Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel

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Followed an approach similar to that of the “Generic Aging Lessons Learned (GALL)” report, NUREG-1801, for aging management and license renewal of nuclear power plants

Incorporated stakeholder comments from U.S. industry, cask vendors, utilities, EPRI, NRC, national laboratories, and Germany (via EPRI’s Extended Storage Collaboration Program).

Referenced in Nuclear Energy Institute (NEI) 14-03, Rev. 0 “Guidance for Operations-based Aging Management on Dry Cask Storage,” which has been submitted for NRC endorsement in Sept. 2014.

Aging management needs for a pilot Interim Storage Facility and beyond (2015)

Supporting storage design concepts for an Interim Storage Facility

Historical perspectives, ongoing development, and international context
Contains five (5) Chapters:

I. Introduction
II. Terms & Definitions
III. Time-limited Aging Analyses (TLAAs)
IV. Aging Management Programs (AMPs)
V. Applications of TLAAs/AMPs
   - NUHOMS
   - HI-STORM
   - TN Metal Casks
   - NAC S/T Casks
   - VSC-24
   - MC-10
   - CASTOR
   - W-150

Appendix A: QA for AMPs
Appendix B: Comparison of TLAAs/AMPs (Rev. 2 vs. GALL)
# Dry Cask Storage Systems in Common Use in the United States

<table>
<thead>
<tr>
<th>Vendor</th>
<th>System</th>
<th>Cask/Canister</th>
<th>Type</th>
<th>Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnergySolutions</td>
<td>FuelSolutions</td>
<td>VSC-24, W150</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td>General Nuclear Systems, Inc.</td>
<td>CASTOR</td>
<td>V/21, X/33</td>
<td>Cask</td>
<td>Bolted</td>
</tr>
<tr>
<td>Holtec International</td>
<td>HI-STAR 100</td>
<td>MPC-68, MPC-80</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td></td>
<td>HI-STORM 100</td>
<td>MPC-24, MPC-32, MPC-68</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td>NAC International, Inc.</td>
<td>S/T</td>
<td>NAC-l28</td>
<td>Cask</td>
<td>Bolted</td>
</tr>
<tr>
<td></td>
<td>MPC</td>
<td>MPC-26, MPC-36</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td></td>
<td>UMS</td>
<td>UMS-24</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td></td>
<td>MAGNASTOR</td>
<td>MAGNASTOR</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td>Transnuclear, Inc.</td>
<td>NUHOMS</td>
<td>52B, 61BT, 61BTH, 7P, 24P,</td>
<td>C/O</td>
<td>Welded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24PHB, 24PT, 24PT1, 32P, 32PT, 32PTH, 12T</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TN-24, TN-32, TN-40, TN-68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Westinghouse</td>
<td>MC-10</td>
<td>MC-10</td>
<td>Cask</td>
<td>Bolted</td>
</tr>
</tbody>
</table>

*a C/O: metallic welded canister with overpack; Cask: self-contained metallic cask with bolted lid*
USNRC ISFSI License Renewal Process (adapted from NUREG-1927, Rev.0)

Regulatory Requirements 10 CFR Part 72
- Licensee/CoC holder information
- Financial information
- Application content
- Environmental report

Scoping Evaluation
- Scoping process
  Identification of intended function of SSCs
- SSCs within the scope of license/CoC renewal
  Identification of SSC subcomponents within scope
- SSCs not within the scope of licensee/CoC renewal

Aging Management Review (AMR)
- Identification of materials and environments
- Identification of aging effects
- Aging management activity
  Approach for addressing the effects of aging

Time-Limited Aging Analyses (TLAAs)
- Identification of applicable SSCs
- TLAA for extended operation

Aging Management Programs (AMPs)
- Aging effects consideration
- Prevention, mitigation, condition and performance monitoring
- Corrective actions

Fuel/Canister Retrievability
Post-storage Transportability 10 CFR Part 71
NUREG-1927 defines six ITS functions of SSCs as follows:
- **CB**: Confinement boundary
- **CC**: Criticality control
- **HT**: Heat transfer
- **RS**: Radiation shielding
- **SS**: Structural support
- **FR**: Fuel retrievability

NUREG/CR-6407 classifies transportation and dry storage system components according to ITS:
- **Category A**: Failure directly results in a condition adversely affecting public health & safety
- **Category B**: Failure indirectly results in a condition adversely affecting public health & safety
- **Category C**: Failure would not significantly reduce the storage effectiveness
Determination of the aging management activity (AMA) required to manage the effects of aging for in-scope SSCs.

