Three Mile Island Unit 2 Key Decisions and Important Events for Removing the Damaged Fuel

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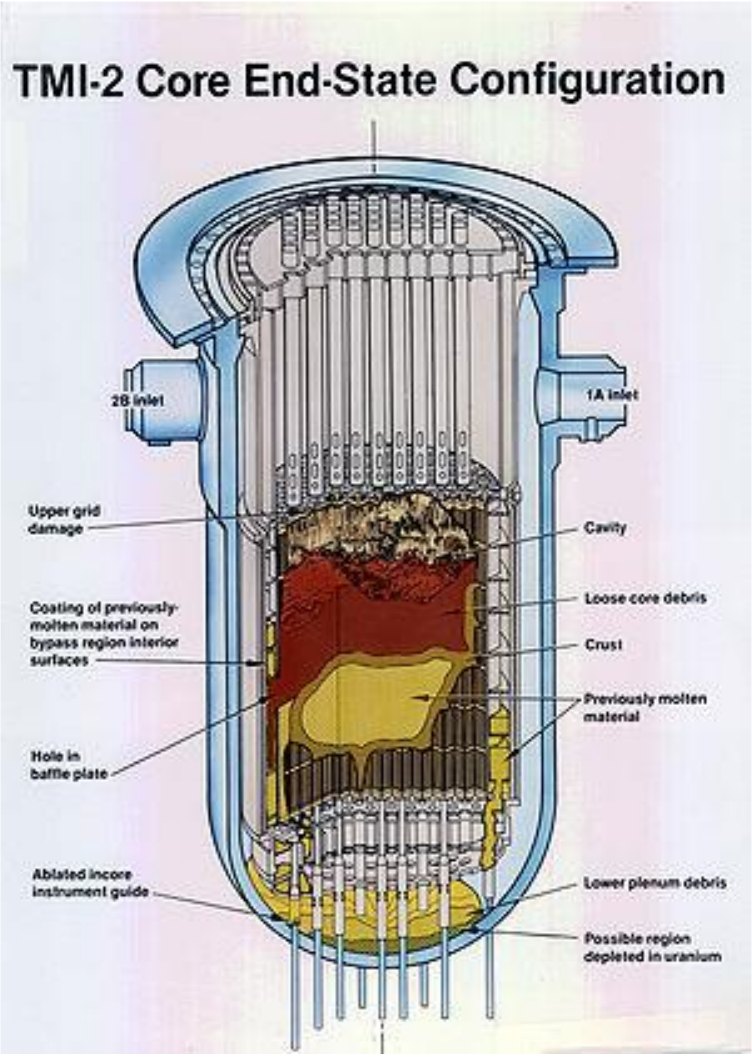
