



The Final Act: Decommissioning

BARRY E. MULLER, PH.D.

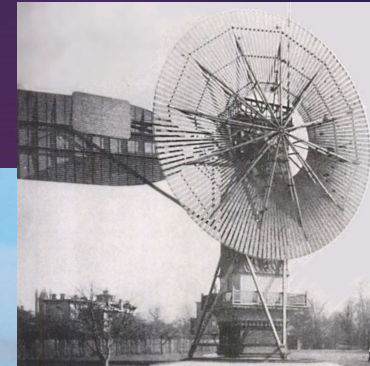
MI-OH SECTION OF THE AMERICAN NUCLEAR SOCIETY, NOVEMBER 2018

Overview

- ▶ Why decommission?
- ▶ What are the options?
- ▶ First steps
- ▶ The Waiting
- ▶ Tidying up
- ▶ Turning in the Keys

Why Decommission?

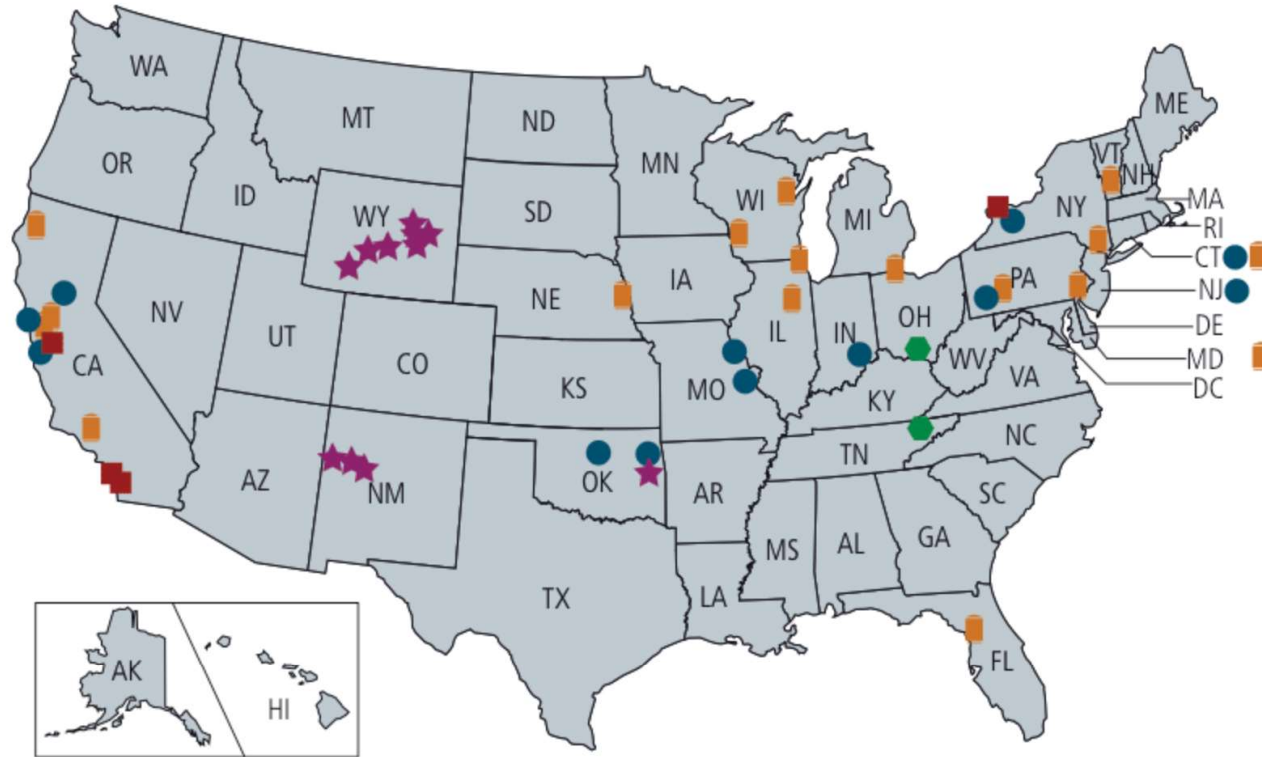
- ▶ End of Licensed Period
- ▶ Economics
 - ▶ Average power prices
 - ▶ Required maintenance
 - ▶ New regulatory requirements
 - ▶ Local
 - ▶ National
 - ▶ Voluntary initiatives?
- ▶ Accident



NRC Post-Fukushima Safety Enhancements



Locations of NRC-Regulated Sites Undergoing Decommissioning



- Power Reactor Sites
- Complex Materials
- Fuel Cycle Facilities
- Research and Test Reactors
- ★ Uranium Recovery Sites



As of July 2018

- DOE?
- FUSRAP?
- International

What's the Point of Decommissioning?

