A Multifunction Cask for At-Reactor Storage of Short-Cooled SNF, Transport, and Disposal

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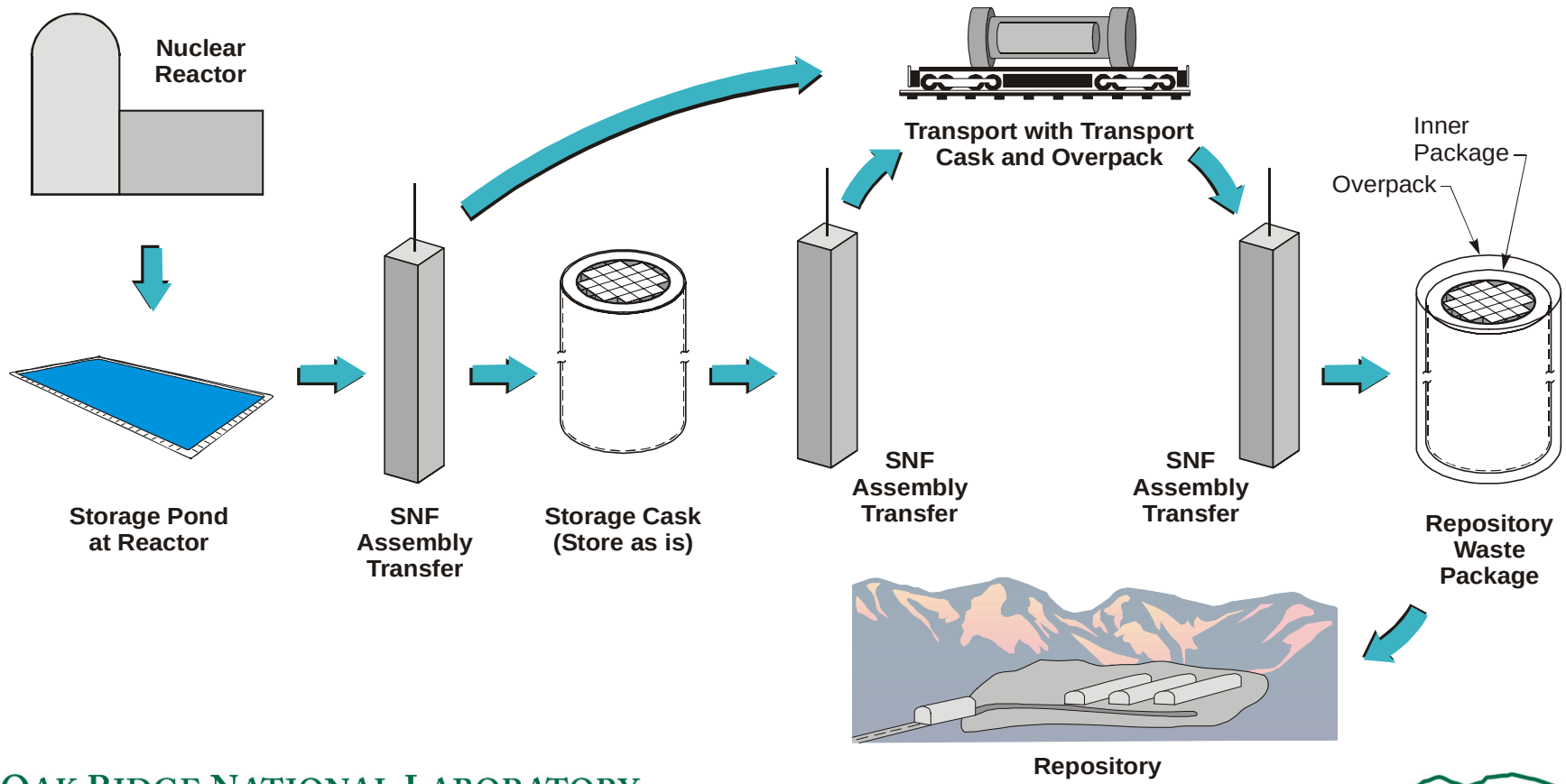
Constraints in the Existing SNF Management System

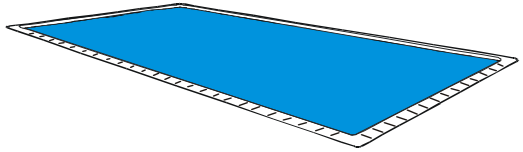
The Existing SNF System Requires Multiple Handing of SNF with Associated Costs and Risks

(Multiple Handling Is Not Done With Other Wastes; Evolved from a System Designed for Reprocessing of SNF)



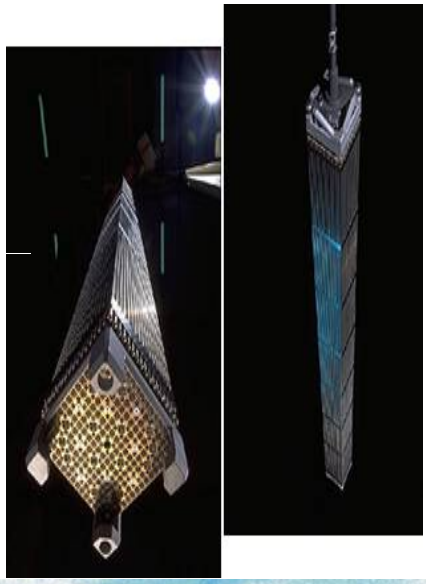
The Existing System Was Not Explicitly Designed to Address Several Other Issues

