General Electric Advanced Technology Manual

Chapter 4.15

Independent Spent Fuel Storage Installation

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4.15 INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)

Learning Objectives:

1. Identify the types of licenses granted by the NRC to store dry spent fuel.

2. Recognize the documents that makeup the licensing basis for ISFSI and how they can be modified, including the following:
   a. Certificate of Compliance
   b. Final Safety Analysis Report
   c. Technical Specifications
   d. 10 CFR 72.212 evaluations (general license only)

3. Recognize the following ISFSI design criteria:
   a. Protection from natural phenomenon (e.g., flooding, seismic events, tornado missiles, etc…).
   b. Protection from fire and control of combustibles.
   c. Radiation Protection
   d. Emergency Planning
   e. Security
   f. Quality Assurance

4. Identify the major steps in moving spent fuel from storage pool to ISFSI pad.

5. Identify the monitoring requirements for ISFSIs once casks are located to the ISFSI.

4.15.1 Introduction

4.15.1.1 Background

For years, nuclear power plants have temporarily stored spent nuclear fuel (SNF) in water pools at their site. Periodically, about one-third of the nuclear fuel in an operating reactor needs to be unloaded and replaced with fresh fuel. Designers of nuclear power plants anticipated that the spent fuel would be reprocessed, with usable portions of the fuel to be recycled and the rest to be disposed as waste. However, commercial reprocessing was never successfully developed in the United States, and a permanent waste repository has not yet been developed. As a result, many of the spent fuel pools at commercial nuclear power plants are nearing capacity.

In the early 1980s, utilities began looking at options for increasing spent fuel storage capacity. Current regulations permit re-racking (placing fuel rod assemblies closer together in spent fuel pools) and fuel rod consolidation, subject to NRC review and approval, to increase the amount of spent fuel that can be stored in the pool. Both of these methods are constrained by the size of the pool.

Another option for increasing capacity is storage in an independent spent fuel storage installation (ISFSI). Such storage may be either at the reactor site or elsewhere. The spent fuel may be stored in wet or dry ISFSIs. On-site storage of spent fuel in dry casks has become increasingly popular among licensees needing additional capacity for storing spent fuel. Fuel that has been stored for at least five years in water has cooled sufficiently, and its radioactivity decreased enough, for it to be removed from the spent fuel pool and loaded into casks. This frees up additional space in the pool for storing spent fuel newly removed from the reactor.

Congress is considering options to create additional storage capacity on federal lands to store commercial spent fuel until a repository or new reprocessing technologies can be developed.

4.15.1.2 Currently

The NRC reviews and approves the designs for spent fuel dry storage systems. The NRC's regulations for review are developed through a public process and provide a sound basis for determining whether use of a proposed storage system will protect public health and safety and the environment.

The NRC periodically inspects the design, fabrication, and the use of dry casks, to ensure licensees and vendors are performing activities in accordance with radiation safety and security requirements, and licensing and quality assurance program commitments.

Dry spent fuel storage in casks is considered to be safe and environmentally sound. Over the last 20 years, there have been no radiation releases which have affected the public, no radioactive contamination, and no known or suspected attempts to sabotage spent fuel casks or ISFSIs. For approval of cask designs, the NRC conducts a technical review to ensure the design would be safe and secure for use at a broad range of nuclear power plant site characteristics, consistent with the requirements for a general license.

Dry casks typically consist of a sealed metal cylinder containing the spent fuel enclosed within a metal or concrete outer shell. In some designs, casks are placed horizontally in a concrete storage bunker; in others, they are set vertically on a concrete pad or vertically down below grade level in a concrete chamber. The list of approved (10CRF 72.214) fuel storage casks are in Table 4.15-1.

Dry cask storage systems are designed to resist floods, tornadoes, projectiles, temperature extremes, and other unusual scenarios. Since the NRC requires the spent fuel to be cooled in the fuel pool for at least five years before being transferred to dry casks, typically, the maximum heat generated from 24 fuel assemblies stored in a cask is less than that given off by a typical home heating system in an hour. As the fuel decays further, the heat generated decreases over time.

Spent fuel is currently in dry storage at ISFSIs located at 40 sites with general licenses and 15 sites with site-specific licenses. The map in Figure 4.15-1 shows the current ISFSIs.

4.15.2 Component Description

The Holtec Hi-Storm storage system consists of four basic parts (including the Hi-Star cask). The loaded Hi-Storm is 11 feet in diameter and 20 feet tall. A brief description of each is included.

4.15.2.1 Multi-Purpose Canister (MPC):

Constructed of ¾ inch thick stainless steel, the MPC stands 15 feet tall and five feet in diameter. The MPC provides storage of 68 BWR fuel bundles with channels (24 – 32 PWR assemblies). It has a nine and a half (9½) inch thick stainless steel lid that is welded to the MPC after loading. The MPC is designed to fit within the Hi-Trac transfer cask and the Hi-Storm 100 Overpack.

4.15.2.2 Hi-Trac transfer cask:

The Hi-Trac transfer cask is a ten inch thick stainless steel shell. The Hi-Trac has a sealed moveable lower lid and an upper cover that is bolted in place. The Hi-Trac is used for as a means of shielding the contents of the MPC while loading and transfer of the MPC to the Hi-Storm Overpack.

4.15.2.3 Hi-Storm 100 Overpack:

The Hi-Storm 100 Overpack is a carbon steel shell filled with concrete. The Hi-Storm overpack is delivered empty and filled with concrete at the site. The Hi-Storm provides physical protection to the MPC while shielding the MPC content's radiation from personnel and the environment. The Hi-Storm is designed to hold the MPC during its storage in the ISFSI.

4.15.2.4 Hi-Star cask:

The Hi-Star cask is separate from the Hi-Storm 100 System, but used in conjunction with the Hi-Storm 100 System. The Hi-Star is a ten inch thick stainless steel cask designed for transport of the MPC to its final destination at a measurable recoverable storage (MRS) facility. The Hi-Star is a reusable cask. Once its contents have been transferred to an MRS it would be unloaded and returned to the facility for loading and transfer of the next batch of SNF to the MRS. Sites typically have at least two of the Hi-Star casks, one for loading while the other is in transient.

4.15.3 Operations

A short discussion of the Holtec Hi-Storm storage system's normal operations follows:

4.15.3.1 Preparation

The Hi-Storm 100 System has many individual parts (Figure 4.15-3). After receipt, and inspection, the Hi-Trac cask is then deposited on and attached to its re-moveable lower lid. The MPC is then aligned and inserted/lowered (Figure 4.15-6) into the Hi-Trac cask. Both can then be raised to the Refuel Floor. The MPC is sealed to the Hi-Trac cask via an inflatable rubber seal around the top of the MPC (Figure 4.15-7).

The Hi- Storm overpack is delivered to the site as an empty shell. The overpack is a tube within a tube design. After its receipt inspection it is raised to a vertical position. The area between the two tubes is then filled with concrete for shielding. Once the concrete has cured and has been inspected, it is ready for loading with an MPC.

4.15.3.2 Loading and Closure of the MPC

After confirming the seal's integrity, the two are then moved over and lowered into the spent fuel pool's (SPF) cask loading area (Figure 4.15-7). Once fully seated the lifting yoke's arms are spread to allow removal of the crane and lifting device (Figure 4.15-8). Fuel loading can now be accomplished. The loading of the 68 fuel bundles is accomplished using normal fuel movement procedures and equipment.

Once loaded the MPC's lid is then lowered into the pool and placed onto the MPC (Figure 4.15-8). The MPC lid has a long drainage tube that reaches to the bottom inside of the MPC (Figure 4.15-9). When the lid is fully seated the lifting device arms are closed to engage the Hi-Trac's trunnions. Once the loaded Hi-Trac is raised to the surface of the SFP a monitored drainage line (Figure 4.15-10) is attached to the top of the MPC lid's drain connection. As the entire Hi-Trac cask, moveable bottom lid, MPC, and MPC lid are raised out of the spent fuel pool the water inside of the MPC is drained/pumped out of the MPC back into the spent fuel pool. This helps reduce the overall weight of the Hi-Trac and MPC prior to its being transported across the refuel floor.

The Hi-Trac, loaded MPC and lid are then moved to a decontamination/work area (Figure 4.15-7a). The cask is then surrounded with work scaffolding and washed clean of contamination. Once decontaminated the MPC lid is welded to the MPC (Figure 4.15-10). The lid provides a shield for the top of the MPC. The MPC is then completely evacuated of water via a vacuum evacuation (Figure 4.15-11a). The MPC is then backfilled with Helium and a plugs are welded into the drain ports on the MPC lid. The MPC has a secondary lid that is welded over the lid weld and drain port welds. The Hi-Trac top lid is then bolted to the top of the Hi-Trac cask. Once the top lid is in place the lift cleats are then bolted to the top of the MPC (Figure 4.15-12a).

The MPC is now ready for transfer to the Hi-Storm cask.

4.15.3.3 Hi-Storm Cask Preparation and Loading

The Hi-Storm cask consists of three basic parts. The Hi-Storm cask, which is the concrete filled outer shell (Figure 4.15-12d), the Hi-Storm cask closure head and an alignment plate. The alignment plate alignments the Hi-Trac's bottom moveable lid to the top of the Hi-Storm cask.

The Hi-Storm without the lid is moved into the reactor building on ground level under the access hatch to the refueling floor. At many sites this involves small clearances between the Hi-Storm cask and the railroad bay doorway. Special low profile rollers are usually employed to accommodate the height restrictions.

The Hi-Trac is first bolted to a mating device that also serves as a drawer opener for the Hi-Trac's bottom lid. These are then lowered from the refuel floor, aligned to the top of the Hi-Storm and bolted into place (Figure 4.15-13). The Hi-Storm now supports the entire weight of the alignment plate, the mating device, the Hi-Trac cask, its lower moveable lid, its upper lid, the MPC and all of its contents. The crane is then disconnected from the Hi-Trac's trunnions and refitted with long straps designed for heavy loads (Figure 4.15-14). These straps are attached to the top of the MPC's lifting cleats through the large opening in the Hi-Trac lid. Once attached, the crane lifts the MPC slightly to remove the weight from the Hi-Trac's lower re-moveable lid. After the weight has been removed, the lower Hi-Trac lid is unbolted from the bottom of the Hi-Trac cask. After unbolting the re-moveable lid is lowered onto the mating device's moveable drawer by deflating the special pads internal to it. The lower lid is then moved horizontally exposing the MPC to the inside of the Hi-Storm cask. The MPC via the long straps is then lowered into the Hi-Storm cask until it rests on the bottom. At this time high radiation areas are possible around the mating device between the Hi-Trac and Hi-Storm. Once fully seated in the Hi-Storm the straps are then disconnected from the overhead crane and allowed to drop onto the top of the MPC down inside of the Hi-Trac cask. The Hi-Trac cask is then unbolted from the mating device and along with the straps, returned to the refuel floor.

The Hi-Trac's re-moveable lower lid is then re-inserted into the mating device and both are then returned to the refuel floor (Figure 4.15-15). The Hi-Storm's alignment plate is then removed.

4.15.3.4 Hi-Storm Handling and ISFSI Storage

The Hi-Storm is moved from the reactor building the same way it was brought in (Figure 4.15-16). Often this not only includes the use of low profile rollers, but often a small towing device is also employed. Being so tall, the Hi-Storm must first be removed from the reactor building prior to installation of the closure head. The closure head is bolted to the top of the Hi-Storm (Figure 4.15-17). The Hi-Storm and its closure head together provide shielding and flow paths for air to circulate around the MPC loaded within. The

Hi-Storm is then lifted approximately six inches off the ground by a Holtec Trawler. The crawler is not only capable of lifting the Hi-Storm, but it is also capable of transporting the Hi-Storm to its resting place within the ISFSI. Due to the weight of the entire Hi-Storm, the loaded MPC within and the trawler combined, many sites have had to evaluate or re-evaluate the entire pathway that is to be traversed by the trawler. This evaluation must include not only the roadway but all of the buried pipes and conduit below that could be crushed under the massive weight.

4.15.3.5 Hi-Star versus the Hi-Storm

The Hi-Star is a cask system designed for the overland transport of SNF. To transport SNF to an MRS the Hi-Storm would have to be unloaded back into the spent fuel pool and reloaded into a Hi-Star cask. As stated above, most sites have at least two of the Hi-Star casks for future transport of their SNF to an MRS.

4.15.4 Requirements of 10CFR72

A short discussion of the general design criteria of 10CFR 72 is given in the paragraphs which follow.

4.15.4.1 Certificate of Compliance (CoC)

The NRC issues a CoC to a vendor following a technical review and approval of a dry storage system’s design in accordance with 10 CFR 72. These certificates are issued for terms not to exceed 20 years from the date of issuance and can be renewed in additional 20-year increments. Renewals must be submitted more than two years prior to the expiration date. Fifteen (15) CoC for the casks above have been issued as of Jan 2011.

4.15.4.2 ISFSI Licenses

The NRC authorizes storage of SNF at an ISFSI under two licensing options: site-specific licensing and general licensing. A site-specific license authorizes operation of a storage facility, subject to the NRC’s standard licensing requirements. The license specifies the type of storage system to be used. Alternatively, nuclear power plant operators may operate an ISFSI under a general license using NRC-approved dry storage casks.

The first U.S. commercial ISFSI was licensed by the NRC in 1986 at the Surry Nuclear Plant in Virginia. Since then, dry cask storage has become common among licensees needing additional SNF storage capacity. Accordingly, SNF is currently in dry storage at 40 general license ISFSIs and 15 site-specific license ISFSIs.

4.15.4.2.1 Site-Specific License

Under a site-specific license, an applicant submits a license application to the NRC, and a technical review is performed on the safety aspects of the proposed ISFSI. If the application is approved, the NRC issues a license that is valid for up to 20 years. The license contains technical requirements and operating conditions (including fuel specifications, cask leak testing, surveillance, and other requirements) for the ISFSI and specifies what the licensee is authorized to store at the site.

