U.S. Experience with Dry Cask Storage
A Regulator's Perspective

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Presentation Overview

- Regulatory Framework
- U.S. Licensing Processes
- Assuring Safety
- Status of Dry Cask Storage in U.S.
- Spent Fuel Integrity Issues
  - High Burnup Fuel
  - Failed Fuel

Regulatory Framework

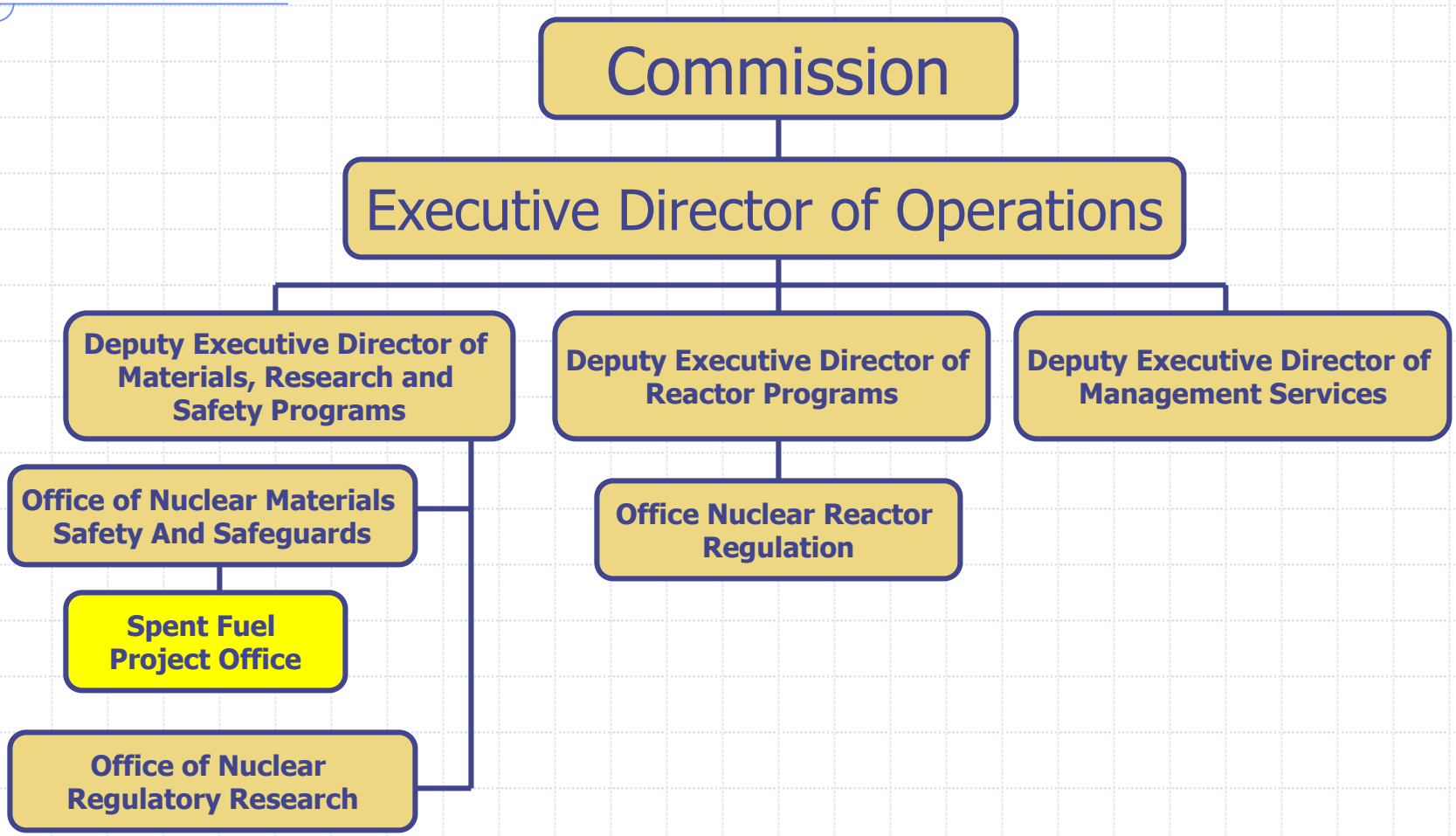
Regulatory Framework

- Atomic Energy Act of 1954
- Nuclear Waste Policy Act of 1982
- 10 CFR Part 72
- NRC's Strategic Plan and Performance Goals
- Spent Fuel Project Office (SFPO)

NRC Performance Goals

- Maintain Safety
- Increase Public Confidence
- Increase Efficiency and Effectiveness
- Reduce Unnecessary Regulatory Burden

USNRC Organization



SFPO Responsibilities

- ISFSI Licensing and Inspection
- Certify Cask Designs for Storage and Transport
- Maintain Storage and Transport Regulations (Parts 71 & 72)
- Assist DOT with Transport Regulations
- Quality Assurance Program Reviews

U.S. Licensing Processes

Options for Spent Fuel Storage Licensing

- Site Specific License
  - Available to Part 50 (Operating Reactor) Licensees
  - Required for Away-from-Reactor Sites
- General License
  - Available to Part 50 Licensees

Site Specific Licensing

- Application Submitted to NRC
  - Safety Analysis Report
  - Environmental Report
- Opportunity for Hearing Provided
- NRC Oversight
  - Review of Application
  - Inspection (site construction, cask fabrication, dry runs, cask loading)

General License Requirements

- Applicable to All Part 50 Licensees
- Requires Use of NRC Certified Casks
- Requires Site Evaluation for Compatibility with Cask Design
- Site Evaluation is Subject to Inspection
- NRC Oversight
  - Inspection (Site Construction and Evaluations, Cask Fabrication, Dry Runs, Cask Loading)

General Licensing Process

- Certificate of Compliance Issuance
- Reactor Licensee Selection, Evaluation, and Construction of Dry Cask Storage System
- NRC Inspections

NRC Inspections

- Pre-Operational Testing
- First Cask Loaded
- Each Loading Campaign
- Periodic Review of ISFSI Activities