- ▶ What Happens to the plant?
 - ▶ Clean (solid) Waste/Debris
 - ▶ Hazardous Waste
 - ▶ Low Level Radwaste
 - ▶ Mixed Waste
 - ▶ Spent Fuel/GTCC Waste
- ▶ What happens to the site?
 - ▶ Brownfield or Greenfield?
 - ▶ Clearance... how to prove?
 - ▶ MARSSIM



Decommissioning - Options

- ▶ Prompt
- ▶ Safe Storage
 - ▶ Initial period to setup facility for...
 - ▶ Storage
 - ▶ Final Dismantling
 - ▶ Duration
 - ▶ US
 - ▶ GB
- ▶ ENTOMB
 - ▶ Commonly in response to an accident
 - ▶ Stabilize facility
 - ▶ Long-term storage

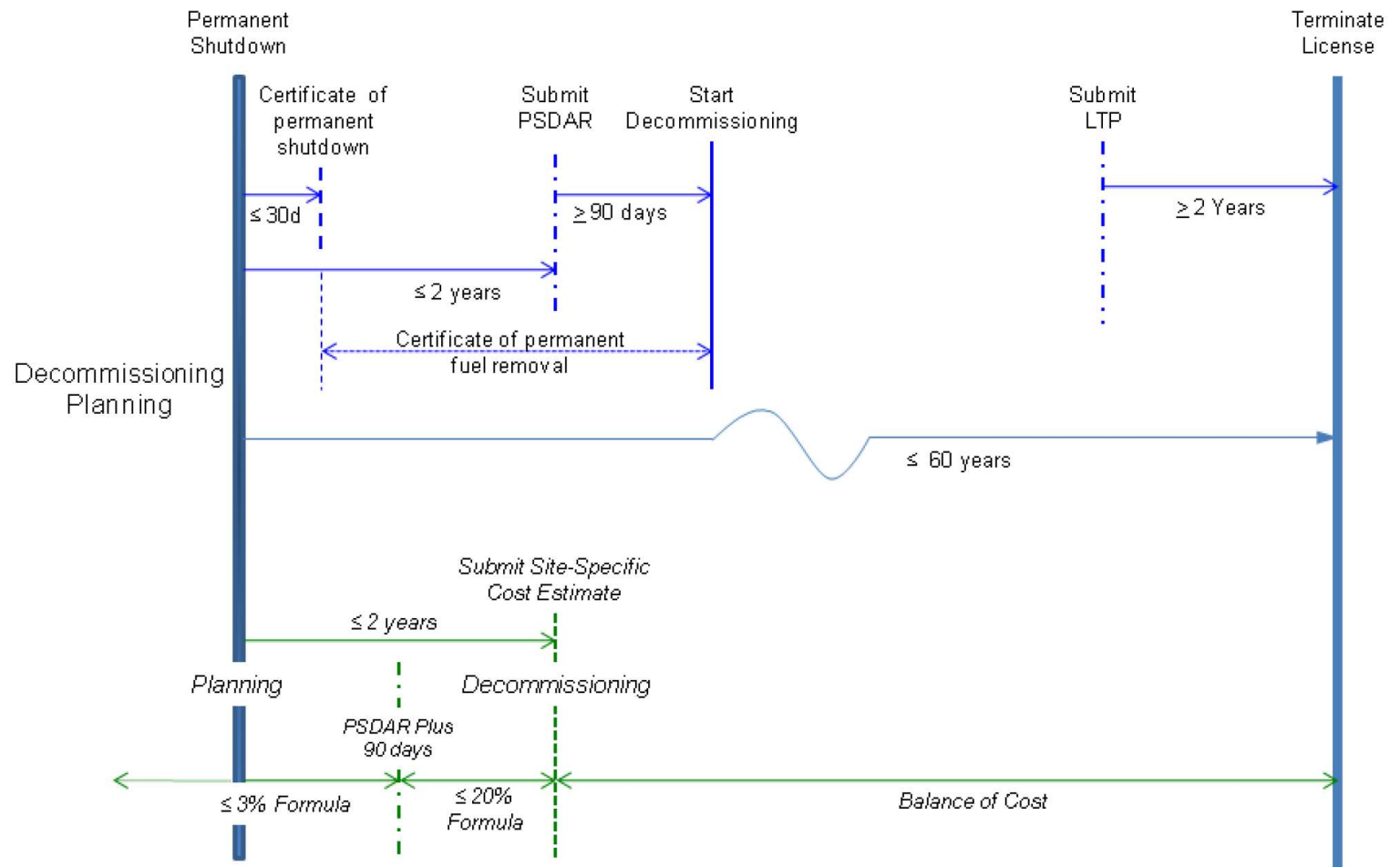


Requirements and Guidance

- US Requirements in 10 CFR 50
 - 10 CFR 50.82 provides the requirements for termination of a license including a requirement for nuclear power reactor licensees to submit a Post-Shutdown Decommissioning Activities Report (PSDAR).
- Reg Guides
 - 1.184 Rev. 1 “Decommissioning of Nuclear Power Reactors
 - 4.2 “Life Cycle Planning for Decommissioning”
