

HI-STORM UMAX: Holtec's Underground Dry Storage System

State-of-the-Art Solution for the Safety and Security of the People and Environment at SONGS



A Presentation to Community Stakeholders

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October 14, 2014

San Juan Capistrano, California



Topical Outline

- 1) Overview of Holtec International and Holtec's HI-STORM UMAX System Design and Implementation
- 2) Defense-in-Depth, Maintenance, and Surveillance Requirements
 - Performance Monitoring Program
- 3) Anticipated Aging Management Plan
 - Canister Monitoring – On-Going Developments
- 4) Mitigation of Degraded Canister
 - Damaged Canister Storage Plan



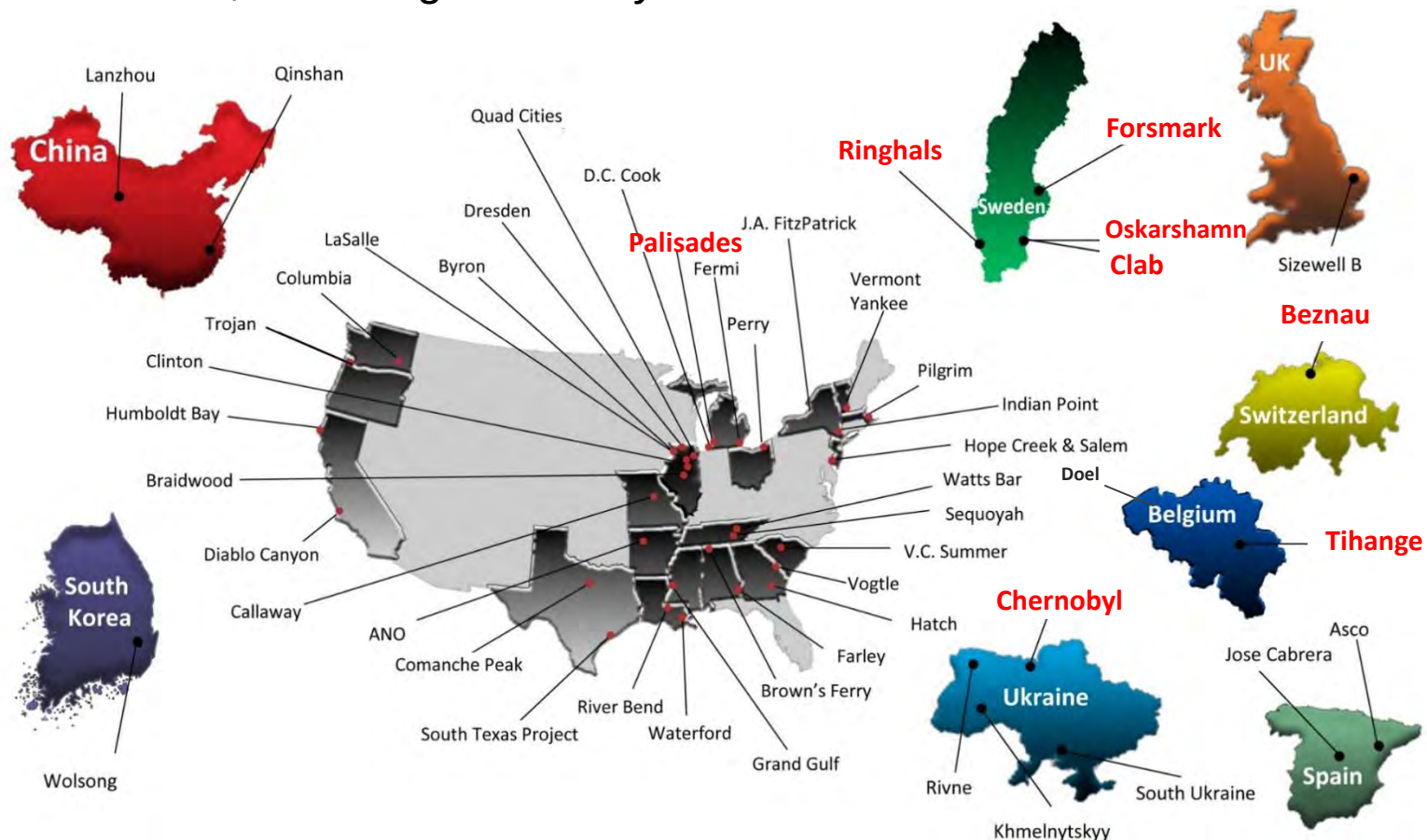
Overview of Holtec International

Holtec is a U.S. Owned Company with Four Operation Centers in Four States



a generation ahead by design

- Holtec has a large international footprint in used fuel management with 67 nuclear units, including Chernobyl.



Holtec has the Most Transportable Dry Storage Systems Loaded Worldwide

Overview of Holtec International

Examples of Holtec's Technology Leadership in Dry Storage



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- Secured license for the **first** multi-purpose canisters in the U.S. (1998).
- Secured license of America's **first** dual-purpose cask, HI-STAR 100 (1998).
- Pioneered the certification of “canning” for storing vulnerable or damaged fuel in the welded canister; a large number have been successfully loaded around the world (Illinois, Oregon, California, and Spain).
- First to obtain the license to store high burnup fuel (2001).
- Licensed industry's first transport cask, HI-STAR 180 for high burnup and MOX fuel (2009).

Holtec holds more Patents on Used Fuel Management Technologies than all World Suppliers Combined

Overview of Holtec International

Holtec has Licensed a Fleet of Used Fuel Transport Casks

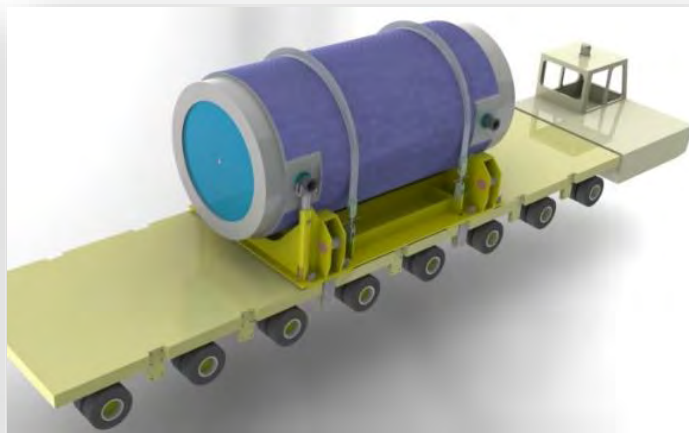


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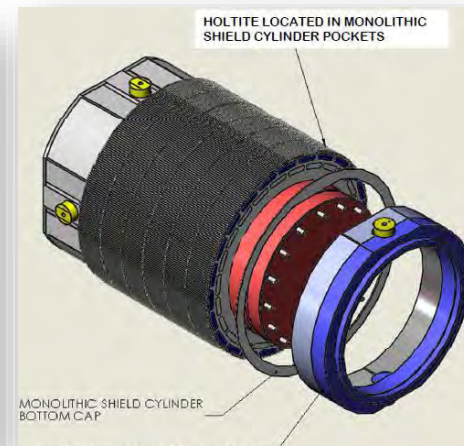
- Industry leader in obtaining transport cask licenses over the past 5 years. Certification effort for Holtec's universal transport cask (HI-STAR 190, proposed for SONGS) is underway; Expected to receive NRC license in 2015.