4.15.4.2.2 General License

A general license authorizes a nuclear plant licensee to store SNF in NRC-approved casks at a site that is licensed to operate a power reactor under 10 CFR Part 50. Licensees are required to demonstrate that their site is adequate for storing SNF in dry casks. The licensee must also make any necessary changes to its security program, emergency plan, quality assurance program, training program, and radiation protection program to incorporate the ISFSI at its location. In addition, these evaluations must show that the cask's technical specifications covered in the Certificate of Compliance (CoC) can be met, including analysis of earthquake intensity and tornado missiles (objects accelerated by very high winds).

The general license option allows plants to avoid repeating certain evaluations – such as environmental impact or seismic reviews – that were already conducted for the plant's operating license.

4.15.4.3 Final Safety Analysis Report

Each application for an ISFSI license must include a Safety Analysis Report describing the proposed ISFSI. The minimum information to be included must consist of the following:

- A description and assessment of the site.
- A discussion of the ISFSI's structures.
- The design of the ISFSI including:
  - the design criteria,
  - the design basis,
  - information relative to materials, arrangement, dimensions and description of all system, structure and component (SSC) important to safety and
  - applicable codes and standards.
- An analysis and evaluation of the design and performance of SSCs assessing the impact on public health and safety including:
  - the margins of safety during normal operation and during expected operational occurrences and
  - the adequacy of SSCs for prevention of and mitigating the consequences of accidents, both natural and manmade phenomena events.
- The means for controlling and limiting occupational radiation exposure.
- The features of the ISFSI to reduce radioactive waste volumes.
- An identification of those subjects that will be probable license conditions and technical specifications.
- A plan for the conduct of operations.
- The technical qualifications of the applicant.

- A description of the applicant's plan for coping with emergencies.
- A description of the equipment to maintain control of radioactive materials (gaseous and liquid) produced during operation, including:
    - an estimate of the radionuclides expected to be released annually,
    - a description of the equipment and processes used in radioactive waste systems and
    - a general description of the provisions for packaging, storage, disposal of solid wastes from the processing of effluents.
- An analysis of the potential dose to an individual outside of the controlled area from accidents and natural phenomena events.
- A description of the quality assurance program.
- A description of the detailed security measures for physical protection.
- A description of preoperational testing and initial operations.
- A description of the decommissioning plan.

4.15.4.4 Technical Specifications

Each application for an ISFSI license must include a proposed technical specifications. The technical specifications must include:

- Functional and operating limits and monitoring instruments and limiting control settings.
- Limiting conditions.
- Surveillance requirements.
- Design features, and
- Administrative controls.

4.15.4.5 10 CFR 72.212 Evaluations (general license only)

General licenses are issued for ISFSIs at power reactor sites. Since these sites are already licensed per 10CFR Part 50 they must maintain physical protection and security of their plants and materials in accordance with Part 73. Therefore, the requirements of 10 CFR 72.212 pertain to a general license and not a site-specific license. Per 72.212 the licensee shall:

- Notify the NRC
    - at least 90 days prior to the first storage of SNF and
    - register each cask no later than 30 after using that cask to store SNF, and
    - pay the fees for inspections related to SNF storage.
- Perform written evaluations prior to use that:
    - the conditions set forth in the CoC have been met,
    - cask storage areas have been adequately designed to support the loads of the stored casks, and
    - that the annual dose to individuals outside the controlled area from the ISFSI, discharges, or operations will not exceed: 25 mrem whole body, 75 mrem thyroid or 25 mrem to any other critical organ, and evaluate any changes to these evaluations.
- Review the FSAR referenced in the CoC.
- Evaluate if the storage of SNF will involve a change to the site's Technical

Specifications.
- Protect the SNF against the design basis threat of radiological sabotage as per the site's security plan and:
  - assure ISFSI activities do not decrease the protection of the site's vital equipment,
  - store the SNF in a protected area,
  - before admission to a new protected area perform personnel searches,
  - provide observational capability via video, guard or watchman, and
  - interdiction or neutralization of threats is not required.
- Review the emergency plan, QA program, training program, and radiation protection program to assure that their effectiveness has not decreased.
- Maintain a copy of the CoC for each cask model used.
- Accurately maintain records showing:
  - name and address of cask vendor,
  - listing of SNF stored in the casks, and
  - any maintenance performed on the cask.
- Conduct activities only in accordance with written procedures.
- Make records and casks available for inspection.

4.15.4.6 Changes, Tests, and Experiments

Changes, tests and experiments are evaluated in a manner very similar to changes, tests and experiments to a facility itself. For a facility the changes would require an evaluation as per 10CFR 50.59. Changes, tests and experiments are evaluated as per 10CFR 72.48. It states that a license holder or holder of a CoC may make changes to the ISFSI, cask design, procedures and conduct tests or experiments not described in the FSAR if:
- a change to the technical specifications is not required,
- a change to the terms, conditions or specifications is not required, and the change, test or experiment does not:
  - result in an increase in the occurrence of an analysed accident,
  - result in an increase in the likelihood of a malfunction of an evaluated SSC,
  - result in an increase in the consequences of an analysed accident,
  - result in an increase in the consequences of a malfunction of an evaluated SSC,
  - create a possible accident of a different type,
  - create a possible malfunction to an SSC with a different result,
  - result in a design basis limit for a fission product barrier being altered, or
  - results in a departure from a method of evaluation described in the FSAR.

Otherwise, a license amendment or CoC amendment would be required

4.15.4.7 General Considerations

The design criteria set forth in 10CFR are the minimum requirements for an ISFSI. An ISFSI must be designed to store SNF. Reactor related waste must not be stored in a cask that also contains SNF, with the exception of materials associated with fuel assemblies (e.g., control rod blades, burnable poison rods, or fuel channels). Liquid reactor wastes may not be stored in an ISFSI. If the ISFSI is a pool type than waste other than fuel must be leach resistant. Design materials must be such that there will be no chemical, galvanic or other reactions between components. The NRC may authorize exceptions on a case by case basis.

4.15.4.7.1 Overall Requirements

4.15.4.7.1.1 Quality Standards

The quality standards of the SSC must be commensurate to the function that they perform.

4.15.4.7.1.2 Protection Against Environmental Conditions and Natural Phenomena

The SSC must be designed to be compatible with the site characteristics and environmental conditions associated with normal operation, maintenance, testing, and be able to withstand postulated accidents. The SSC must be designed to withstand earthquakes, tornados, lightning, hurricanes, floods, tsunami, or seiches. The design of the SSC must reflect:

- consideration of the most severe reported natural phenomena for the site and surrounding area, and
- appropriate combinations of normal and accident conditions and the effects of natural phenomena.

The ISFSI should be designed to prevent the collapse of building structures or the dropping of heavy loads on SNF or SSCs.

Capability of determining the intensity natural phenomena for comparison with the design basis of the SSCs.

If the ISFSI is located over an aquifer that is a major water resource then measures must be taken to prevent the transport of radioactive materials through this pathway.

4.15.4.7.1.3 Protection Against Fires and Explosions

SSCs must be designed to perform their safety function under credible fire and explosion exposure conditions. Non-combustible and heat-resistant materials must be used whenever practical.

4.15.4,7.1.4 Sharing of SSCs

SSCs must not be shared between an ISFSI and other facilities unless it is shown that the capability of either will not be impaired.

4.15.4.7.1.5 Proximity of Sites

An ISFSI near another nuclear facility must be designed and operated to ensure that the effects of their cumulative operations will not constitute an unreasonable to the public.

4.15.4.7.1.6 Testing and Maintenance of SSCs

SSCs must be designed to permit inspection, maintenance and testing.

4.15.4.7.1.7 Emergency Capability

SSCs must be designed for emergencies and provide for accessibility to the equipment of onsite and offsite emergency facilities and services (e. g., ambulance, fire departments, police departments, hospitals, etc.)

4.15.4.7.1.8 Confinement Barriers and Systems

SNF cladding must be protected from degradation that leads to gross ruptures so as to not pose operational safety problems with respect to its removal from storage.

For underwater storage of SNF, where the water serves as a shield for radioactive materials, systems for maintaining purity and water level must be designed so that any abnormal operation or failure in those systems will not cause level to fall below safe limits.

Ventilation and off-gas systems must be provided where necessary to ensure confinement of airborne radioactive particulate materials.

Storage confinement systems must have the capability of continuous monitoring.

4.15.4.7.1.9 Instrumentation and Control Systems

Instrumentation and control systems must be provided to monitor systems and conditions over anticipated ranges of normal and off-normal operation.

4.15.4.7.1.10 Control Room or Control Area

A control room, if appropriate, must be designed for occupancy and actions to provide safe control under normal, off-normal or accident conditions.

4.15.4.7.1.11 Utility or Other Services

Each utility service system must be designed to meet emergency conditions.

Emergency utility services must be designed to permit testing of operability and capacity.

Provisions must be made so that, in the event of a loss of power, emergency power will be provided to instruments, service systems, the central security alarm station, and operating systems to allow safe storage.

The sharing of utilities or other services between an ISFSI and other facilities must not increase the probability or consequences of an accident or malfunction nor reduce the margin of safety defined in the basis of the technical specifications of either facility.

4.15.4.7.1.12 Retrievability

Storage systems must be designed to allow ready retrieval of SNF for further processing or disposal.

4.15.4.7.2 Criteria for Nuclear Criticality Safety

4.15.4.7.2.1 Design for Criticality Safety

SNF handling, packaging, transfer and storage must be designed to be maintained subcritical and require at least two changes to occur before a criticality accident is possible.

4.15.4.7.2.2 Methods of Criticality Control

An ISFSI must be designed with favourable geometry or neutron absorbing materials or both.

4.15.4.7.2.3 Criticality Monitoring

A criticality monitoring system shall be maintained with clearly audible alarm signals.

4.15.4.7.3 Criteria for Radiological Protection

4.15.4.7.4 Exposure Control

Radiation protection must be provided to all personnel that may be exposed to radiation or airborne radioactive materials by:

- preventing the accumulation of radioactive materials,
- decontaminating,
- controlling access,
- measuring,
- minimizing work times, and
- shielding personnel.

4.15.4.7.5 Radiological Alarm Systems

Radiological alarm systems must be provided in accessible work areas.

4.15.4.7.6 Effluent and Direct Radiation Monitoring

A means of measuring effluent medium radiation, diluting flow, and the radiation in and around the work areas must be provided.

4.15.4.7.7 Effluent Control

The ISFSI must be designed to provide means to limit to levels as low as reasonably achievable the release of radioactive materials in effluents.

4.15.4.8 Criteria for Storage and Handling

4.15.4.8.1 SNF Storage and Handling Systems

SNF storage and handling systems must be designed to ensure adequate safety under normal and accident conditions. They must be designed with:

- testability,
- shielding of radiation,
- confinement,
- heat removal capability, and
- a minimization of radioactive waste generated.

4.15.4.8.2 Waste Treatment

Radioactive waste treatment facilities must be provided.

4.15.4.9 Criteria for Decommissioning

The ISFSI must be designed for decommissioning.

4.15.5 Summary

The Waste Management Policy Act of 1982 placed a 0.10¢ per kilowatt hour fee on all consumers who use electricity generated by nuclear power. These fees have been collected by the utility and forwarded to the government to finance the construction and operation of an MRS. To date the creation of an MRS has not come to fruition and does not seem to be in the foreseeable future. In light of these facts the utilities have built alternate storage facilities for their SNF. Sites are required to maintain enough space in their spent fuel pools for a full core off-load, should it be required. As sites age and the spent fuel pools begin to fill up an alternative storage location has become a necessity.

Table 4.15-1 10CFR 72.214 List of Approved Spent Fuel Storage Casks

Model: CASTOR V/21
Certificate Number: 1000
Company: General Nuclear Systems
Expiration Date: Aug 17, 2010

Model: NAC-C28 S/T
Certificate Number: 1003
Company: Nuclear Assurance Corporation
Expiration Date: Aug 17, 2010

Model: VSC-24
Certificate Number: 1005
Company: Transnuclear, Inc.
Expiration Date: May 07, 2013

Model: HI-STORM 100 SYSTEMS
Certificate Number: 1014
Company: Holtec International
Expiration Date: May 31, 2020

Model: TN-32, 32A, and 32B
Certificate Number: 1021
Company: Transnuclear, Inc.
Expiration Date: Apr 19, 2020

Model: WSNF-220 (et all)
Certificate Number: 1026
Company: BNC Fuel Solutions Corporation
Expiration Date: Feb 15, 2021

Model: Standardized Advanced NUHOMS-24PT1 and 24PT4
Certificate Number: 1029
Company: Transnuclear, Inc.
Expiration Date: Feb 05, 2023

Model: MAGNASTORE
Certificate Number: 1031
Company: NAC International, Inc.
Expiration Date: Feb 04, 2029

Model: NAC S/T
Certificate Number: 1002
Company: Nuclear Assurance Corp
Expiration Date: Aug 17, 2010

Model: NUHOMS-24P (et all)
Certificate Number: 1004
Company: Transnuclear, Inc.
Expiration Date: Jan 23, 2015

Model: HI-STAR 100
Certificate Number: 1008
Company: Holtec International
Expiration Date: Oct 04, 2019

Model: NAC-UMS
Certificate Number: 1015
Company: NAC International, Inc.
Expiration Date: Nov 20, 2020

Model: NAC-MPC
Certificate Number: 1025
Company: NAC International, Inc.
Expiration Date: Apr 10, 2020

Model: TN-68
Certificate Number: 1027
Company: Transnuclear, Inc.
Expiration Date: May 28, 2020

Model: NUHOMS- HD-32PTH
Certificate Number: 1030
Company: Transnuclear, Inc.
Expiration Date: Jan 10, 2027