 - 4.22 “Decommissioning Planning During Operations”

Overview

SIMPLE DECOMMISSIONING TIMELINE



Initial Steps

- ▶ Historical Site Assessment/Characterization
 - ▶ Required for planning and disposal
 - ▶ Review historical records to determine
 - ▶ Extent of possible contamination on site
 - ▶ Occurrence and degree of contamination in the facility
 - ▶ Records include
 - ▶ 10 CFR 50.75(g) files
 - ▶ Condition Reports
 - ▶ Facility modification records

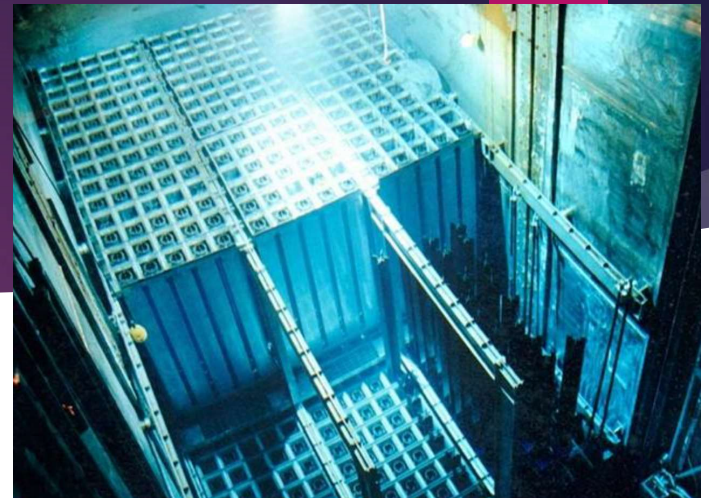
Initial Steps

- ▶ Regulatory Requirements
 - ▶ Significant Reduction after Permanent S/D
- ▶ Maintenance Requirements
 - ▶ Significant reduction with reduced regulatory requirements
- ▶ Qualifications
 - ▶ E.g. No need for SROs, now Certified Fuel Handlers
 - ▶ Impact on Accredited Training Programs

Modified Tech Specs

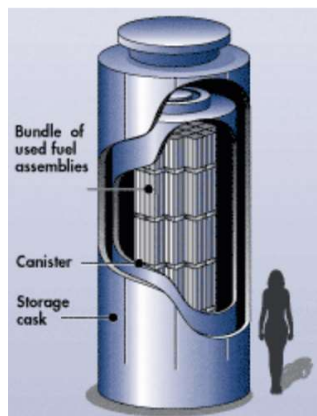
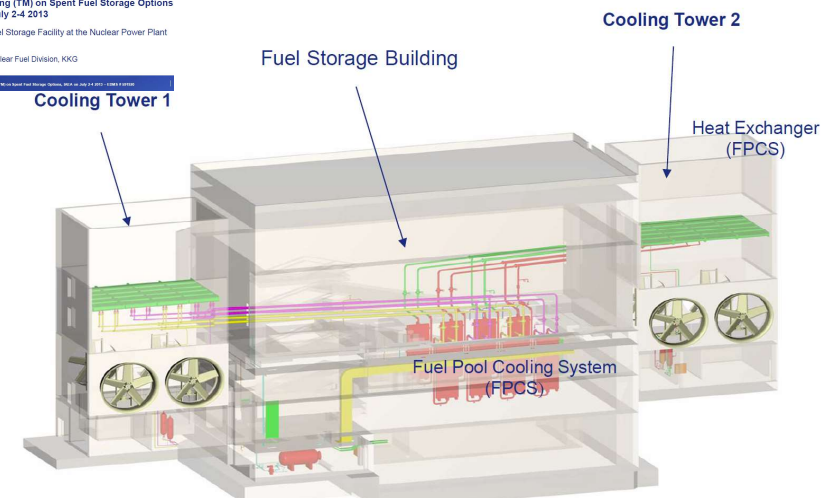
Initial Steps

