The most trusted source of nuclear fuel cycle and reactor market research and analysis

Information and data services for suppliers, utilities, investors, and government agencies worldwide

- Founded in March 1994
- 15 professionals in company, plus wide consultant base
- Staff located in: Atlanta, Boston, Austin, Vienna, and others

Three major lines of business

- Specialized client support throughout nuclear fuel cycle
- Publishing industry market reports
- Nuclear fuel price indicators and data services

Leading publisher of nuclear fuel prices

- Launched uranium futures contract with CME/NYMEX in May 2007
UxC Covers All Fuel Cycle Segments

- Uranium Exploration & Development
- Mining of Uranium Ore
- Milling of Ore to U₃O₈ Concentrates
- Conversion to UF₆
- Uranium Enrichment (SWU)
- Fuel Fabrication
- Nuclear Reactor
- Spent Fuel Storage
- Waste Disposal
- U & Pu Recycle
- Reprocessing
SpentFUEL

Appeals Court Issues Final Ruling on MOX Shutdown

On January 3, 2019, the US Court of Appeals for the Fourth Circuit issued a final ruling that allows the US Department of Energy to terminate the construction of the Mixed-Oxide (MOX) Fuel Fabrication Facility located at the Savannah River Site (SRS) in South Carolina. The decision by the three-judge panel vacated a preliminary injunction that Judge Richard S. Ball of the US District Court for the District of South Carolina at Augusta had granted in favor of the Sierra Club, a community group, and local residents who had sued the federal government to block the project.

Judge James A. Wynn wrote, “We conclude that South Carolina has not established standing to pursue each of these claims. Accordingly, we vacate the preliminary injunction imposed by the district court.”

The ruling also described the history of the MOX program, noting that in 2003, when Congress directed the Department of Energy to build a plant for the construction and operation of the MOX facility, Congress authorized the Secretary to make a decision if the construction was feasible and economic subsidies for the MOX facility were not being made. In April 2012, the Department of Energy announced that the MOX facility would not reach criticality due to cost overruns. DOE agreed to buy spent fuel from Russia and stored it at the Savannah River Site, where it supports the high-level radioactive waste treatment and disposal program.

SpentFUEL content...

StoreFUEL and Decommissioning Report

INMM Spent Fuel Management Seminar January 2019 - 4
Currently 446 nuclear power reactors are operating in 30 countries plus Taiwan, and 50 are under construction.

Spent fuel treatment, storage, and disposal are crucial components of the nuclear fuel cycle. The IAEA has encouraged its Member States to develop and implement a “cradle to grave” approach to radioactive waste with disposal as the end point.
Deep geological disposal is widely accepted as the end point for spent nuclear fuel and HLW.

No such facility is currently operating. NIMBY attitude and other reasons.

Repository programs are in process in multiple nations. Finland is the only country to have a construction license; repository operations are expected to begin in 2025.
Spent Fuel Storage

- Collectively, nuclear power plants discharge about 11,300 MT of spent fuel each year (average 2015-2035).
- Through the end of 2018, about 422,000 MT of spent fuel have been discharged.
- At least 50 countries have spent fuel in storage awaiting reprocessing or disposal.
- About 80% of the global inventory is located in the US and Western Europe.
- UxC estimates that by 2035 the amount of spent fuel discharged will be nearly 618,000 MT and the amount in storage will be nearly 450,000 MT.
Spent Fuel: A Waste or Resource?

- Spent fuel is not considered a waste in some countries. Current worldwide reprocessing capacity totals about 3,970 MT a year.
- Japan plans to have an 800 MT facility online in late 2021.
- China has announced its intentions to reprocess spent fuel at a new 800 MT plant.
- The UK ended reprocessing operations at THORP in November 2018, but will continue to reprocess Magnox spent fuel until 2020.
- UxC estimates that about 133,000 MT of spent fuel from commercial NPPs have been reprocessed through 2018, and that by 2035 the total will be close to 170,000 MT.