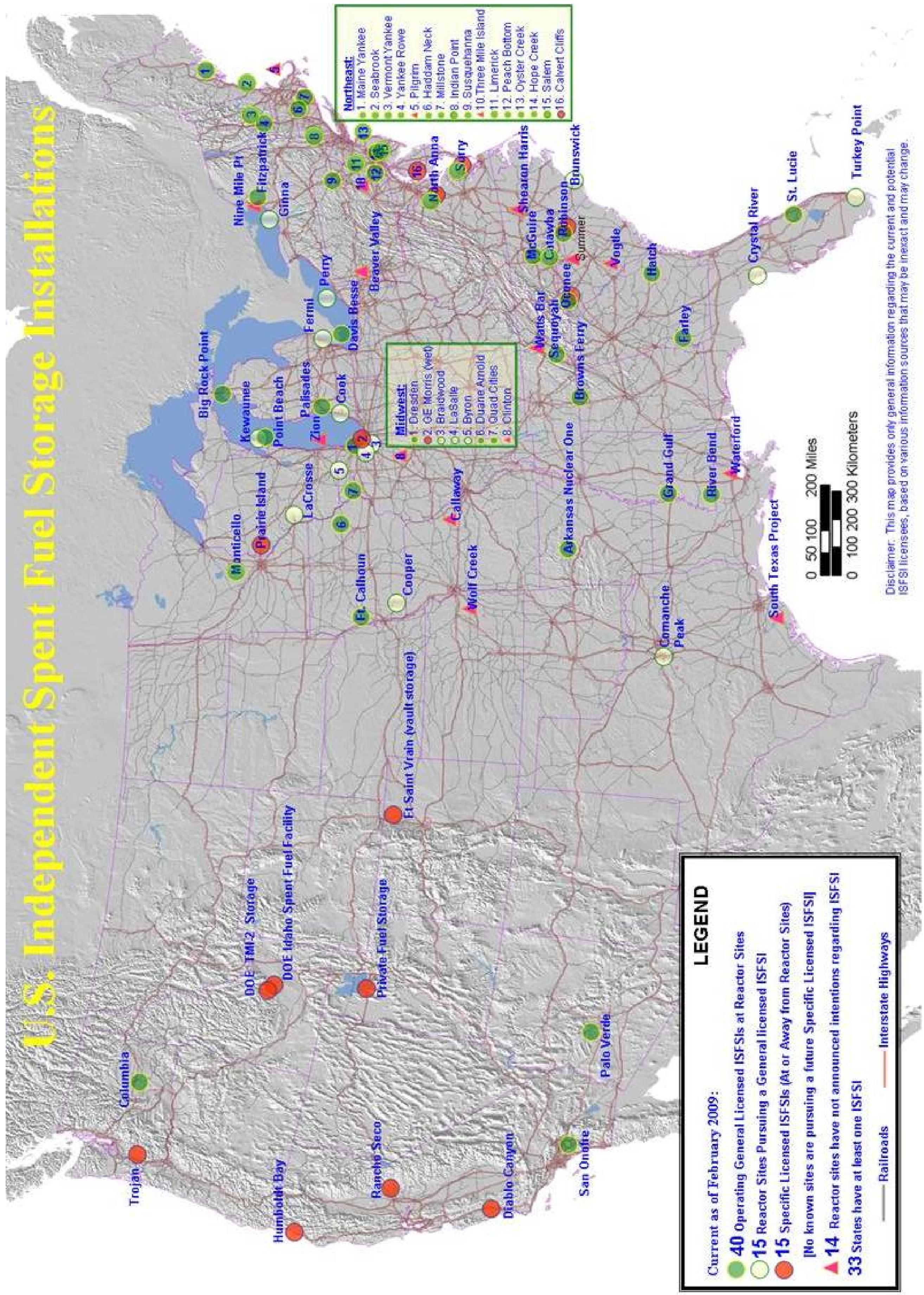


Figure 4.15-1 ISFSI Locations in the US

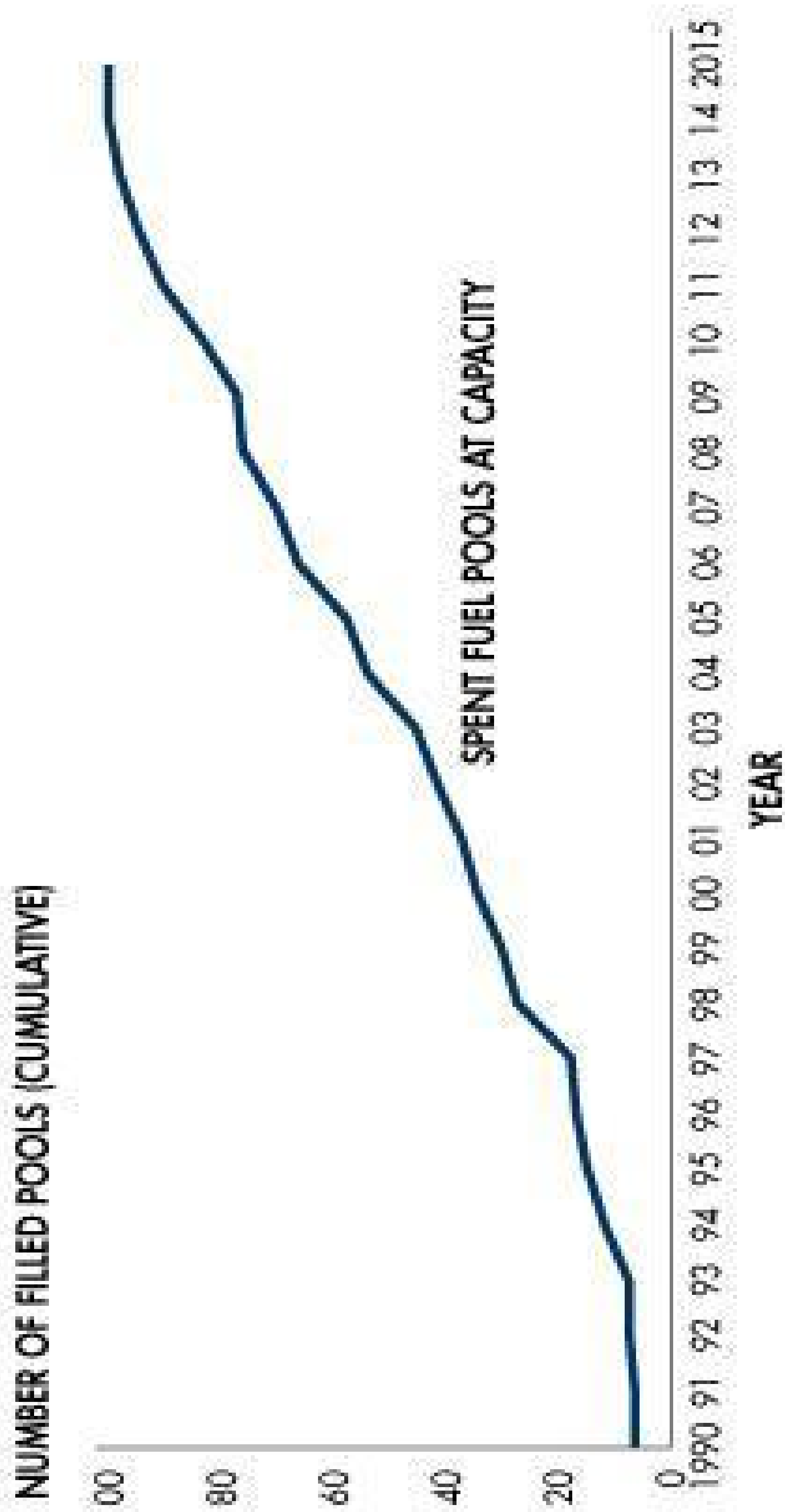
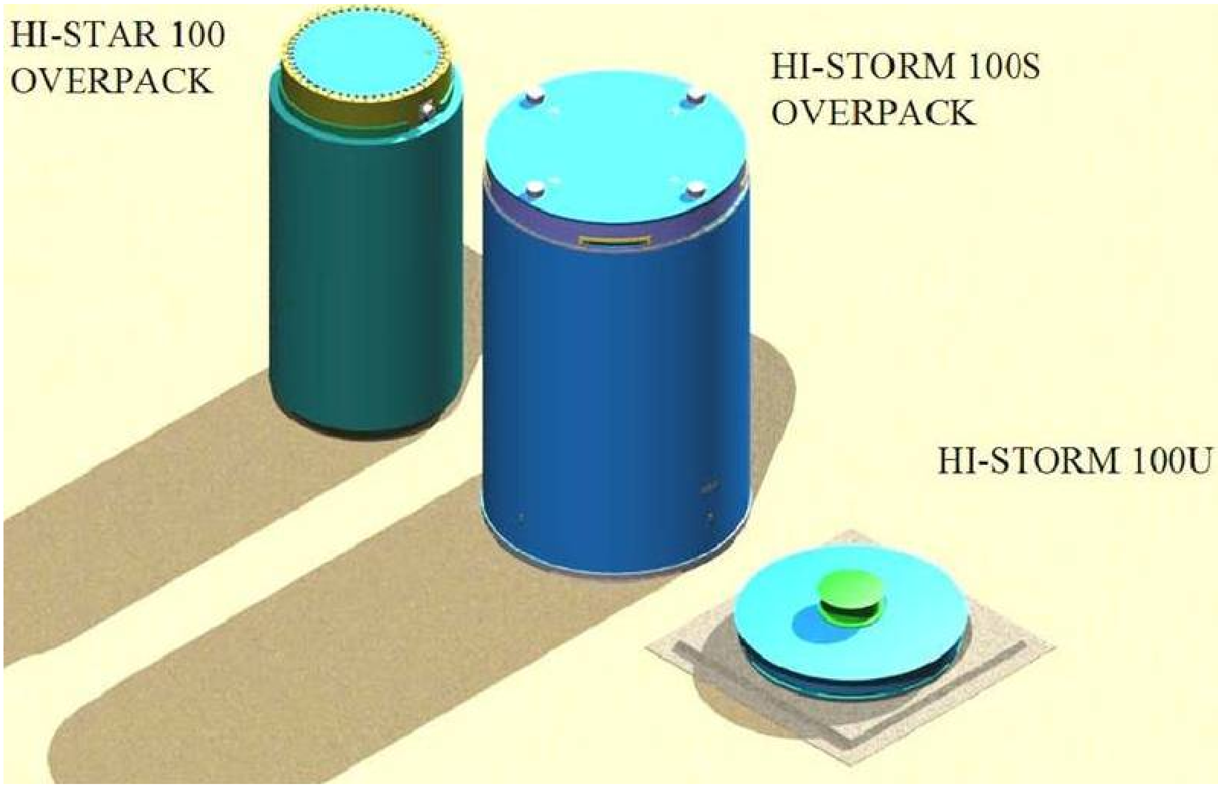
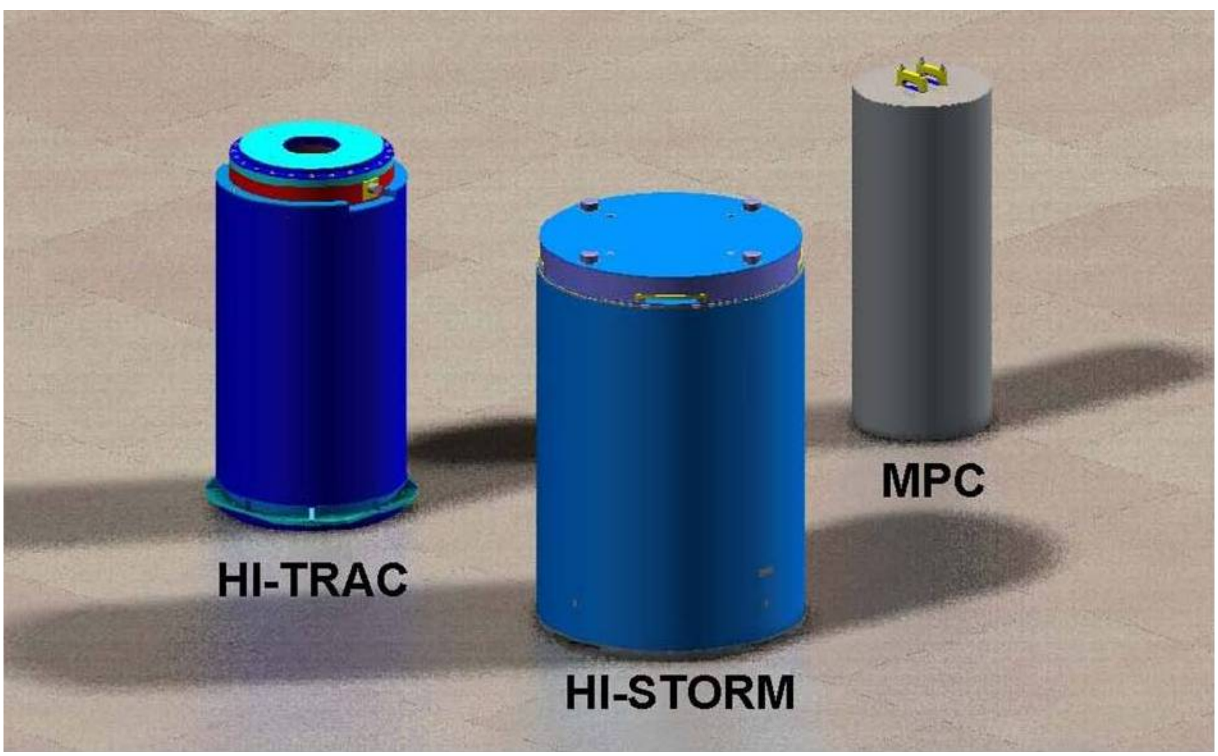