Economic storage of SNF with high security

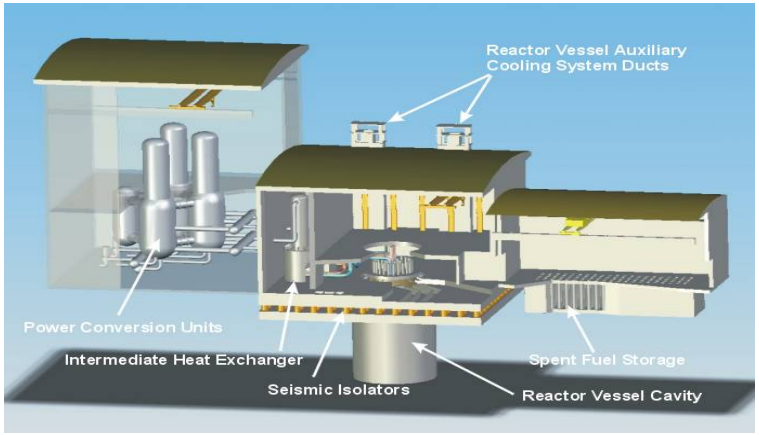


Storage Pond

Disposal of all once-through-cycle wastes: SNF and depleted uranium



Advanced reactor fuel storage



Its Time to Rethink Once-Through Fuel Cycles: System and Cask Design

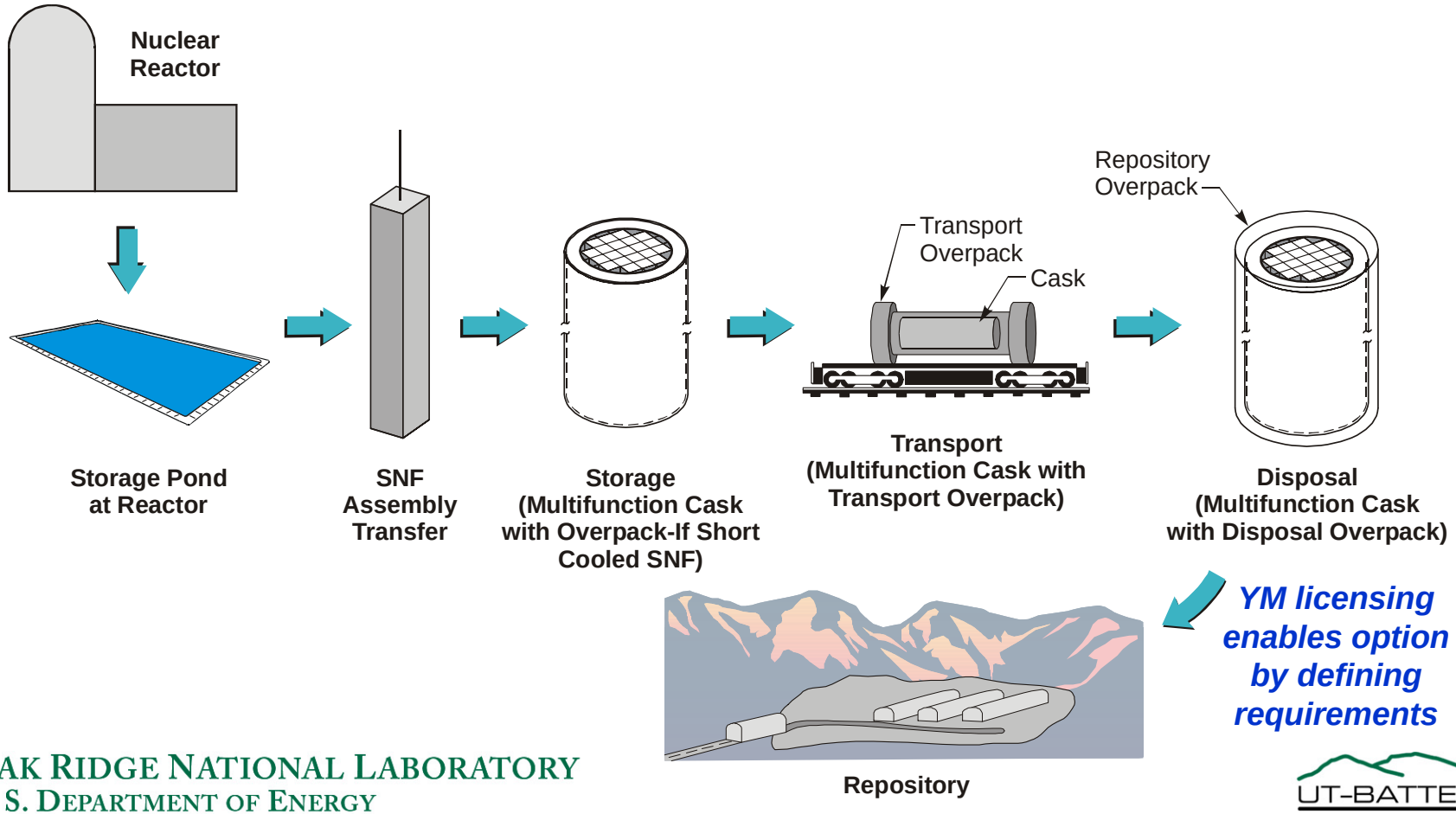
(Coupled System: *Must Consider All Components*)

- **Multipurpose cask: load at reactor, store, transport, and dispose of SNF**
- **Improved cask**
  - **Higher capacity for improved economics**
  - **Assault resistant for better protection and lower security costs**
  - **Higher decay-heat removal for storage of short-cooled SNF**