Can TLAA adequately predict degradation associated with the identified aging effect?

Yes

Is TLAA reconfirmed for the period of extended operation?

Yes

TLAA confirmed and documented in SAR Supplement. No further action necessary.

No

Action Required:
Modification of existing site AMA or development of a new AMA to be reviewed by the NRC and documented in SAR supplement.

No

Is the SSC within an existing AMP?

Yes

Is the identified aging effect managed by an existing AMP?

Yes

Aging effects on SSCs are adequately managed. Document in SAR supplement. No further action necessary.

No

AMP

No

TLAA
### Aging Effects and Mechanisms

Table D.1 from NUREG-1927 (based on NUREG-1557)

<table>
<thead>
<tr>
<th>Aging Effects of SSCs</th>
<th>Possible Aging Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concrete Structures:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Scalling, cracking, and spalling</td>
<td>Freeze-Thaw</td>
</tr>
<tr>
<td>2. Increase in porosity and permeability</td>
<td>Leaching of Calcium Hydroxide</td>
</tr>
<tr>
<td>3. Increase in porosity and permeability, cracking</td>
<td>Aggressive Chemical Attack</td>
</tr>
<tr>
<td>4. Expansion and cracking</td>
<td>Reaction with Aggregates</td>
</tr>
<tr>
<td>5. Loss of strength and modulus</td>
<td>Elevated Temperature</td>
</tr>
<tr>
<td>6. Loss of strength and modulus</td>
<td>Irradiation of Concrete</td>
</tr>
<tr>
<td>7. Deformation</td>
<td>Creep</td>
</tr>
<tr>
<td>8. Cracking</td>
<td>Shrinkage</td>
</tr>
<tr>
<td>9. Loss of material</td>
<td>Corrosion</td>
</tr>
<tr>
<td>10. Loss of material</td>
<td>Abrasion and Cavitation</td>
</tr>
<tr>
<td>11. Cracking</td>
<td>Restraining, Shrinkage, Creep and Aggressive Enviroment</td>
</tr>
<tr>
<td>12. Loss of strength</td>
<td>Concrete Interaction with Aluminum</td>
</tr>
<tr>
<td>13. Cathodic protection effect on bond strength</td>
<td>Cathodic Protection Current</td>
</tr>
<tr>
<td><strong>Structural Steel:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Loss of material</td>
<td>Corrosion Local or Atmospheric</td>
</tr>
<tr>
<td>2. Loss of strength and modulus</td>
<td>Elevated Temperature</td>
</tr>
<tr>
<td>3. Loss of fracture toughness</td>
<td>Irradiation</td>
</tr>
<tr>
<td>4. Crack initiation and growth</td>
<td>Stress-Corrosion Cracking</td>
</tr>
<tr>
<td><strong>Reinforcing Steel (Rebar):</strong></td>
<td></td>
</tr>
<tr>
<td>1. Cracking, spalling, loss of bond and material</td>
<td>Corrosion of Embedded Steel</td>
</tr>
<tr>
<td>2. Loss of strength and modulus</td>
<td>Elevated Temperature</td>
</tr>
<tr>
<td>3. Loss of strength and modulus</td>
<td>Irradiation</td>
</tr>
<tr>
<td><strong>Miscellaneous:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Cracking, distortion, increase in component stress</td>
<td>Settlement</td>
</tr>
<tr>
<td>2. Loss of fracture toughness</td>
<td>Strain Aging (of Carbon Steel)</td>
</tr>
<tr>
<td>3. Reduction in design margin</td>
<td>Loss of Prestress</td>
</tr>
<tr>
<td>4. Loss of Material</td>
<td>Corrosion of Steel Piles</td>
</tr>
<tr>
<td>5. Loss of Material</td>
<td>Corrosion of Tendons</td>
</tr>
<tr>
<td><strong>Cask Internals:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Loss of material</td>
<td>Corrosion, Boric-Acid</td>
</tr>
<tr>
<td>2. Change in dimension</td>
<td>Creep</td>
</tr>
<tr>
<td>3. Wall thinning</td>
<td>Erosion Corrosion</td>
</tr>
<tr>
<td>4. Crack initiation and growth</td>
<td>Stress-Corrosion Cracking</td>
</tr>
<tr>
<td>5. Loss of fracture toughness</td>
<td>Neutron Irradiation</td>
</tr>
<tr>
<td>6. Loss of preload</td>
<td>Stress Relaxation</td>
</tr>
<tr>
<td>7. Loss of fracture toughness</td>
<td>Thermal Embrittlement</td>
</tr>
<tr>
<td>8. Attrition</td>
<td>Wear</td>
</tr>
<tr>
<td><strong>Zircaloy Cladding (Not in NUREG-1927)</strong></td>
<td></td>
</tr>
<tr>
<td>1. Embrittlement</td>
<td>Hydride reorientation (High-burnup fuel only)</td>
</tr>
</tbody>
</table>
Aging Management Activities — TLAA and AMP

