34th INMM Spent Fuel Management Seminar

Spent Fuel Management Activities at Holtec

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SNF Management Activities

Topics

- Holtec International Overview
- Holtec Innovations
- Canister-Based Aboveground and Belowground Systems
- Spent Nuclear Fuel Management Goals
- Regionalized Loading
- Loading Plan Software
- Summary and Conclusions
Who is Holtec International?

- A vertically integrated turnkey supplier of goods and services to the power generation industry
- Established in 1986
- Orders booked for future deliveries: 5.0 Billion USD +
- No history of long-term debt
- Highest industrial credit rating [D&B-1R2]
- Financially strong with self-financed R&D
- Largest exporter in US for capital equipment supporting the nuclear industry
- 116 nuclear plants worldwide: 65 domestic, 51 international
- Over 60,000 SNF assemblies loaded into Holtec Dry Cask Storage/Transport Systems
- 1,200 + Holtec supplied systems are loaded
Holtec’s Worldwide Operation Centers

- Holtec International Corporate Headquarters, Jupiter, Florida
- Krishna P. Singh Technology Campus (Corporate Technology Center, Holtec Manufacturing Division), Camden, New Jersey
- Holtec Manufacturing Division, Pittsburgh, Pennsylvania
- Orrvilon Manufacturing Center, Orville, Ohio
- Holtec Asia Manufacturing Center, Dahej, India
- Holtec Asia, Pune, India
- Sizlon Limited, Sizewell B Power Station, Suffolk, United Kingdom
- Holtec Ukraine, Kiev, Ukraine
- Holtec Africa, Honeydew, South Africa
- Holtec Arabia, Dubai
- Holtec Brazil, Rio de Janeiro, Brazil
Holtec’s Manufacturing Capabilities
Three Major U.S. Manufacturing Plants

- Holtec Manufacturing Division (HMD)
  - Turtle Creek, PA
- Orrvilon, Inc. (ORR)
  - Orrville, Ohio
- Advanced Manufacturing Division (AMD)
  - Camden, NJ
- 1.4M ft² of Total Shop Space
Holtec is a Vertically Integrated Turnkey Supplier of Goods and Services to Clients on Six Continents

- Holtec’s vertical integration spans:
  - Design
  - Engineering and Licensing
  - Fabrication
  - Critical Material Supply
  - Site Installation
  - Construction
  - Operations

- This allows for:
  - Coupling of design, fabrication, and construction
  - Control over quality, delivery, and costs
  - Expedited Delivery
  - Integrated solutions for customers
  - Turnkey projects
Holtec Innovation

- Having our own manufacturing facilities provides us with the ideal basis to develop and implement safety improvements in design and manufacturing.

- Example: Ongoing focus on developing technologies to reduce the risk of stress corrosion cracking in safety related components.
  - ✔ Reduction of overall amount of welds and heat input per weld for canisters.
  - ✔ Laser Peening of welds.
  - ✔ Development of new welding technologies such as hybrid laser welding to combat aging related issues in dry storage.
Holtec’s HI-STORM Canister-based Systems
Aboveground and Belowground Systems

HI-STAR
STORAGE AND TRANSPORT CASK
(INTERIM STORAGE AND OFFSITE TRANSPORT)

HI-TRAC
TRANSFER CASK
(ONSITE TRANSFER/TRANSPORT)

MPC
MULTI-PURPOSE CANISTER
(STORAGE/TRANSPORT/DISPOSAL)

HI-STORM 100 AND HI-STORM FW
ABOVEGROUND STORAGE CASK
(INTERIM STORAGE)

HI-STORM 100U AND HI-STORM UMAX
UNDERGROUND STORAGE CASK
(INTERIM STORAGE)
Holtec’s Canister Technology

- Provides containment of fuel, fuel debris, or non-fuel hardware and waste
- Canisters are protected by “Overpacks” during storage, onsite transfer, and offsite transport
- Benefits of Canisters
  - Welded lids provide highest level of protection of material
  - Canisters are transportable without repackaging
  - Fuel handled one time
  - Contents are retrievable using weld removal technology
- Only provider of Double Wall Canisters (DWCs)
  - Developed for Chernobyl damaged fuel
  - Two independent barriers to protect contents
  - Interior stainless steel canister is protected from the environment
  - Allows for leak test verification if required by monitoring shell-to-shell gap
  - Over 350 DWCs on order between EDF and Chernobyl
Multi-Purpose Canister (MPC)