HI-STAR 100



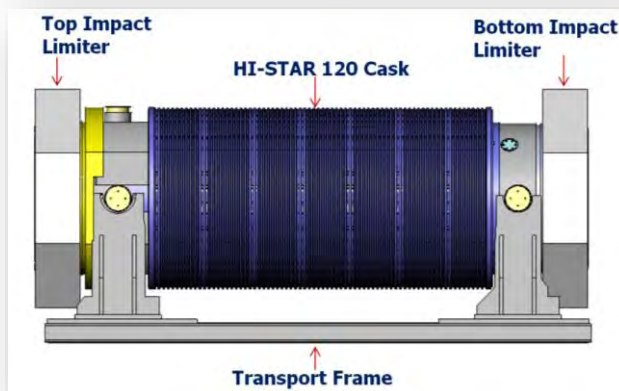
HI-STAR 180



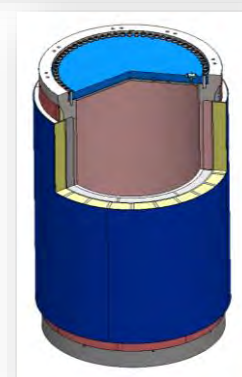
HI-STAR 180D



HI-STAR 60



HI-STAR 120

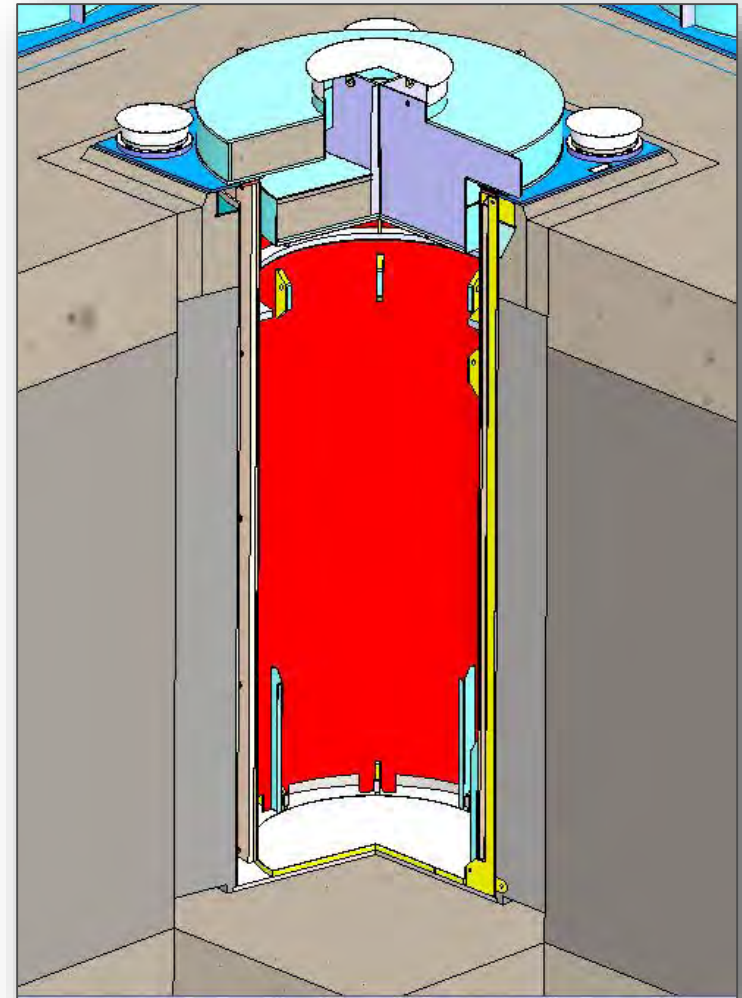


HI-STAR 190

Essential Features of Holtec's HI-STORM Dry Storage Systems

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- Canisters are stored vertically.
 - Reduced rate of solute deposition on vertical surfaces.
 - Vertically oriented fuel rods provide significant self-shielding.
 - Entire shell surface can be conveniently inspected.
- Biological shielding uses structural steel with enclosed concrete to prevent spalling of concrete due to aging.
 - Steel structure is more resistant to incident missiles or crashing airplanes.