Multifunction Cask System

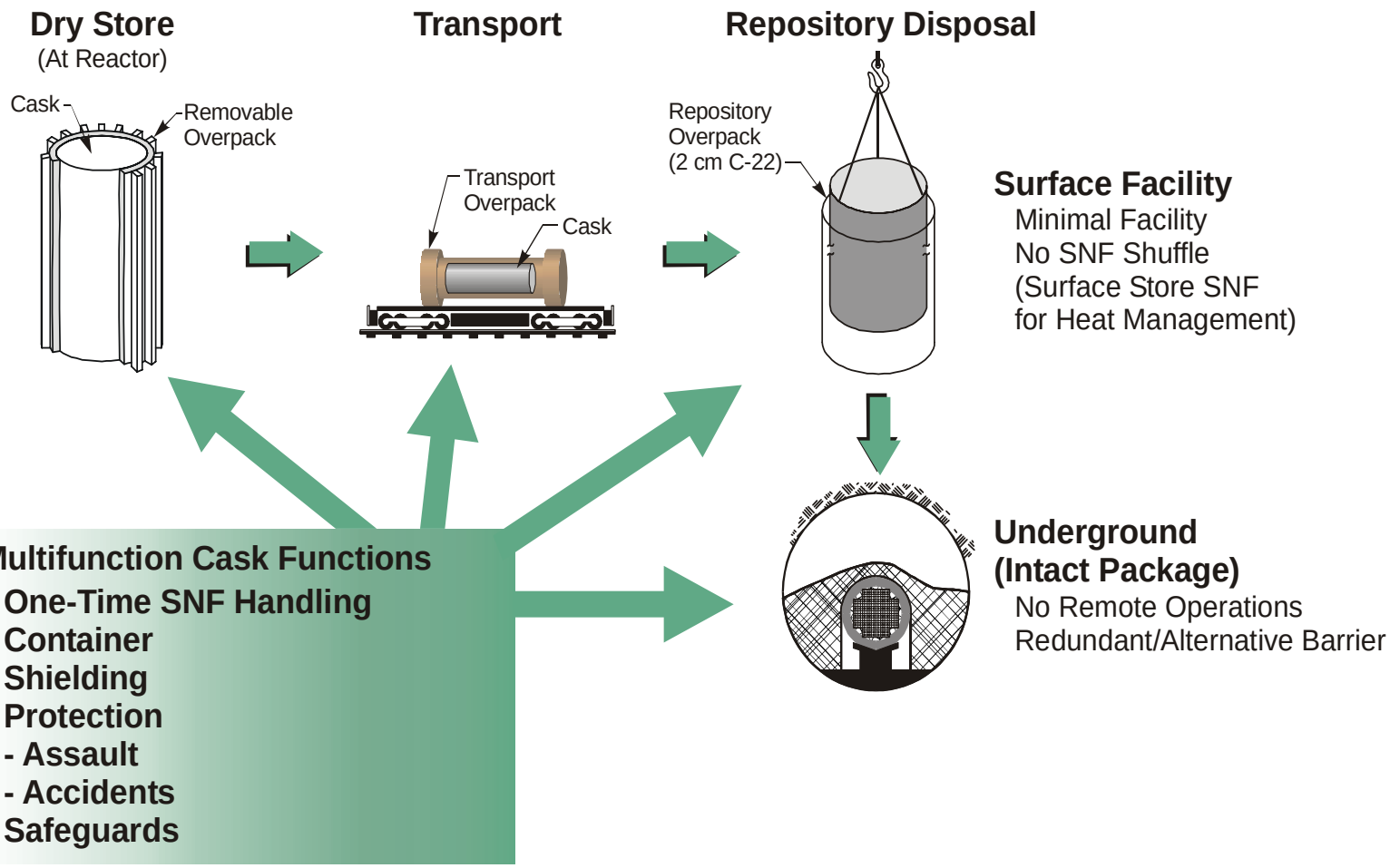
A Multifunction SNF Cask Is Proposed for Storage, Transport, and Disposal

(SNF Handled One Time; All Other Operations Are Contact Handled; Transition Options: Store-Transport, Transport-Store-Dispose and Store-Dispose)



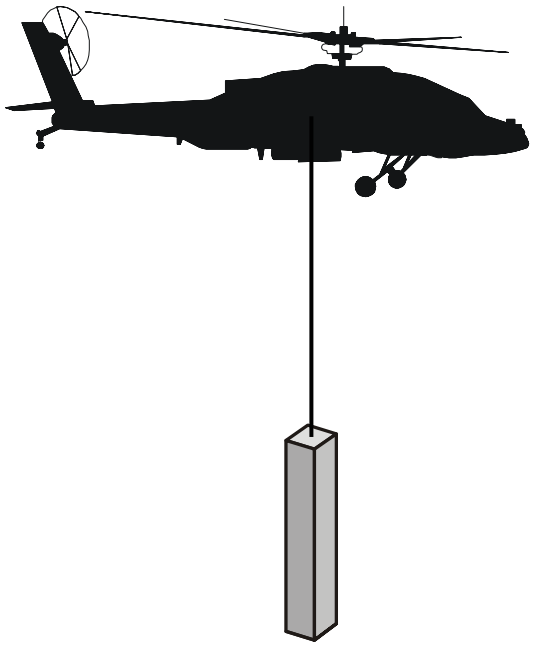
YM licensing enables option by defining requirements

The Cask Has Multiple Functions
(Handling, Shielding, Protection, and Safeguards)



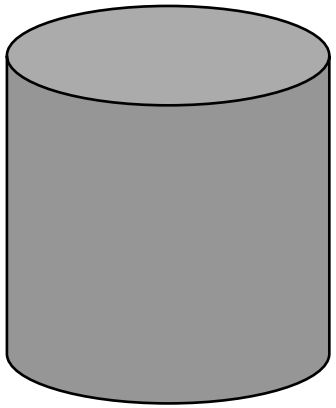
The Characteristics of Multifunction Casks Provide Protection Against Theft or Diversion

Fuel Assembly



Low weight (~1/2 ton), small size

Multipurpose Cask



Large weight (>70 tons), large size, detectable from from orbit, option of transponder

