

# Conditioning of LLW, ILW and HLW

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**JAPAN ATOMIC ENERGY AGENCY**

International Atomic Energy Agency Scientific Forum

**RADIOACTIVE WASTE:  
MEETING THE CHALLENGE**

Science and Technology for  
Safe and Sustainable Solutions

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# Basic Consideration of conditioning of radioactive waste

IAEA-TECDOC-1616  
Development of Specifications for Radioactive Waste Packages  
IAEA-TECDOC-1616

IAEA-TECDOC-1504  
Innovative waste treatment and conditioning technologies at nuclear power plants

IAEA-TECDOC-864  
Requirements and methods for low and intermediate level waste package acceptability

IAEA-TECDOC-959  
Inspection and testing in conditioning of radioactive waste

IAEA SAFETY STANDARDS SERIES  
Predisposal Management of High Level Radioactive Waste  
SAFETY GUIDE  
IAEA SAFETY STANDARDS SERIES  
Predisposal Management of Low and Intermediate Level Radioactive Waste  
SAFETY GUIDE  
No. WS-G-2.5  
INTERNATIONAL ATOMIC ENERGY AGENCY VIENNA

IAEA Safety Standards  
for protecting people and the environment  
Predisposal Management of Radioactive Waste  
General Safety Requirements Part 5  
No. GSR Part 5  
IAEA International Atomic Energy Agency

**IAEA TECDOC Series**

**Technical Standards / Criteria of Waste Conditioning for Member States of the IAEA**

**IAEA SAFETY STANDARDS Series**

# Conditioning of Radioactive Waste

## **(1) Objective**

- ✓ To convert the waste to a solid form
- ✓ With a decreased solubility and improved mechanical stability

