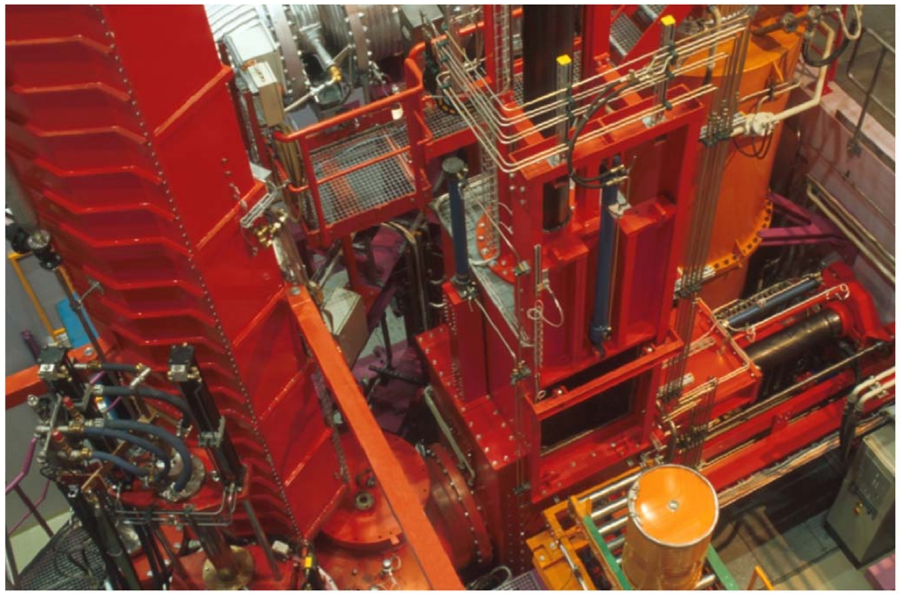
	Supercompaction	Incineration
Investment Cost	low	high
operation	Easy to operate	More difficult
Volume Reduction Factor	1.25 to 2,5	35 to 80
Quality final product for disposal	Poor to moderate	Good (mineralised product)

Volume Reduction Factor: $\frac{\text{Volume of incoming waste}}{\text{Volume of conditioned waste}}$

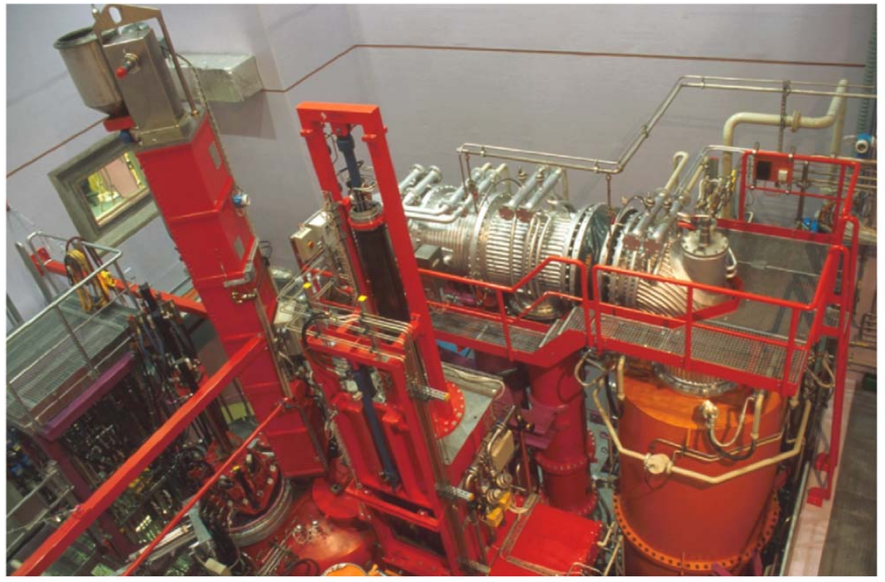
New technologies: plasma treatment

- With plasma, the organic material is vaporised in volatile hydrocarbons, carbon monoxide, etc. while non-combustible and other inorganic constituents are melted and transformed into **glassy slag.**
- Typical temperature: 5000°C
- Suitable for complex waste mixtures: complete 200l drums containing plastics, wood, metal, insulation material, sludges, etc, can be treated as is.
- Suitable for reconditionning of historical waste which do not comply with actual Waste Acceptance Criteria.