- ▶ Dealing with Spent Fuel – The options
 - ▶ Spent Fuel “Island” (Yankee Rowe)
 - ▶ New, Dedicated, Wet Fuel Storage Facility (Gösgen, CH)
 - ▶ Dry-Cask Storage (ISFSI)
 - ▶ Separate license



Fuel Pool Cooling System

Technical Meeting (TM) on Spent Fuel Storage Options
IAEA Vienna, July 2-4 2013
External Spent Fuel Storage Facility at the Nuclear Power Plant
in Gösgen
Urs Appenzeler, Nuclear Fuel Division, KKG



Initial Steps

- ▶ Mothballing Plant Systems/Prep for Dismantling
 - ▶ De-energizing
 - ▶ Removal and processing of liquids for discharge or disposal
 - ▶ Shipment of wastes for disposal
 - ▶ Decontamination or fixing loose contamination
- ▶ Repowering and Temporary Utilities
 - ▶ SONGS 1
 - ▶ “Approximately 100,000 feet (30.5 km) of “orange sleeved” cable was purchase for the decommissioning.” Simplified dismantling (LOTO) also safer.
 - ▶ Mühlheim-Kärlich
 - ▶ Installed new, temporary, power and ventilation to simplify dismantling.
 - ▶ Sized for decom, easier maintenance, lower maintenance requirements because more modern



<https://www.group.rwe/en/our-portfolio/our-sites/muelheim-kaerlich-nuclear-power-plant>

Initial Steps

▶ Staffing

▶ Fort Saint Vrain Experience

- ▶ Need to have a plan
- ▶ Requires flexibility to account for employees needs
- ▶ Difficulties include
 - ▶ Retaining key personnel
 - ▶ Finding positions within the remaining organization
 - ▶ Privacy (different packages for different employees)

Initial Steps

- ▶ Determination of Management Model
 - ▶ Licensee
 - ▶ Manages the whole project as general contractor
 - ▶ Decommissioning Operations Contractor
 - ▶ DOC manages day-to-day operations
 - ▶ Was used as fixed-priced at some Yankee Plants
 - ▶ Usually unsuccessful
 - ▶ License Transfer to Decommissioning Company
 - ▶ Holtec
 - ▶ EnergySolutions
 - ▶ Northstar & Areva formed “Accelerated Decommissioning Partners”

Safe Storage

- ▶ Monitoring and Security
 - ▶ Ensuring facility access is controlled
 - ▶ Security Staff
 - ▶ Minimal Administration
 - ▶ Periodic monitoring to ensure
 - ▶ Remaining systems aren't degrading
 - ▶ Contamination isn't spreading
 - ▶ Document control and management anticipated to be a challenge
 - ▶ Evolving electronic standards
 - ▶ Secure management of physical copies