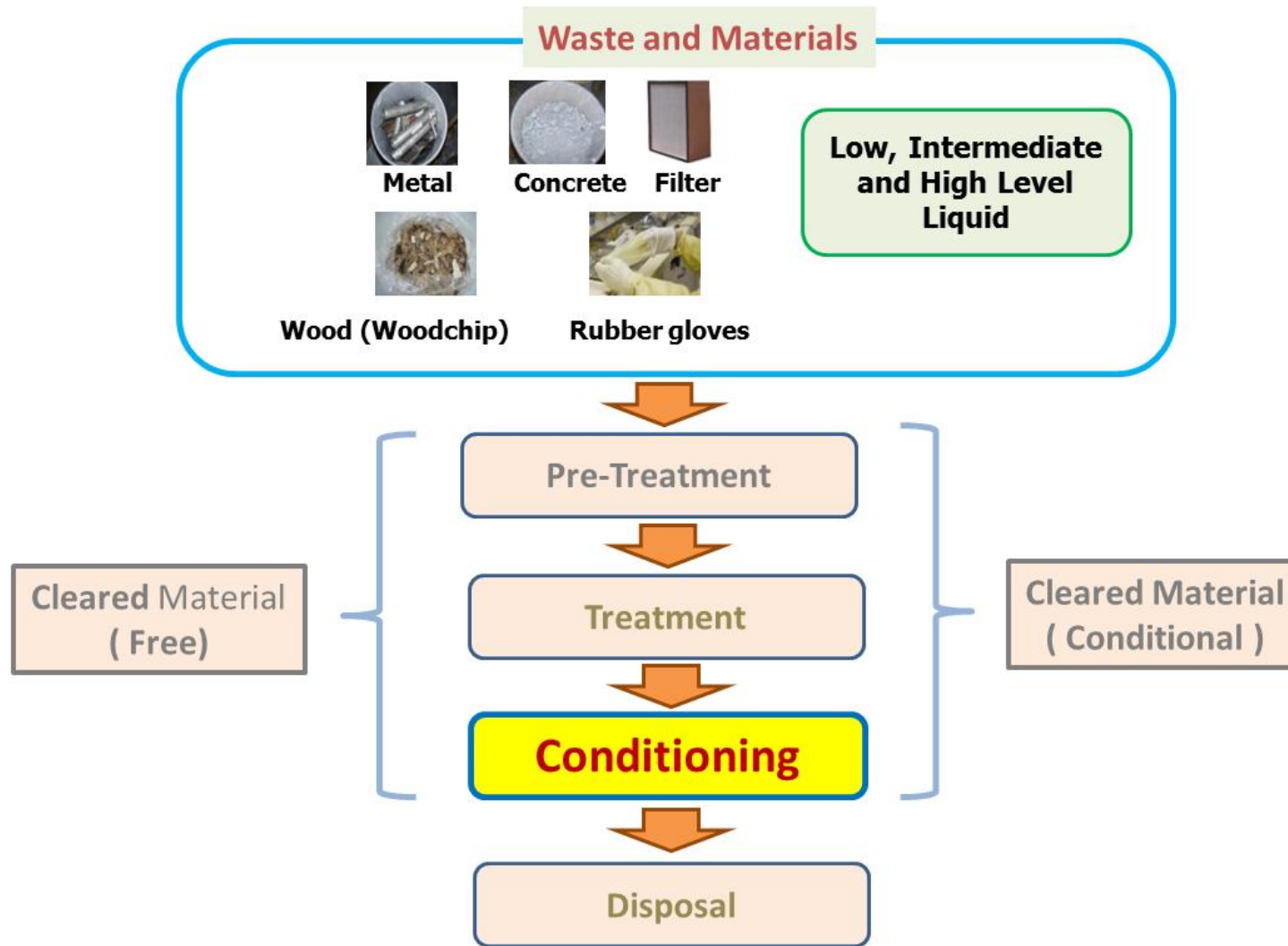
## **(2) Process**

- ✓ Establishment Technologies
  - Cementation, bituminization, polymerization, calcination ...L&ILW
  - Vitrification ...HLW

## **(3) Essential to be taken account of**

- ✓ The radiological characteristic of the waste
- ✓ Physical state of waste
- ✓ Chemical nature of the waste
- ✓ Compatibility of the waste
  - With matrix material
  - between matrix material and disposal environment
- ✓ Waste acceptance criteria of the repository