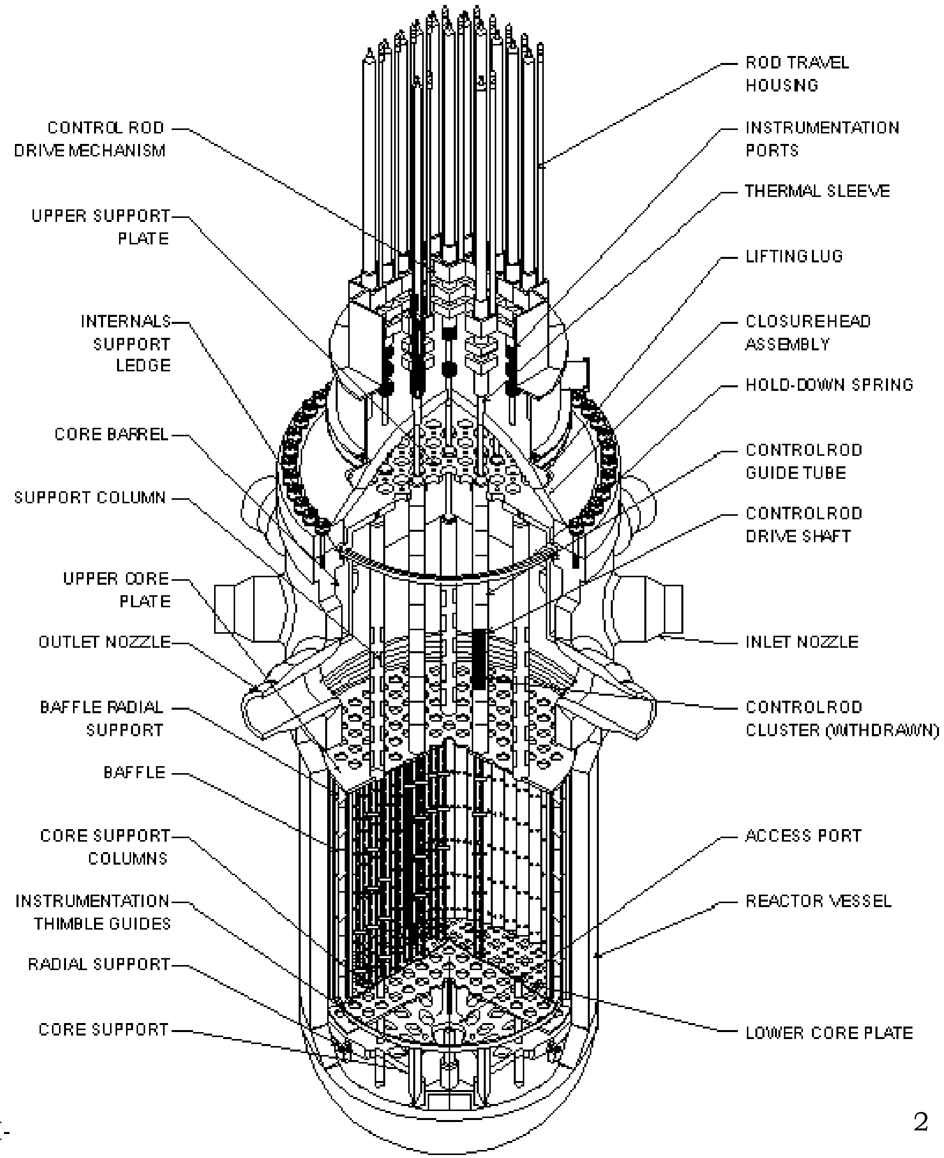
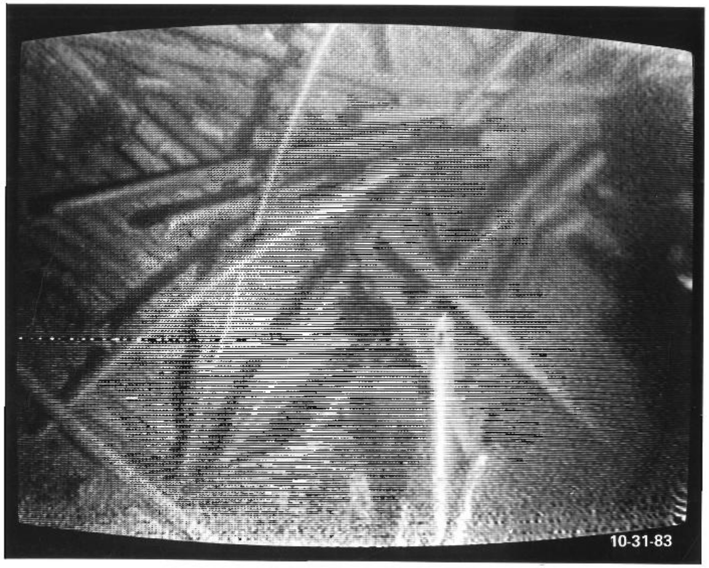
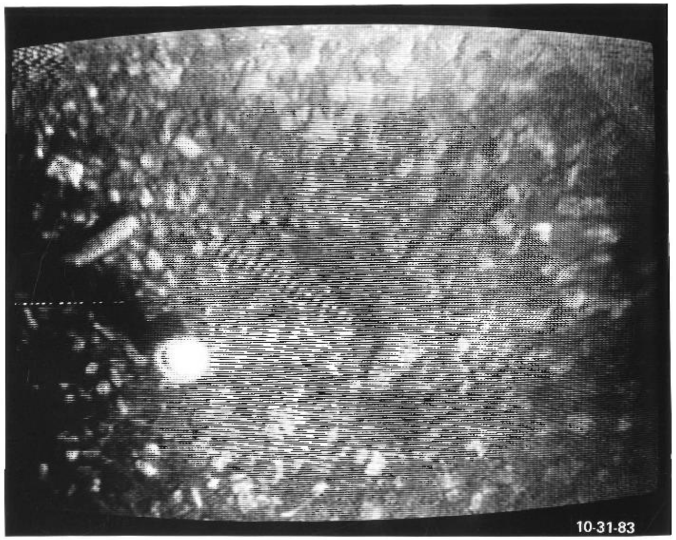
Damaged Fuel and Debris