Source: UxC Nuclear Industry Value Chain
In a few countries centralized storage facilities, both wet and dry, are operation or planned:

- Finland
- France
- Germany (no further shipments planned)
- Hungary
- Spain (construction suspended)
- Sweden
- Switzerland
- Ukraine
- US
It’s still Groundhog Day for nuclear waste policy in the United States.  

- January 31, 2018 marked 20 years since the US government defaulted on its obligation to remove spent fuel from reactor sites.
  - DOE’s FY 17 financial report stated that DOJ has paid $6.9 billion out of the Judgment Fund for settlements and final judgments.
  - 39 Cases have been settled; 54 cases resolved for a total of $2 billion in damages.
  - DOE estimated future liability as of Sept 30, 2017 to be $27.2 billion (assuming a FY 2019 restart of YM licensing proceedings).
  - Some states have imposed per-cask fees for storage.
An Optimistic bunch

- Once again, legislation was introduced in Congress that would give DOE clear authority to store spent fuel even without progress on a repository. The bill actually passed in the House in May (340-72) but the Senate never did craft its own version, H.R. 3053, *the Nuclear Waste Policy Amendments Act of 2018*
  - Sen. Alexander thinks 2019 Congress will finally solve the stalemate.

- Industry groups continue to promote restarting Yucca Mountain licensing while pursuing consolidated storage in parallel.

- The President was praised for including money in his budget request to restart the Yucca Mountain licensing proceedings, but Congress never appropriated any money for that purpose – again.
US Policy Status

► But the basis for that optimism is disappearing

- When visiting Nevada before the mid-term elections and stumping for Sen. Heller, President Trump appeared to back off his support for Yucca Mountain when he was quoted as saying “I think you should do things where people want them to happen so I would be very inclined to be against it.”

► Is support for Yucca Mountain beginning to wane, finally?
Some Highlights of 2018

- Consolidated storage – NRC reviews of Holtec and Interim Storage Partners continues.
  - ASLB is holding hearings in NM next week on Holtec’s application.
- Deep Isolation
- Sandia Transatlantic test
- High Burn-up Cask Demonstration Project
Dry Storage in the US

► Every US nuclear reactor site except for TMI-1, Shearon Harris, and Wolf Creek has an ISFSI.
  ● Wolf Creek signed a contract with TN for dry storage starting in 2021 (announced August 2); will use NUHOMS EOS 37.
  ● TMI-1 has signed a contract but not yet announced.

► South Texas Project is planning to have an ISFSI in operation in 2019; plans to load first Holtec systems this month.

Source: US NRC
CoC and ISFSI license renewals

- NRC expects a surge of renewal applications by 2020.
- Currently the NRC is reviewing:
  - TMI-2
  - Trojan
  - Rancho Seco
  - Humboldt Bay
- Renewals for Diablo Canyon and Idaho Spent Fuel facility are coming up.
Storage CoC renewal applications

- Storage CoC renewals:
  - NUHOMS – Renewed CoC took effect on December 11, 2017.
  - Other systems will be up for renewal before 2020.
    - The NRC is expecting to receive renewal applications for the HI-STORM 100, the TN-32, TN-68, NAC-MPC, and NAC-UMS.
Growth of Commercial Dry Storage in the US

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Assemblies</th>
<th>Casks</th>
<th># Placed in Service</th>
<th># of ISFSIs</th>
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<td>2014</td>
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<td>2016</td>
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<td>2018</td>
<td>126,521</td>
<td>2,981</td>
<td>261</td>
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</tr>
</tbody>
</table>
Reactor Closures in 2018-2025

► Oyster Creek September 17, 2018

► 2019-2025
  ● 2019 Three Mile Island 1 and Pilgrim
  ● 2020 Davis Besse, Duane Arnold, Indian Point 2
  ● 2021 Beaver Valley, Perry, Indian Point 3
  ● 2022 Palisades
  ● 2024 Diablo Canyon 1
  ● 2025 Diablo Canyon 2
New decommissioning models to accelerate decommissioning:

- VY sale to NorthStar approved January 11, 2019.