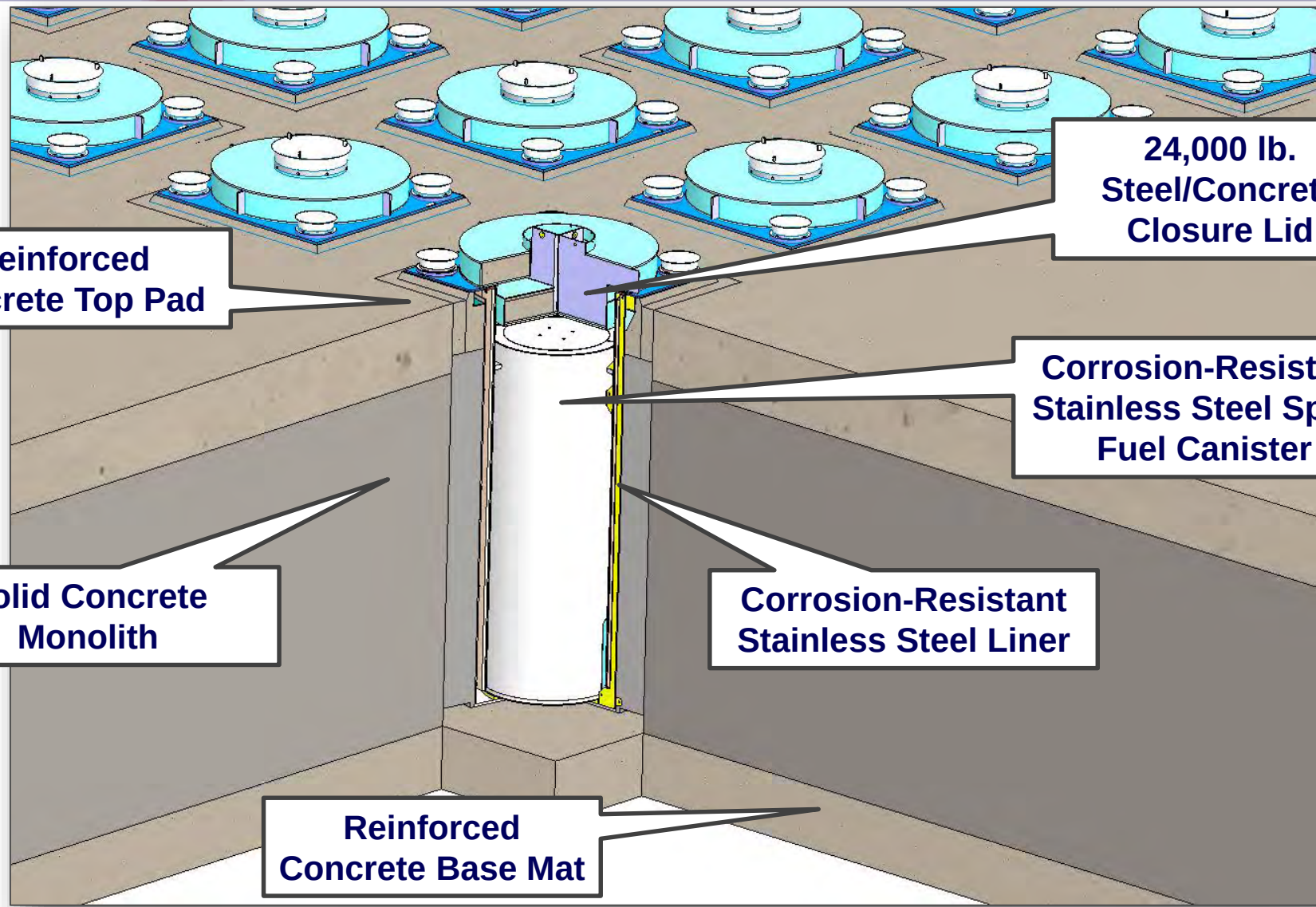


HI-STORM UMAX Cavity

Introduction to Holtec's HI-STORM UMAX Underground Dry Storage System



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**Reinforced
Concrete Top Pad**

**24,000 lb.
Steel/Concrete
Closure Lid**

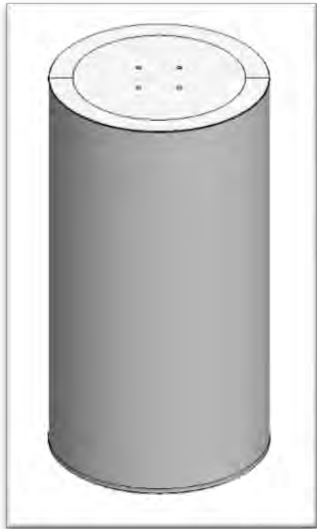
**Corrosion-Resistant
Stainless Steel Spent
Fuel Canister**

**Solid Concrete
Monolith**

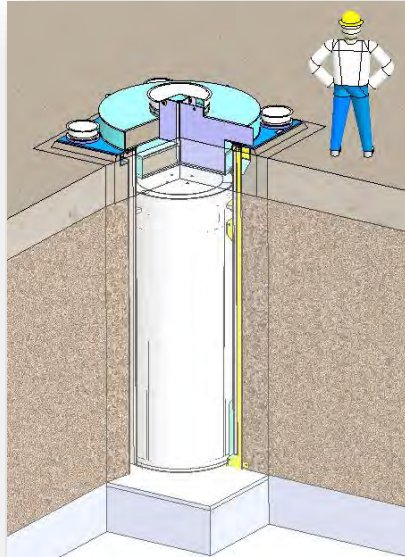
**Corrosion-Resistant
Stainless Steel Liner**

**Reinforced
Concrete Base Mat**

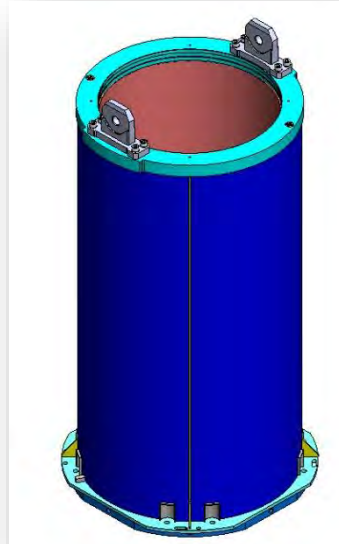
Constituent Components of the HI-STORM UMAX System for SONGS



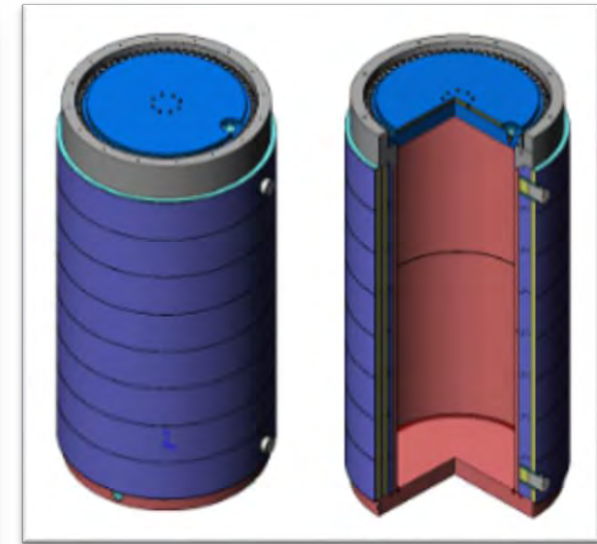
Multi-Purpose Canister (MPC-37)
Meets the most stringent ASME Code.



HI-STORM UMAX
Underground storage module designed for virtually zero dose, low profile, full protection from extreme environmental events.



HI-TRAC VW On-Site Transfer Cask
Assures safe movement of the MPC during on-site loading and transfer operations from the spent fuel pool to the HI-STORM UMAX.