Assuring Safety

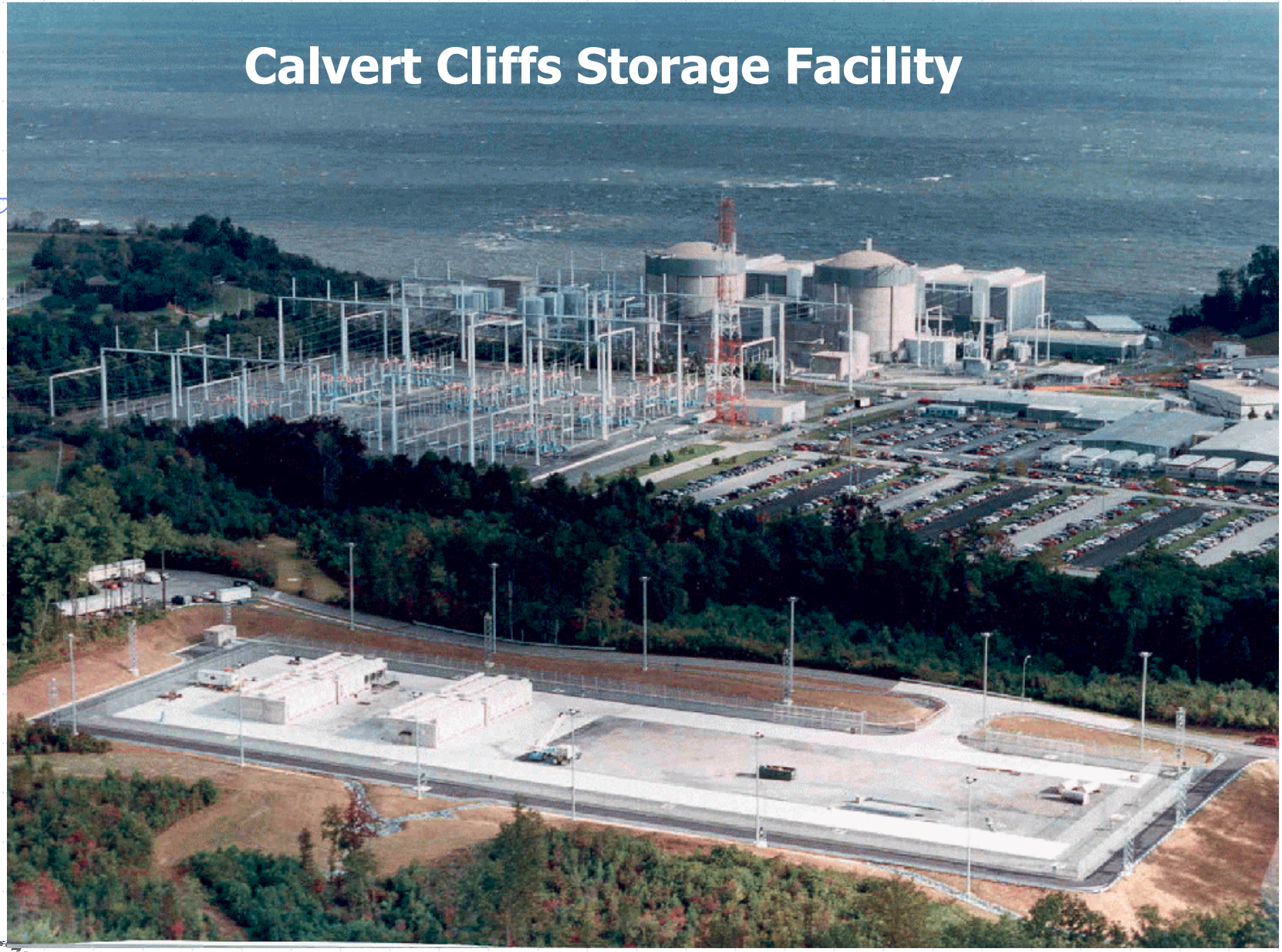
Dry Cask Storage

- Passive System
- Multiple Boundaries Between Fuel and Environment
- Dose Limits Lower Than Operating Reactors

Safety Objectives

- Ensure Dose Limits are Controlled
  - Maintain Subcriticality
  - Ensure Confinement of Spent Fuel
  - Structural, Thermal, and Materials Considerations
- Maintain Retrievability of Spent Fuel

Calvert Cliffs Storage Facility



Safety Reviews

- Structural
- Thermal
- Shielding
- Criticality
- Confinement
- Materials
- Operating Procedures
- Accident Analysis
- Radiation Protection
- Quality Assurance
- Emergency Planning
- Physical Security

Safety Reviews

- Types of Hazards Considered
  - Unusual Events
    - Cask Misloading, Severe Environmental Conditions, Handling Errors, Air Flow Blockage
  - Accidents
    - Include Earthquakes, Fires, Floods, Lightning, Tornado, and Cask Drop and Tip-Over

