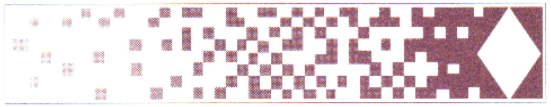

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The US Spent Nuclear Fuel Management System: Emerging Issues

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Briefing to the Nuclear Regulatory Commission

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Planned Elements of Spent Nuclear Fuel (SNF) Management System

- At-reactor storage ← **Only active element today**
- Consolidated storage
- Geologic repository

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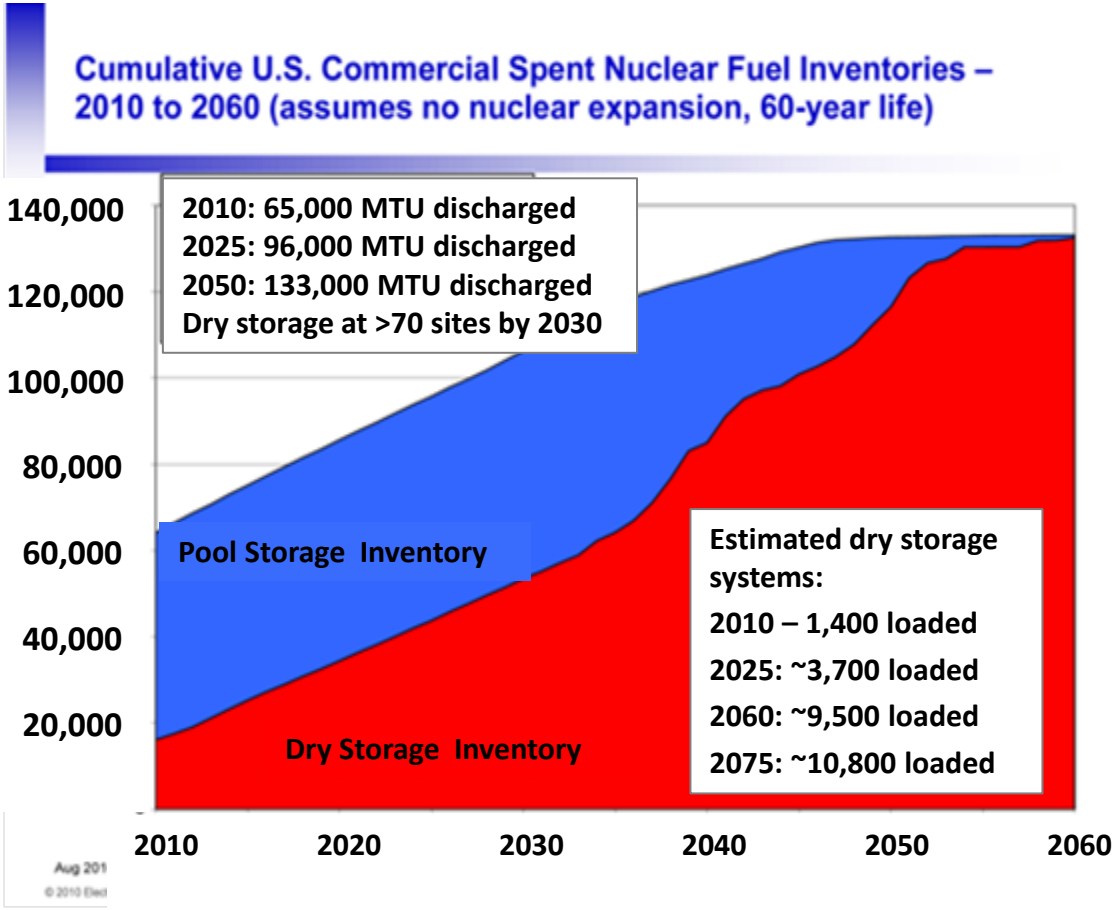
At-Reactor Storage: What Has Changed?