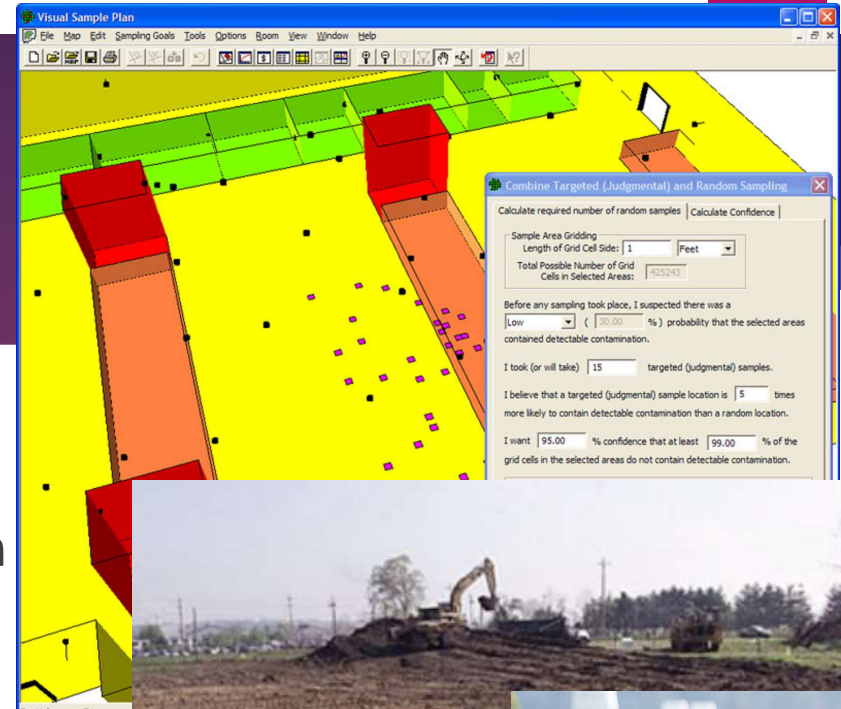
Demolition and Disposal

- ▶ Removal of SSCs
- ▶ Sequencing important so that required support systems are not dismantled ahead of schedule
- ▶ If performed after storage period
 - ▶ dose may be lower
 - ▶ Knowledge of plant and systems (operation) may be a challenge (Chalk River)
- ▶ Ends with structure demolition
 - ▶ Dismantling
 - ▶ Implosion
- ▶ Disposal at licensed facilities (Now vs later)



Site Decontamination

- ▶ Initial basis is the HSA
- ▶ Surveys performed to determine extent of remaining contamination
 - ▶ Initial Surveys
 - ▶ Characterization Surveys
- ▶ Removal of contamination
 - ▶ Extent and level of effort based on post license-termination use of the property
- ▶ Final Status Survey
 - ▶ MARSSIM



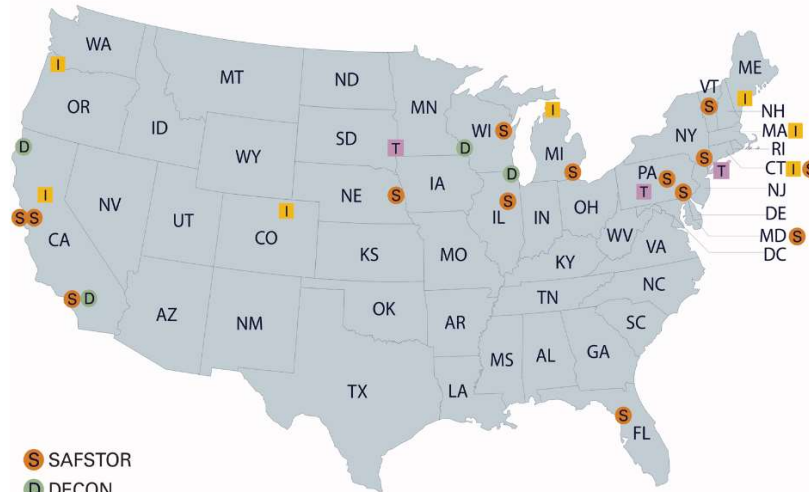
License Termination

Per 10 CFR 50.82...

- ▶ (6) The Commission will terminate the license if it determines that—
 - ▶ (i) The decommissioning has been performed in accordance with the approved decommissioning plan, and
 - ▶ (ii) The terminal radiation survey and associated documentation demonstrate that the facility and site are suitable for release in accordance with the criteria for decommissioning in 10 CFR part 20, subpart E.

Current US Status

Power Reactors Decommissioning Status



- S SAFSTOR
- D DECON

Decommissioning Completed

- I ISFSI (Independent Spent Fuel Storage Installation) only
- T License Terminated (no fuel on site)

CALIFORNIA	FLORIDA	MICHIGAN	PENNSYLVANIA
S GE EVESR	S Crystal River 3	S Fermi 1	T Saxton
S GE VBWR	ILLINOIS	I Big Rock Point	S Peach Bottom 1
D Humboldt Bay 3	S Dresden 1	NEBRASKA	S Three Mile Island 2
I Rancho Seco	D Zion 1 and 2	S Fort Calhoun	SOUTH DAKOTA
S San Onofre 1	MARYLAND	NEW YORK	T Pathfinder
D San Onofre 2 and 3	S N.S. Savannah	S Indian Point 1	VERMONT
COLORADO	MASSACHUSETTS	T Shoreham	S Vermont Yankee
I Fort St. Vrain (DOE License)	I Yankee Rowe	OREGON	WISCONSIN
CONNECTICUT	MAINE	I Trojan	D LaCrosse
S Millstone 1	I Maine Yankee		S Kewaunee
I Haddam Neck			

As of July 2018