Cermet SNF Cask

Developing a Cask to Match Performance Goals

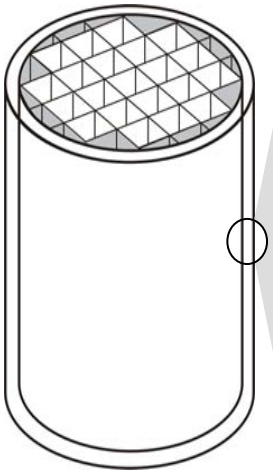
Because of Their Material Properties, Cermet SNF Cask Performance Exceeds That of Other Casks

Cermets Are Used for Demanding Applications

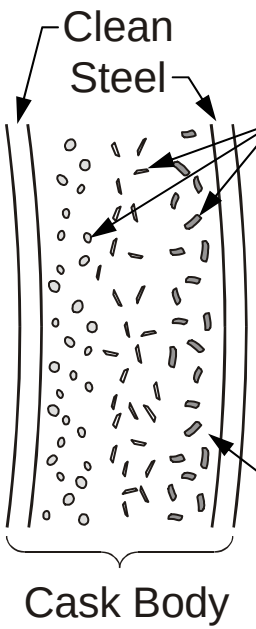
Brake Shoes

Main Battle Tank Armor

Cutting Tools



Cermet Body Cross Section



Ceramics
- Armor (Al_2O_3, SiC)
- Neutron Shielding (DUO_2, Gd_2O_3)
- Gamma Shielding (DUO_2)

Metal Matrix
- Strength
- Thermal Conductivity

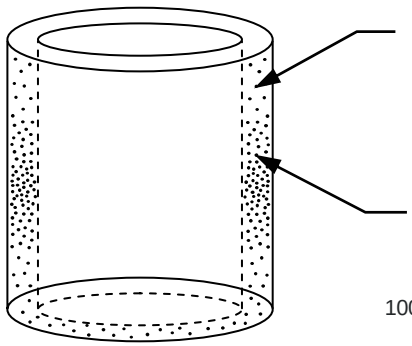
New cermet manufacturing method for low-cost production

Basis for Cermet SNF Cask Performance

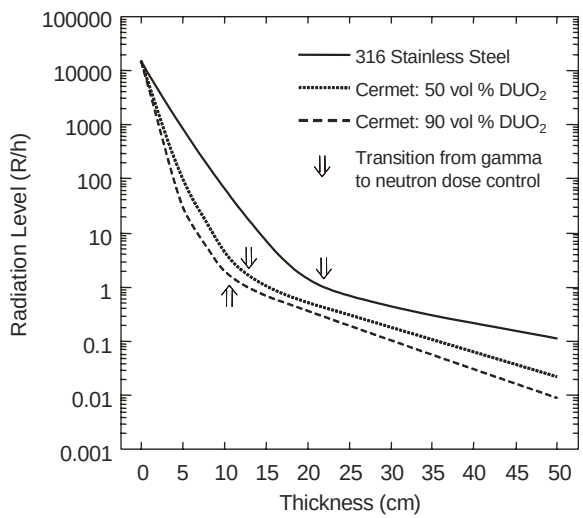
Better Shielding

(Increased capacity for a given cask weight)