- **Time-Limited Aging Analysis (TLAA)** — To assess SSCs that have a time-dependent operating life, e.g., fatigue (cycles to failure), time limited (operating hours until replacement), or time-dependent degradation of properties (aging effects).

- **Aging Management Program (AMP)** — To ensure aging effects do not result in a loss of intended ITS function of the SSCs that are within the scope of renewal, for the term of the renewal.

AMPS are generally of four types: *Prevention, Mitigation, Condition Monitoring and Performance Monitoring*. Each AMP contains 10 elements:

- Scope of Program
- Preventive Actions
- Parameters Monitored or Inspected
- Detection of Aging Effects
- Monitoring and Trending
- Acceptance Criteria
- Corrective Actions
- Confirmation Process
- Administration Control
- Operating Experience
Time-Limited Aging Analyses (TLAAs):

- III.1: Identification of Time-Limited Aging Analyses
- III.2: Fatigue of Metal and Concrete Structure and Components
- III.3: Corrosion Analysis of Metal Components
- III.4: Time-Dependent Degradation of Neutron-Absorbing Materials
- III.5: Time-Dependent Degradation of Radiation-Shielding Materials
- III.6: Environmental Qualification of Electrical Equipment
- III.7: Other Site-Specific Time-Limited Aging Analyses

Aging Management Programs (AMPs):

- IV.S1: Concrete Structures Monitoring Program
- IV.S2: Monitoring of Protective Coatings on Carbon Steel Structures
- IV.M1: External Surfaces Monitoring of Mechanical Components
- IV.M2: Ventilation System Surveillance Program
- IV.M3: Welded Canister Seal and Leakage Monitoring Program
- IV.M4: Bolted cask Seal and Leakage Monitoring Program
- IV.M5: Canister/Cask Internals Structural and Functional Integrity
NUHOMS Dry Spent Fuel Storage