Damage Examples

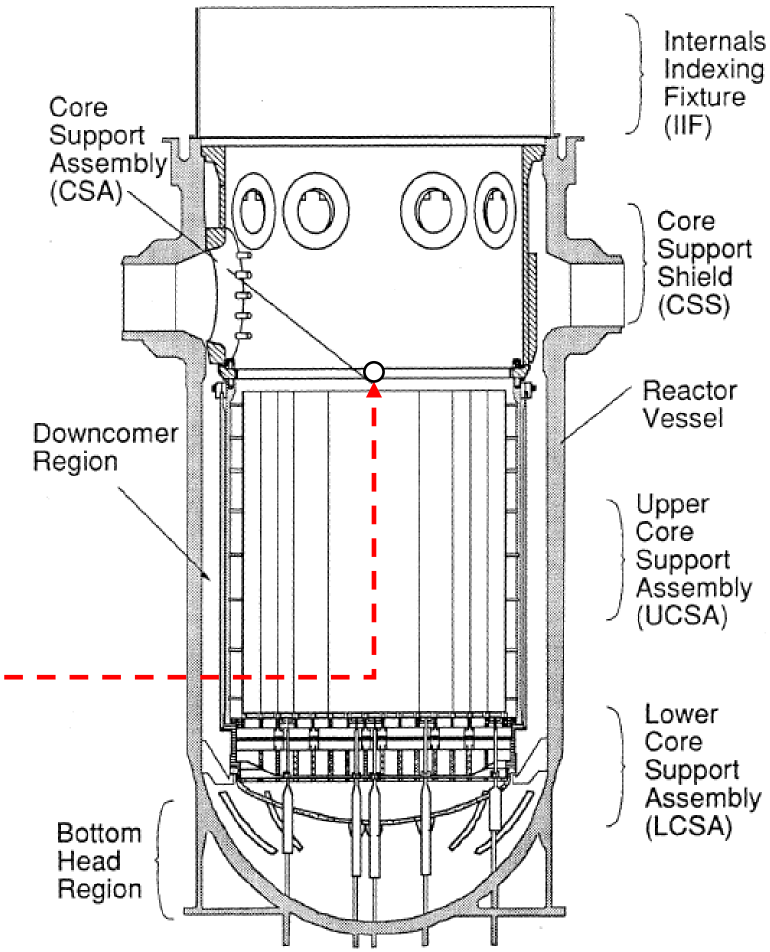




Various Areas for Defueling

- Core Cavity
- Lower Support Grid
- Flow Distributor
- Behind and within the Core Baffle Plates
- Lower Head
- Elsewhere in the Reactor Systems