Figure 4.15-2 Projected Loss of Fuel Storage Reserve

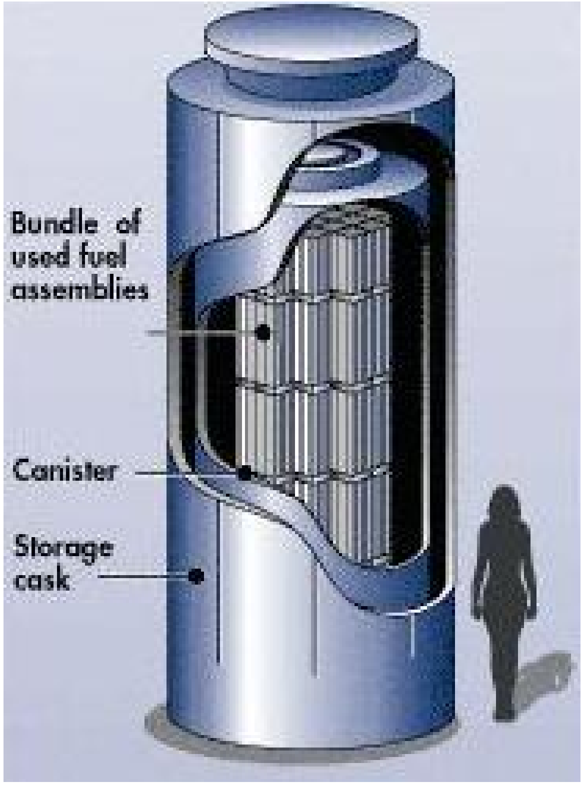


(a) Holtec Storage Systems



(b) Hi-Storm 100 System

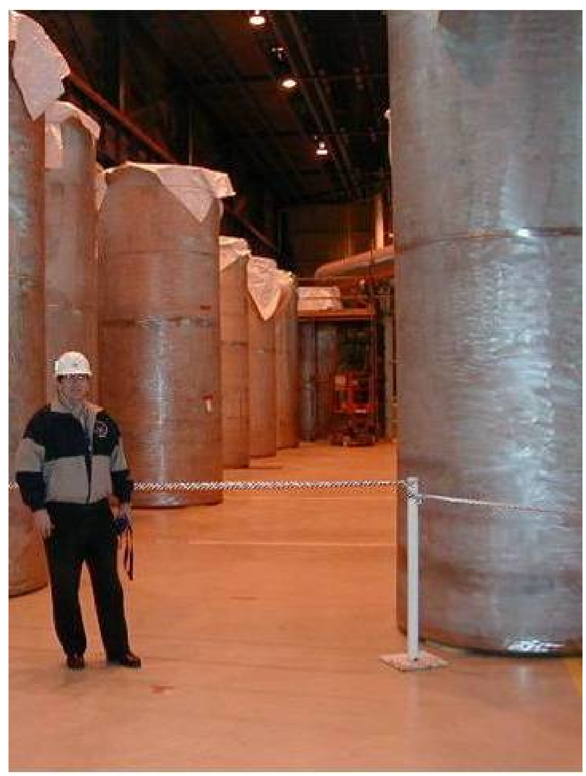
Figure 4.15-3 Holtec Storage Systems



(a) Relative Size of Hi-Star

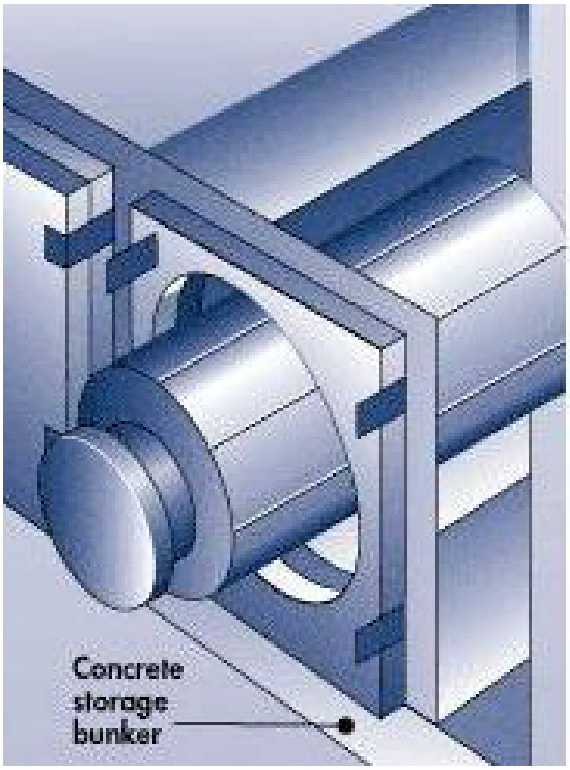
(b) Hi-Star on Pad

(c) Hi-Storm on Pad



(d) MPC Canisters

Figure 4.15-4 Vertical Storage Components



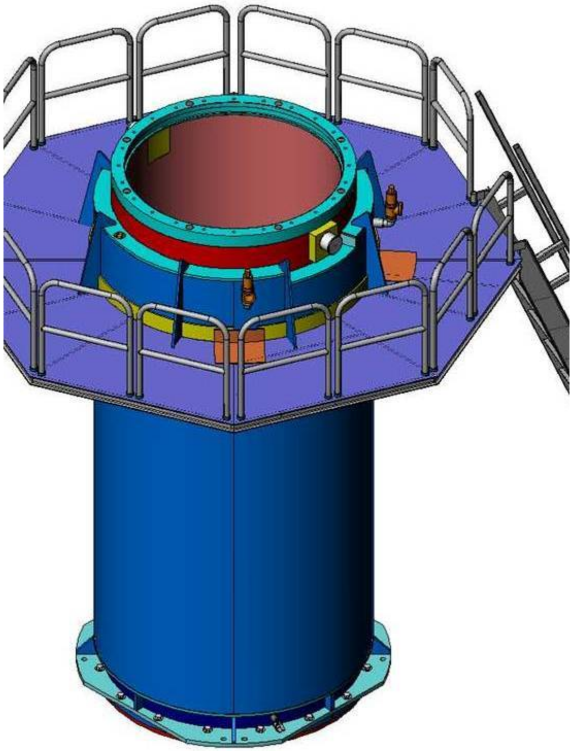
(a) Horizontal Storage

(b) Horizontal Vault

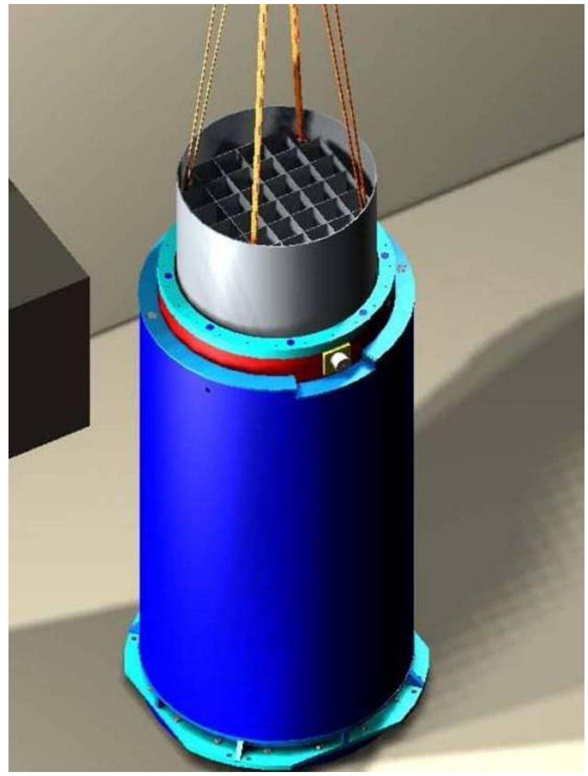
(c) Loading Horizontal Vault

(d) NUHOMS Storage

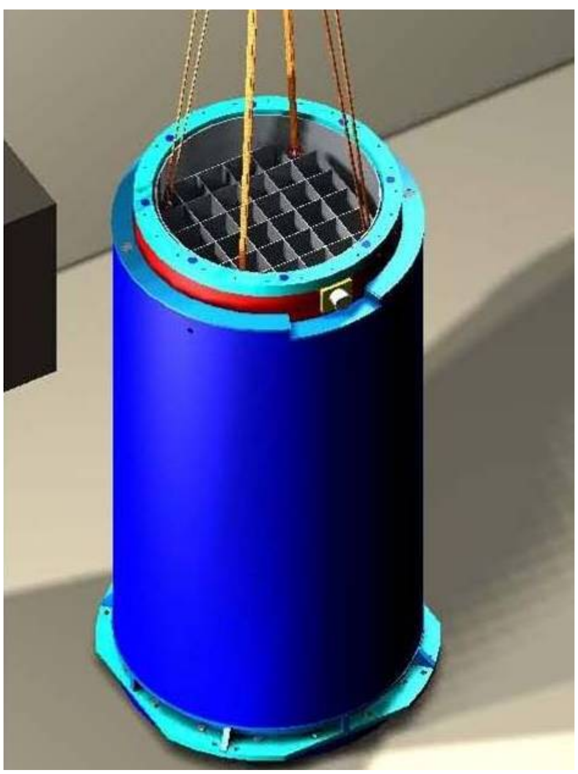
Figure 4.15-5 NUHOMS Storage System



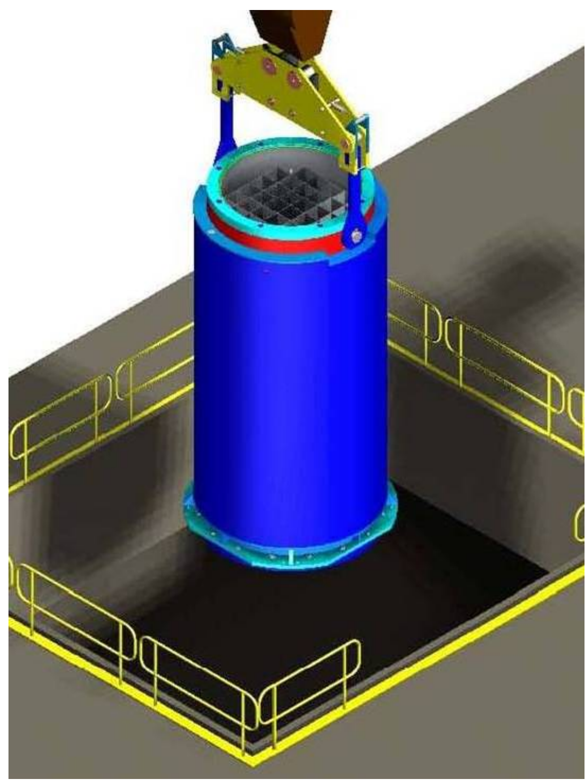
(a) Hanging Cask Work Platform



(b) Installing MPC in Hi-Trac

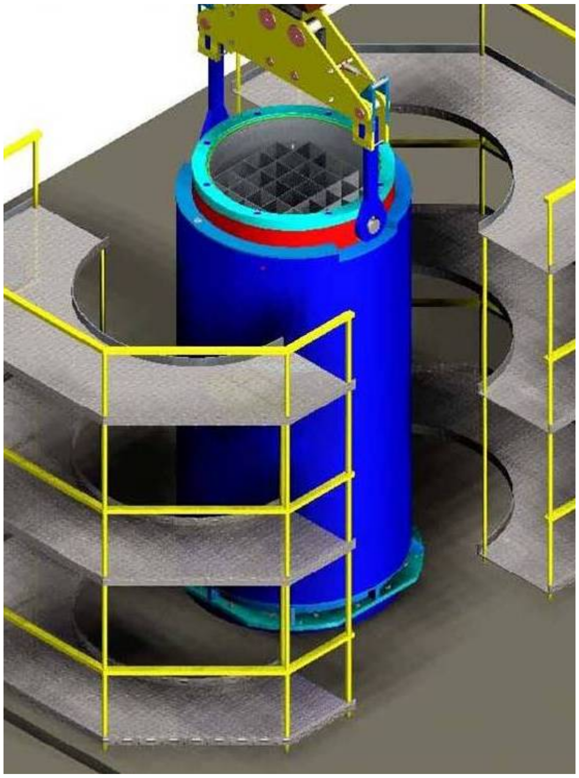


(c) MPC Fully Seated in Hi-Trac

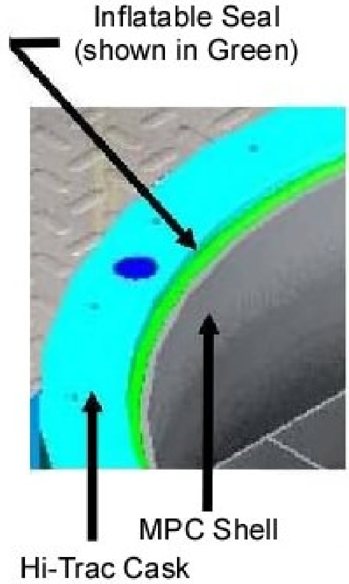


(d) Hi-Trac Raised to Refuel Floor

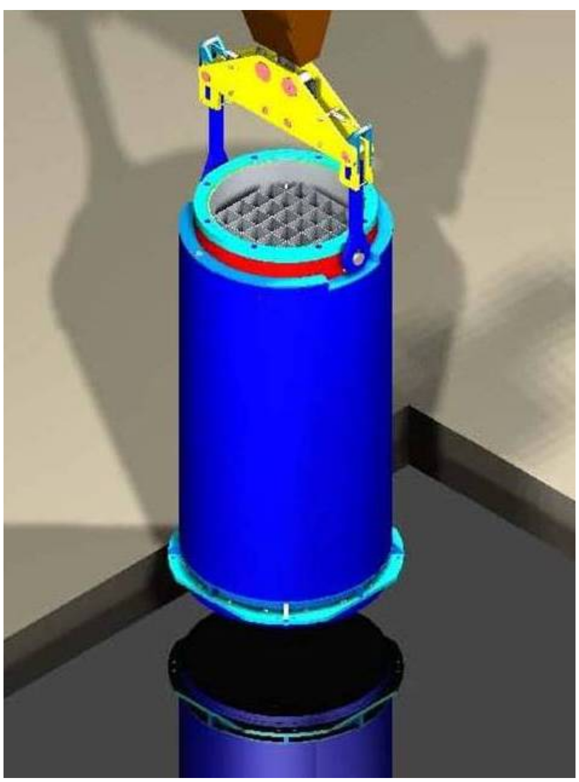
Figure 4.15-6 Beginning Cask Operations



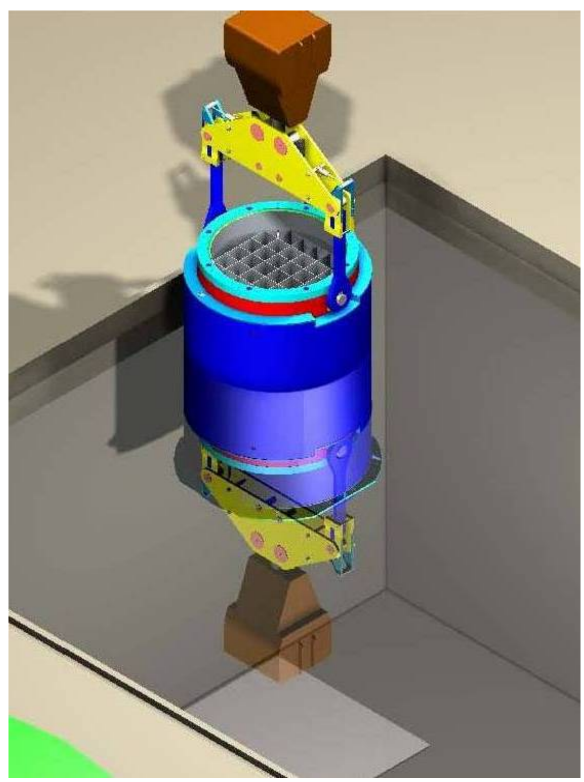
(a) Hi-Trac Placed in Prep-Washdown Area