Oconee 84/2026 (24P); 50/1200 (24PHB)
Calvert Cliffs 48/1152 (24P); 28/896 (32P)
<table>
<thead>
<tr>
<th>Item</th>
<th>Structure and/or Component</th>
<th>Intended Function</th>
<th>Material</th>
<th>Environ</th>
<th>Aging Effect/ Mechanism</th>
<th>Aging Management Program (AMP)</th>
<th>Program Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.1.A-5</td>
<td>Concrete: HSM walls, roof, and floor; inlet and outlet vents shielding blocks (A)</td>
<td>RS, SS, HT Reinforced Concrete</td>
<td>Air – inside the module, uncontrolled, radiation and elevated temperature</td>
<td>Reduction of strength and degradation of shielding performance of concrete due to elevated temperature (&gt;150°F general, &gt;200°F local) and long-term exposure to gamma radiation (&gt;10¹⁰ rads)</td>
<td>The compressive strength and shielding performance of plain concrete are maintained by ensuring that the minimum concrete density is achieved during construction and the allowable concrete temperature and radiation limits are not exceeded. The implementation of 10 CFR 72 and ASME Section XI, Subsection IWL would not enable identification of the reduction of strength and modulus of elasticity due to elevated temperature and gamma radiation. Thus, for any portions of concrete in HSM that exceed specified limits for temperature and gamma radiation, further evaluations are warranted.</td>
<td>Further evaluation, if temperature and gamma radiation limits are exceeded</td>
<td></td>
</tr>
</tbody>
</table>
Table V.1.B    NUHOMS Dry Spent-Fuel Storage: **Dry Shielded Canister (DSC)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Structure and/or Component</th>
<th>Intended Function</th>
<th>Material</th>
<th>Environ</th>
<th>Aging Effect/ Mechanism</th>
<th>Aging Management Program (AMP)</th>
<th>Program Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.1.B-1</td>
<td><strong>DSC:</strong> Shell (including welds) (A)</td>
<td>CB, HT, SS, FR</td>
<td>Stainless steel</td>
<td>Air – inside the HSM, uncontrolled (external), Helium (internal)</td>
<td><strong>Cumulative fatigue damage due to cyclic loading</strong></td>
<td>Fatigue is a TLAA to be evaluated for the requested period of extended operation. See III.2 “Fatigue of Metal and Concrete Structures and Components” for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.</td>
<td>TLAA</td>
</tr>
<tr>
<td>V.1.B-2</td>
<td><strong>DSC</strong> confinement boundary: Shell, outer top cover plate, outer bottom cover plate, and welds (A)</td>
<td>CB, HT, SS, FR</td>
<td>Stainless steel</td>
<td>Air – inside the HSM, uncontrolled (external), Helium (internal)</td>
<td><strong>Cracking and leakage due to stress corrosion cracking (SCC) when exposed to moisture and aggressive chemicals in the environment (e.g., chloride in marine environment)</strong></td>
<td>IV.M1, “External Surfaces Monitoring of Mechanical Components ” IV.M3, “Welded Canister Seal and Leakage Monitoring Program”</td>
<td>Generic programs</td>
</tr>
</tbody>
</table>
HI-STORM 100 System

Diablo Canyon

- Lid
- Shield Block
- Canister
- Air Exit Vent
- Cask Outer Shell
- Cask Inner Shell
- Radial Shield
- Baseplate
- Pedestal Shield
- Air Inlet Vent
### Table V.2.A1 HI-STORM 100 System: Storage Overpack

<table>
<thead>
<tr>
<th>Item</th>
<th>Structure and/or Component</th>
<th>Intended Function</th>
<th>Material</th>
<th>Environ</th>
<th>Aging Effect/ Mechanism</th>
<th>Aging Management Program (AMP)</th>
<th>Program Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.2.A1-4</td>
<td>Ventilation air openings: Air ducts, screens, gamma shield cross plates (A)</td>
<td>HT</td>
<td>Carbon or low-alloy steel</td>
<td>Air – inside the module, uncontrolled or Air – outdoor</td>
<td>Reduced heat convection capacity due to blockage</td>
<td>IV.M2, “Ventilation System Surveillance Program”</td>
<td>Generic program</td>
</tr>
<tr>
<td>V.2 A1-5</td>
<td>Anchor Studs (for anchored cask) (A)</td>
<td>SS</td>
<td>SA-193, SA-354, SA-479, SA-540, SA-564, SA-574, SA-638</td>
<td>Air – outdoor or marine environ (if applicable)</td>
<td>Loss of preload due to self-loosening; loss of material due to corrosion; cracking due to SCC</td>
<td>IV.M1, “External Surfaces Monitoring of Mechanical Components”</td>
<td>Generic program</td>
</tr>
<tr>
<td>V.2.A1-6</td>
<td>Anchor Studs (for anchored cask) (A)</td>
<td>SS</td>
<td>SA-193, SA-354, SA-479, SA-540, SA-564, SA-574, SA-638</td>
<td>Air – outdoor</td>
<td>Cumulative fatigue damage due to cyclic loading</td>
<td>Fatigue is a TLAA to be evaluated for the requested period of extended operation. See III.2 “Fatigue of Metal and Concrete Structures and Components” for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.</td>
<td>TLAA</td>
</tr>
</tbody>
</table>
Table V.2.B  HI-STORM 100 or HI-STAR 100 System: Multipurpose Canister (MPC)

