



# Calcine Disposition Project – Technology Demonstration



**Valerie Kimbro**

February 22, 2024

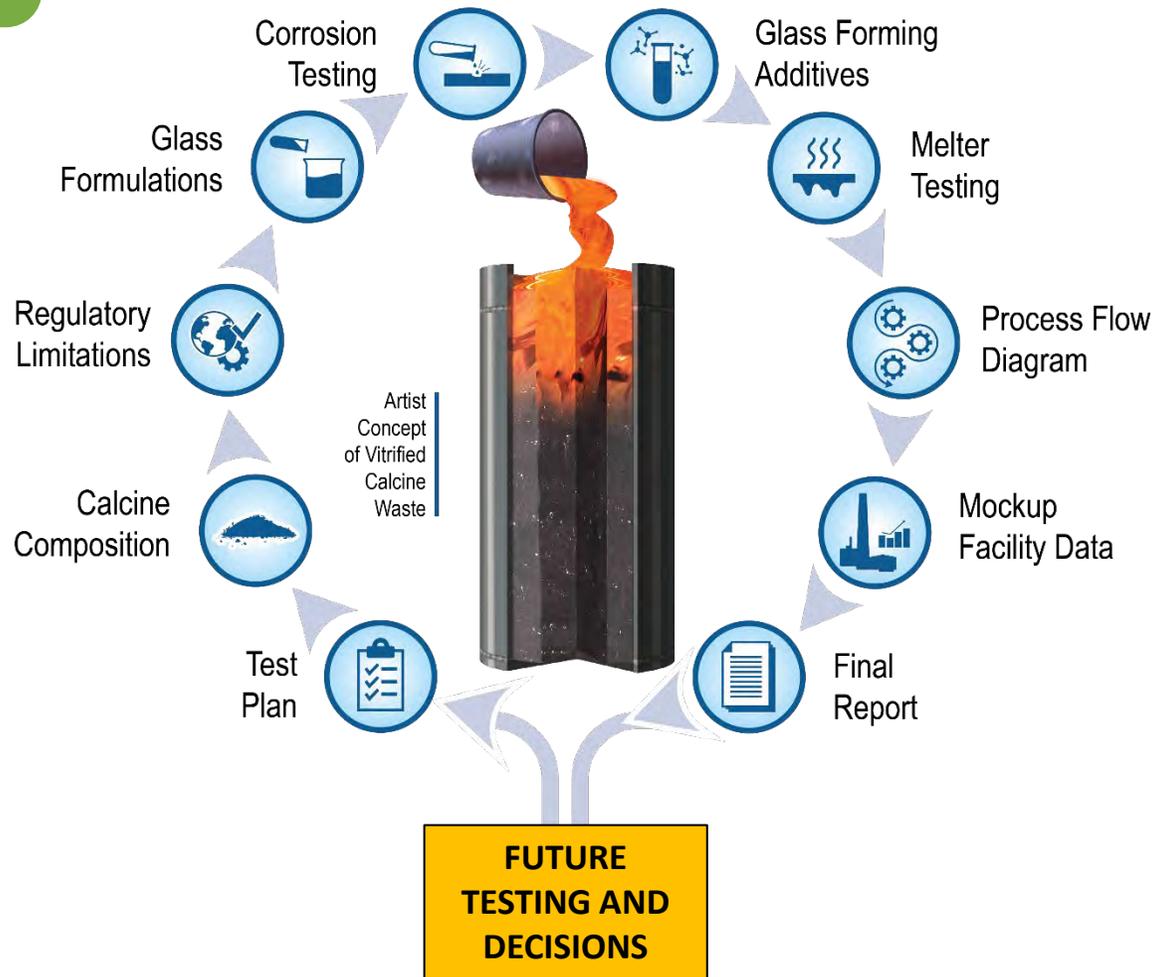




## Vitrification Technology Validation

- Objective is to gather meaningful data to validate the different vitrification technologies with respect to treating mixed high-level radioactive waste (HLW) (i.e., calcine)
- A statement of work—developed and reviewed by experts within DOE and the industry—is being executed by multiple vendors

*Glass melt demonstration at Catholic University, Washington D.C., October 2022*



## Calcine Vitrification Studies

- Execute several tasks that will validate the feasibility of the vendor technology to treat calcine
- Perform work at the required quality level to provide data that can be used for future decisions and design inputs

*Illustration showing tasks that will be completed by each of the vendors*

# Vitrification

- Achieved by heating materials (waste and glass forming additives) until they liquidize, then cooling the liquid so that it forms a glassy solid
- Used in disposal and long-term storage of nuclear waste
- Treatment method for mixed HLW throughout the world
- Glass is a long-lasting, durable material that effectively immobilizes radioactive hazardous material