(b) Location of Inflatable Annulus Seal

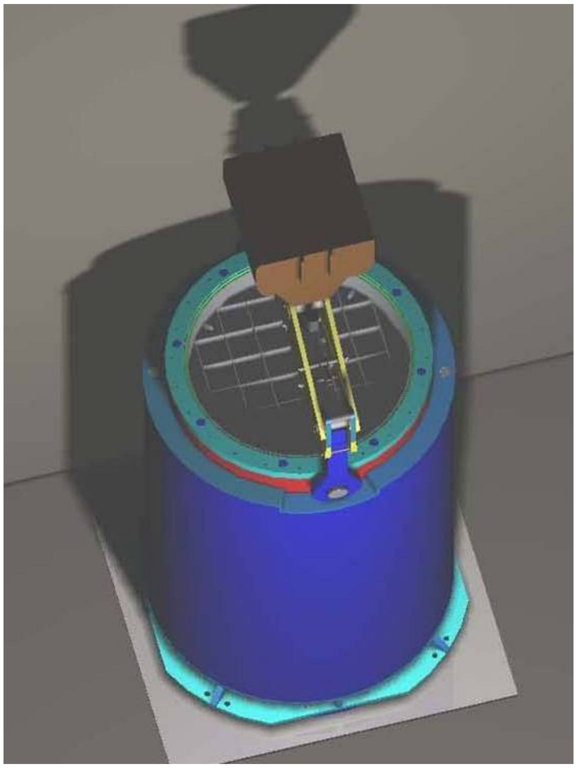


(c) Hi-Trac over Cask Loading Area of SFP

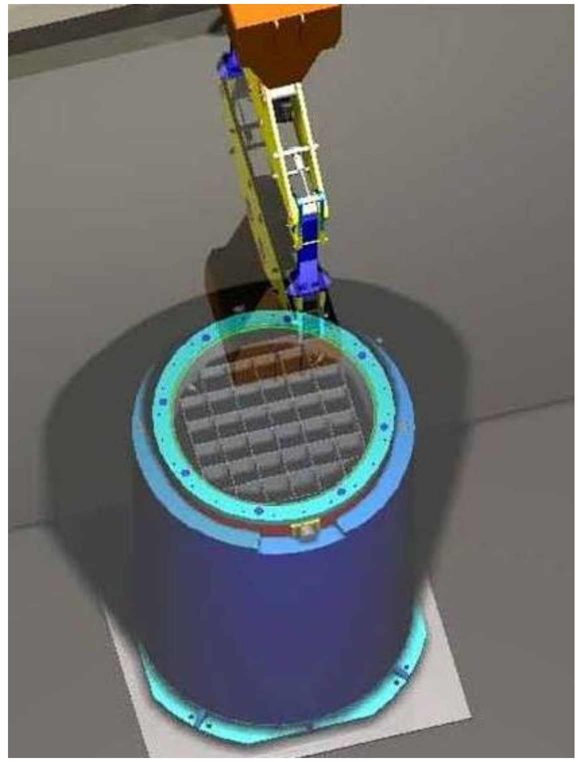


(d) Lowering Cask Into Spent Fuel Pool

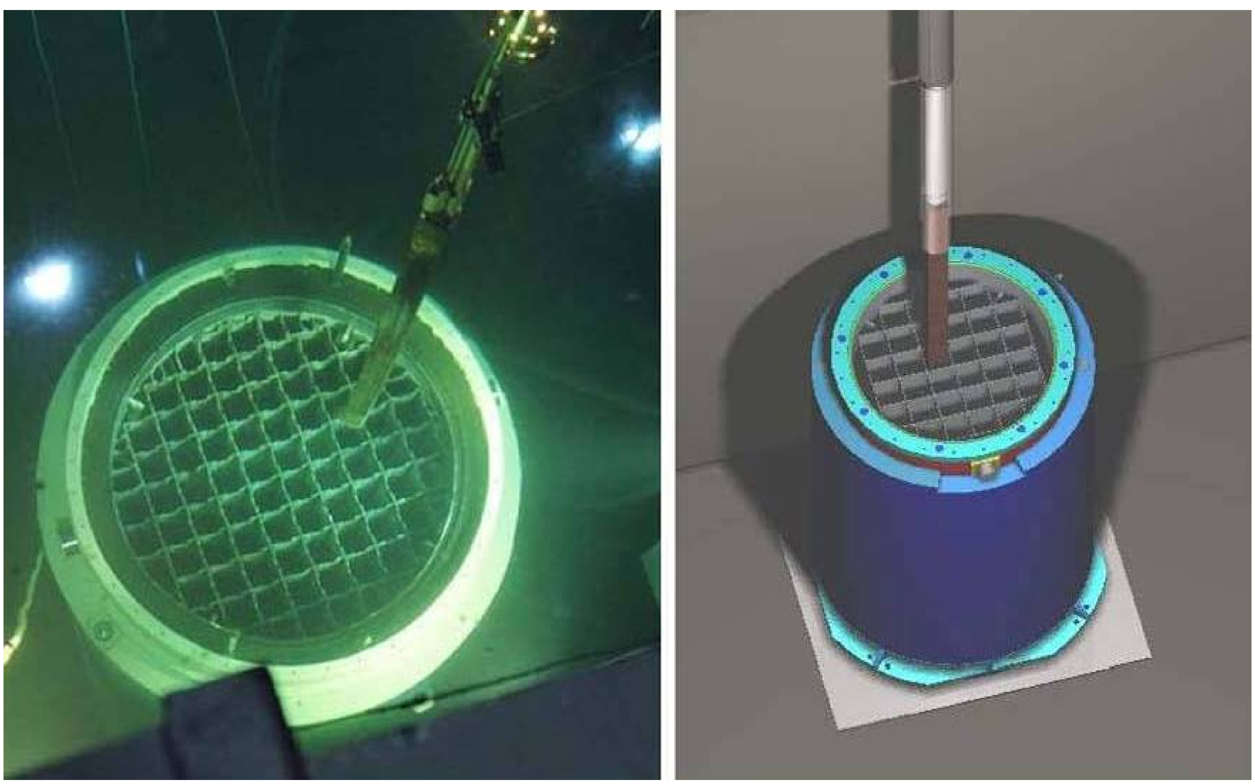
Figure 4.15-7 Cask Prep and Positioning



(a) Hi-Trac Seated in Cask Loading Area of SFP



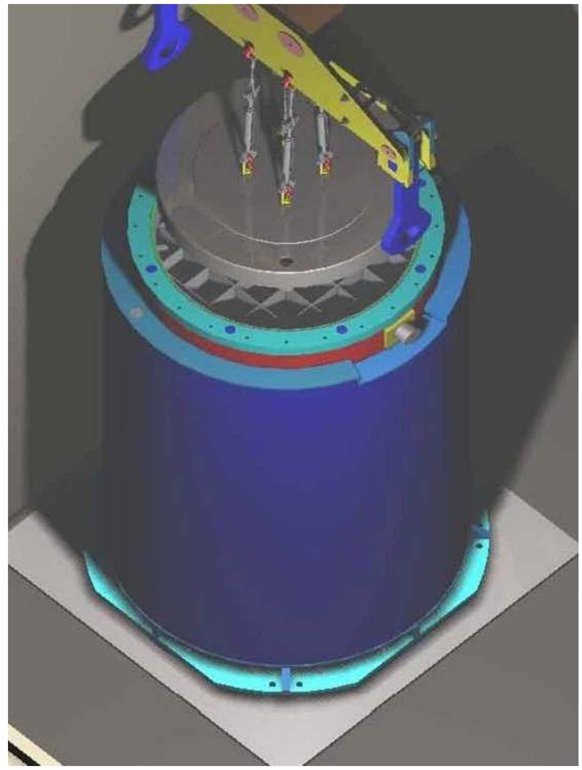
(b) Lift Yoke Disconnected from Hi-Trac



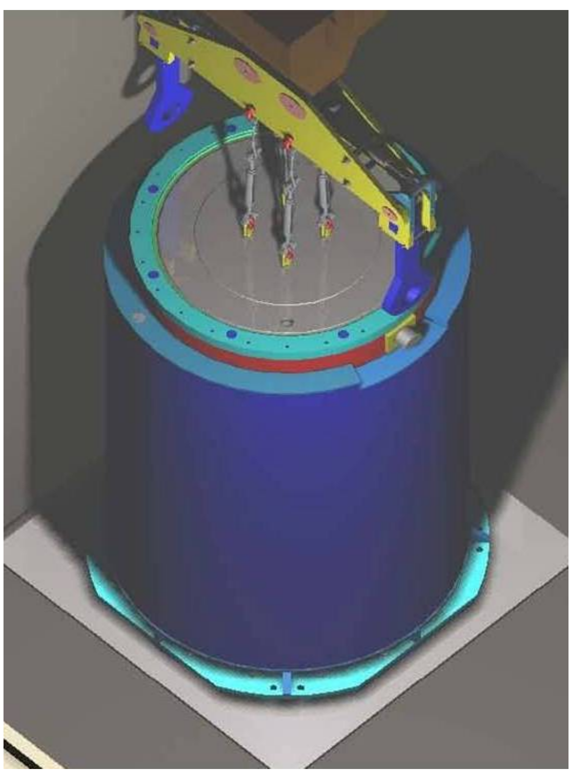
(c) Hi-Trac MPC Fuel Loading

Figure 4.15-8 Hi-Trac Seating and MPC Fuel Loading

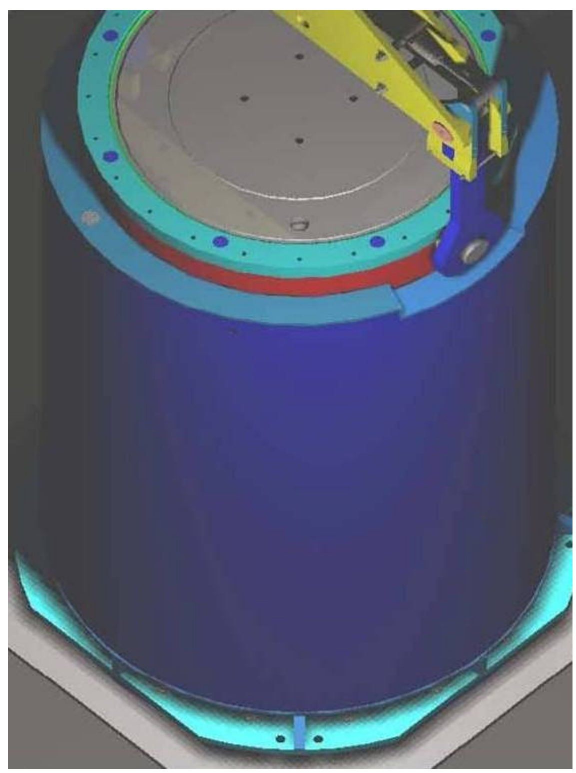
(a) MPC Lid Test Fit During Initial Preparation