<table>
<thead>
<tr>
<th>Item</th>
<th>Structure and/or Component</th>
<th>Intended Function</th>
<th>Material</th>
<th>Environ</th>
<th>Aging Effect/ Mechanism</th>
<th>Aging Management Program (AMP)</th>
<th>Program Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.2.B-1</td>
<td>MPC: Baseplate, shell, lid, port cover, closure ring, and associated welds; fuel basket and fuel spacer (A)</td>
<td>CB, CC, HT, SS, FR</td>
<td>Stainless steel: 304 SS, 304LN SS, 316 SS, 316LN SS</td>
<td>Air – inside the overpack, uncontrolled (external); Helium (internal)</td>
<td>Cumulative fatigue damage due to cyclic loading</td>
<td>Fatigue is a TLAA to be evaluated for the requested period of extended operation. See III.2, “Fatigue of Metal and Concrete Structures and Components,” for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.</td>
<td>TLAA</td>
</tr>
<tr>
<td>V.2.B-3</td>
<td>MPC Internals: Fuel basket, spacer, basket support; heat conduction elements; drain pipe, vent port; neutron absorber panels (in stainless steel sheathing) (A)</td>
<td>CC, CB, HT, SS, FR</td>
<td>Stainless steel, aluminum alloy, borated aluminum or boron carbide/aluminum alloy plate or BORAL composite</td>
<td>Helium, radiation, and elevated temperature</td>
<td>Degradation of heat transfer, criticality control, radiation shield, confinement boundary, or structural support functions of the MPC internals due to extended exposure to high temperature and radiation.</td>
<td>IV.M5, “Canister/Cask Internals Structural and Functional Integrity Monitoring Program”</td>
<td>Generic program</td>
</tr>
</tbody>
</table>

Degradation of neutron-absorbing materials is a TLAA to be evaluated for the requested period of extended operation. See III.4, “Time-Dependent Degradation of Neutron-Absorbing Materials,” for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.
TN Metal Spent Fuel Storage Cask

North Anna
### V.3.B TN Metal Spent Fuel Storage Cask

#### Table V.3.B TN Metal Spent-Fuel Storage Cask: Internal Contents of the Confinement Vessel

<table>
<thead>
<tr>
<th>Item</th>
<th>Structure and/or Component</th>
<th>Intended Function</th>
<th>Material</th>
<th>Environ.</th>
<th>Aging Effect/ Mechanism</th>
<th>Aging Management Program (AMP)</th>
<th>Program Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.3.B-3</td>
<td>Cover plates and bolting (access requires removal of overpressure tank and top lid neutron shield): Drain, vent and overpressure port (A)</td>
<td>CB, SS, HT</td>
<td>Low-alloy steel</td>
<td>Air – enclosed space, uncontrolled (external); Helium (internal)</td>
<td>Loss of material due to corrosion</td>
<td>IV.M1, “External Surfaces Monitoring of Mechanical Components” Further evaluation is required to determine if periodic inspection is needed to manage loss of material due to corrosion for these components.</td>
<td>Generic program</td>
</tr>
<tr>
<td>V.3.B-4</td>
<td>Helicoflex seals (includes stainless steel cladding on sealing surface): Lid, drain, vent and overpressure port closures (A)</td>
<td>CB</td>
<td>Aluminum, silver, stainless steel, Ni-base alloys</td>
<td>Air – enclosed space, uncontrolled (external), Helium (internal)</td>
<td>Loss of sealing forces due to stress relaxation and creep of the metallic O-rings, corrosion and loss of preload of the closure bolts</td>
<td>IV.M4, “Bolted Cask Seal and Leakage Monitoring Program”</td>
<td>Generic program</td>
</tr>
</tbody>
</table>
The goal of this report is to help establish the technical basis for extended long-term storage and subsequent transportation of used fuel, which may occur multiple times before final disposal at a mined repository or geological disposal facility.