Plasma technology



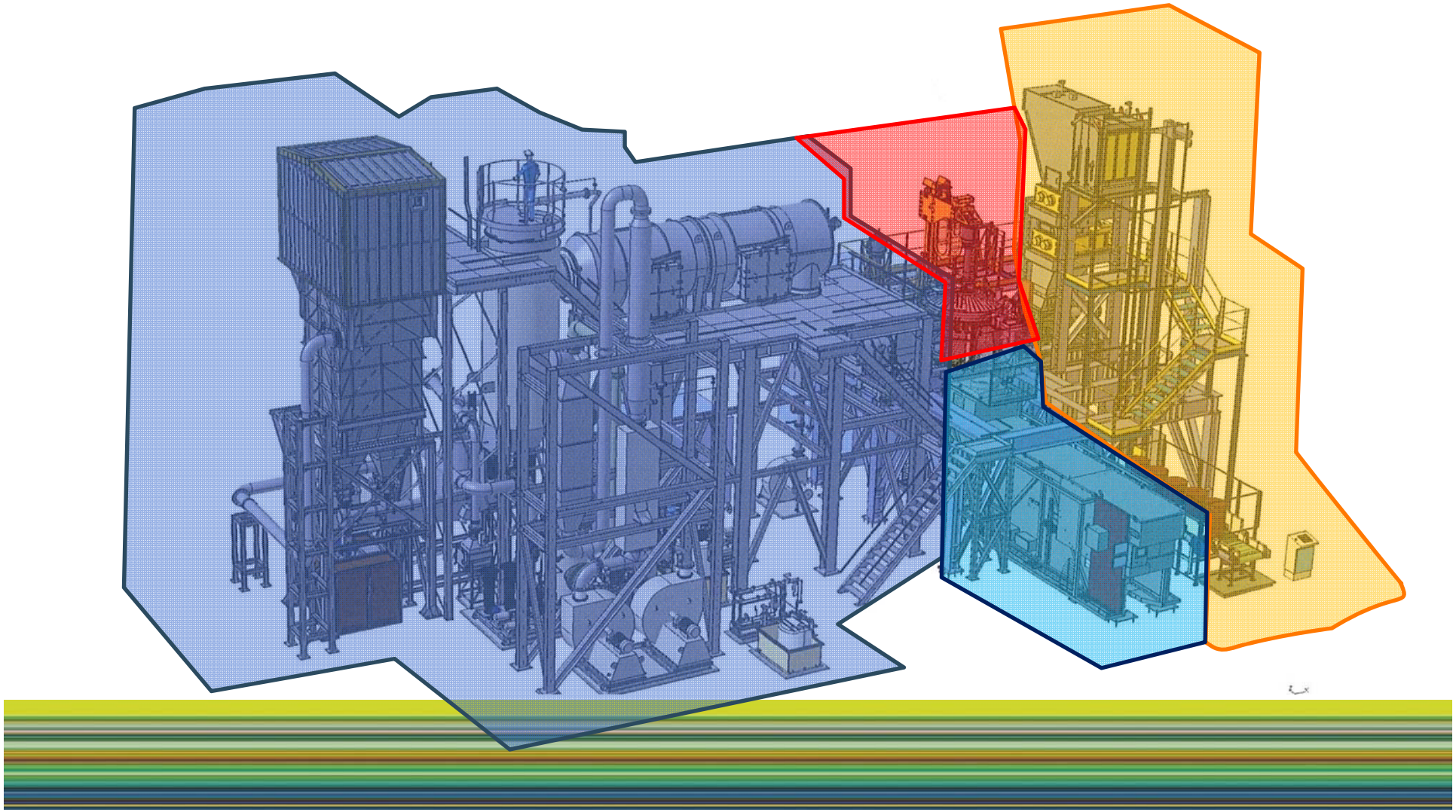
Industrial facility which operates successfully by ZWILAG in Switserland from mid 2004



- Nowadays: 2 campaigns of 10 weeks per year
- About 500 drums or 100 ton per campaign
- End 2013: Total 8000 drums or 1300 ton
- Run on a commercial base

Plasma technology

Plasma facility under construction for Kozloduy NPP in Bulgaria



Plasma technology

program 250 ton or 700m³ per year	Plasma facility		Supercompaction	
Lifetime	20	years	20	years
Facility cost	**20.000.000**	€	**2.500.000**	€
Operational costs for 250 tons or 700m³	3.000.000	€/year	770.000	€/year
final package inclusieve cementation	2.500	€/m³	2.500	€/m³
Disposal cost	15.000	€/m3	15.000	€/m3
annual cost inclus 5% amortisation for 250 ton or 700m³	4.000.000	€/y	895.000	€/y
VRF	**20**		**2,0**	
final volume for incoming volume of 700m³	35	m³	350	m³
cost final package inclusieve final cementation	87.500	€	875.000	€
cost disposal	**525.000**	€	**5.250.000**	€
annual cost plus cost final package	4.087.500	€	1.770.000	€
total: annual cost plus cost final package plus disposal	**4.612.500**	€	**7.020.000**	€

Plasma: high investment costs, good final product with high VRF, low disposal cost

Supercompaction: low investment, poor to moderate final product with low VRF, high disposal cost

Plasma technology

Plasma technology

Conclusions

- Well proven technologies are existing for treating gas, liquid and solid wastes
- Promising alternative technologies are present for treating problematic wastes
- Not only volume reduction of radioactive waste but also the more strict Waste Acceptance Criteria for disposal are important in selecting a solid waste technology
- Supercompaction of organic/inorganic waste mixtures is an easy process and apparently cheap but the more expensive thermal treatment should be considered

Thank you for your attention