Variable-Density Cask Wall

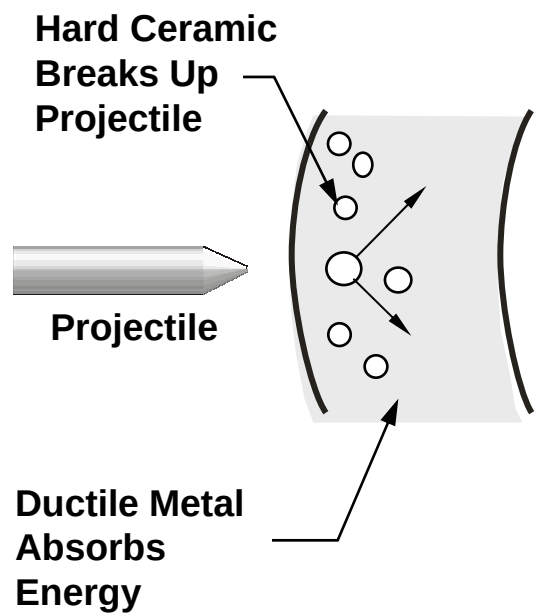


Superior Shielding
DUO_2 Particulates
Steel Matrix



Assault Resistance

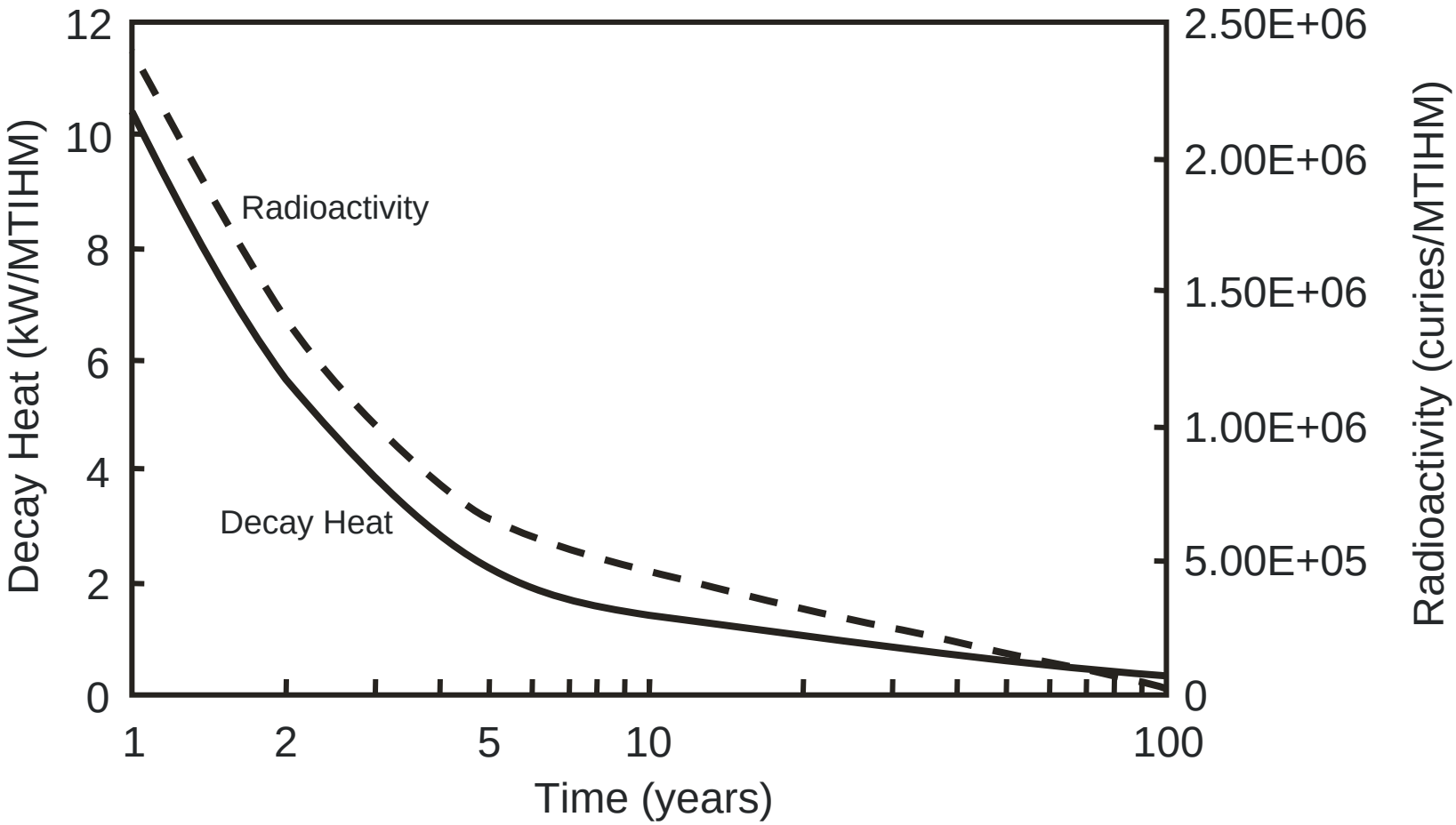
(Traditional cermet application)



Cask Decay Heat Removal

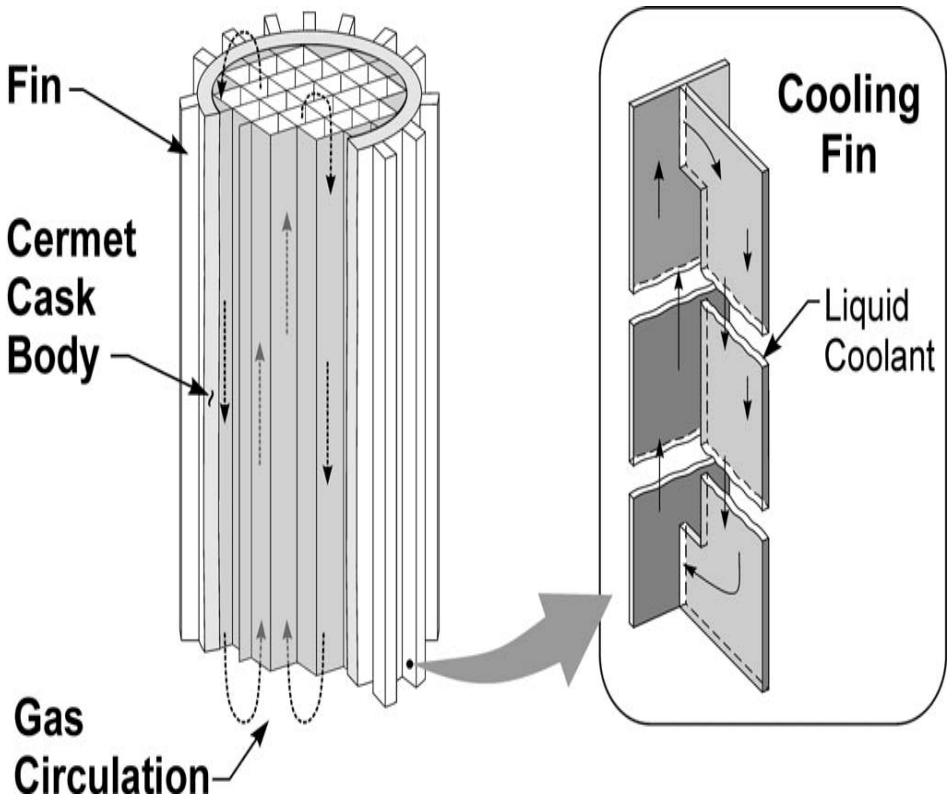
The Other Constraint in Cask Design

Decay Heat Controls the Design of SNF Cask Systems for Large Casks and Short-Cooled SNF