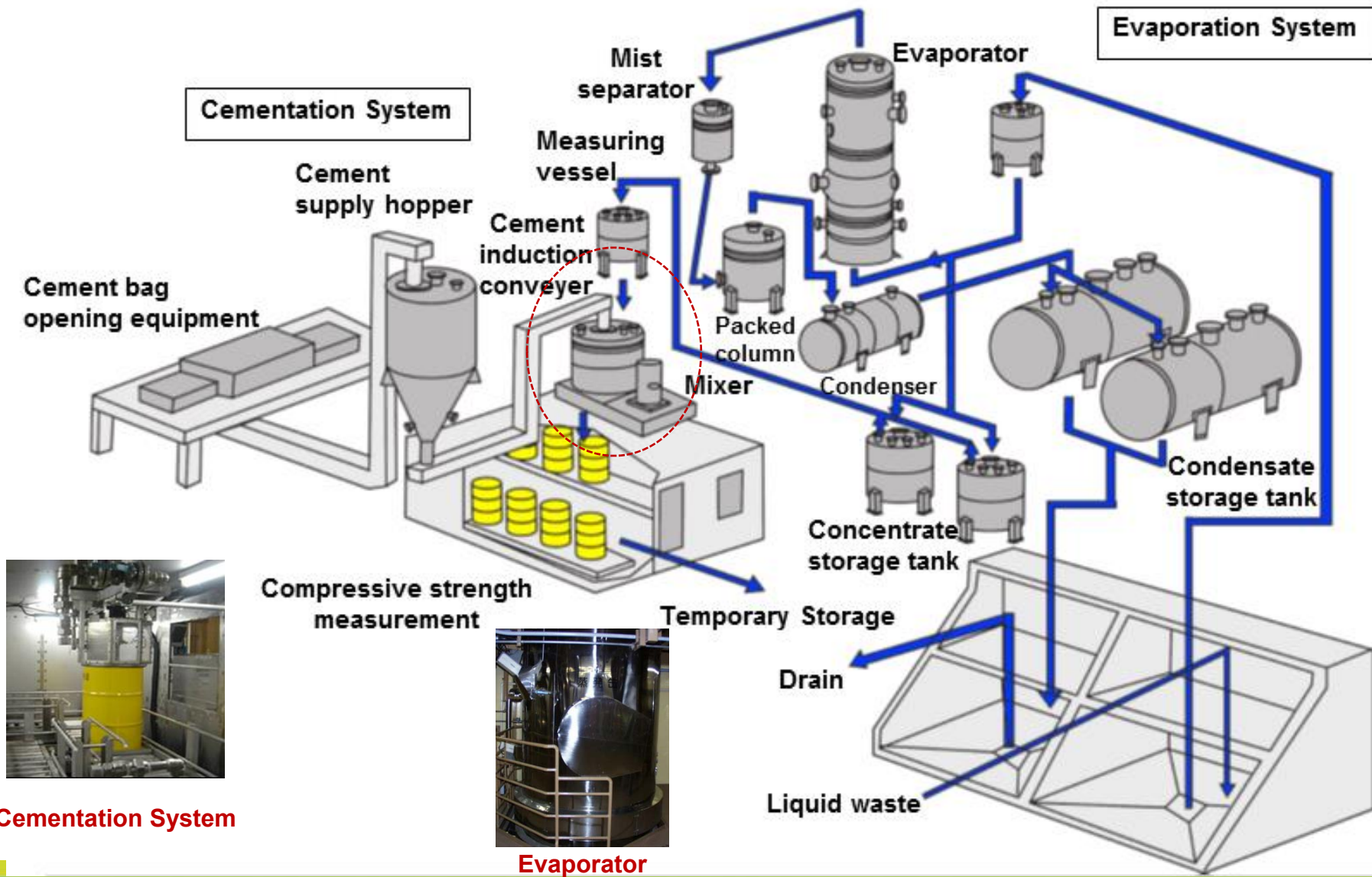
# Stream of radioactive waste; generation, treatment/conditioning and disposal



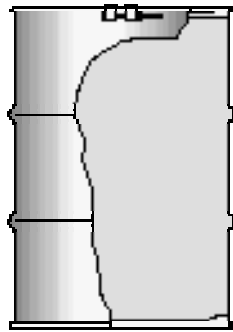
## Various Conditioning Methods for Radioactive Waste

Waste Type	Conditioning Process
Low Level Waste (LLW)	Cementation, Bituminization, Polymerization
Intermediate Level Waste (ILW)	Cementation, Bituminization, Polymerization, Calcination
High Level Waste (HLW)	Vitrification

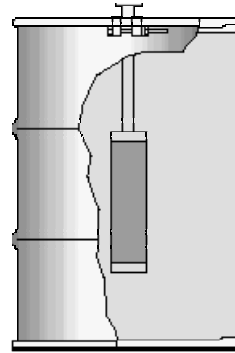
# Conditioning by Cementation (Example)



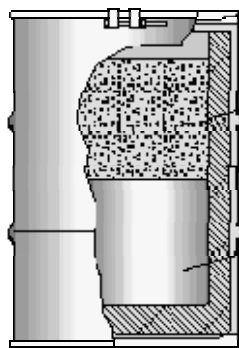
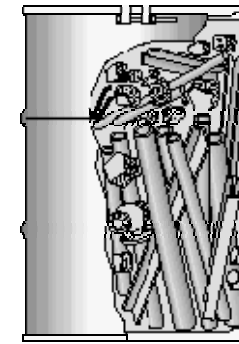
# Conditioned Waste for Disposal (Cement solidification)