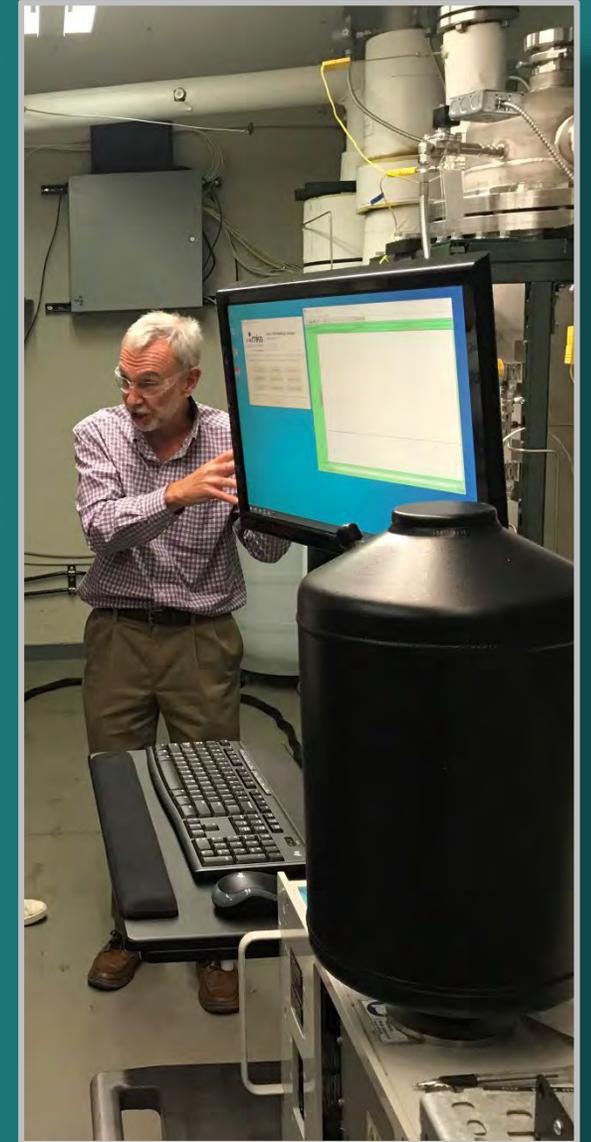
*Photo from lab-scale testing using calcine simulant*



*Glass made with Zr-calcine at 35% waste loading*

# Vitrification Technologies

- Joule Heated Ceramic Melter (JHCM)
  - Used within the DOE complex, Europe, Japan
  - Used to treat LLW and HLW
- Cold Crucible Induction Melter (CCIM)
  - Used in France, Russia, and Korea
  - Used to treat HLW
- In-Container
  - Used in US, Europe, Japan, Australia
  - Used for LLW and different mixed media waste (e.g. soil, sludges, and debris)
  - Full-scale pilots in operation for HLW



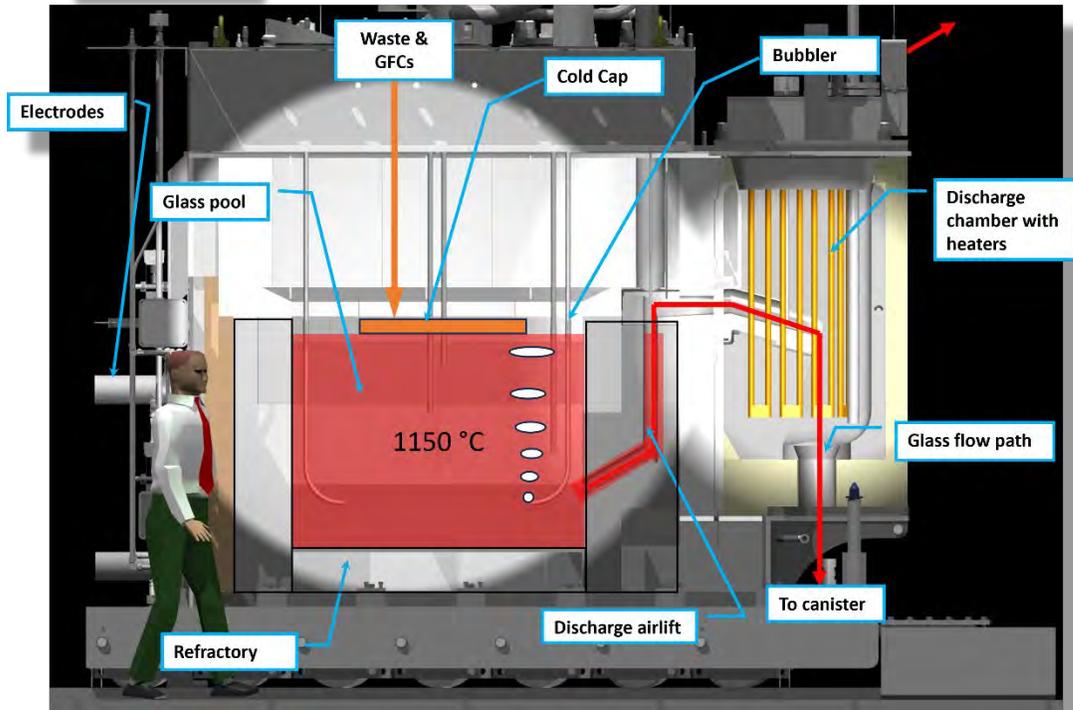
*Test facility tour at Catholic University,  
Washington D.C., October 2022*