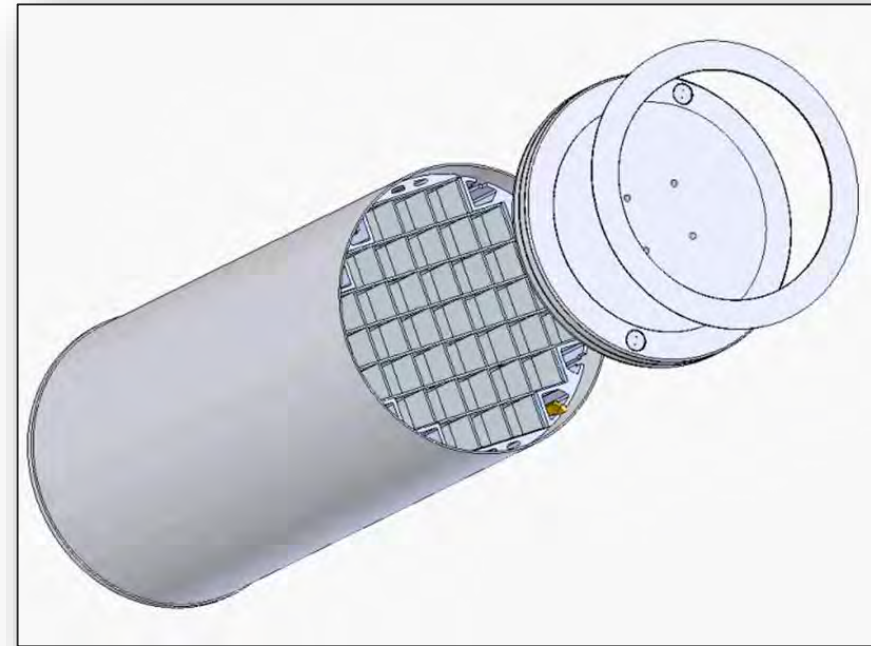
HI-STAR 190 Off-Site Transportation Cask
Qualified to transport MPC-37 containing high-burnup fuel.

Holtec's HI-STORM UMAX Multi-Purpose Canister



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- Canister shell is made of 5/8-inch thick, high-quality, stainless steel type 316L, providing extreme corrosion resistance in marine environments.
- Canister lid (9.5-inches thick) is strength welded to the shell, and further protected by a redundant closure ring to ensure long service life.
- Canister is licensed for the storage of Damaged Fuel Containers ("cans").



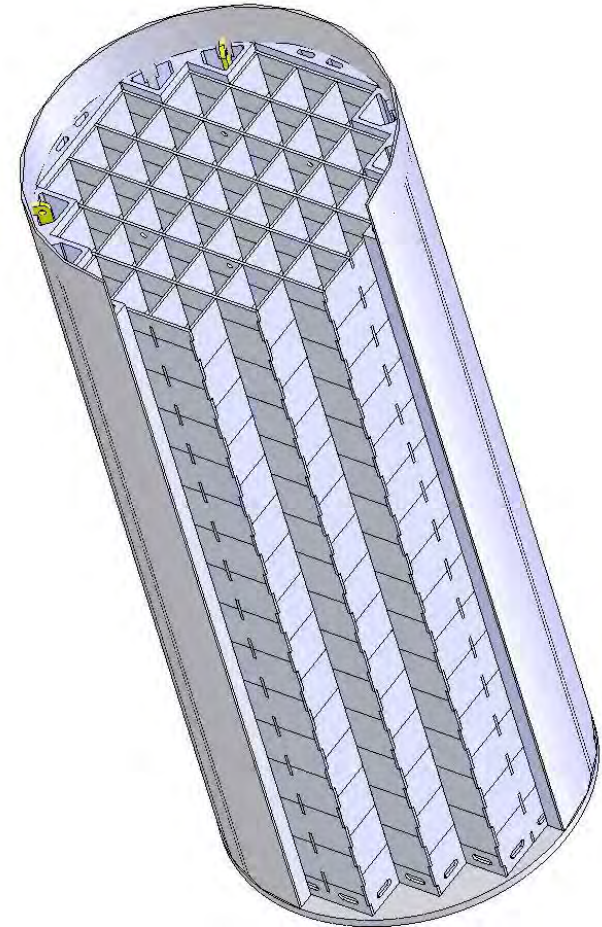
**HI-STORM UMAX Canister
(MPC-37)**

Holtec's HI-STORM UMAX System Design and Implementation

Decommissioning Benefits of Vertical Storage and MPC-37

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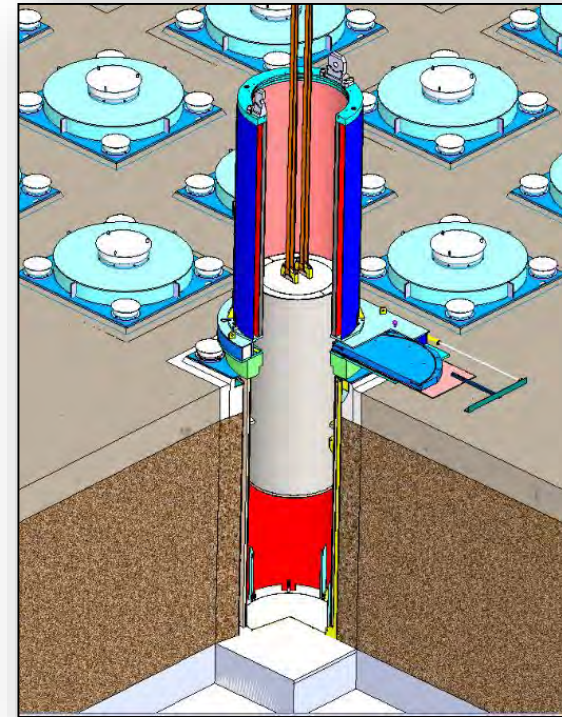
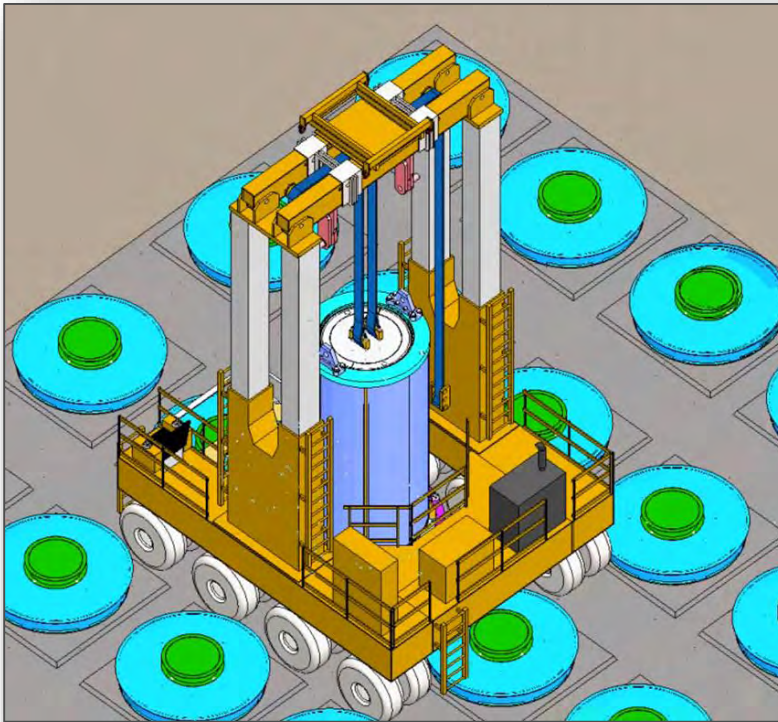
- MPC-37 stores 37 used fuel assemblies
 - High storage capacity of MPC-37 requires fewer storage system and fewer off-site transports.
 - Enables expedited defueling of the spent fuel pools.
 - Enables prompt decommissioning of the site.
- High heat rejection capacity of MPC-37 (47kW) ensures low fuel cladding temperature in service.
- Keeps fuel in the orientation (vertical) for which it is designed. No risk of creep-induced deformation in long-term storage.
- MPC-37 stands on solid ground.