Standard Review Plans

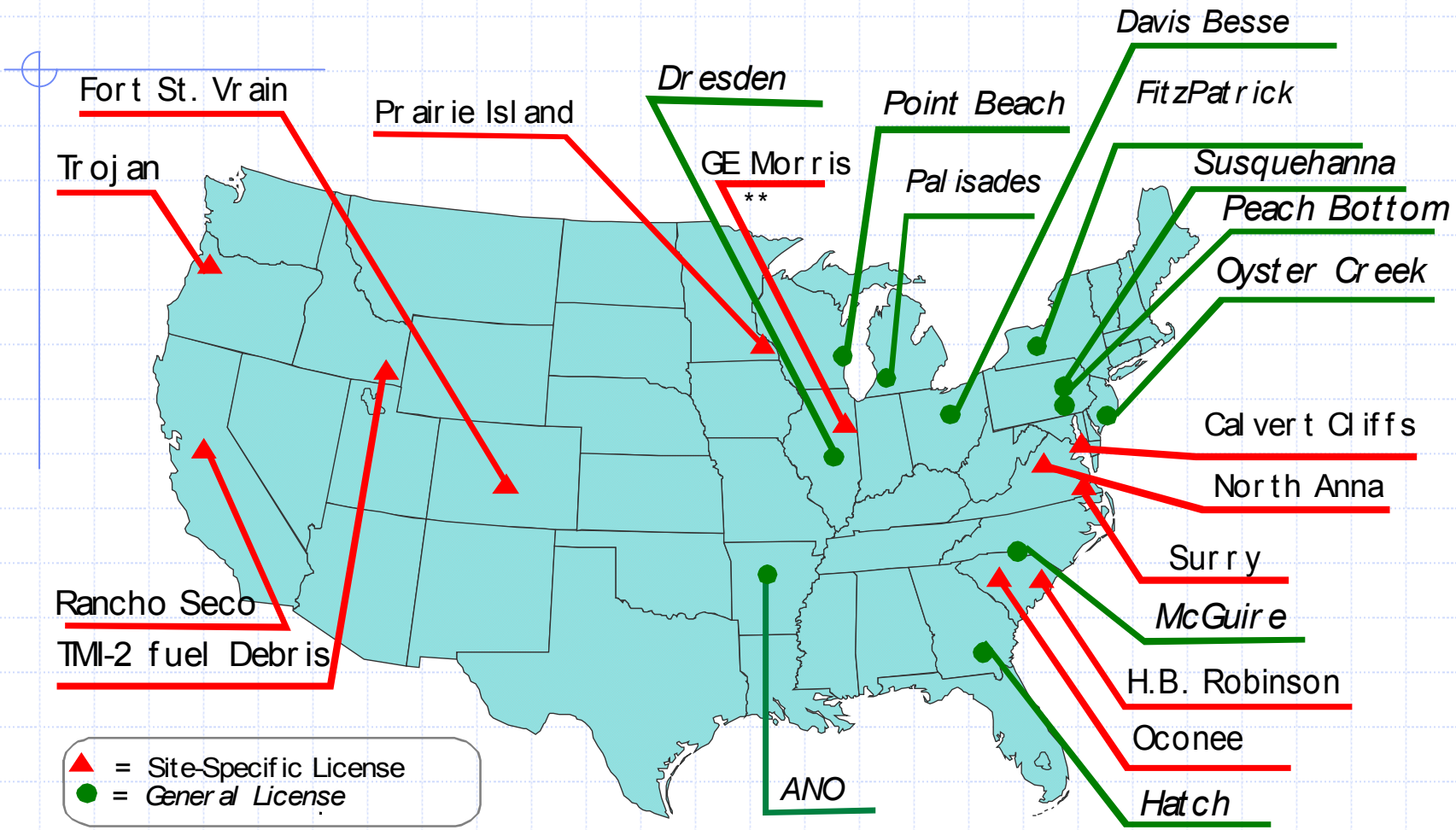
- Dry Cask Storage Systems (NUREG 1536)
- Spent Fuel Dry Storage Facilities (NUREG 1567)
- Transport Packages for Spent Fuel (NUREG 1617)
- Transportation Packages for Radioactive Material (NUREG 1609)

Interim Staff Guidance

- Supplements to SRPs
- Addresses Emergent Review Issues
- Provides for Immediate Use by Staff and Applicants
- Recognized as Interim Approach for Some Issues