- 1980 – fears of running out of reactor storage space
- 1980s – demonstration of dry storage casks for low burnup fuel
- Expectation with federal waste acceptance in 2000
  - ~4000 MTU (peak) in dry storage at reactors
  - ~36,000 MTU (peak) in pool storage at reactors
- Today – most reactor sites have dry cask storage
  - ~20,000 MTU in dry storage increasing at ~ 2000 MTU/ year
  - ~50,000 MTU in pools



Source: Electric Power Research Institute

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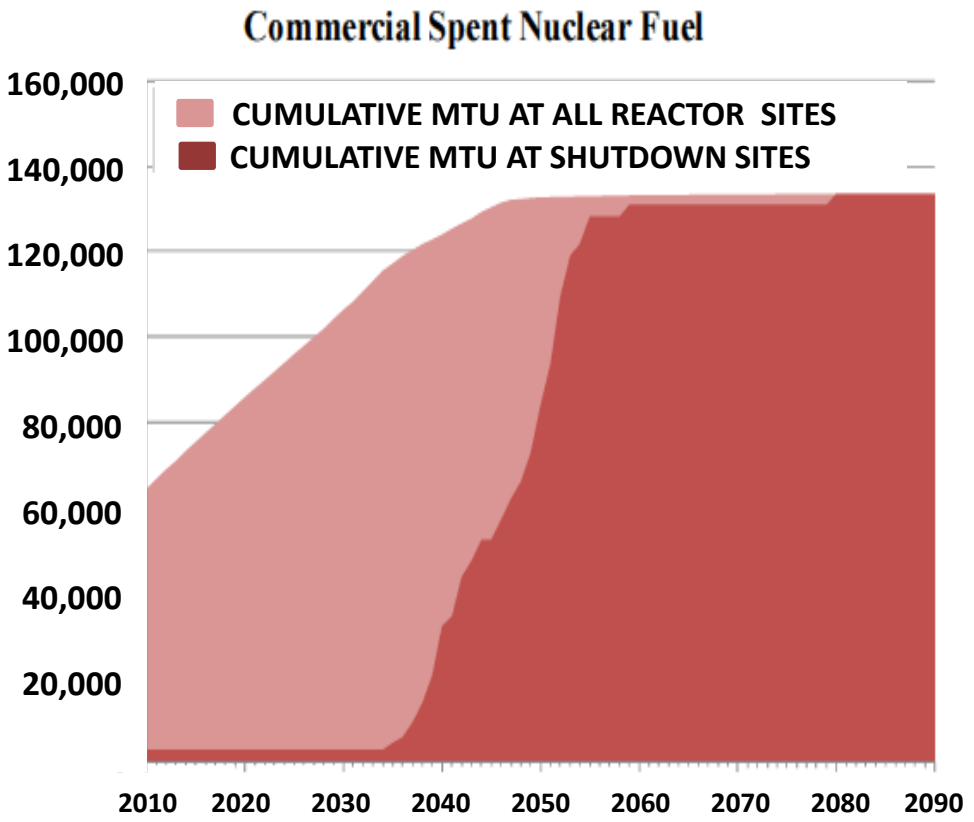
Decommissioned Plant Storage as Emerging Element of the System

- 1980s expectation – shutdown sites would be cleared of spent fuel quickly with federal acceptance beginning ~2000
- Wave of shutdowns starting in 2030s and acceptance delayed to 2025 or later make that questionable
- Ability to move storage canisters soon after shutdown may be limited even after acceptance begins if current trends continue
  - Increasing burnups (up to 65 GWd)
  - Higher-capacity canisters (up to 37 PWR assemblies)
  - Higher thermal limits for storage (up to 40kW) than for transportation (up to ~25 kW)



Spent fuel at reactor sites assuming no movement to central location

Source: Hamal, et al., *Spent Nuclear Fuel Management: How centralized interim storage can expand options and reduce costs*

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Clearing Spent Fuel from Shutdown Sites Could Be an Extended Process

- Largest dry storage canisters loaded to storage thermal limits with high-burnup fuel may have to cool on site for decades before they can be moved (red curve)
- Removal of bare fuel from reactor sites in transportation casks loaded to transportation thermal limits could allow for earlier clearance of shutdown sites (blue curve)