Bottom of the Upper Core Support Assembly



Reactor Pressure Vessel Cutaway View

Defueling Progress and Key Impacts

1982-1983
Defueling Options Evaluations

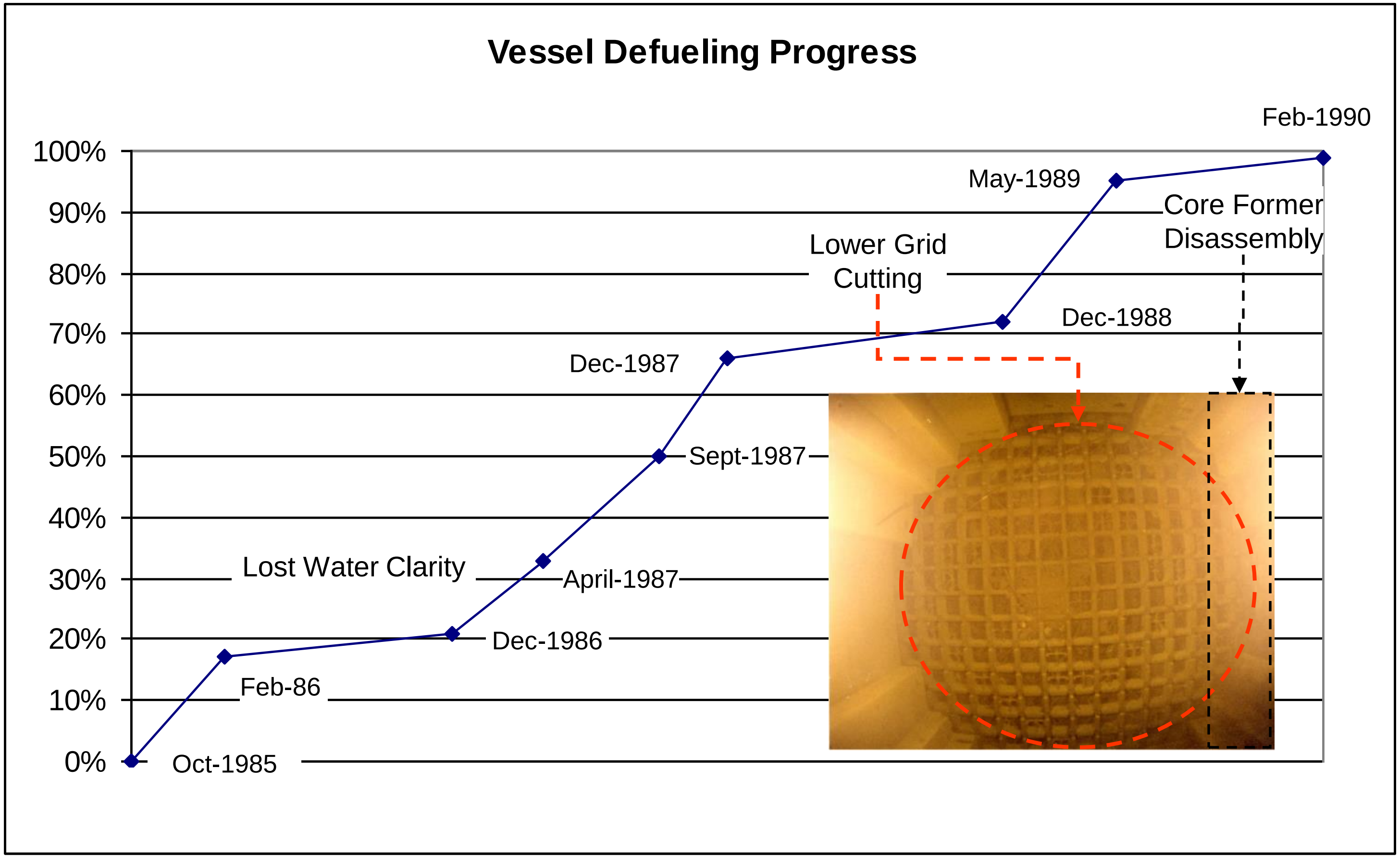
1982
First Video of Core

1983
First Sample

1983
Sonar Mapping & Improved Video

1984
Defueling Method Decision
Dry Canal & Mostly Manual

Mid-1984
Vessel Head Lift



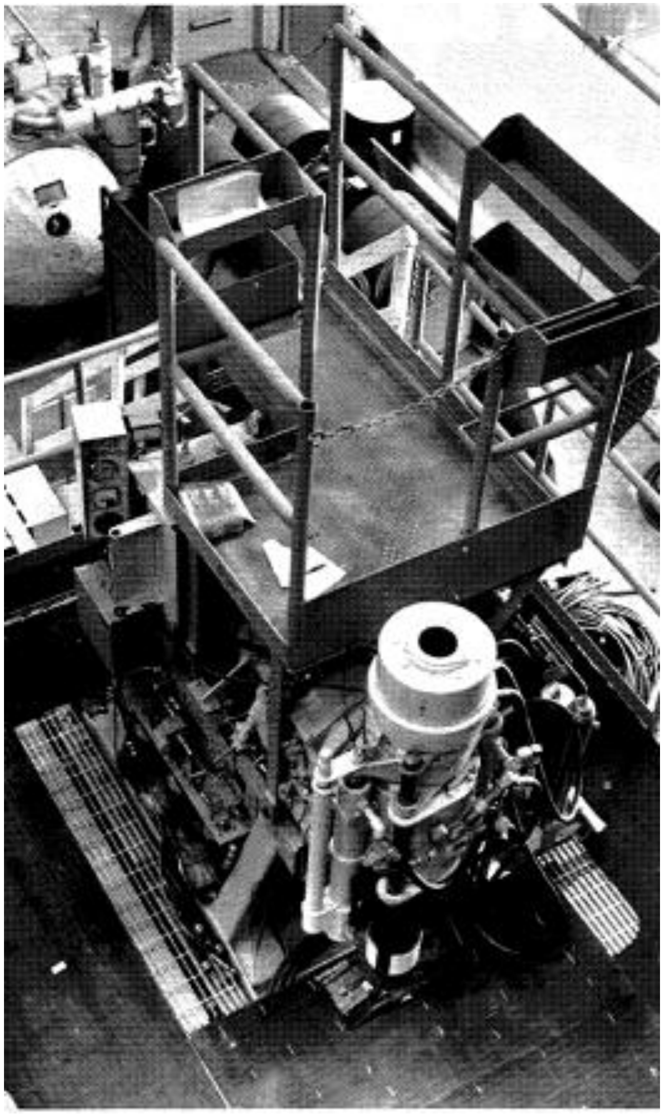
Removal Methods

- Five concepts for fuel removal *before visual characterization*; none were used:
  - Dual Telescoping Tube, Manipulator
  - Manual Defueling Cylinder
  - Indirect Defueling Cylinder
  - Flexible Membrane
  - Dry
- Later, a remotely operated service arm, shredder, and vacuum transfer system was considered and rejected
- Final method chosen was an adapted mining drill (the core bore) and manual methods

Core Boring Machine

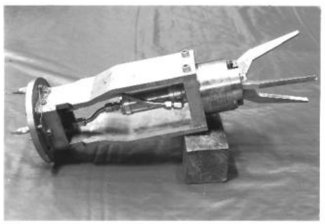
- Adapted from commercial mining drilling equipment
- One of the most important machines for the project
- First use with hollow core bits: 10 samples 1.8 m long x 6.4 cm diameter (figure below)
- Second use with solid face bits to chew through the hard once-molten mass in the core region
- Third use was assisting lower grid and instrument tubes by grinding metal (next viewgraph)