U.S. Experience with Dry Cask Storage

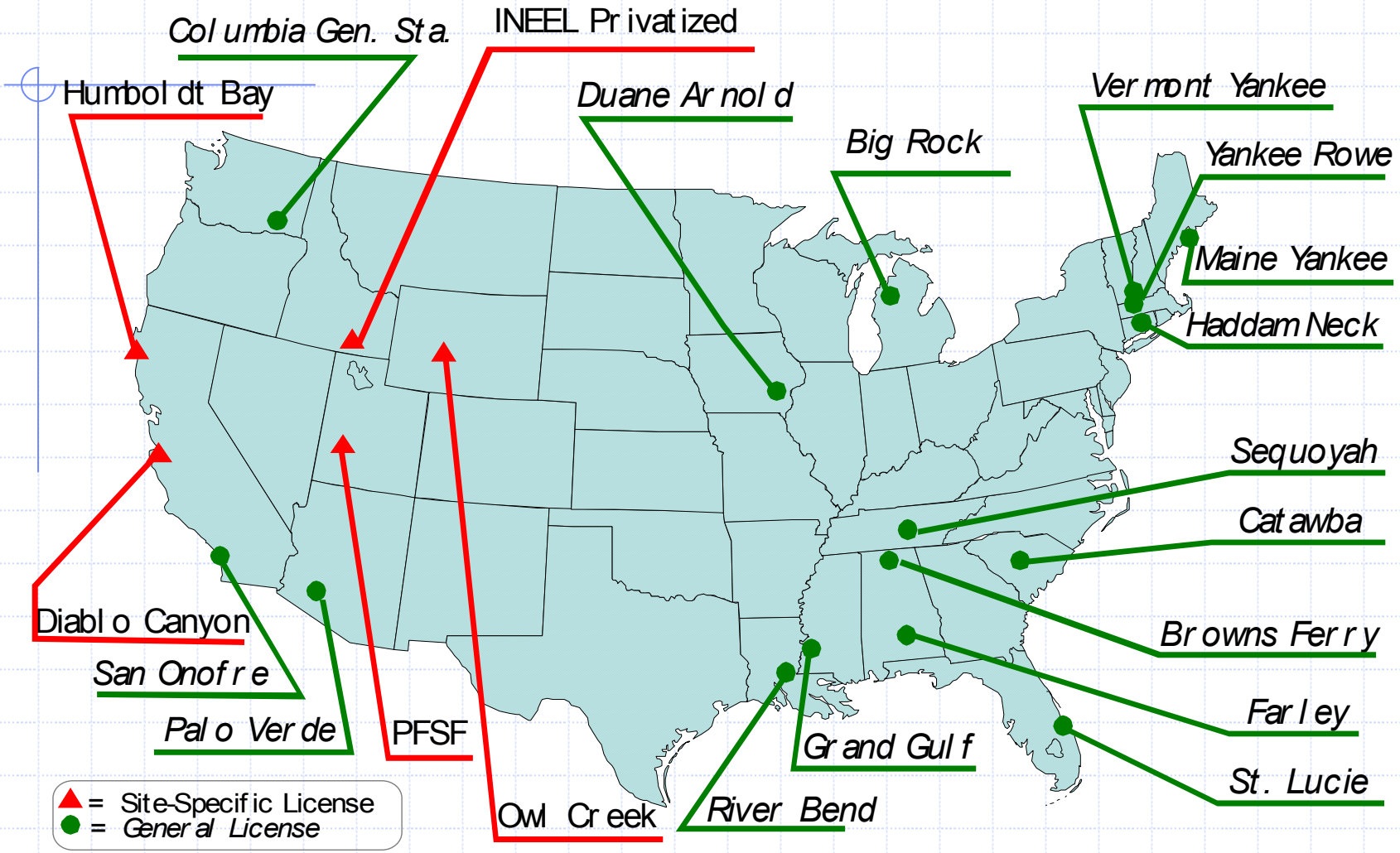
Operating Spent Fuel Storage Sites (ISFSI)



