Industry Status
Drivers of Early Shutdown Decisions

Declining Wholesale Electricity Prices

- WEST (ZONE A)
- HUD VL (ZONE G)
- Mass Hub
- PJM East HUB
- PJM WEST HUB
- CHICAGO HUB
- CENERGY-INDIANA ZONE

Price Range:
- $45-75/MWh
- $30-50/MWh
- $30-42/MWh

Forward Prices

ISFSI Status in the United States

- **Used fuel inventory**
  - Approximately 80,960 MTU
  - Increases 2 - 2.4k MTU annually

- **ISFSI storage**
  - 117,579 assemblies
  - 33,515 MTU (39%)
  - 2,698 casks/modules loaded
  - 72 Operating ISFSIs
    - 1 pool ISFSI, 1 modular vault

- **Projections for 2020**
  - Estimating 86,000 MTU total
  - Estimating 35,000 MTU at ISFSI
  - 3,200 casks/modules loaded
  - At 76 ISFSIs
    - Almost all plant sites + Morris & INEL
  - Fuel from 119 reactors

*As of December 31, 2017
Transportation of Spent Fuel - So What?

• Total Value Proposition

• “Back End” Actions Impactful

• Success Depends on Efficient Management
NEI National Nuclear Energy Strategy

NATIONAL NUCLEAR ENERGY STRATEGY

PRESERVE
Appropriately value nuclear generation

SUSTAIN
Create sustainability via improved regulatory framework and reduced burden

INNOVATE
Innovate, commercialize, and deploy new nuclear

THRIVE
Compete globally
NATIONAL IMPERATIVES

- JOBS & INFRASTRUCTURE
- U.S. GLOBAL INFLUENCE & NATIONAL SECURITY
- REGULATORY EFFICIENCY
- INNOVATION & TECHNOLOGY LEADERSHIP
- AIR QUALITY & SUSTAINABLE DEVELOPMENT
- CLIMATE CHANGE
- CLEAN ELECTRIC POWER DEMAND
The Industry Approach

Used Fuel Working Group

- Dry Cask Vendor Task Force
- Dry Cask Storage Task Force
- Used Fuel Transportation Task Force
The Industry Approach

• Used Fuel Transportation Task Force Vision-

“Prepare industry to transport used nuclear fuel from ISFSI locations to interim and/or permanent storage facilities by 2022.”
The Industry Approach

Used Fuel Transportation

Task Force

- External Affairs
- Pre-Shipment Planning/Incident Management
- Technical/Regulatory
- DOE Interface
Are We Ready to Roll?

Re-invent the Wheel?

Or Check the Tire Pressure?
Transportation Experience
The Transportation Story

• The 70+ year history of nuclear materials and used fuel transportation demonstrates a commendable safety record
  – No harmful radiation release
  – Proven regulatory requirements and industry processes
  – Safe shipment from ISFSIs to a centralized location is strongly supported by experience.
The Transportation Story

• The U.S. Navy has completed around 850 shipments totaling over 1.6 million miles of transport
• Since the mid-1970’s there have been over 1,300 safe shipments of commercial used fuel in the United States
• Since 1990, more than 60 shipments including more than 250 transportation casks of foreign research reactor fuel and been shipped to and within the United States by sea, land and air
• Internationally, over 70,000 metric tons of used fuel have been transported by road, rail and sea
Opportunities for Near Term Transportation
Shutdown Sites with Used Fuel

Shutdown Sites Without An Operating Reactor

- **California**
  - Humboldt Bay
  - Rancho Seco
  - San Onofre

- **Colorado**
  - Ft. St. Vrain

- **Connecticut**
  - Connecticut Yankee

- **Florida**
  - Crystal River

- **Illinois**
  - Zion

- **Maine**
  - Maine Yankee

- **Massachusetts**
  - Yankee Rowe

- **Michigan**
  - Big Rock Point

- **Nebraska**
  - Ft Calhoun

- **Oregon**
  - Trojan

- **Vermont**
  - Vermont Yankee

- **Wisconsin**
  - LaCrosse
  - Kewaunee
## Premature Nuclear Plant Closures

<table>
<thead>
<tr>
<th>Plant</th>
<th>MWe</th>
<th>Closure Year</th>
<th>Reason</th>
<th>Generation in Final Year (billion kWh per year)</th>
<th>CO2 Emissions Avoided in Final Year (M tons/year)</th>
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<td>Crystal River 3</td>
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<td>Mechanical</td>
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<td>San Onofre 2 &amp; 3</td>
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<td><strong>TOTAL</strong></td>
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<td>Indian Point 2 &amp; 3</td>
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<td><strong>89.7</strong></td>
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Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the Environmental Protection Agency and latest plant generation data from the Energy Information Administration. Updated: March 2018.
Implementation

Utility

Transport

Waste Control Specialists

Eddy-Lea Energy Alliance
Regulatory Considerations

- Storage regulations (Part 72) assure safety in initial storage
- Transport regulations (Part 71) assure safety during transport
- Sandia full scale testing shows accelerations and forces are very low and transport conditions are benign
- Under normal, significant event-free transport, fuel and canister remain safe to return to storage
“72-71-72” Optimization

- Aged storage canisters transport to and storage at CISF

- Inspection guidance and assessment methodology for aging management including:
  - MAPS Report (Managing Aging Processes in Storage NUREG 2214)
  - NEI 14-03 (Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management)
  - NUREG 1927 rev. 1 (Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel)
  - Aging Management INPO Database

- Combined efforts of NEI, NRC, DOT, DOE suppliers and industry at-large
Thermal Margin
Transformational Opportunity

- Estimated Peak Cladding Temperatures artificially high
- Temperatures far below design limit - cladding degradation is unlikely
- Significant benefits to be realized from improved modeling
Benefits of Improved Thermal Models

• Improve Operational Flexibility
• Support Risk Informing Dry Storage and Aging Management
• Facilitate Transportation and Ultimate Disposal
Industry Activities

• Guidance addressing regulatory requirements with licensees and cask suppliers is being developed

• Research to address thermal margin improvement is underway

• Aging Management protocols and inspection technology are being developed
Incentive for Legislative Action

H.R. 3053 - Pathway to a Durable, Effective and Financially Disciplined Program

- $800 million in current mandatory spending authority simply pays to maintain status quo with no programmatic advances; likely to increase in the absence of a renewed program.

- New Mandatory authority represents authority to withdraw past deposits, not draw on general fund; it is capped at less than current mandatory spending and stage-gated based on program performance metrics.

- Meeting legally-binding commitments requires either upfront, lump sum appropriations or mandatory spending authority
Conclusions
The Path Forward – Key Take Aways

• Used Fuel May Be Transported as Early as 2022

• Industry Preparations Underway

• Industry Actions Point to Readiness

• Not an Overwhelming Challenge

• Minimal Increase in Annual Shipments
• Interact with industry for planning development of transportation readiness
• Align “reasonable assurance” expectations with industry and regulators
• Increase urgency and accelerate timeline to match up with potential CISF readiness in 2022