Tungsten Carbide Teeth with Synthetic Diamond



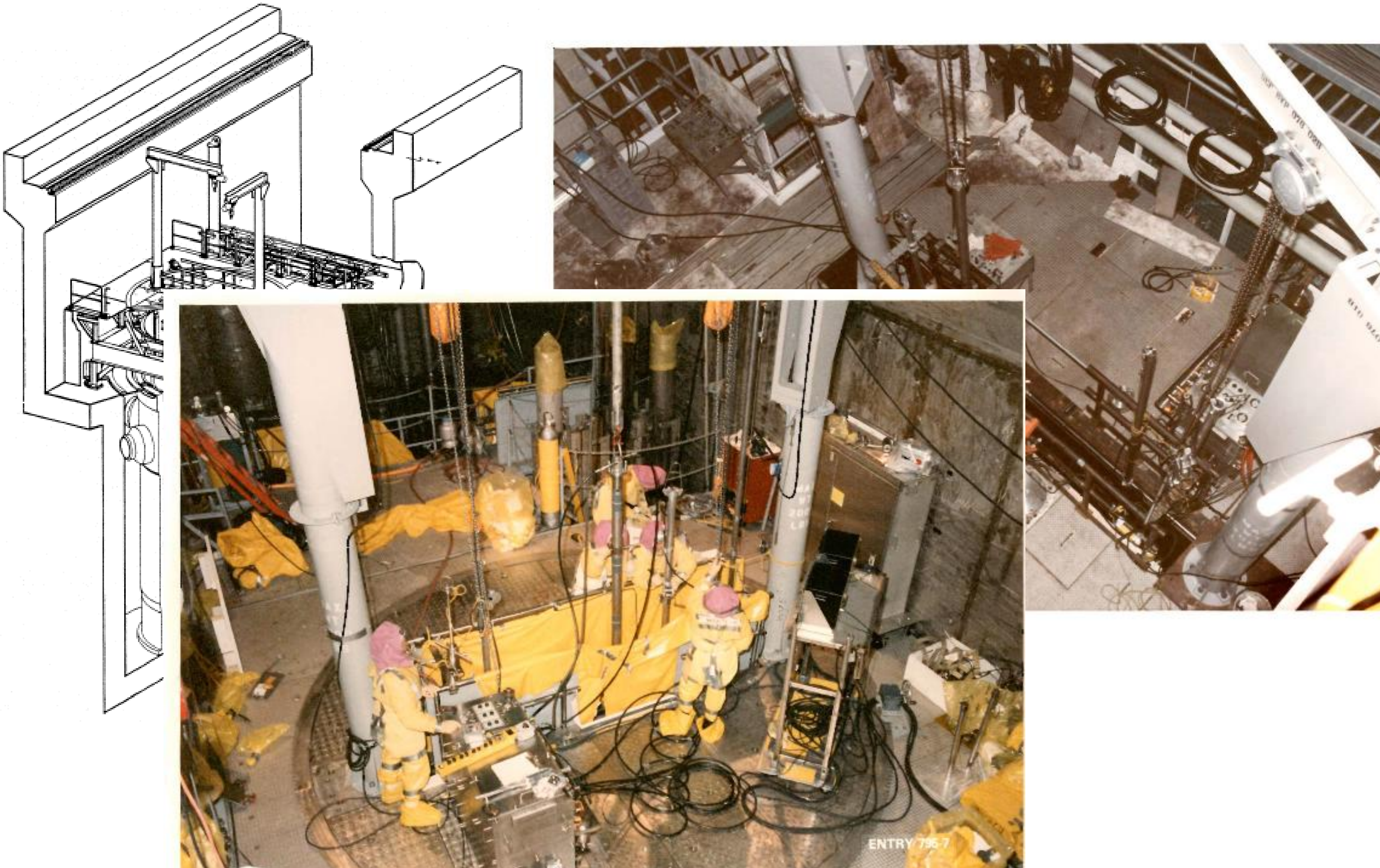
Fuel Removal Tools and Equipment

- Some Manual Tools

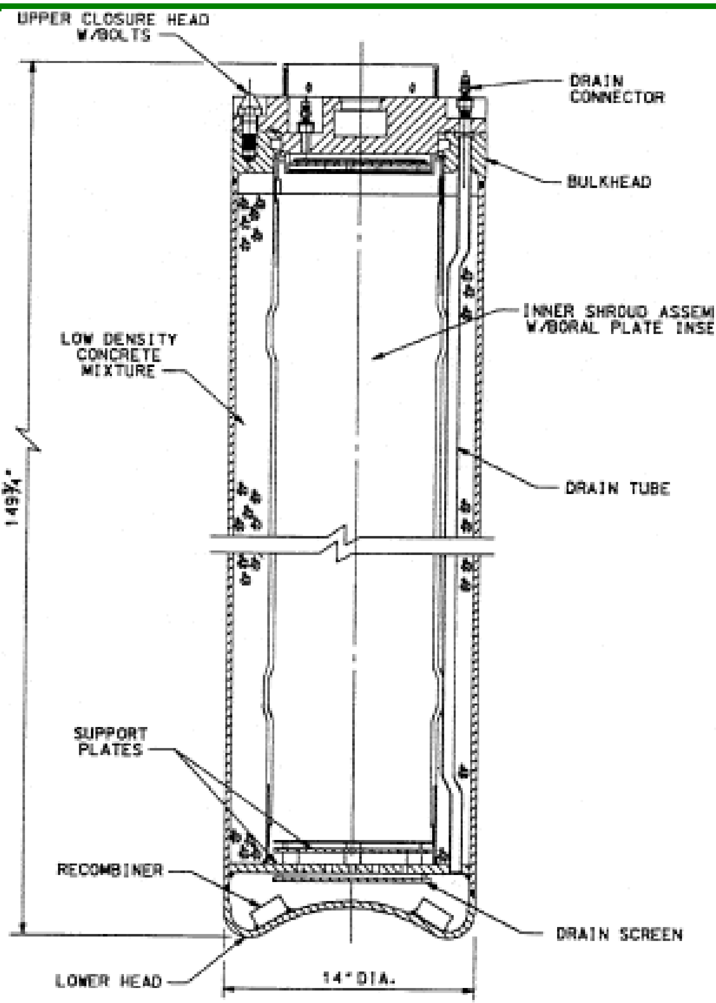


- Powered Equipment
  - Core Boring Machine
  - Plasma Arc
  - Power Assisted shears
  - Bulk Removal
  - Water Vacuum and Air Lift
- Manual Controlled Equipment
  - Grippers
  - Buckets