(b) MPC Lid Installation in Spent Fuel Pool

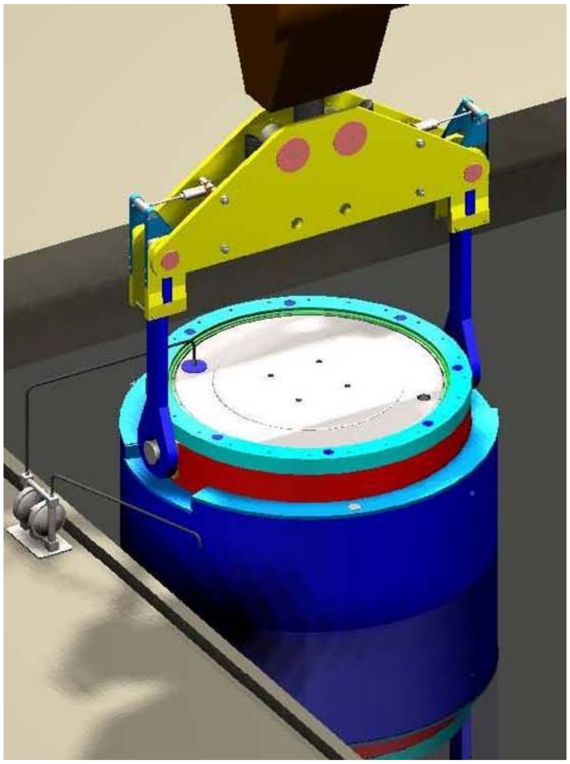


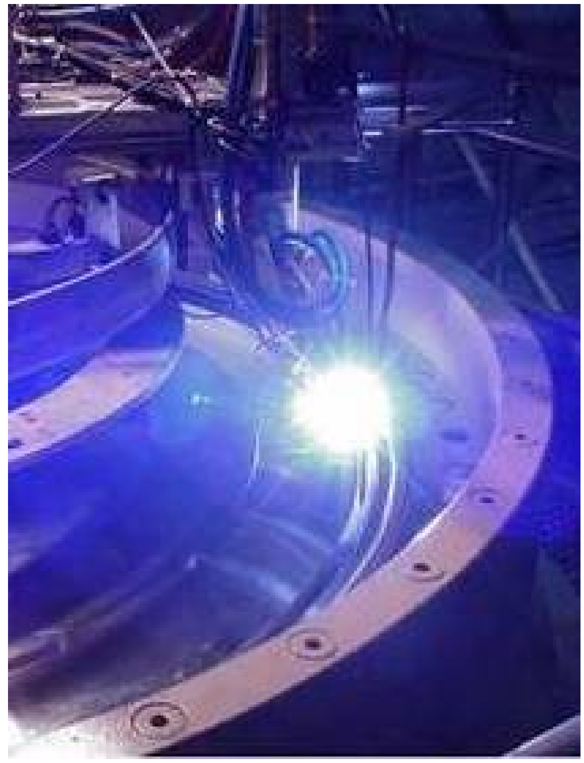
(c) Lid Fully Seated on MPC in SFP



(d) Lift Yoke Engages Trunnions

Figure 4.15-9 MPC Lid Installation While in Spent Fuel Pool



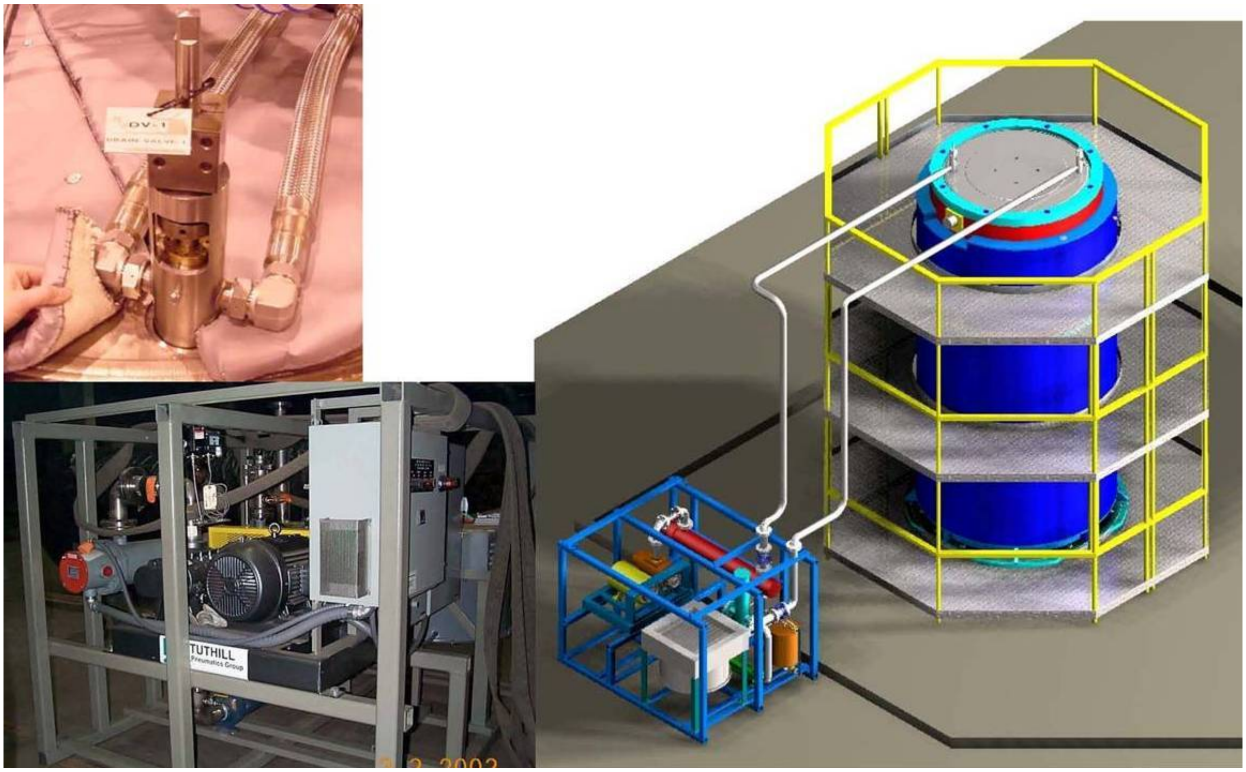


(a) Hi-Trac Raised While Being Drained

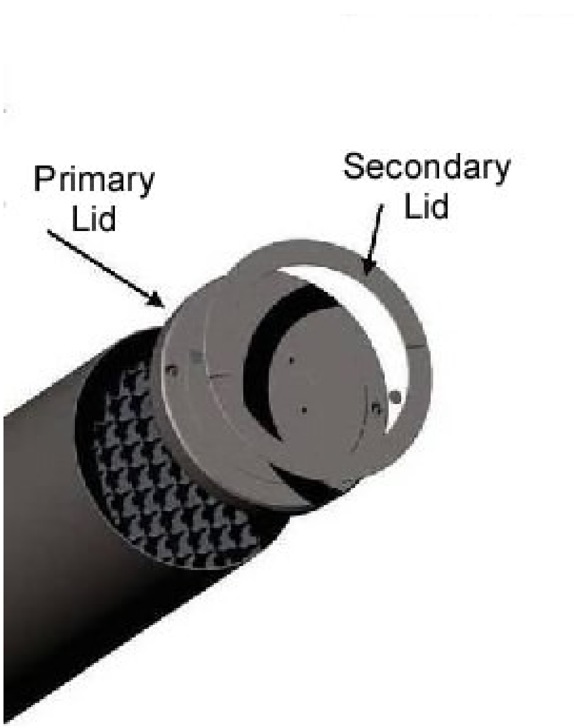
(b) MPC Lid Welding

(c) MPC Lid Welding Operations

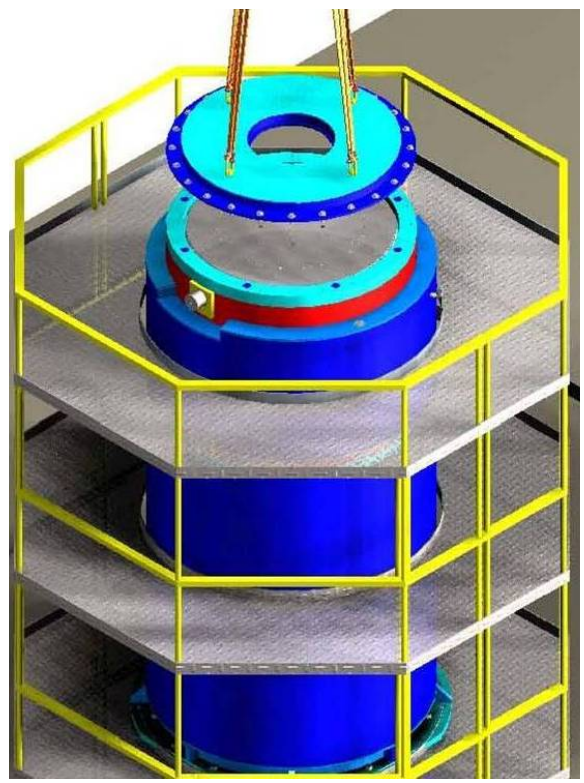
Figure 4.15-10 Hi-Trac Removal form SFP and MPC Lid Welding Operations



(a) MPC Drying and Backfill Operation

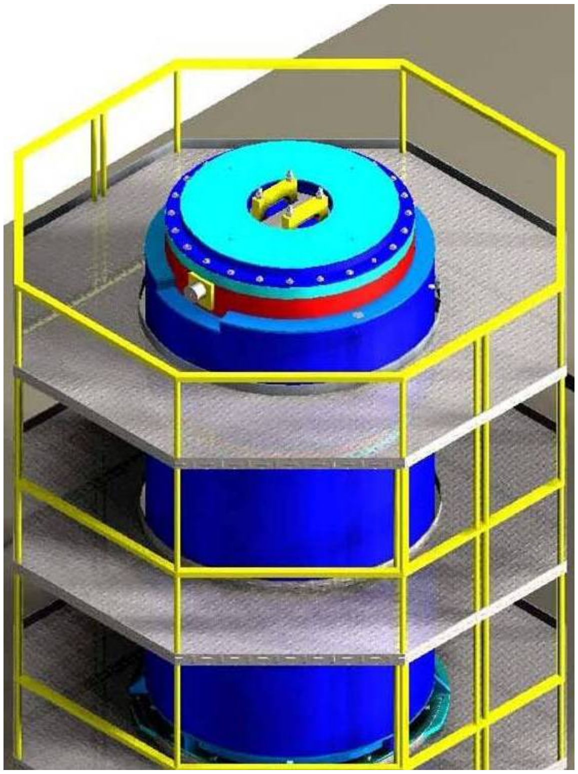


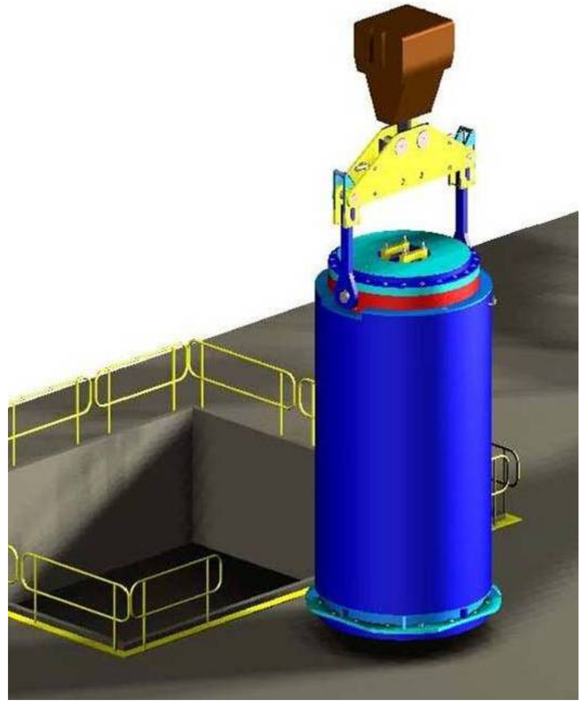
(b) MPC Lids



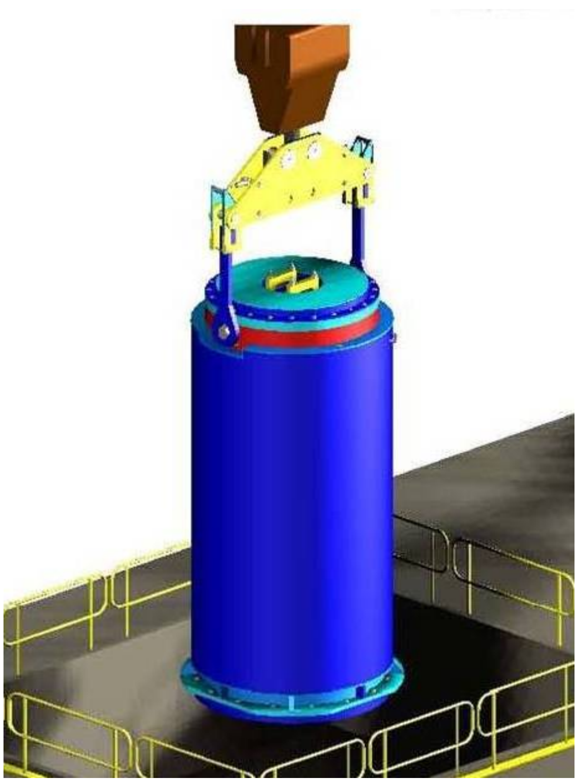
(c) Hi-Trac Top Lid Installation

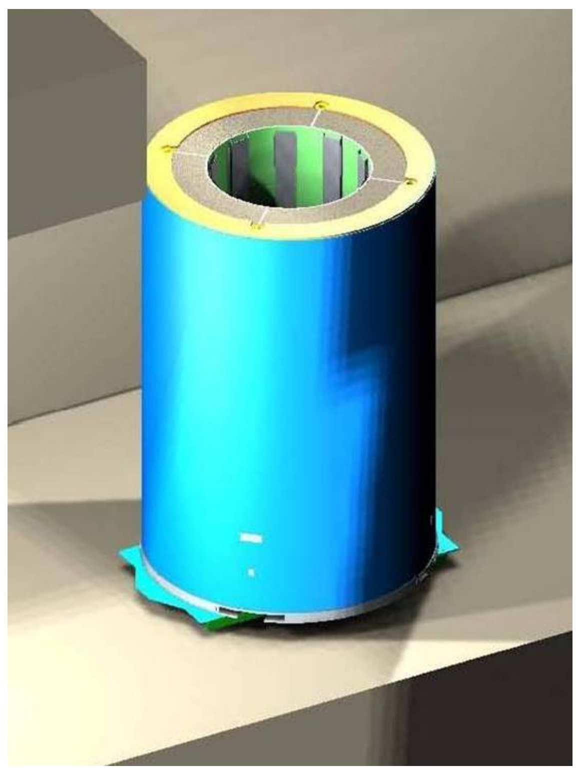
Figure 4.15-11 MPC Drying, Backfill and Hi-Trac Top Lid Installation