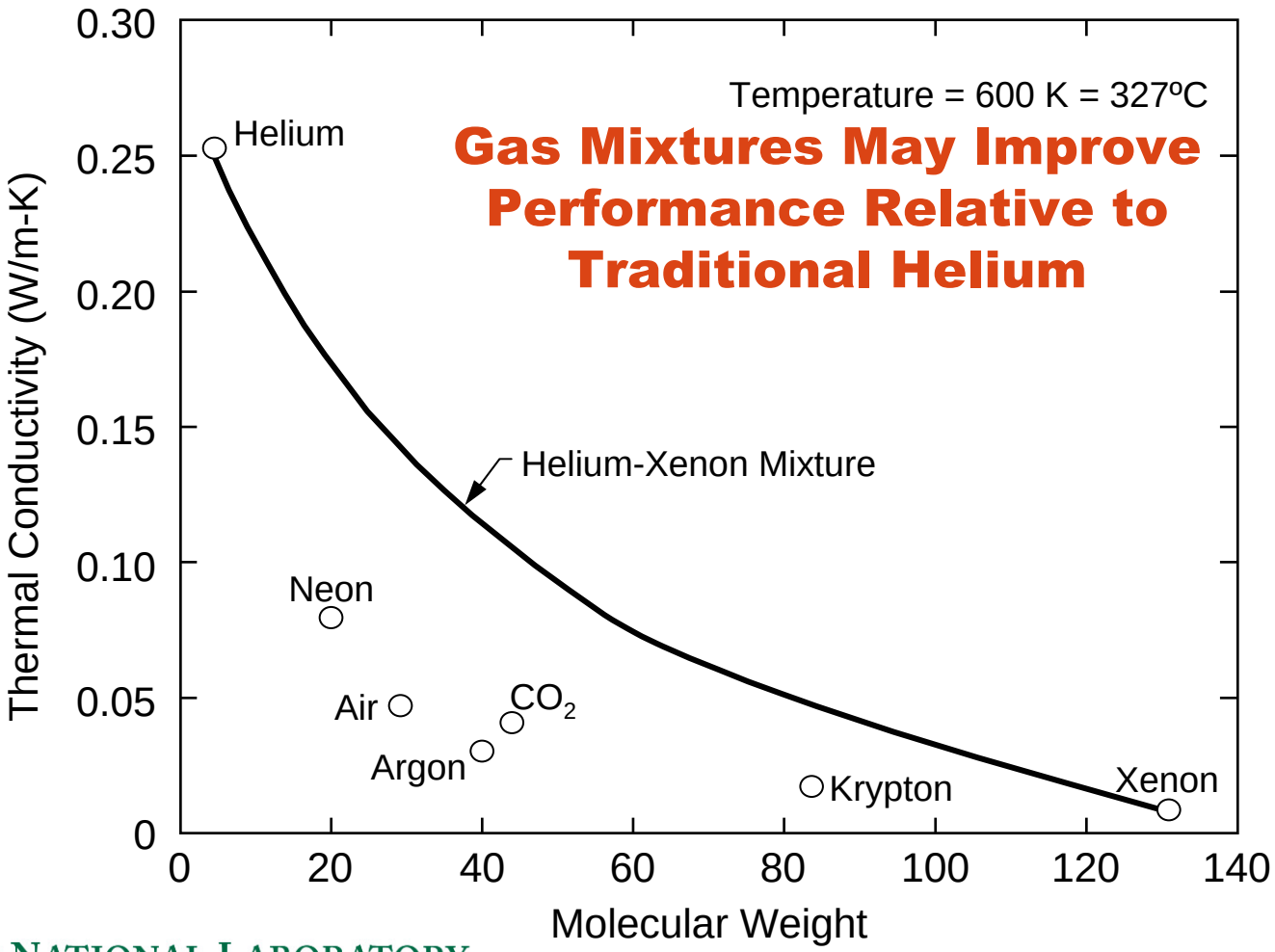
High-Performance Heat Removal Requires Efficient Heat Transport Across Three Barriers

(Improved Heat Transport For Two Barriers)