**Homogeneous Solidification  
By Cement, Plastic and Bitumen  
(Radioactive liquid waste)**

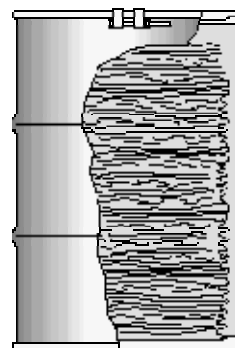


**Cement solidification of  
Miscellaneous Solid Waste  
(Metal & Concrete etc.)**

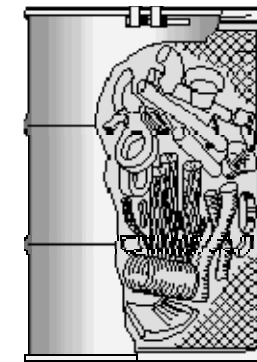


**Cement solidification of  
Melted Solid Waste**

Ceramic  
Canister  
Metal



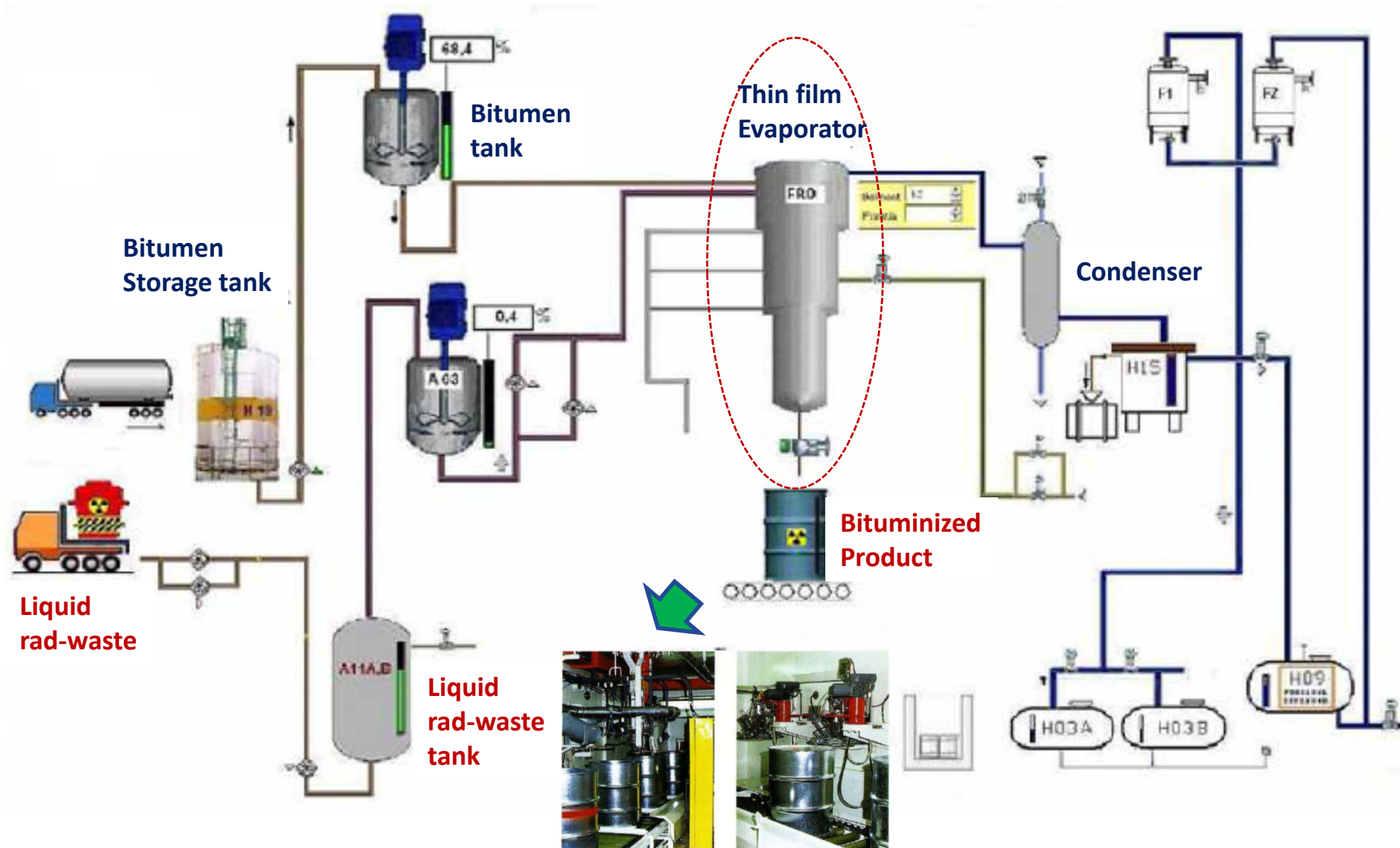
**Cement solidification of  
Compressed Solid Waste**