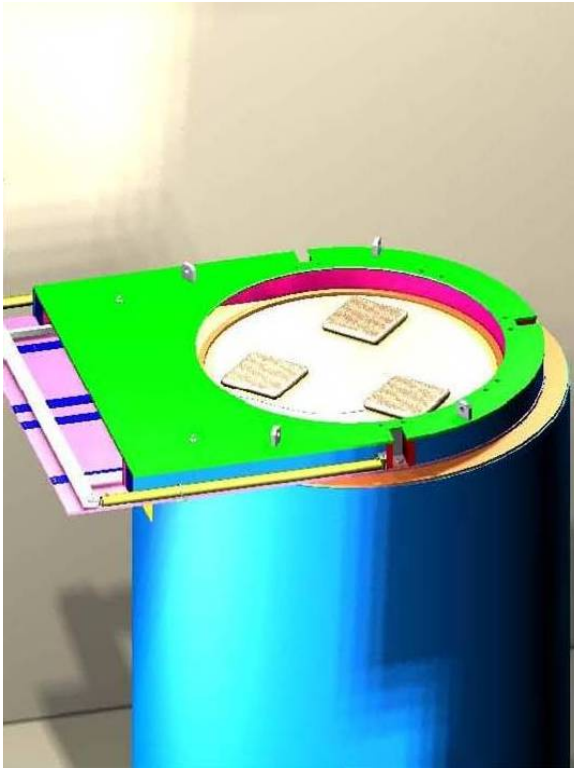
(a) MPC with Lift Cleats Installed **(b) Hi-Trac Movement to Hatchway**



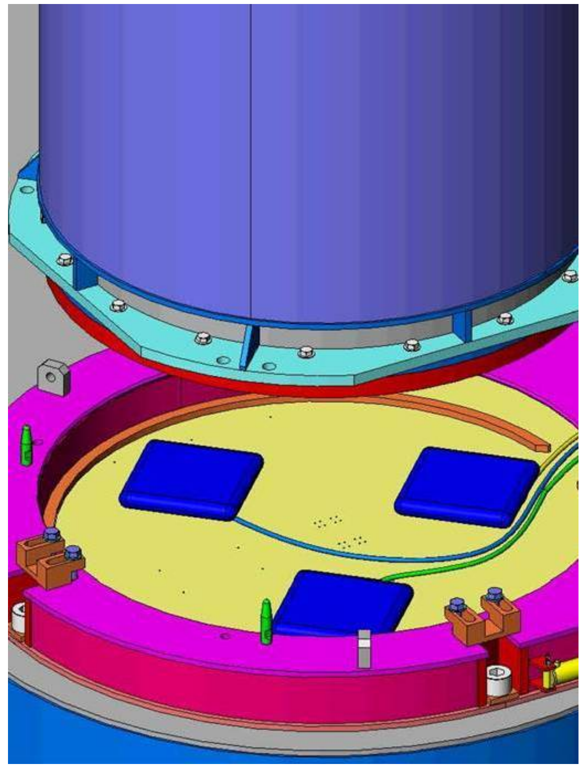


(c) Hi-Trac Positioned for Lowering **(d) Hi-Storm with Lid Removed**

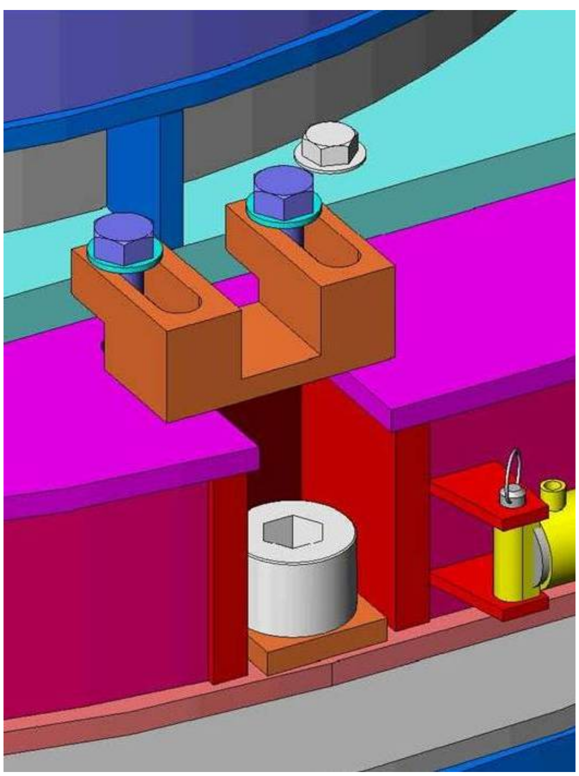
Figure 4.15-12 Install Lift Cleats and Lower Hi-Trac through Hatchway



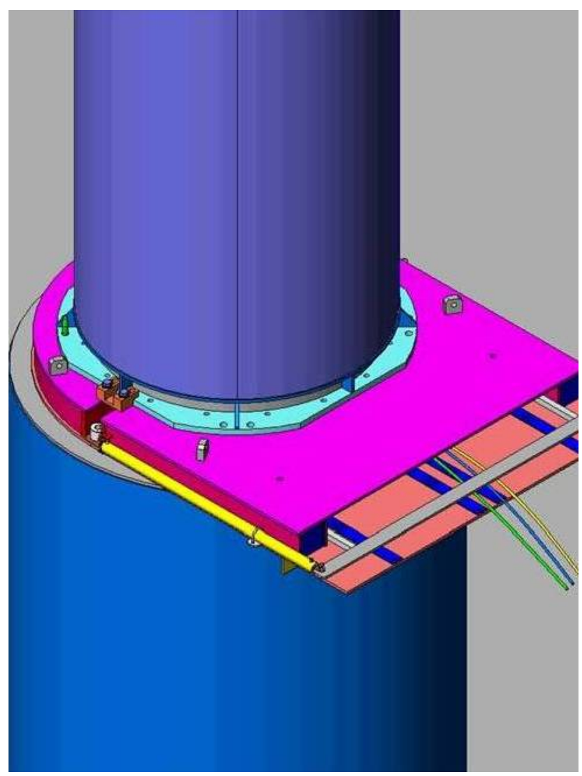
(a) Mating Device Placement on Hi-Storm



(b) Hi-Trac Placement on Mating Device

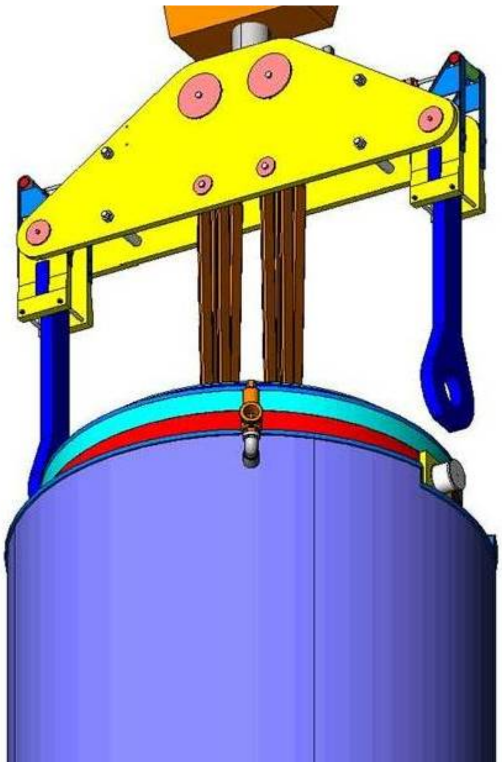


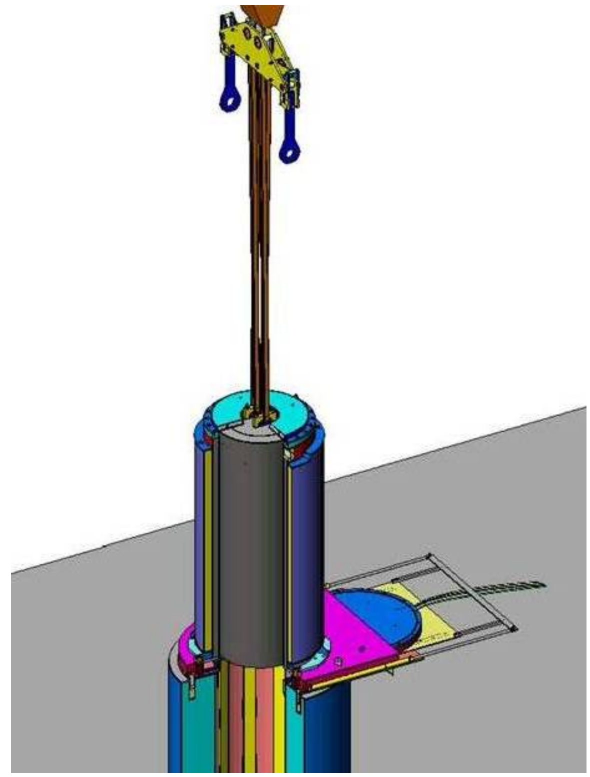
(c) Removal of Pool Lid Bolts



(d) Stack Up Configuration

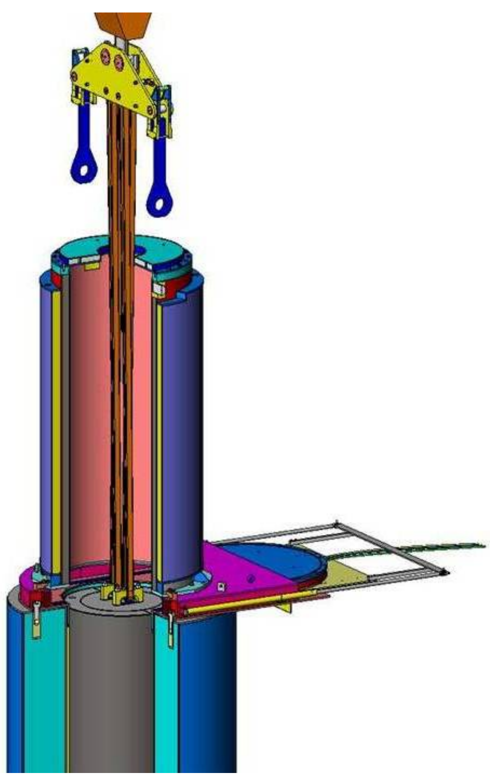
Figure 4.15-13 Mating Device Placement and Stack Up of Hi-Trac and Hi-Storm

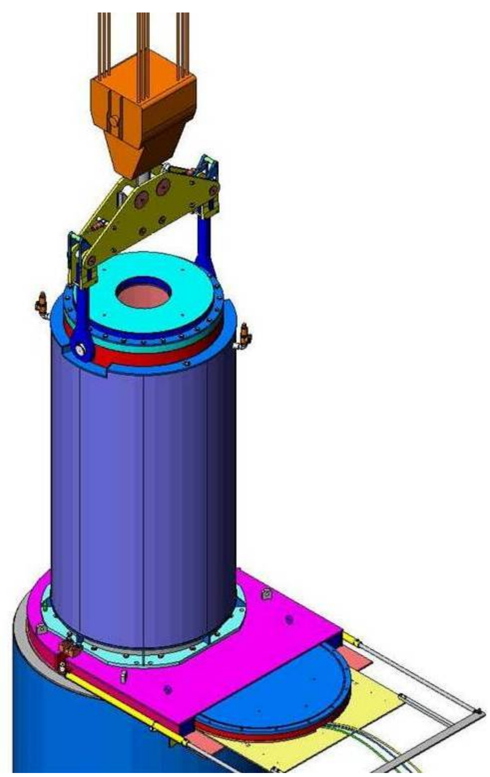




(a) Slight Raising of MPC to Remove Pool Lid

(b) Opening the Mating Device Drawer

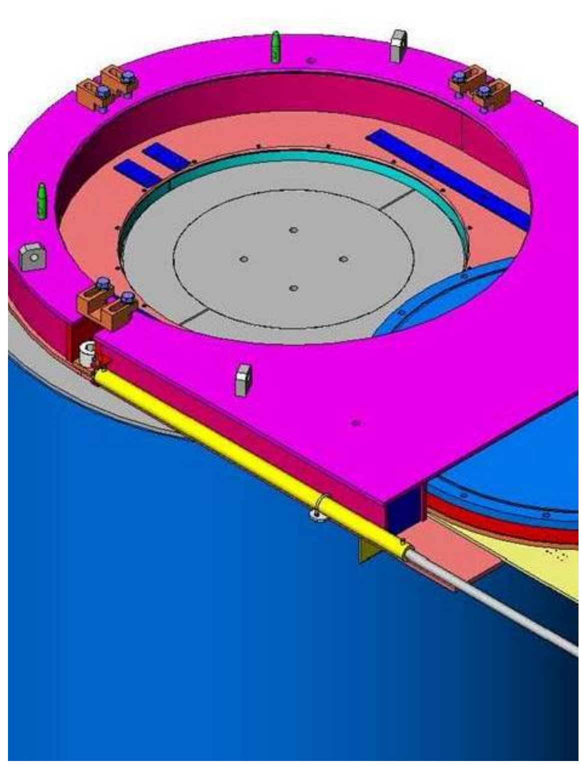




(c) Lowering MPC into Hi-Storm

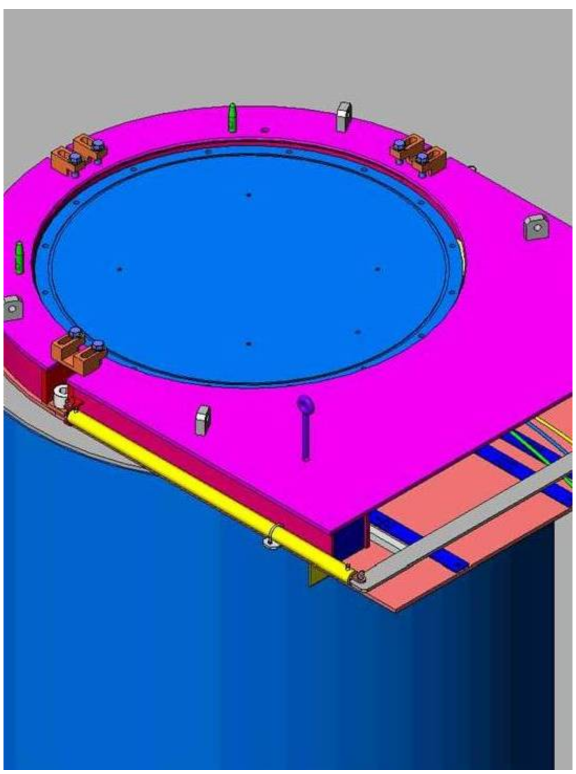
(d) Removal of Hi-Trac from top of Hi-Storm