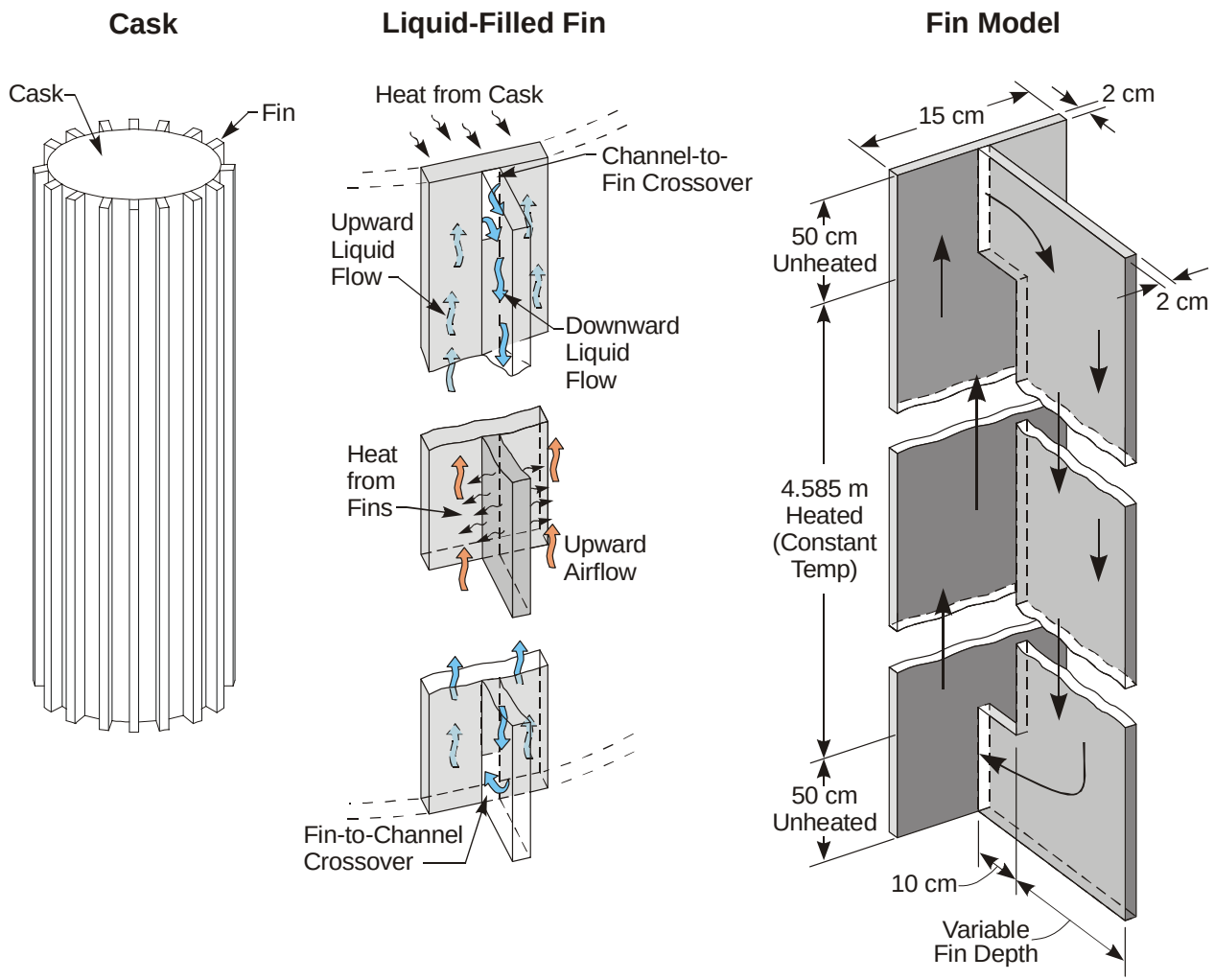


- **Heat transport from SNF to cask wall**
  - **Gas Convection**
- **Conduction through cask wall**
  - **Metal matrix**
- **Heat transport from cask wall to air**
  - **Liquid cooling**
  - **High surface area**

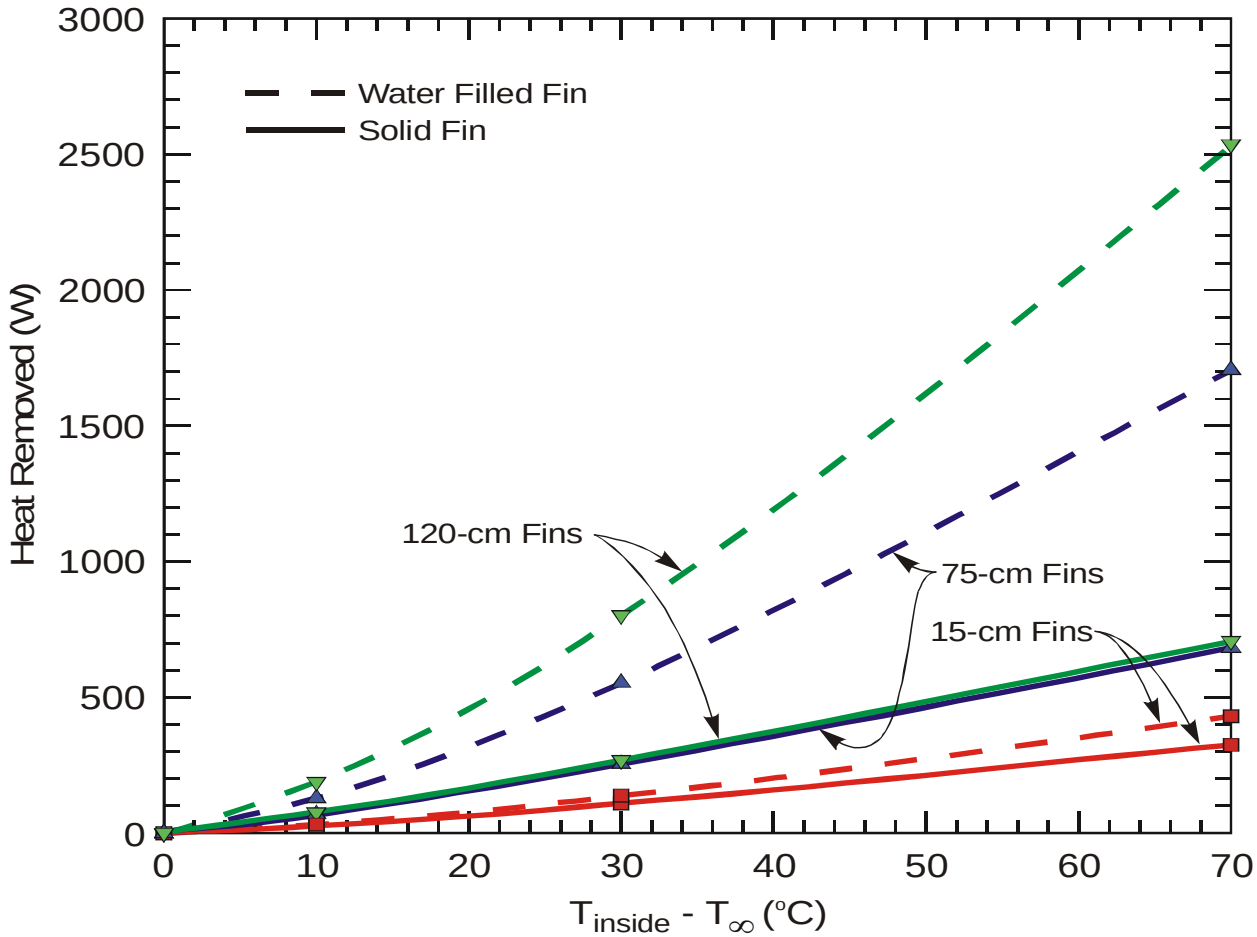
Convective Heat Transport Is Maximized With a High Thermal Conductivity for Heat Transfer (e.g. He) and a High Density for Convection (e.g. Xe) Gas