MPC-37 Canister

Holtec's HI-STORM UMAX System Design and Implementation

- Installing the loaded canister in HI-STORM UMAX is a simple, low dose operation that relies only on gravity.
- Canister is vertically stored underground in a clean, dry cavity.

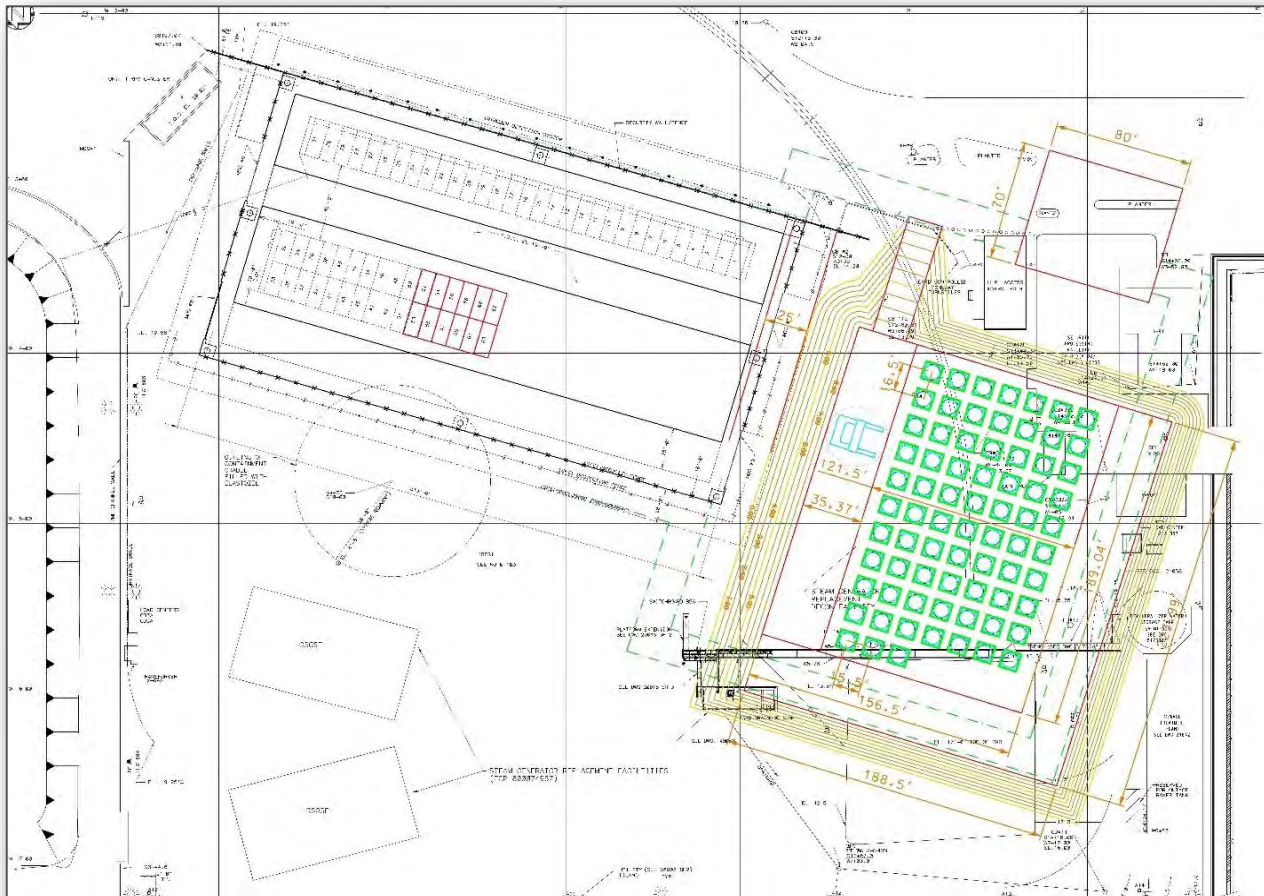


HI-STORM UMAX MPC-37 being Installed in the Underground Cavity

Holtec's HI-STORM UMAX System Design and Implementation

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- Holtec's HI-STORM UMAX will have 73 dry storage cavities to defuel the spent fuel pools – compact footprint.



Holtec's HI-STORM UMAX System Design and Implementation

High Seismic Canister Storage in California



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- In California, Holtec deployed the first anchored aboveground dry storage system at Diablo Canyon and later deployed underground dry storage systems at Humboldt Bay.



Underground Vertical Dry Storage Systems at Humboldt Bay (2006)

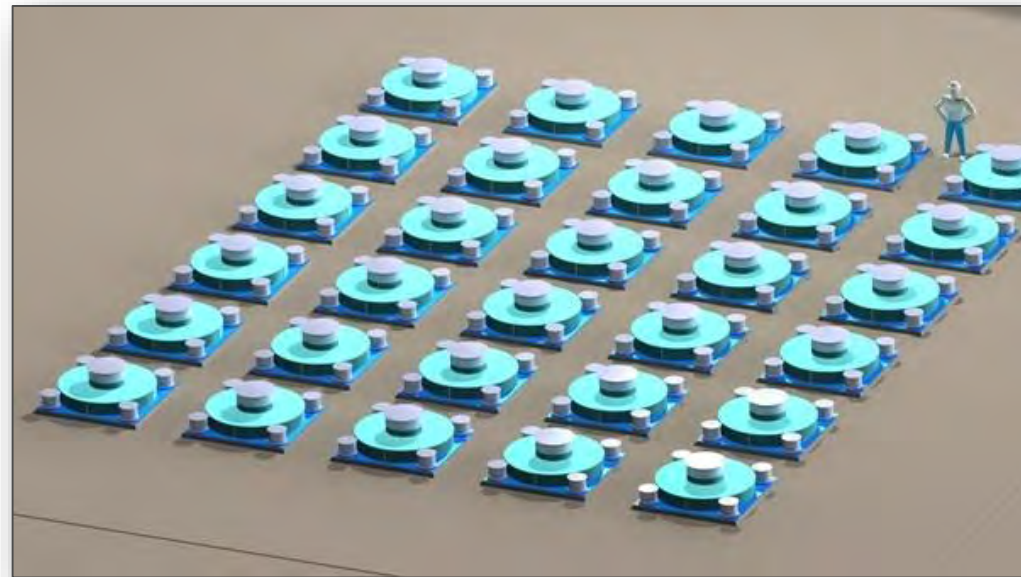


Anchored Vertical HI-STORM Systems at Diablo Canyon (2003)