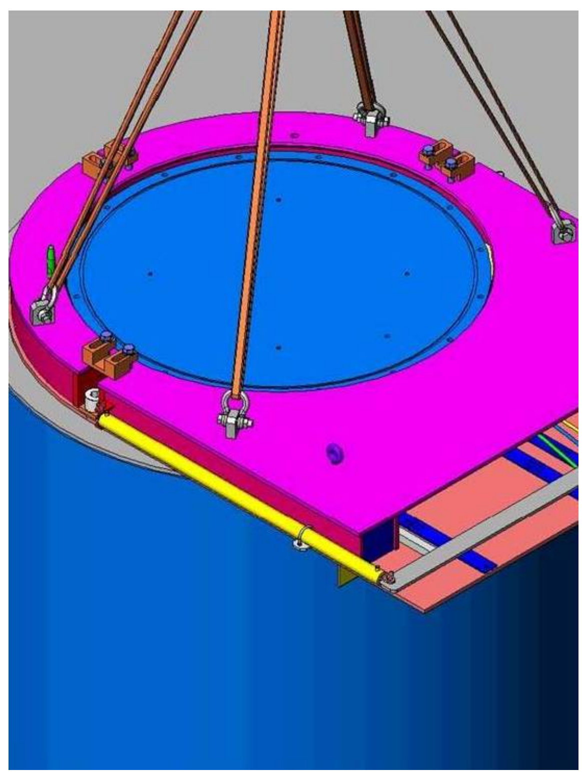
Figure 4.15-14 Transfer of MPC from Hi-Trac to Hi-Storm



(a) Transfer of MPC from Hi-Trac to Hi-Storm

(b) MPC Lift Cleats Removed



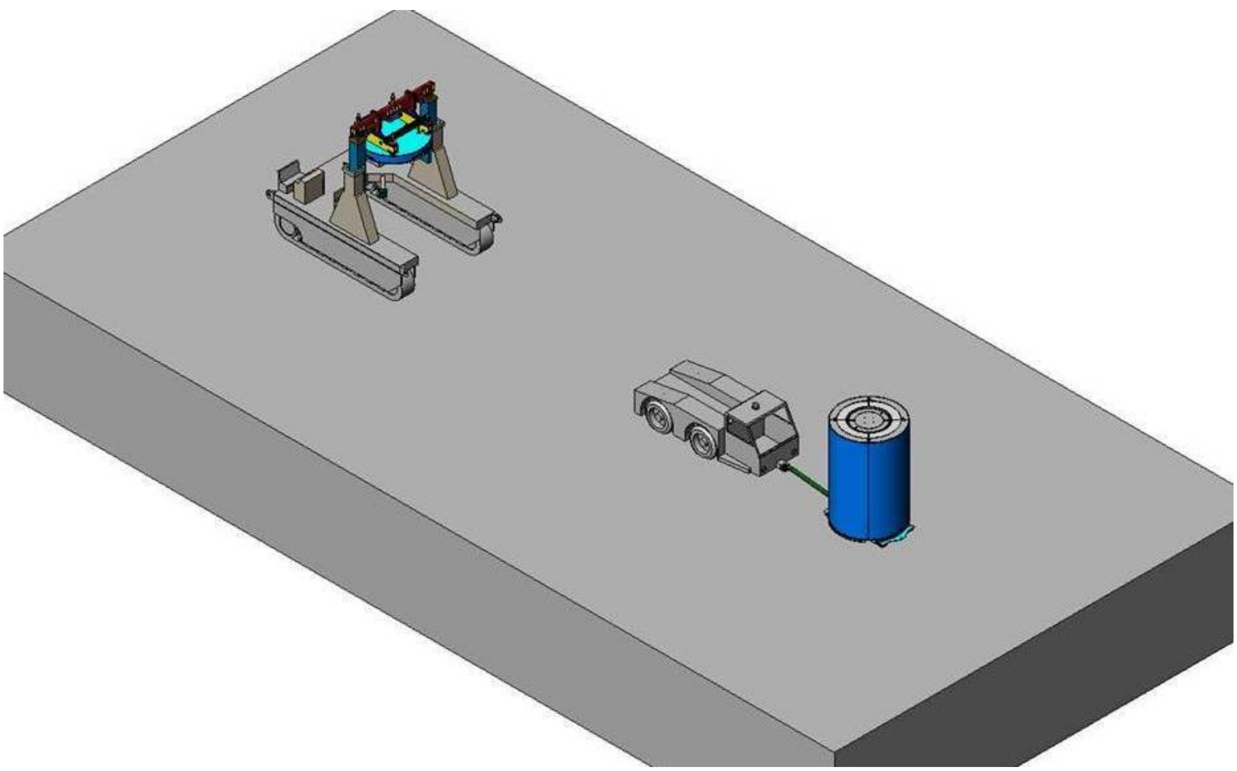


(c) Mating Device Drawer Closed

(d) Removal of Mating Device

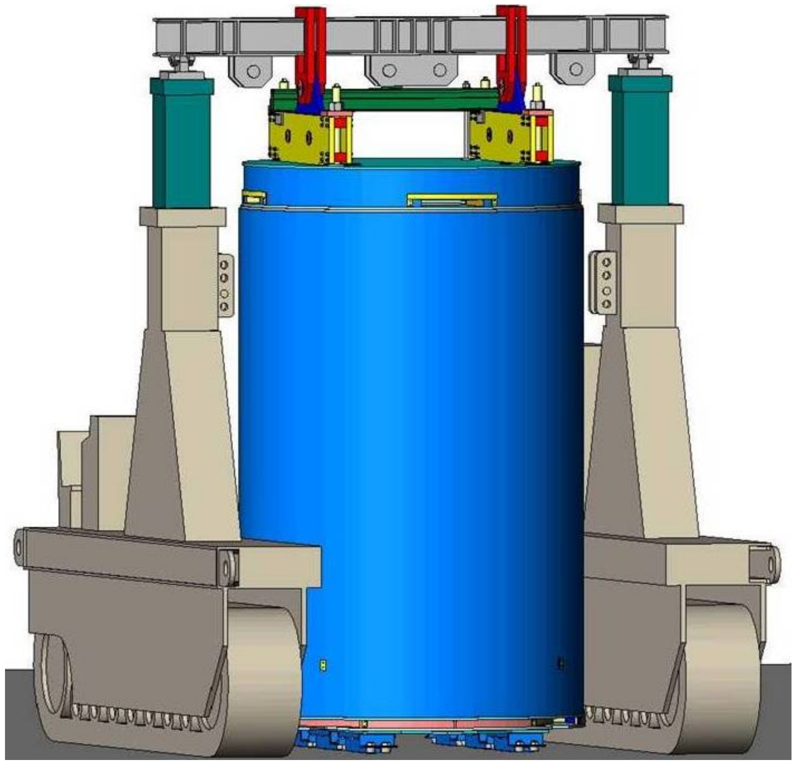
Figure 4.15-15 Removal of Mating Device

(a) Cask Crawler Vehicle



(b) Moving Hi-Storm Out of Reactor Building on Low Profile Rollers

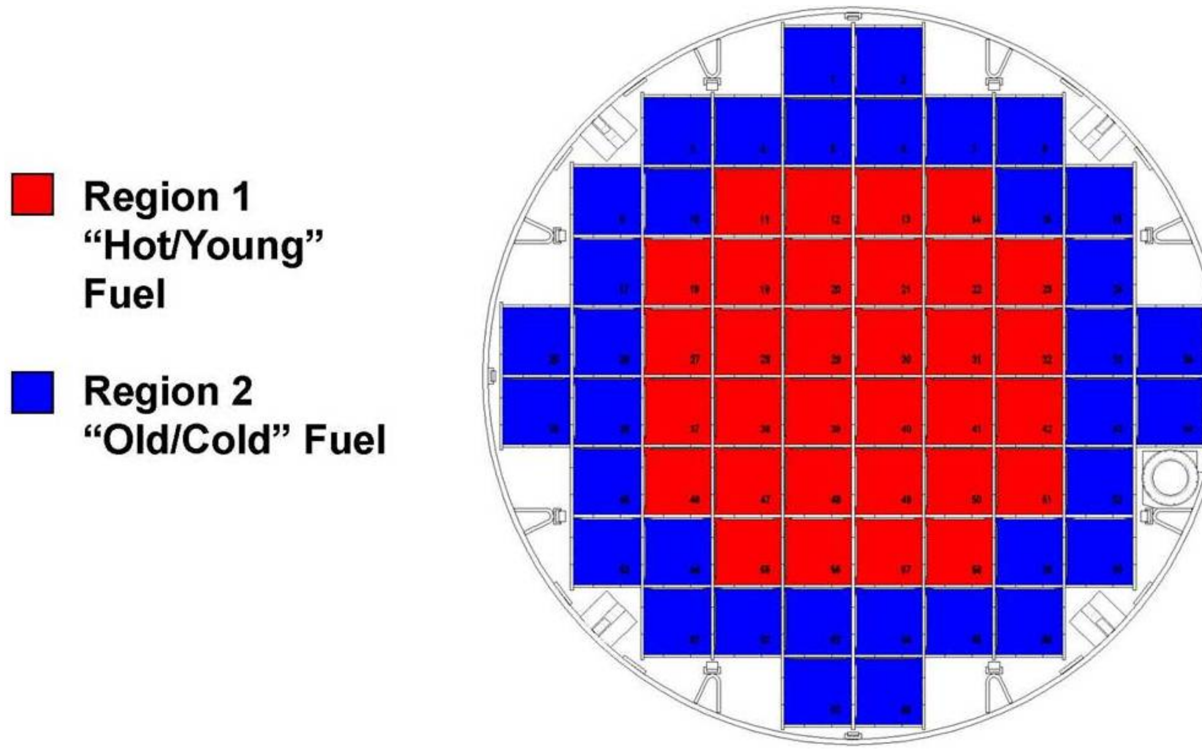
Figure 4.15-16 Moving Loaded Hi-Storm Out of Reactor Building



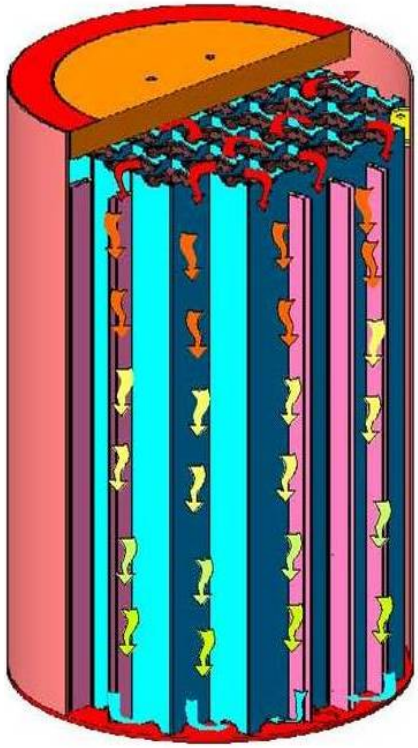
(a) Hi-Storm Lid Installation and Movement to ISFSI

(b) Transferring Hi-Storm to ISFSI Pad

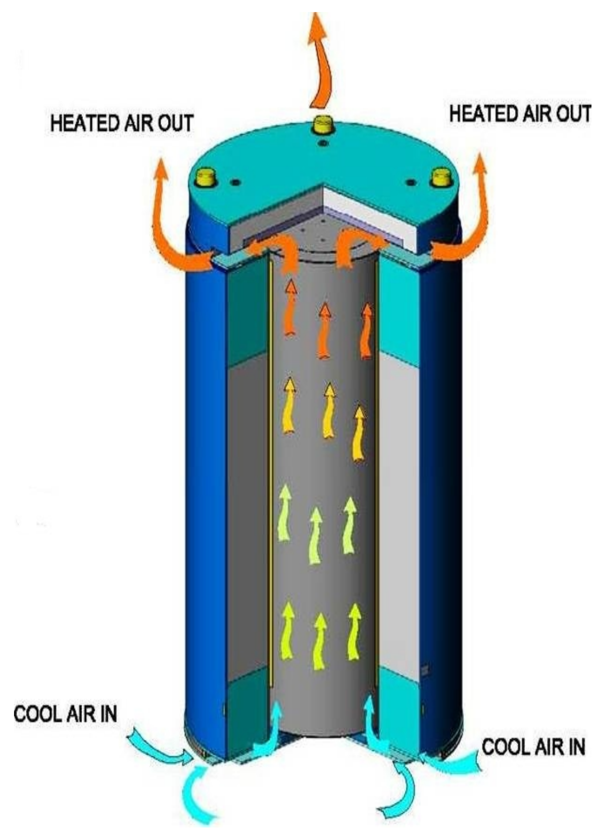
Figure 4.15-17 Lid Installation and Transfer to the ISFSI



(a) Regionalized Loading



(b) Regionalized Loading Helium Flows Within the MPC



(c) Hi-Storm Natural Circulation Cooling Air Flow

Figure 4.15-18 Natural Circulation of Cooling Flows