Decay Heat Removal Can Be Increased By Using Fins With Natural Circulation of Liquids

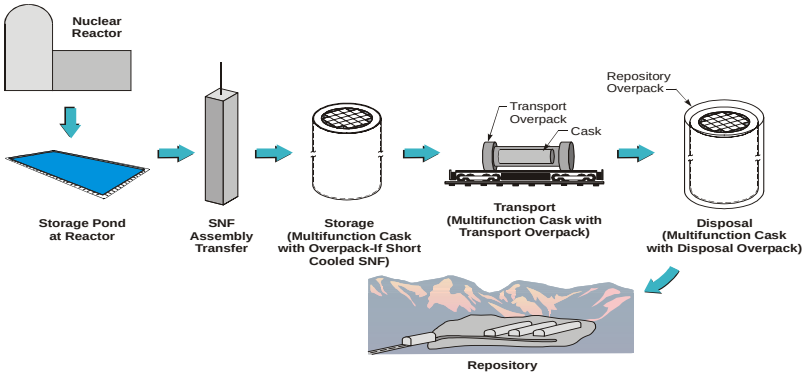


Heat Rejection From Solid and Water-Filled Fins Versus Temperature and Fin Depth



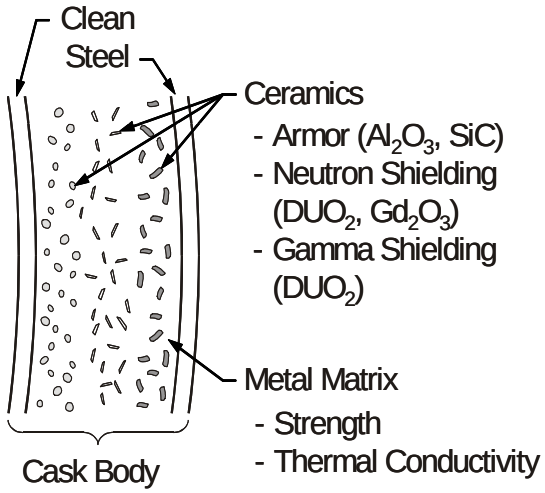
Conclusions: Changing Conditions Require Rethinking SNF Management

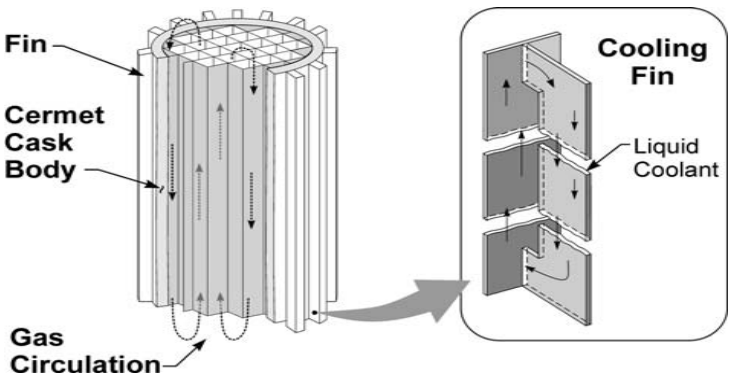
New Technologies May Reduce Cost and Risk



←Multifunction Casks

Cermet Cask Bodies→

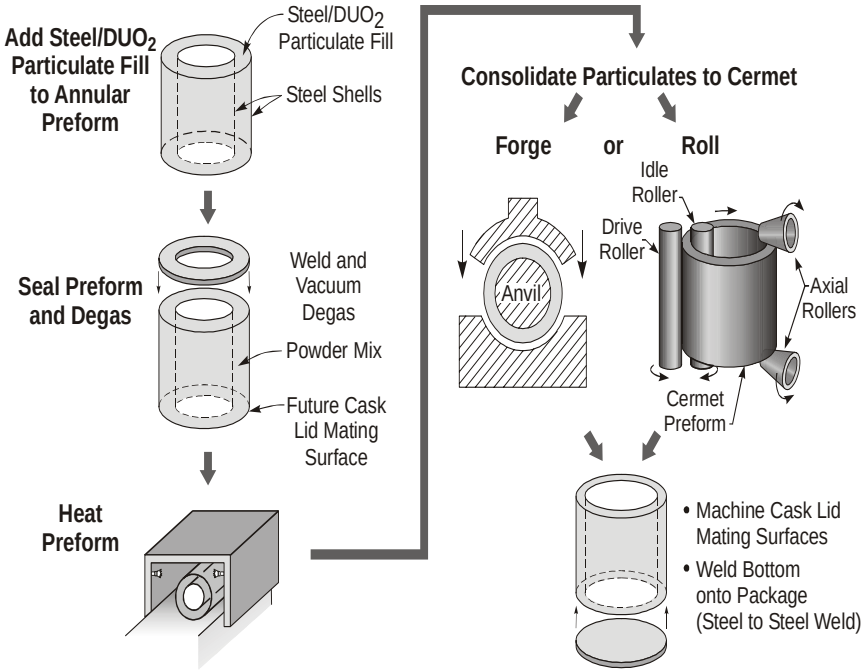




←Advanced Cask Cooling

Backup Slides

The Key Issue Is Cost: New Method May Make Cermet Casks Economically Viable



- Unique capabilities
  - Variable ceramic fraction anywhere in cask
  - Variable ceramic composition anywhere in cask
  - Near final-form cermet
    - Cermets are difficult to weld
    - Cermets are difficult to machine
- Manufacturing studies under way
- Patents pending
- CRADA with Holtec
  - Holtec makes one-half of all casks in the United States
  - U.S. vendor

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