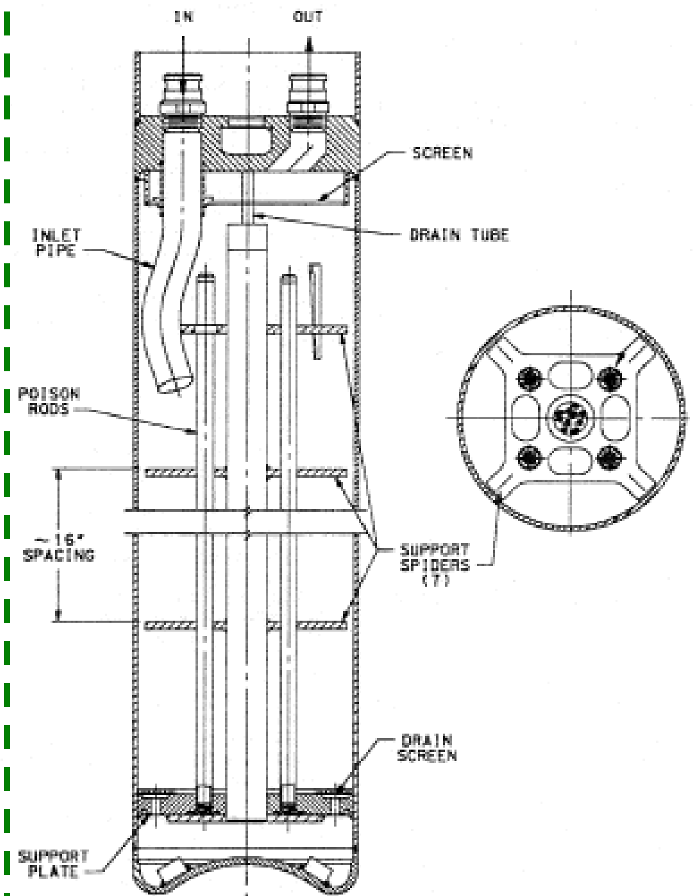
Work Platform



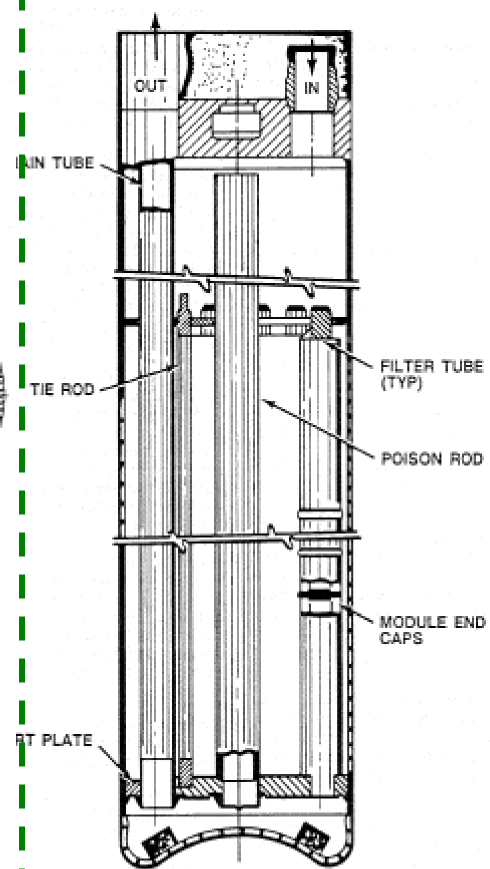
Three Canister Design – 341 Shipped



271 Fuel & Debris Canisters

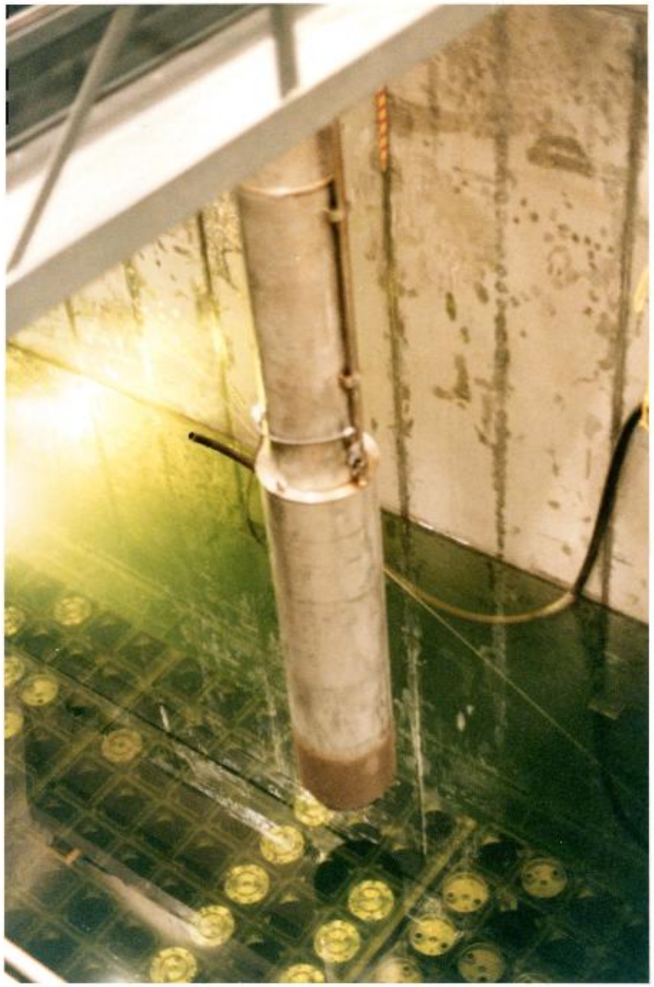


10 Knockout Canisters
(for vacuum tools)



60 Filter Canisters
(water processing)

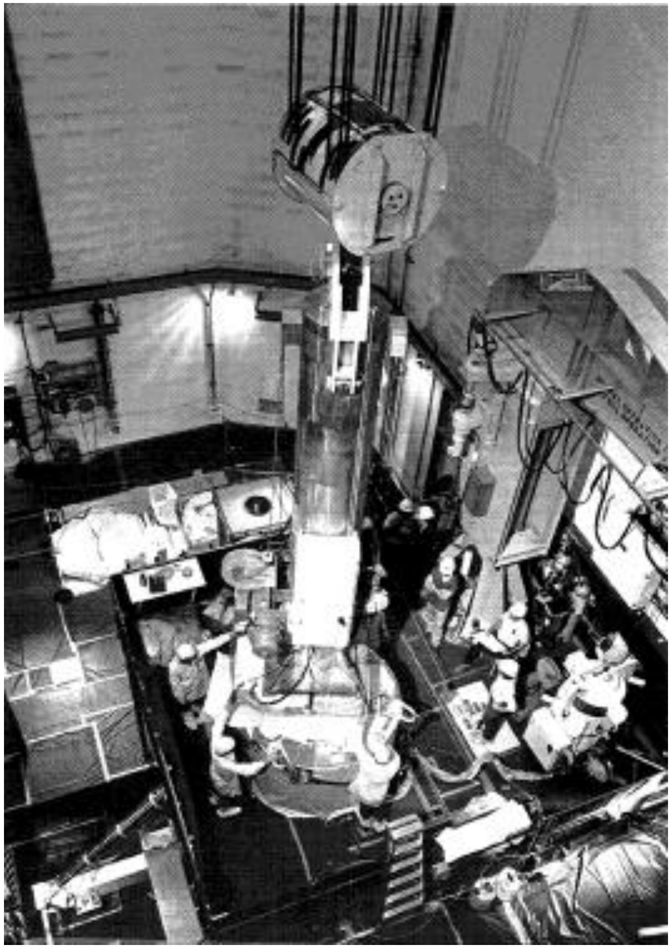
Packaging & Transport



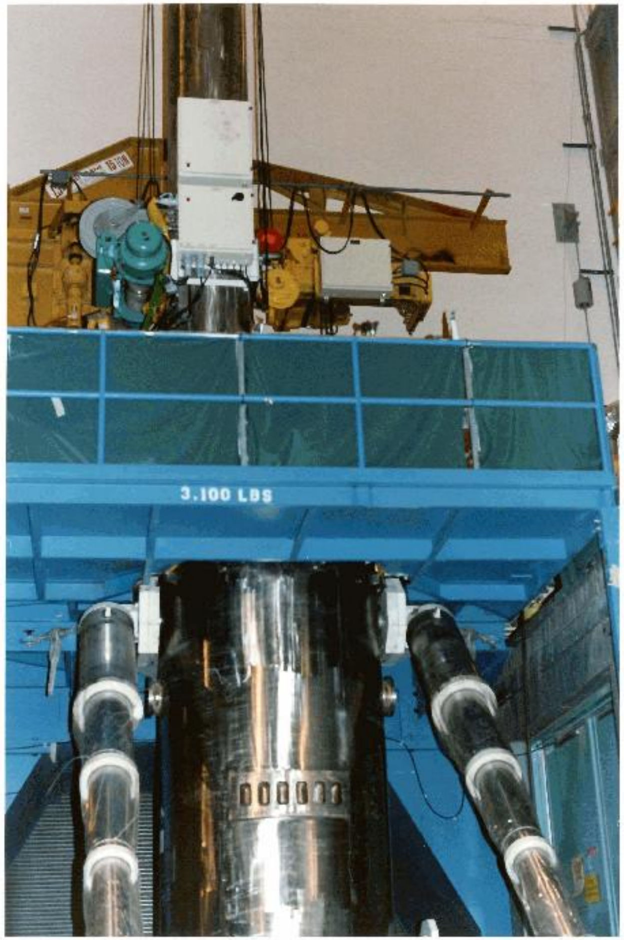
Canister Staging in Spent Fuel Pool

Transfer Cask Operations

Staging & Shipping

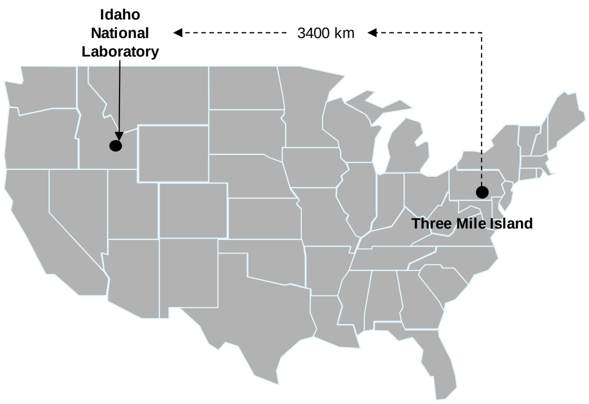


Loading the Shipping Cask



Shipping Cask

Packaging, Transport, & Storage at Idaho



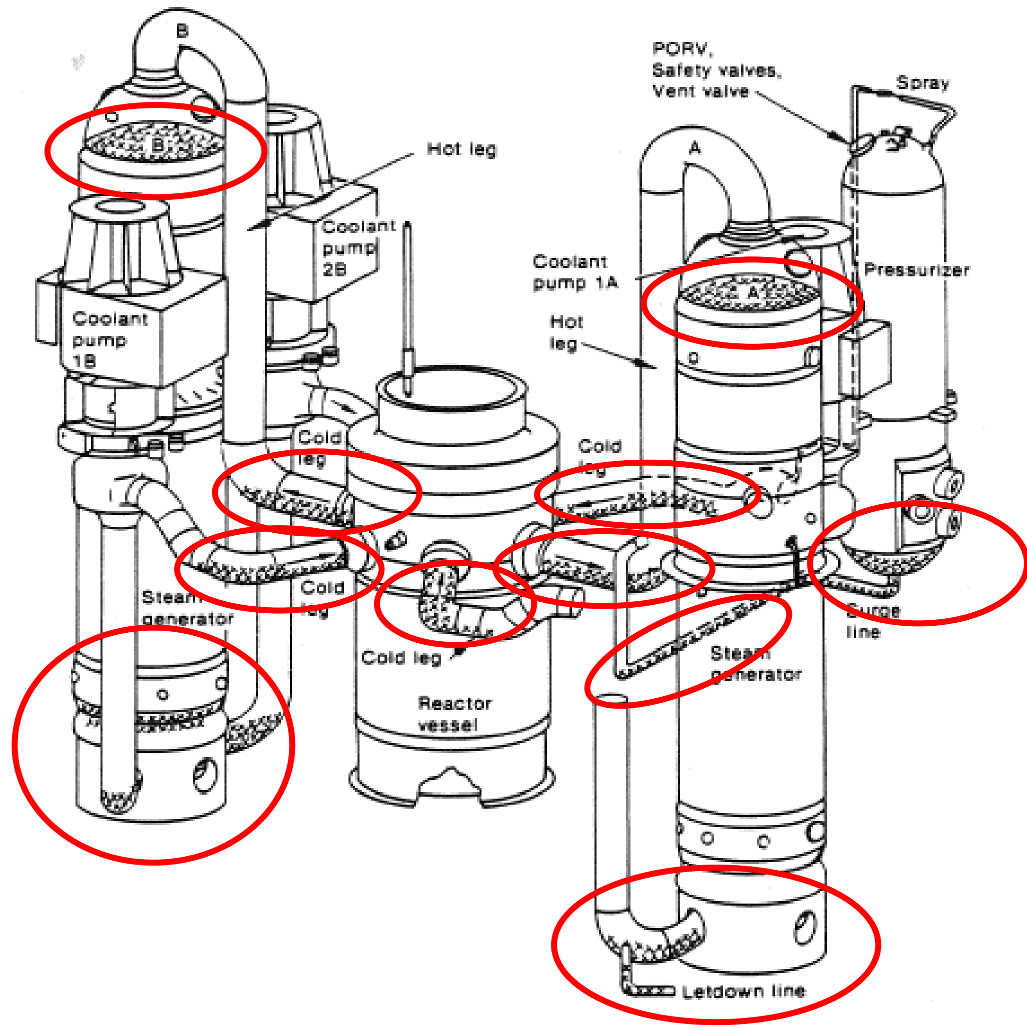
1986 to 1990
341 canisters of fuel & debris in 46 shipments by rail cask to the Idaho National Laboratory

1990 to 2000
Wet Storage in Spent Fuel Storage Pool

2000 – 2001
Removed from pool, dewatered, dried, and placed in dry storage

Possible Remaining Fuel Particulate

- Residual Fuel*
  - RPV: < 900 kg