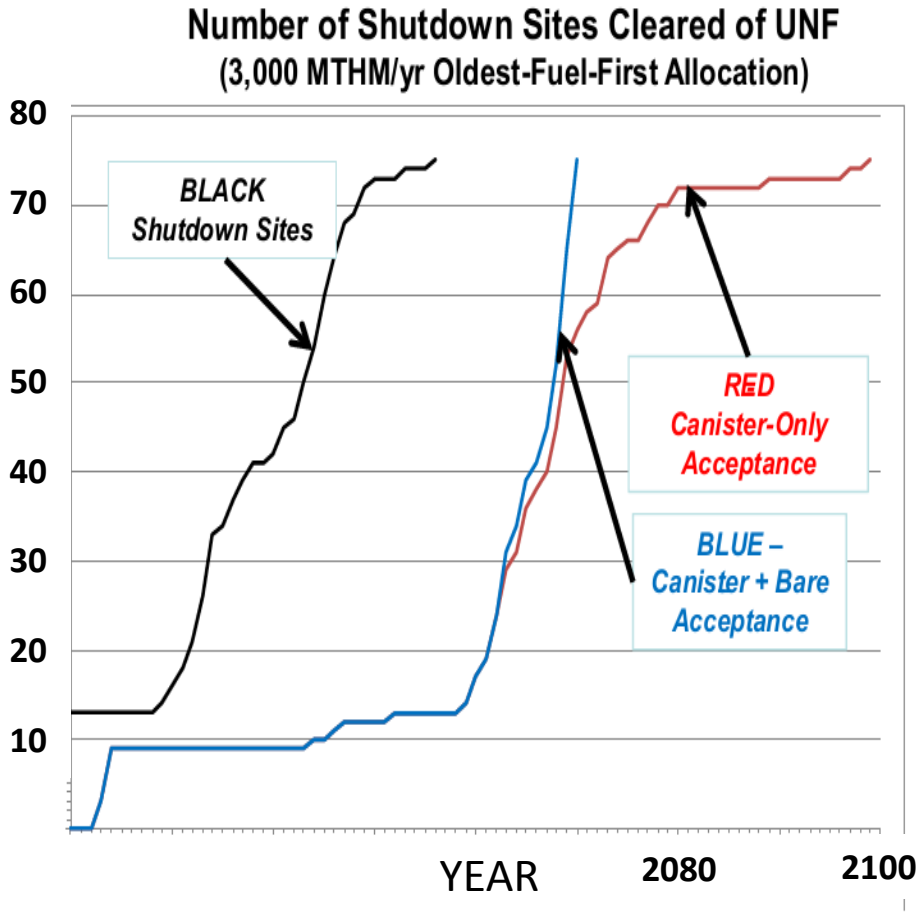
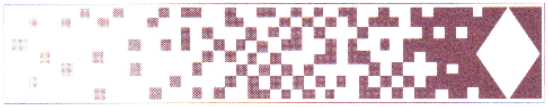


Chart Source: Derived from presentation by Jeffrey Williams, U.S. Department of Energy , at the Nuclear Waste Technical Review Board workshop on spent fuel, November 18-19, 2013



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Implications

- Fuel storage at shutdown reactor sites will become an increasingly important part of the spent fuel management system
- Designs and regulatory approaches are needed to reduce delay between storage canister loading and transportation offsite
- Uncertainties about transportability of canisters after extended storage suggest timely movement to central facilities to avoid repackaging at shutdown reactor sites
- Centralized facilities may need to accept uncanistered fuel to minimize post-shutdown storage at reactor sites
- Update of storage and transportation regulations should address these issues

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Centralized Storage

- Perennial recommendation of policy reviews
- Monitored Retrievable Storage (MRS) included in Nuclear Waste Policy Act (NWPA)
- MRS included in DOE plans until mid-1990s
  - As integral part of system, not just a way to accept SNF until a repository is available
- BRC recommended prompt action on storage
- Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* calls for consolidated storage facility(ies)