**Cement solidification of  
Miscellaneous Solid Waste  
(Plastic & Rubber etc.)**

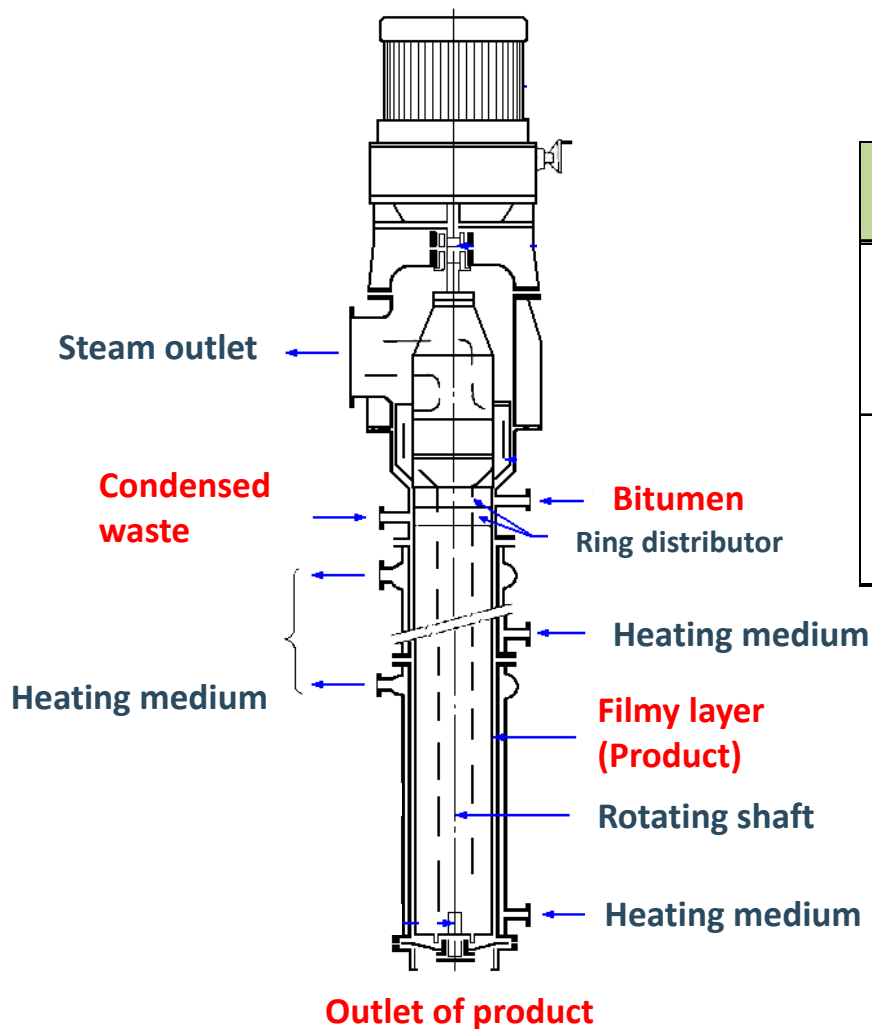
Inner Basket

# Conditioning by Bituminization (Example)



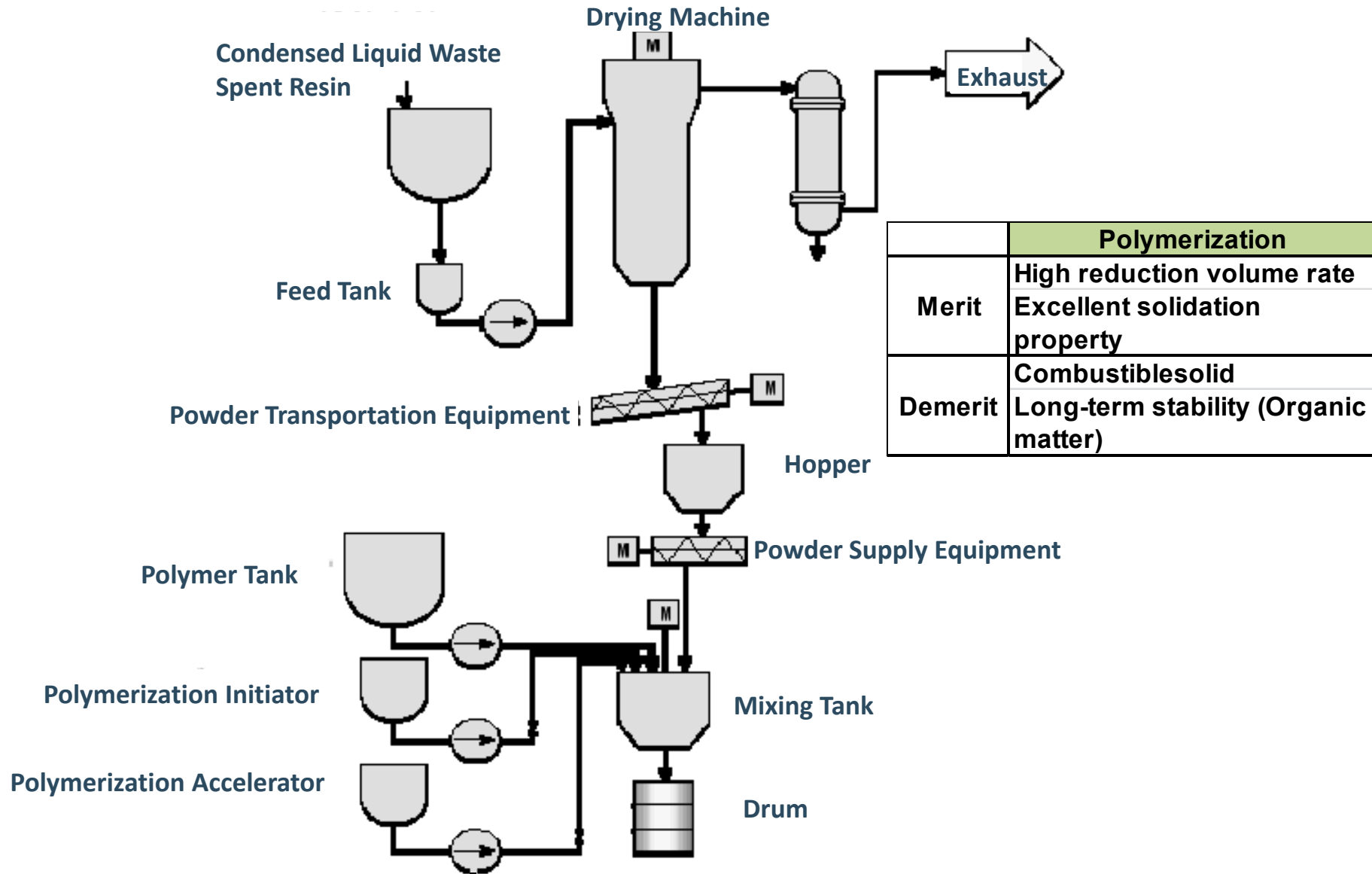