** GE Morris uses wet storage

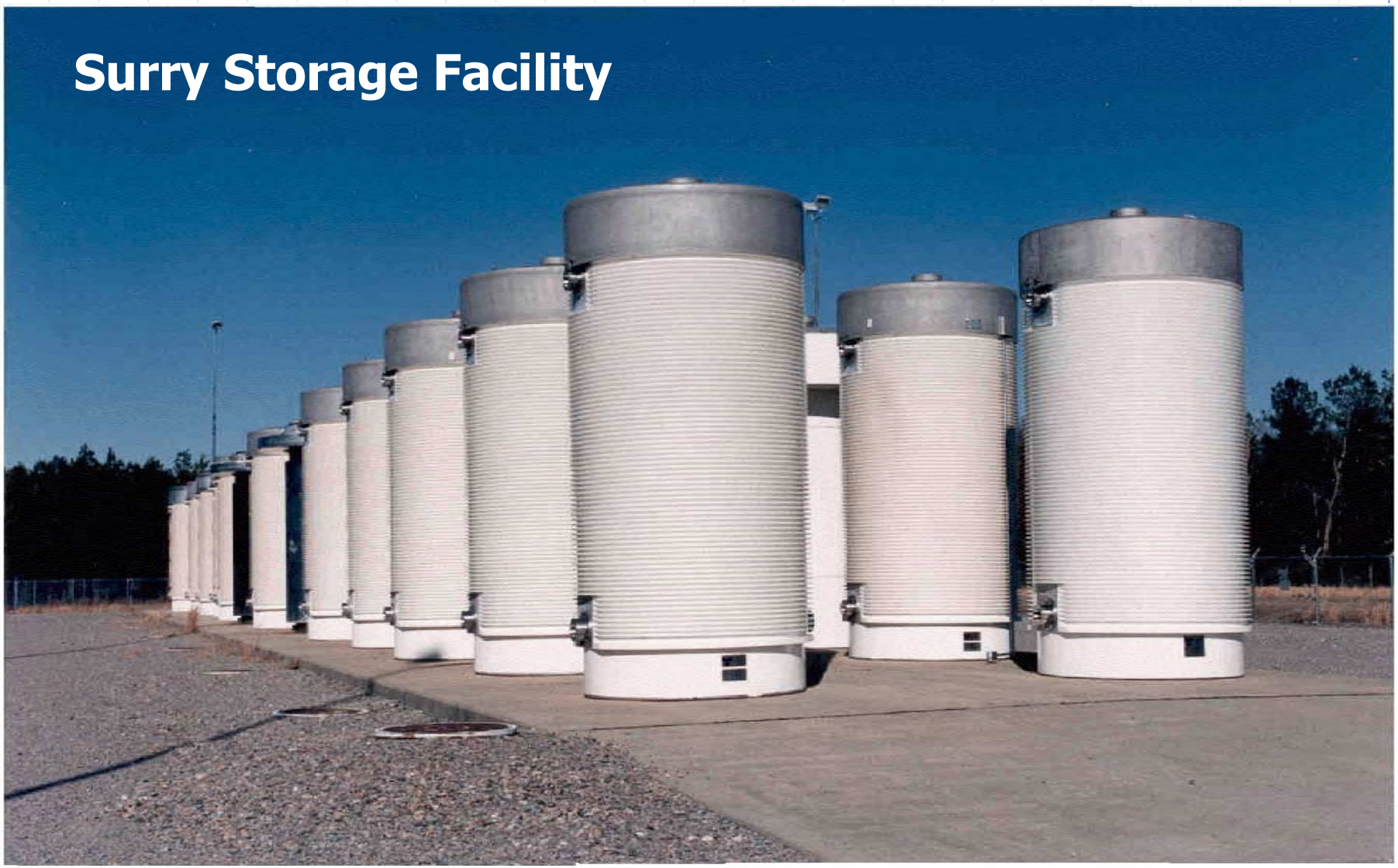
Information as of May 15, 2002

Potential Near-Term New ISFSI Sites



Calvert Cliffs Storage Facility

Surry Storage Facility



Safety and Security

- No Spent Fuel Storage Cask Releases of Radiation Which Could Impact the Public
- No Known Attempts at Sabotage of Spent Fuel Stored in Dry Storage Casks
- Preliminary Dry Cask Storage PRA Analyses Show Very Low Potential Risk