Holtec's HI-STORM UMAX and MPC-37 System Design and Implementation

HI-STORM UMAX Excels in Dose Attenuation, Seismic Resistance, and Security

- Extreme Seismic Resistance Capability: exceeds SONGS specified earthquake criteria
- HI-STORM UMAX underground storage cavities are encased by a 25 feet thick concrete monolith.
- Dose: Indistinguishable from background radiation at the boundary fence
- Aesthetics and Security: Visually inconspicuous

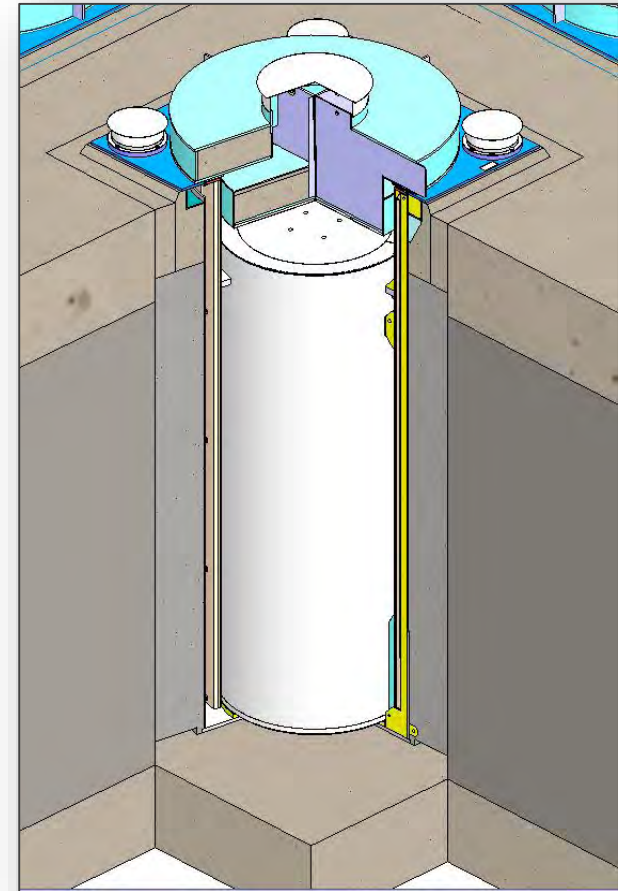


HI-STORM UMAX ISFSI

Holtec's HI-STORM UMAX System Design and Implementation

HI-STORM UMAX Cavity is Invulnerable to Ground Water Ingress, Fire, Flood, and Tsunami

- There is no path for ground water to intrude into the HI-STORM UMAX cavity.
- Flooding of any severity will not challenge HI-STORM UMAX's performance.
- Any fire in the HI-STORM UMAX cavity will self-extinguish.
- HI-STORM UMAX is designed to withstand beyond design basis tsunami impact.
- Provides convenient removal features for water, mud, and debris.

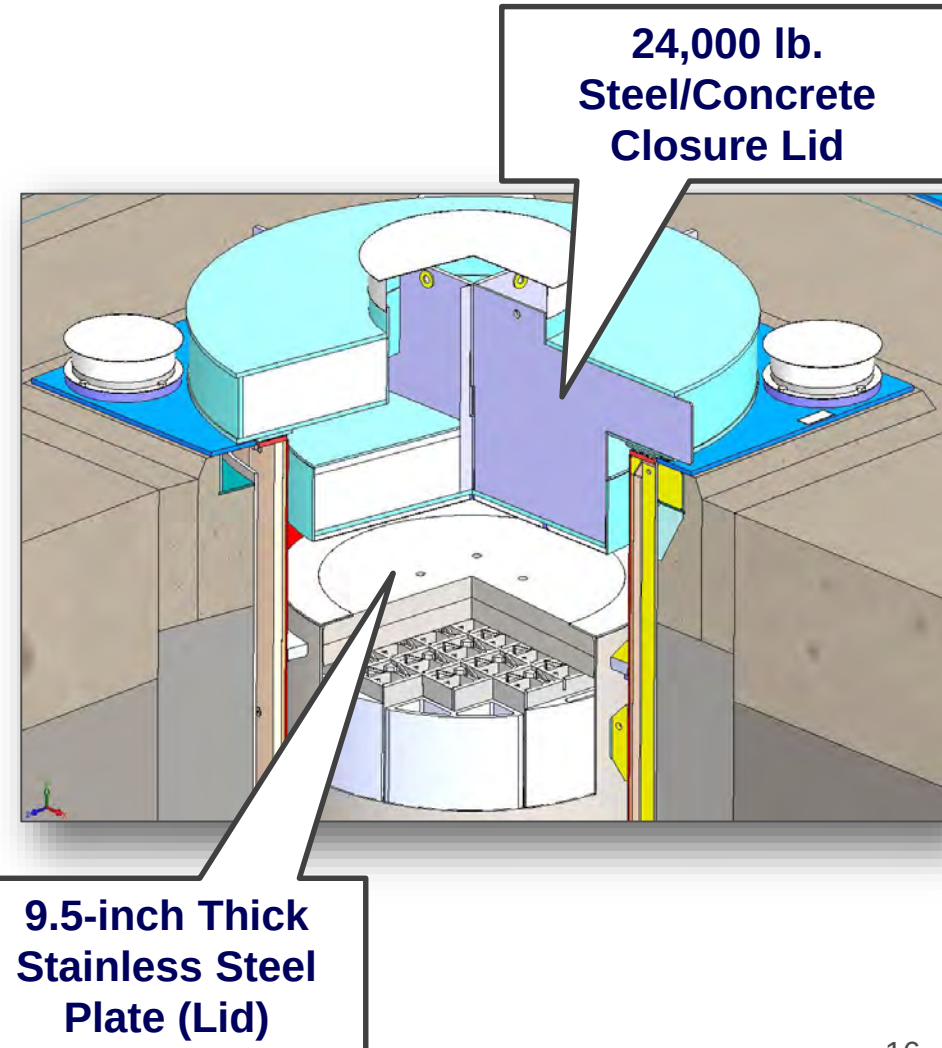


HI-STORM UMAX Cross-Section

HI-STORM UMAX is Fortified to Withstand Beyond Design Basis Threats

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- HI-STORM UMAX was designed in the wake of 9/11.
- The cylindrical surfaces of the stored canisters are inaccessible to any missile or projectile.
- The only access to the MPC-37 is guarded by a 36-inch thick stainless steel and concrete lid.
- Below the Closure Lid, the canister is protected by a 9.5-inch thick solid stainless steel lid.
- All Design Basis and Beyond Design Basis Threats cannot cause loss of confinement of the stored canister.