# Thin-film Evaporator for Solidification of Liquid LLW by Bitumen

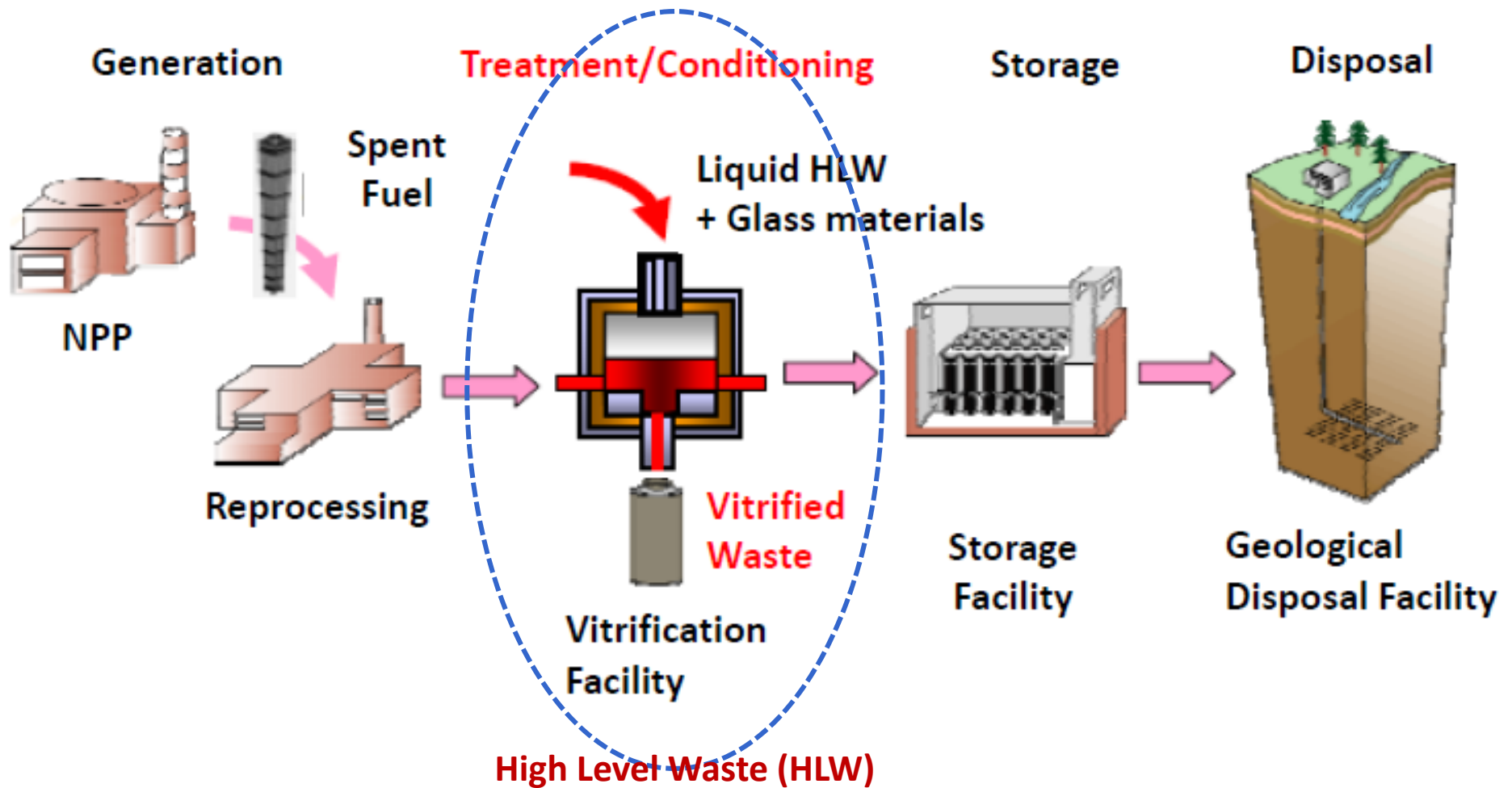


Method	Cementation	Bituminization
Merit	Cost effective and easy to get material	High reduction volume rate
	Long-term stability	Excellent leaching resistance
	Simple process	
Demerit	Low reduction volume rate	Combustiblesolid
		Long-term stability (biodegradation, radiation impact)