  - In the Reactor Coolant System: < 133 kg
  - Criticality ruled out by analysis
- Assessment Required a Combination of*
  - Video inspection for locations
  - Gamma dose rate and spectroscopy
  - Passive neutron solid state track recorders, activation, BF3 detectors
  - Active neutron interrogation
  - Alpha Detectors
  - Sample Analysis



Events/Decisions(1)

Events/Decisions	Significance
Decisions for removal required visual characterization	First idea of what conditions really were; complete assessment took another year; could not proceed to plan defueling without this knowledge
Decision to not to install in-core shredding equipment in the vessel	• New application for the proposed technology, concern that failure would cause problems, relied mostly on manual manipulation with power assist • Allowed defueling to start earlier, knowing that overall schedule would not be minimized. This was preferred over a 3 year development for a remote system/equipment
Decision to leave refueling canal dry	• Less depth for manually operated tools • Shielded work platform 2m above the reactor pressure vessel flange • Reduced need for water processing • Dose rates were low within the refueling canal
Use of Core Boring Machine was essential	• Samples of the fuel and debris that was melted together • Breaking up the crust and molten mass when manual methods were unsuccessful

Events/Decisions(2)

Events/Decisions	Significance
Unanticipated biological growth in water fouled filters	Caused a year delay; managing water clarity is extremely important
DOE to take Fuel & Debris New cask design and license Ship Fuel to Idaho by Rail and not Truck	• Handling and shipping design and fabrication could not take place until destination was determined • Allowed fuel & debris canisters to be removed from TM • New cask could be designed for the TMI canisters • Fewer shipments
Transfer to Dry Storage	Long term storage stability, also allowed demolition of fuel pool at Idaho