Defense-in-Depth, Maintenance, and Surveillance Requirements

Defense-in-Depth in Manufacturing



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- Integrated design and manufacturing under NRC, ASME, and ISO-approved Quality Assurance Program.

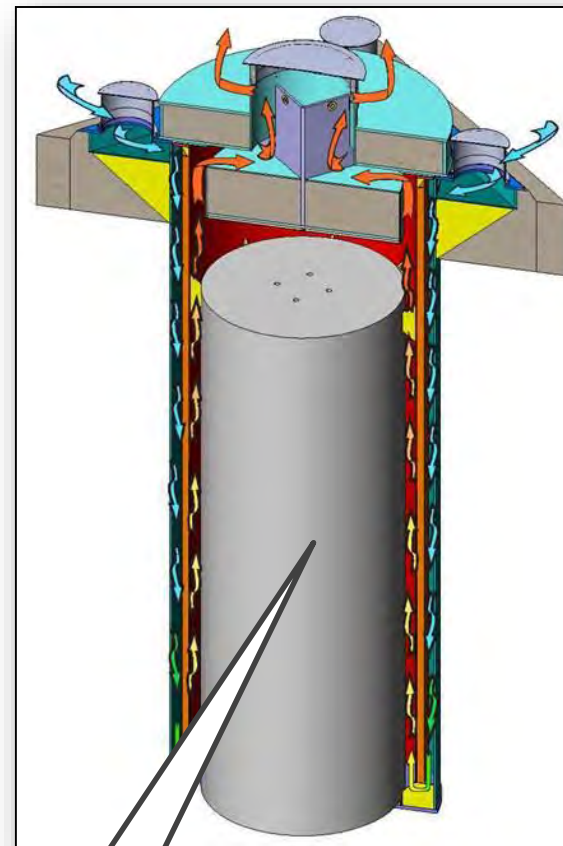


HI-STORM UMAX Steel Components Fabricated at the U.S. Holtec Manufacturing Division₁₇

Defense-in-Depth, Maintenance, and Surveillance Requirements

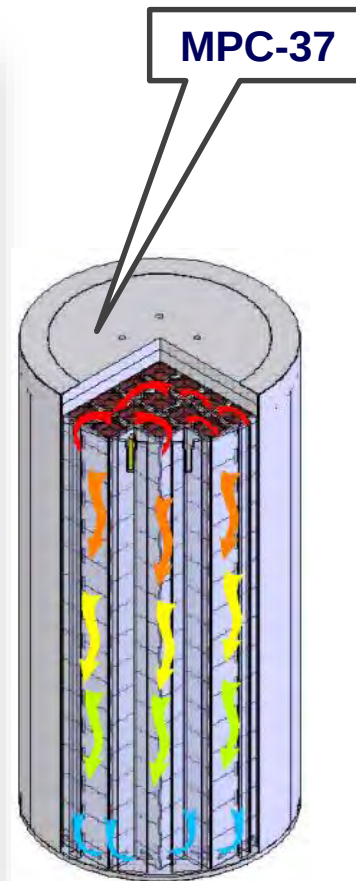
Defense-in-Depth by Design

- Canister oriented vertically to minimize salt deposits from accumulating on the canister's shell surface.
- The warm surface of the canister discourages dissolved salts in the air from condensing.
- The vertical orientation allows for complete access to the shell surface for inspection.
- Vertical orientation ensures that there are no crevices on the canister shell where contaminants can collect and concentrate.



MPC-37

**Thermo-siphon Action in the
HI-STORM UMAX**



Defense-in-Depth, Maintenance, and Surveillance Requirements

Defense-in-Depth during Canister Loading

- The Forced Helium Dehydrator (FHD), invented and licensed by Holtec in 2002 provides additional protection to used fuel during drying by maintaining low fuel cladding temperatures.
- FHD is currently in use at 30 reactor units to protect used fuel from failure during canister drying operations.



**Holtec's Patented Forced Helium
Dehydration System**

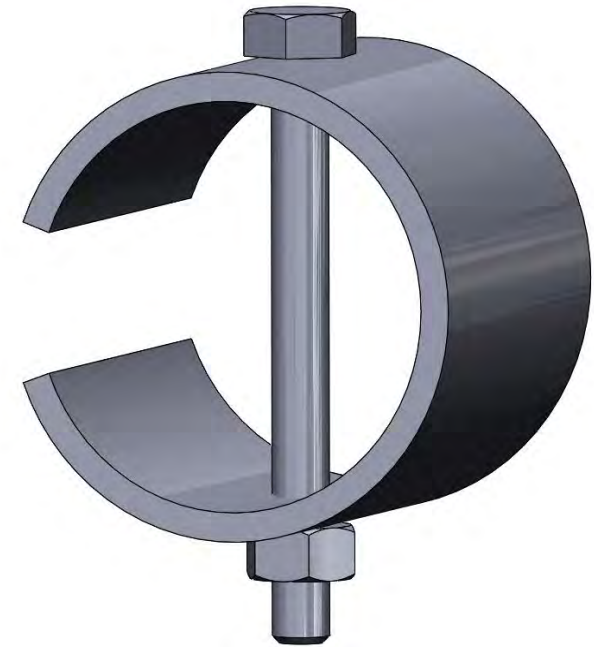
Canister Integrity Monitoring Program

Defense-in-Depth, Maintenance, and Surveillance Requirements



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- **Canister Integrity Monitoring Program** Provides early detection of potential threats to confinement integrity.
- **Prediction of Flaw Initiation**
 - Material coupons are placed in the HI-STORM UMAX to serve as a pre-cursor of potential canister degradation.
 - Coupons bound the worst-case conditions of canister temperature, stress, and air flow conditions.
 - Periodic Surface Sampling for the presence of contaminants.



**Typical Damage
Predictive Coupon**

***Pre-stressed to induce early
stress corrosion cracking**

■ **Flaw and Failure Detection**

- Surface Visual Examination
 - Full-length, 360-degree visual canister and HI-STORM UMAX visual examination.
 - Lighting and cameras can focus on any part of the canister shell or vertical HI-STORM UMAX structure and measure the geometry of an indication.
- Removal of the canister into the HI-TRAC Transfer Cask for an Integrated Helium Leakage Test
 - Integrated Helium Leakage Test is quick, easy, absolute, and will find microscopic flaws undetectable by other means.

■ **Monitoring**

- Periodic inspection of the canisters to monitor changes in any previously-found indications and identification of any new indications.

Canister Integrity Monitoring Program

Defense-in-Depth, Maintenance, and Surveillance Requirements



a generation ahead by design

- As shown at Hope Creek below, Holtec's Canister Integrity Monitoring Program **Detects and Tracks** indications long before they become a threat.