- In August, Holtec announced plans to acquire Oyster Creek, Pilgrim, and Palisades, and the Big Rock Point ISFSI.

- Generally preferred by communities; cost savings; other advantages.
Transferring the spent fuel from the pool to dry storage is an important decommissioning milestone.

- Cask vendors have designed (or are designing) casks that can store spent fuel that has only been stored in the pool for two years in order to accelerate decommissioning of the plant.

- Out of a total of 2,981 casks in service in the US, 551 of these are at permanently shutdown sites.
Shutdown Sites

- Southern California Edison is loading the rest of SONGS spent fuel into HI-STORM UMAX systems.

- In 2018, Vermont Yankee completed the transfer of all spent fuel out of the pool into dry storage.

Source: SCE
Omaha Public Power District

- Fort Calhoun shut down October 24, 2016.
- 944 assemblies in the Fort Calhoun pool need to go into dry storage. Currently the site has 10 NUHOMS 32PT systems in use, storing 320 assemblies.
- TN will provide 30 additional NUHOMS 32PT systems for the final spent fuel offload (and 2 for GTCC).
- OPPD first selected the SAFSTOR approach then the Board decided to change to immediate dismantling (DECON).
- Likely to decommission using contractor but with OPPD maintain control.
Spent Fuel Storage Key Players - US

- **Holtec International**
  - Best known for its HI-STORM cask technology.
  - In use at 35 US sites (will be 36 later this month when STP begins loading) with almost 1,200 casks in service.
  - Newer variations of the HI-STORM 100 include the HI-STORM FW and the HI-STORM UMAX.
  - In 2018, 172 Holtec casks were deployed in the US, a significant increase over 2017 when 92 were deployed.
Spent Fuel Storage Key Players - US

- TN Americas is Orano’s dry storage and spent fuel transport company
  - Currently markets the modular NUHOMS dry cask system
  - New NUHOMS EOS system shown below
  - Has over 48,800 assemblies stored in 1,232 systems in the US
  - In 2018, 85 TN systems were deployed in the US

Photo credit: TN
NAC International

- Specializes in nuclear materials transport, spent fuel storage and transport technologies, nuclear fuel cycle consulting, and fuel cycle information services.

- NAC systems are in use at 11 US sites with more than 450 casks in service. 193 of those are at permanently shutdown sites.
EnergySolutions (ES)

- Renewal of its VSC-24 system was finalized in early 2017.
- ES has 66 cask systems storing 1,833 assemblies in use at 4 US plants.
- ES operates a LLW facility in Utah and Tennessee.
- ES also manages customized projects for utility customers, such as the Zion and LACBWR decommissioning projects.
Current Status of Dry Storage

Number of Assemblies in dry storage at the end of 2018

Dual-Purpose concrete casks in use

Source: January 2019 StoreFUEL
Market Share – BWR Fuel

Dual-purpose concrete systems deployed

- TN Americas: 38%
- NAC: 0%
- Other: 1%
- BWR: 61%

BWR assemblies in dual-purpose concrete systems

- TN Americas: 34%
- NAC: 0%
- Other: 1%
- Holtec: 65%

Source: January 2019 StoreFUEL
Market Share – PWR Fuel

Dual-purpose concrete systems deployed

- TN Americas 41%
- NAC 22%
- Holtec 33%
- Other 4%

PWR assemblies in dual-purpose concrete systems

- TN Americas 29%
- NAC 32%
- Holtec 39%
- Other 0%

Source: January 2019 StoreFUEL
Market Share at Shutdown Sites

- NAC: 39%
- TN Americas: 36%
- BFS/ES: 2%
- Holtec: 23%

Source: January 2019 StoreFUEL
Final Thoughts

1. The US dry storage market will continue to grow. With premature reactor shutdowns, the number of casks required in the near term will increase but in the longer term, fewer casks will be required.

2. 261 casks were deployed in 2018, and at least that many are expected to be placed into service in 2019 at commercial reactor sites in the US.

3. The global dry storage market also will continue to grow as a result of decommissioning plants and delays in repository programs.
Thank you

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