It is suggested that future efforts should include development of additional TLAAs and AMPs that may be deemed necessary, and further evaluation of the adequacy of the recommended TLAAs and AMPs that may need augmentation.

Industry and site-specific operating experience of the various dry cask storage systems (DCSSs) at Independent Spent Fuel Storage Installations (ISFSIs) located across the country should be periodically examined to

(a) ascertain the potential aging effects on the SSCs in the DCSSs, thereby enabling a compilation of existing aging management activities, and

(b) assess these activities’ adequacy for extended long-term storage and subsequent transportation of used fuel.
The Generic Aging Lessons Learned (GALL) Report contains the staff’s generic evaluation of the existing plant programs and documents the technical basis for determining where existing programs are adequate without modification and where existing programs should be augmented for the period of extended operation.

The GALL Report also contains recommendations on specific areas for which existing programs should be augmented for license renewal.

An applicant may reference the GALL Report in a license renewal application to demonstrate that the programs at the applicant’s facility correspond to those reviewed and approved in the GALL Report.

The information in the GALL Report has been incorporated into the NUREG-1800, “Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants,” as directed by the Commission, to improve the efficiency of the license renewal process.
• (a) (1) requires licensees to monitor the performance or condition of SSC and to establish goals to promote improved SSC performance, when warranted. Goals and monitoring are to be established commensurate with safety and are to consider industry-wide operating experience, where practical.

• (a) (2) states that monitoring pursuant to (a) (1) is not required for SSCs that are being effectively maintained by a preventive maintenance program.

• (a) (3) requires that performance- and condition-monitoring activities be evaluated at least every refueling cycle (not to exceed an interval of 24 months), taking industry-wide operation experience into account, where practical.

• (a) (4) states that licensees shall assess and manage the increase in risk that may result from proposed maintenance activities.
“Tollgate” is a new term created by the nuclear industry to address the fact that the applicability of potential dry cask storage aging mechanisms may not be able to be verified at the time license and CoC renewal applications are submitted.

This information would enhance the current understanding of the future state of dry spent fuel and the canisters that contain it.

Tollgates are part of a learning, operations-based aging management program implemented by licensees via requirements in the renewed license or CoC and associated final safety analysis report.

These requirements obligate the licensees to perform periodic assessments of the aggregate state of knowledge of aging-related operational experience, research, monitoring, and inspections to ascertain the ability of in-scope DCSS design SSCs to continue performing their intended safety functions throughout the requested period of extended operation.
As mentioned earlier, the aging management report recommends periodic assessment of industry and site-specific operating experience of the various DCSSs/ISFSIs, which share the same basic philosophy as that of the tollgates in NEI 14-03 and NUREG-1927.
Evaluating interim storage design concepts, with input from industry contractors
- *Generic Design Alternatives for Dry Storage of Used Nuclear Fuel* (CB&I)

Developed and documented facility functions and requirements

Evaluated costs and impacts of opening non-disposable storage canisters (AREVA, CB&I)

Initiated efforts related to assessing aging management needs for a pilot Interim Storage Facility (ISF) and beyond (ANL, SRNL)

BRC recommendation: “Perform systems analyses and design studies needed to develop a conceptual design for a spent fuel storage facility”

NFST is laying the groundwork for Consolidated Interim Storage
Pilot ISF Capable of Handling a Wide Range of Systems at Shutdown Sites – Storage/Transportation/Storage (72/71/72)