Operational Experience

- No Operational Incidents Have Resulted in Reduction of Safety to Worker, Public or Environment
  - Minor Design Changes During Fabrication
  - Loose Lid Bolts, Pressure Switches
  - Corrosion of Secondary Metallic Lid Seals
  - Issues with Crane and Rigging Equipment

Spent Fuel Integrity Issues

High Burnup Fuel

Safety Objectives

- Ensure Dose Limits are Controlled
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  - Ensure Confinement of Spent Fuel
  - Structural, Thermal, and Materials Considerations
- Maintain Retrievability of Spent Fuel

Characteristics of High Burnup Fuel

- High Burnup Fuel Characteristics
  - Estimated Hoop Stresses: 50-150 MPa at Storage Temperatures
  - Oxide Thickness: 30-100 Micrometers, Varies Axially and at Grid Spacers, Spallation
  - Hydrogen: up to 600 ppm (Average), up to 1200-1500 ppm Locally as Hydride Lenses, Zirconium Hydrides Generally Oriented Circumferential

Temperatures for Storage Operations

		Vacuum Drying		Transfer Operations		Normal Storage Conditions	
Cask	Fuel Type	Time Hrs	Temp. °C	Time Hrs	Temp. °C	Allowable Temp. °C	Calculated Temp. °C
A	PWR	10	363	16	363	380	354
B	PWR	36	501	?	?	327	296
C	PWR	48	510	30+	510	382	376
D	PWR	<50	487	?	?	384	370
E	PWR	32	380	48	320	385	385
F	BWR	10	345	24	345	380	343
G	BWR	48	324	?	?	342	261
H	BWR	48	510	30+	510	398	393
I	BWR	<50	530	?	?	421	415

Current Guidance

- Intact fuel
  - Oxide Thickness Less than 70-80 Micrometers
  - 1% Creep Strain Limit to Calculate Temperature Limits
  - Fission Gases Available for Release to Cask Environment
  - Cladding Must Maintain As-Analyzed Configuration
- Damaged fuel
  - Oxide Thickness Greater than 70-80 Micrometers
  - Can Fuel or Provide Alternative Justification

Revising the Guidance

- Revised Guidance will Become Independent of
  - Oxide Thickness and Creep Strain Limit
  - Cladding Material and Burnup Level
- Changing Approach to Calculate Temperature Limits
- ANL Research will Confirm Staff's Approach
- Revision Completed July 2002

Spent Fuel Integrity Issues

Failed Fuel

Current Guidance

- Defines "Damaged Fuel"
  - Based Only on Cladding Defects
- Assures Retrievability of Fuel from Storage and Transportation Casks
- Simplifies Safety Analyses
- Casks Provide Radiological Boundary, Not the Cladding

Lessons Learned

- Varying Reactor Operating Conditions Can Lead to a Variety of Damage Conditions
- Need to Assure Retrievability of **All** Fuel while Relieving Burden to Licensees

Revising the Guidance

- Revised Guidance will:
  - Expand Definition of Damaged Fuel
    - Cladding Damage
    - Assembly Hardware Damage (e.g., Grid Spacers & Straps)
    - Fuel Debris
  - Provide Protocol for Classifying Damaged Fuel Based on Records, Inspections, Testing
  - Rely on Analysis to Otherwise Demonstrate Fuel Integrity
- Minimize Fuel Canning Operations