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

Vessel Defueling Progress

Lost Water Clarity

Lower Grid Cutting

Core Former Disassembly

Oct-85
Apr-86
Nov-86
May-87
Dec-87
Jun-88
Jan-89
Aug-89

Feb-86
Dec-1986
April-1987
Sept-1987
Dec-1987
May-1989
Feb-1990

TMI-2 Overview 5
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
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)

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<thead>
<tr>
<th>Events/Decisions</th>
<th>Significance</th>
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<tr>
<td>Decisions for removal required visual characterization</td>
<td>First idea of what conditions really were; complete assessment took another year; could not proceed to plan defueling without this knowledge</td>
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<td>Decision to not to install in-core shredding equipment in the vessel</td>
<td>• New application for the proposed technology, concern that failure would cause problems, relied mostly on manual manipulation with power assist&lt;br&gt;• 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</td>
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<td>Decision to leave refueling canal dry</td>
<td>• Less depth for manually operated tools&lt;br&gt;• Shielded work platform 2m above the reactor pressure vessel flange&lt;br&gt;• Reduced need for water processing&lt;br&gt;• Dose rates were low within the refueling canal</td>
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<td>Use of Core Boring Machine was essential</td>
<td>• Samples of the fuel and debris that was melted together&lt;br&gt;• Breaking up the crust and molten mass when manual methods were unsuccessful</td>
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# Events/Decisions (2)

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<td>Unanticipated biological growth in water fouled filters</td>
<td>Caused a year delay; managing water clarity is extremely important</td>
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| 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    |