Holtec's Surface Sampling Inspection Tool In-Use at PSEG

Canister Integrity Monitoring Program

Defense-in-Depth, Maintenance, and Surveillance Requirements

- Holtec's Surface Sampling Inspection Tool previously used to take samples from canisters stored in marine environments at Diablo Canyon and Hope Creek as part of the EPRI study.

Average Deposition in mg/m² (Threshold is 500)

Canister Location	Salem/Hope Creek	Diablo Canyon
9.5-inch Thick SS Top Lid (Horizontal)	25	180
Side Wall (Vertical)	5	5
Years in Use	5	2
Visual Surface Condition	Shiny	Shiny

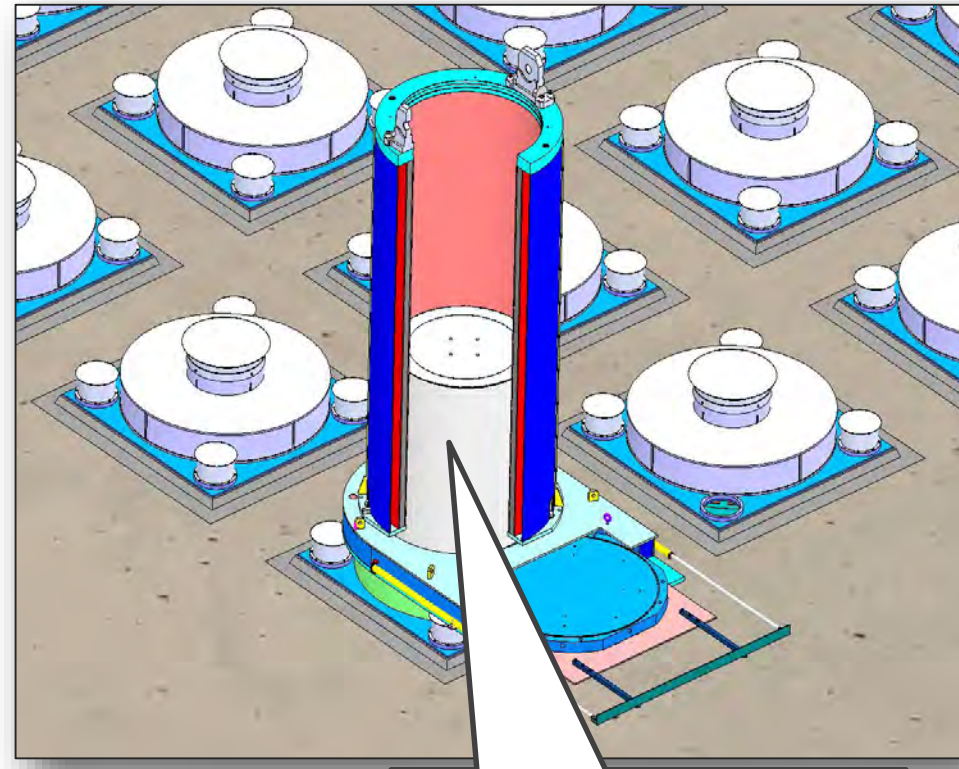


Holtec Developed Surface Sampling Inspection Tool ²³

Canister Monitoring – Ongoing Advances in Aging Management Plan

Advanced Inspection Techniques Made Easy by the Vertically-Oriented Canister

- Precise volumetric measurement method for indications
 - Currently under development in conjunction with Rolls Royce and Electricite De France for use at Sizewell.
 - Rotating sensors located in the Mating Device scan the entire canister shell surface.
- Continuous Lid Temperature Monitoring (Being Developed for Chernobyl)
 - A sudden change in the temperature may indicate a deviation in canister conditions.



MPC is Raised into HI-TRAC as Sensors Scan Entire MPC Shell Surface

Damaged Canister Storage Plan

Mitigation of Degraded Canister Using HI-TRAC VW

- SONGS will have two HI-TRAC VW Transfer Casks ready to serve as confinement provider to a damaged canister.
- Separate, stand-alone, oversized HI-STORM UMAX cavity will eliminate the need to maintain the spent fuel pool or hot cell.
- The loaded HI-TRAC VW will be stored vertically in the specially designed spare HI-STORM UMAX cavity.
- HI-TRAC VW will provide radionuclide confinement for an extended period.



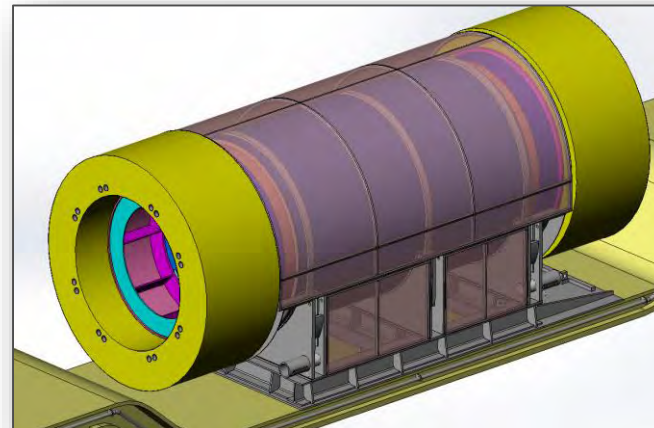
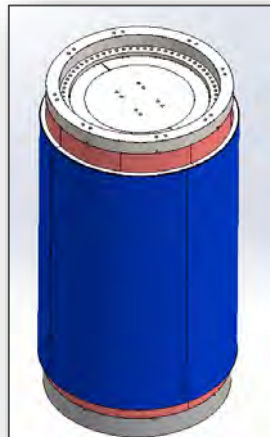
HI-TRAC with Leak-Tight Lid

Damaged Canister Storage Plan

Alternative Method for Mitigation of Degraded Canister Using HI-STAR 190

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- In the unlikely event of a threat of loss of confinement integrity is indicated, as an alternate approach:
 - Canister is placed into the HI-STAR 190 Transportation Cask, located in the oversized HI-STORM UMAX cavity.
 - Lid is sealed and leak tested.
 - Cask provides radionuclide confinement.
- Casks are temporarily stored vertically in a HI-STORM UMAX cavity.
- The loaded HI-STAR 190 is readily transportable off-site.



Canister Installed in HI-STAR 190 Transportation Cask (left); HI-STAR 190 Transportation Cask Ready for Off-Site Shipment (right)

Concluding Remarks

- HI-STORM UMAX is designed to withstand the California Coastal Commission earthquake with large margins.
- HI-STORM UMAX is designed to withstand severe environmental threats, such as flood, tsunami, fire, without threat to the system's confinement integrity.
- HI-STORM UMAX is designed to provide a long, trouble-free service life.
- HI-STORM UMAX's Canister Integrity Monitoring Program provides a comprehensive approach to prevention, detection, monitoring, and remediation.
- HI-STORM UMAX provides ultimate safety and security for public health and safety.