# Technology Facts and Figures



JHCM	CCIM	In-Container
<ul style="list-style-type: none"><li>• Continuous process</li><li>• Unlimited scale</li><li>• Low temperature (950 – 1200°C)</li><li>• In-melt electrodes</li><li>• Over 30 years operation in the DOE complex</li></ul>	<ul style="list-style-type: none"><li>• Continuous process</li><li>• Limited scale</li><li>• High temperature (&gt;1300°C)</li><li>• Non-intrusive induction energy</li><li>• Over 12 years industrial operation*</li></ul>	<ul style="list-style-type: none"><li>• Batch process</li><li>• Custom size</li><li>• Wide temperature range (1100 – 1600°C)</li><li>• In-melt electrodes/non-intrusive induction energy</li><li>• Over 20 years industrial operation</li></ul>

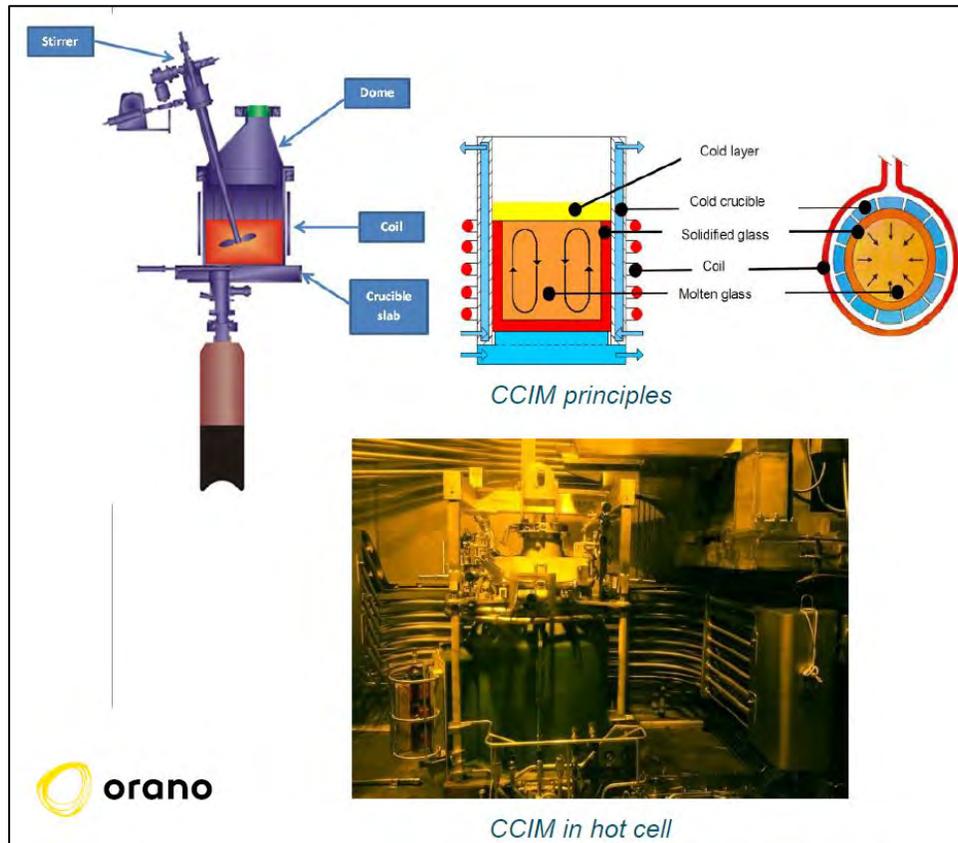
\*France has also used IHMM (induction heated metallic melter) for over 40 years



*Illustration of the primary systems of the Joule Heated Ceramic Melter*

## JHCM Principles of Operation

- Refractory/ceramic lined vessel
- Sealed vessel
- Submerged, permanent electrodes
- A/C power
- Vertical melting process
- Continuously stirred



 orano

*Illustration of the primary systems and photo of the Cold Crucible Induction Melter*

## CCIM Principles of Operation

- Glass heated by a current that is passed through an induction coil surrounding the crucible
- Solidified layer of glass protects the melter from the corrosive melt
- Mixing ensured by bubbling and stirring



*HLW canisters used at the Defense Waste Processing Facility at the Savannah River Site*

## In-Container Principles of Operation

- Canister used as the melter
- Canister is filled with waste and glass forming additives
- Mixing ensured by heat and convection
- Uses either in-melt electrodes or non-intrusive induction energy

# Importance of Vendor Studies

- Each vendor provides valuable insight respective to their technology and the potential treatment of calcine
- Current demonstrations are scheduled to complete fall of 2024
- Results will be used to inform next steps of the validation process

