Our Environment is slowly changing

- Increasing number of shutdown reactors (planned, prematurely or unplanned)
- Recycling is not always an option (political reasons, economical, …)
- Continuous delays in repository implementation
Spent Fuel management Challenges for Shutdown Reactors

• For “Older” shutdown reactors with no accessible off site storage solution, manage the “aging factors”
  • Storage systems
  • Infrastructure at and around site
  • Spent fuel
  • Staff managing the facility? ISFSI
  • With Need to maintain competencies until spent fuel can be shipped off site
    (relicensing needs, inspection, monitoring,…)

• For “recent” shutdown and/or reactors to shutdown
  • Quick spent fuel defueling
  • Possible space issue on-site
  • Need to maintain competencies until spent fuel can be shipped off site
Challenge of Aging of spent fuel storage systems

With Extension of dry storage well beyond original license, risks to be mitigated

Safety:
- Fuel integrity over time
- Aging of materials/storage components

Security:
- With less radiation over-time, easier access to fuel

Capability:
- Lost of records especially on stranded sites (fuel, systems,..)
- Higher risks on stranded sites with no used fuel pool and “aging “expertise
Orano TN Proactively developing solutions for shutdown reactors

- Re-licensing
- Inspection and monitoring/repair tools
- Site/ISFSI Management
- Quick pool defueling
- Reduced footprint storage systems
- Fuel Behavior evaluation
- Consolidated Interim Storage
Extension of on-site specific and/or generic license

Orano TN has already successfully supported customer to extend their storage license in the USA (Initial license for 20 years – renewal +40 years)

Dual purpose designs:
- Prairie Island
- North Anna
- Surry

Canister/Concrete system designs
- Robinson
- Oconee
- Calvert Cliff
- Rancho Seco
- Idaho national lab
Preparing for extended storage: What is Aging Management?

ISFSI* Aging Management Program

1. **Aging Management Plan**
   - Prepare Aging Management Program (AMP) per NUREG-1927 guidelines
   - Perform AMP including inspection/restoration of covered areas of storage components such as outer surfaces of canisters, inner surfaces of HSMs

2. **Inspection/Monitoring/Mitigations of Accessible ISFSI Components**
   - Inspect/restore accessible (outer) areas of all ISFSI components including pad, fence, access roads, HSM outer surface, cask paint, etc

A Comprehensive Program to Manage, Monitor, Inspect and Repair an ISFSI

* Independent Spent Fuel Storage Installation

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Orano TN proactive in developing program and technologies for Aging Management

Aging Management Program required per regulation to extend operation of dry storage sites

Visual Inspection
- Design allows complete accessibility of canister and module

Surface chloride concentration measurement
- SaltSmart Sensor Device Tool

Canister Surface Inspection
- NDE* tools designed to read location of any surface defects found for easy repair
- Capability for numerous testing methods such as visual, Eddy Current, Ultrasonic tests
- Built-in radiation shielding features for worker safety during inspection

Canister Weld Inspection
- Ring travel – 100% access to canister welds

* Non Destructive Examination
Quick pool defueling

Capability to empty the spent fuel pool quickly allows nuclear operators to reduce costs

• **Canister/Concrete systems:**
  - 37PWR / 89BWR
  - Increased heat load capacity allows loading of shorter-cooled fuel

• **Dual purpose systems:**
  - 24 or 32 or 37 PWR / 69 BWR
  - Flexibility for loading plan with high burn up fuel or with large number of MOX used fuel and easy adaptation to non standard fuel

Higher capability of heat load, short cooling time, high burnup fuel system is very desirable
Ensuring of continuous safety of the dry storage systems in accordance with regulatory requirements

**ISFSI (Independent Spent Fuel Installation) Management**
- Responsible for the administration of safety program and achievement of safety performance levels
- Training
- Support for the development of procedures
- Support coordination with local government or competent authority
- Management of Site Security
Dry Storage of spent nuclear fuels
A New Innovative Compact Design: MATRIX HSM*

- Smallest footprint in industry: average of 45% smaller footprint
- Significant cost reductions
- Indoor or outdoor
- Designed to facilitate aging management (user friendly)
- Increased performance (extreme weather and other unplanned events considered for the design)

Already sold in the USA
2018: Full scape prototype
2021: Operations start

* Horizontal Storage Module
High Burn-Up Fuel Study

Supporting international initiatives to evaluate fuel behavior overtime

Under a DOE/ EPRI contract, Develop and conduct a full-scale test using High Burnup Used fuel (>45,000 MWd/MtU) to collect confirmatory data for extended dry cask storage of HBU fuel at plant sites using modified TN-32B.

**Team** – Orano Federal Services, Orano TN

**Current Project** - 4.5 years with Cask loading and monitoring in 2017 and planned total storage at North Anna 10 years of thermocouple instrumentation data collection

![Image of a cask with equipment](image1)

HBU R&D cask on ISFSI pad at NAPS with data logger and solar collector installed 12/1/17

Samples analyzed for hydrogen, oxygen, moisture and gamma spec.
Split samples also sent to SNL.

![Image of gas grab samples](image2)

Gas grab samples collected in SS containers after helium backfill.

![Image of IAEA June 2018](image3)
Consolidated Interim Storage to reduce uncertainties (risks and costs)

Mutualization of resources will become beneficial as on-site interim storage must be extended for unknown time periods.

Site Location Map

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Conclusions

- The environment is changing:
  - More and more shutdown reactors
  - Interim storage will have to be extended for time period well beyond the original license > 80 and/100 years?
  - Reactor operators have the burden to manage spent fuel management until final disposal solutions are available
  - Based on its experience in cask designs, transportation and other services, Orano TN is developing services to assist interim storage of spent fuel management from pool to delivery at final disposal site
THANK YOU FOR YOUR ATTENTION!
Assisting nuclear operators to manage the used fuel

<table>
<thead>
<tr>
<th>Spent Fuel Management Activities from Pool to Repository</th>
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</thead>
<tbody>
<tr>
<td>Pool cleaning (none spent fuel eqt stored in pools)</td>
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<tr>
<td>Pad design, construction and licensing</td>
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<tr>
<td>Pool to Pad/storage building</td>
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<tr>
<td>Supply licensed dry storage systems</td>
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<tr>
<td>Manage shutdown /stranded NPP sites ...</td>
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<tr>
<td>Transportation Services to Consolidated site or recycling, or repository, ...</td>
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<tr>
<td>Consolidated site Management.</td>
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Transport to recycling and/or repository

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