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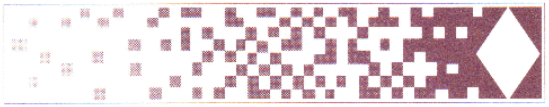
Changed Expectations about Central Storage

- Central facility designs have assumed dry storage in single standard canister systems
  - MRS: receive bare fuel, store in MRS-specific DPC
  - Private Fuel Storage : receive and store single DPC system
  - Yucca Mountain: receive both Transportation-Aging-Disposal canisters (TADs) and DPCs (immediately repackaged into TADs), for aging or direct disposal
- Central storage facility now may receive and store multiple types and ages of already-loaded canisters
- Storage period may be much longer than expected



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Implications

- Central storage facility design and licensing issues will be more complex than previously anticipated
- Potential new licensing issues should be identified and addressed as soon as possible
  - Pilot facility for 12 shutdown plant sites will need to handle:
    - 17 different canister designs,
    - 8 different storage overpack designs
    - 8 different transport overpack designs
  - Larger scale storage facility may require large-scale receipt and handling of bare fuel assemblies

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Repository

- Geologic repository is still the desired end-state of the system
  - NWPA focused on repository development
  - BRC urged prompt action towards a repository
  - Administration's *Strategy* includes progress on a repository with site selection by 2026
- Generic repository regulations need to be updated early in the siting process (BRC)
- Preclosure and postclosure issues need to be addressed

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Preclosure Issues

- Repository surface facilities may conduct same activities as a central storage facility
- Part 63 is risk-informed, Parts 71 and 72 are not, leading to potentially different regulatory treatment of same activities at different locations
- Updated regulations should aim for uniform treatment of spent fuel management activities wherever they are performed
  - Avoid regulatory differences that could drive system decisions (e.g. location of repackaging)

Post closure Issues

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- Dramatic escalation of expectations about required scope of site characterization had major impact on NWPA repository program
  - 1981 NRC estimate: underground test facility with two shafts and up to 1,000 feet of tunnels, costing $25 million to $30 million* ; Yucca Mountain Exploratory Studies Facility had >5 miles of tunnels
  - Escalation of cost estimates to ~$1B per site by 1987 was an important contributor to decision to limit characterization to a single site
- Federal budget constraints might not accommodate both central storage and a similar repository siting process
- Updated generic repository regulations should establish reasonable expectations for a decision-focused site characterization process, based on experience to date
  - WIPP and Yucca Mountain
  - Other countries (Sweden, Finland, Canada) that engage the licensing process with more streamlined site characterization

*U.S. Nuclear Regulatory Commission, ‘ ‘Disposal of High- Level Radioactive Wastes in Geologic Repositories: Licensing Procedures,” Federal Register, vol. 46, No. 37, Feb. 25, 1981, p. 13973,

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System Issues

- Growing interest in staged, adaptive development with significant evolution of activities and facilities over time
- Existing regulations were not developed with that in mind, although the NAS *One Step at a Time* study recognized "there are no restrictions precluding DOE from implementing Adaptive Staging"
- BRC recommendation – "Standards for a disposal facility should explicitly recognize and facilitate an adaptive, staged approach to development"
- Also applicable to central storage facility that may evolve from a pilot focused on accepting only canistered fuel to a large-scale facility accepting bare fuel

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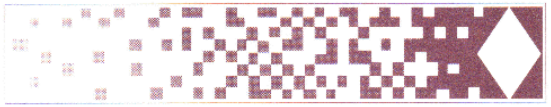
Conclusions

- Regulations now in place may be challenged by:
  - More complex central storage facility design and licensing issues than previously anticipated
    - Receipt and storage of multiple canister designs after various periods of storage at reactor sites
    - Large scale receipt and handling of bare fuel assemblies
  - Need for more streamlined and timely repository site characterization
- Issues should be identified and addressed as soon as possible



Thank you for your attention