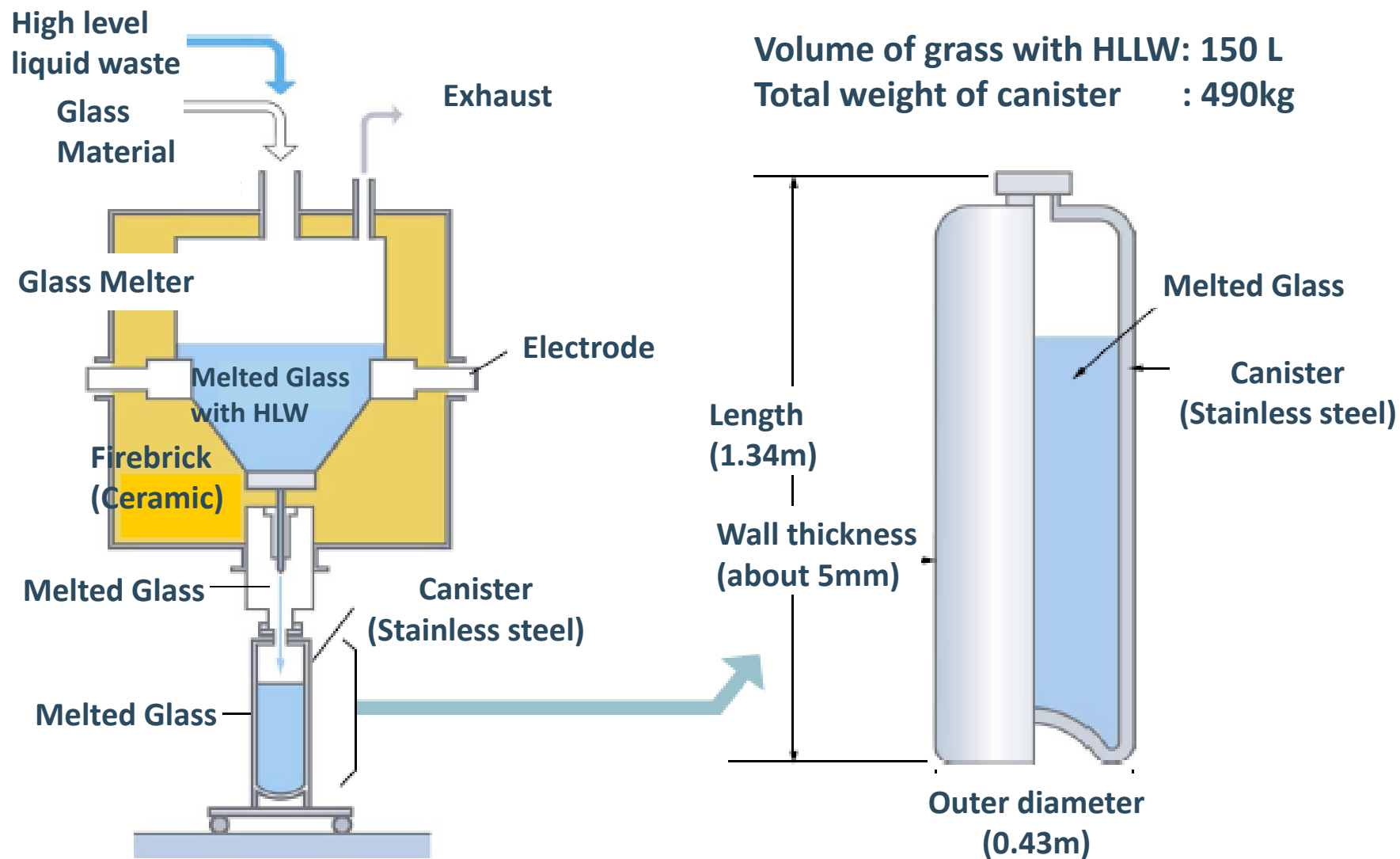
# Conditioning by Polymerization



# From generation to disposal of High Level Waste



# Conditioning of High Level Waste (Example)



# Summary

- ✓ It is possible to make the package (conditioning) of the radioactive waste to dispose safely without depending on the category of high, intermediate and low level waste.
- ✓ A necessary technical standard is established, and conditioning is performed to meet this, and also a record is maintained.
- ✓ It is necessary to carry out the conditioning and the disposal of the radioactive waste reasonably while securing safety.