- HI-STORM 100 System:
  - ✓ MPC-24, MPC-32, MPC-68
- HI-STORM FW System:
  - ✓ MPC-37, MPC-89
- All stainless construction
- HI-STORM 100: Fixed Neutron Poison Material
- HI-STORM FW: Basket is Entirely Made of Neutron Poison Material
- MPC has no bolted closure or mechanical seals
- 100 Year Service Life
- Honeycomb basket maximizes structural strength, heat transfer, and shielding
- ASME Section III, Class 1 (subsection NB) compliant
Multi-Purpose Canister (MPC) Thermal Performance

- Designed for passive heat removal
- Filled with helium to provide an inert heat transfer medium
- Heated helium rises on interior as it passes spent fuel
- Hot fuel can be stored in the center and is shielded by cold fuel stored on the outer row. This is what we call “Regionalized Loading”
- Helium is cooled on periphery and falls under force of gravity
- Allows for better heat removal of higher burnup fuel with shorter cooling times
Holtec’s Below-grade Dry Storage Technology (HI-STORM UMAX)

- Passive heat rejection
- Capacity to store 37 spent PWR fuel assemblies or 89 spent BWR fuel assemblies
- Canister is entirely below grade
- Size – HI-STORM UMAX is licensed to store canisters up to 75 ¾ inches in diameter, and up to 213 inches tall
- 22 ft. deep x 11 ft. wide
HI-STORM UMAX Characteristics

- Operational Advantages
  - Ergonomic

- Maximizes Security
  - Facility is visually inconspicuous
  - Profile < 2 ft. tall
  - Less visible target from the air
  - Reduced visibility from public land
  - No area of obstructed view

- Maximizes Safety
  - Minimize dose to environment & crew
  - Virtually immune to environmental disasters - hurricanes, floods, tornados, earthquakes
  - Designed to withstand crashing aircraft or on-site fire without any radiological consequences
HI-STORM UMAX ISFSI PAD
Holtec’s HI-STORE
Consolidated Interim Storage Facility

- Initial Storage Capacity = 500 canisters (8,680 MTU)
- Total Storage Capacity = 10,000 canisters (173,000 MTU)
- Facility utilizes 500 of the 1,000 acres available
- NRC Completes Review: July 2020
- Operations could commence by 2023
Spent Fuel Management Goals and Technologies

- Overarching goal of spent fuel management is safety
  - √ Goal 1: Minimize and/or manage dose to the public and to plant personnel
  - √ Goal 2: Move fuel into dry storage in a timely manner
- Holtec’s technologies to address both simultaneously
  - √ Regionalized Loading
  - √ Loading Optimization Software
Regionalized Loading

All of Holtec’s MPCs offer regionalized loading schemes, where either 2 or 3 concentric regions or groups of cells that are specified with different performance parameters in terms of heat loads, burnups and cooling times.

- **HI-STORM 100: 2 Regions**
  - Inner – Hotter Fuel
  - Outer – Colder fuel

- **HI-STORM FW: 3 Regions**
  - Inner – Medium fuel
  - Intermediate – Hotter Fuel
  - Outer – Colder Fuel
Regionalized Loading (cont.)

- Moving hotter fuel away from the basket periphery reduces dose (Goal 1)
- All MPCs operate in vertical orientation with a pressurized internal that very effectively promotes thermosiphon effects (heat transfer through convection) inside the canister. This allows to maintain peak cladding temperatures below safety limits even with hot fuel in the center or intermediate region (Goal 2)
Loading Plan Software

Holtec has developed a state of the art fuel loading plan software to aid in the development of plant specific loading plans and generic loading patterns.

Key Features include:

- ✔ Built-In COC Compliance, across multiple cask types and doockets
- ✔ Dose optimal loading configurations within existing patterns
- ✔ Assurance of sustainable Spent Fuel Pool configurations
- ✔ Cost Benefit Analysis for operational decisions in context of dose or timing
- ✔ Capable of considering plant specific restrictions (Heat Load Limits, Damage, Sipping Campaigns, Inaccessible Assemblies)
- ✔ Predictive of observed cumulative crew dose
Improvement in Projected Dose

Using this approach, Holtec’s current loading plans reflect an overall 30-50% reduction in dose relative to previous numerical approaches.
Summary and Conclusions

- Holtec’s loading software has led to significant improvements in our approach to performing fuel selection and developing loading patterns.

- Dose projections are predictive of measured crew dose for meaningful ALARA planning and dose targets. Reduction in dose estimates translate directly into crew savings.

- Early strategic planning for decommissioning has the capability of improving the overall fuel transfer schedule by months and years.