- **LaCrosse**
  - 5*:0**
  - NAC-MPC with MPC-LACBWR canister

- **Trojan**
  - 34*:0**
  - TranStor cask with Holtec MPC-24E/EF canisters

- **Humboldt Bay**
  - 5*:1**
  - Holtec HI-STAR HB with MPC-HB canister

- **Rancho Seco**
  - 21*:1**
  - TransNuclear NUHOMS with FO-DSC, FC-DSC, and FF-DSC canisters

- **Zion**
  - 61*:4** (est.)
  - NAC MAGNASTOR with TSC-37 canister

- **Big Rock Point**
  - 7*:1**
  - BFS/ES Fuel Solutions W150 with W74 canister

- **Yankee Rowe**
  - 15*:1**
  - NAC-MPC with Yankee-MPC canister

- **Maine Yankee**
  - 60*:4**
  - NAC-UMS with transportable storage canister (TSC)

- **Connecticut Yankee**
  - 40*:3**
  - NAC-MPC with CY-MPC canister

- **Storage**
  - Options

- **248 UNF casks**
- **15 GTCC casks (est.)**
- **7,649 assemblies**
- **2813 MTHM**
- **4 different vendors**
- **7 storage systems**

- "*UNF Casks
- "**GTCC Casks"
Comparison of TLAAs/AMPs in ISFSI/CoC Renewal Applications with those in the DOE/ANL Aging Management Report is part of an effort supporting the assessment of aging management needs for a Pilot ISF and beyond.

The main purpose of the comparison is to assess the overall consistency and identify gaps, if any, in the TLAAs and AMPs for potential update of the aging management report, which is a key reference in NEI 14-03, “Guidance for Operations-based Aging Management on Dry Cask Storage, Sept. 2014.”

NEI 14-03, Rev. 0 was submitted for NRC endorsement in Sept. 2014, while NRC is updating its ISFSI/CoC renewal guidance in NUREG-1927 Rev. 1 that also contains three AMPs.

Aging management guidance development is expected to remain very active in the U.S. during the next 2-3 years.
ISFSI/CoC Renewal Applications (2006 – 2015)*

ISFSI:
- Surry
- Oconee**
- Robinson**
- Prairie Island (pending)
- Calvert Cliffs**

CoC:
- VSC-24 (pending)
- Standardized Advanced NUHOMS (pending)

TLAAs/AMPs in Calvert Cliffs ISFSI LRA (DOE/ANL Rev. 2 report)

- **Four (4) TLAAs:**
  - DSC Fatigue (III.2)
  - Neutron Poison Plates B Depletion (III.4)
  - Fuel Cladding Thickness and Maximum Temperature (III.1)
  - Thermal and radiation degradation of HSM concrete (III.2, III.3, III.7)

- **Seven (7) AMPs:**
  - Dry Shielded Canister (DSC) External Surfaces (IV.M1, IV.M3)
  - Concrete HSM (IV.S1, IV.S2, IV.M1, IV.M2)
  - High Burnup Fuel (IV.M5)
  - Transfer Cask, Transfer Cask Lifting Yoke, Cask Support Platform, and Cask Handling Crane (None)

- Although the titles of TLAAs/AMPs in the ISFSI/CoC renewal applications and the aging management report are different, preliminary comparison showed them to be broadly consistent and should be applicable to a pilot ISF.
EPRI’s Extended Storage Collaboration Program

- Established in 2009 to “Provide the technical bases to ensure continued safe, long term used fuel storage and future transportability”

- Bring together US and International organizations engaged with active or planned R&D to share information, Identify common goals and needs, and potential areas of “formal” collaboration

- Meeting twice a year; Dec 2014 meeting: 114 registered attendees from 10 countries, IAEA

- Six current subcommittees:
  - Concrete
  - CISCC
  - Fuels High Burnup Demo
  - International
  - NDE

- Tremendous amount of information sharing in recent years, e.g., international data gaps associated with extended storage and transportation of used fuel
Extended “Long-Term” Storage of Used Fuel – Safe and Secure and transportable/retrievable after storage

Unattended Toll Booth

1986 t = 20 t = 60 t = 80 t = 120 year

1986 

2015
Acknowledgment

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The Rev. 2 report is available at:

www.osti.gov

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