Using DOE System Analysis Tools to Inform Planning for an Integrated Transportation System

Jack Wheeler
U.S. Department of Energy

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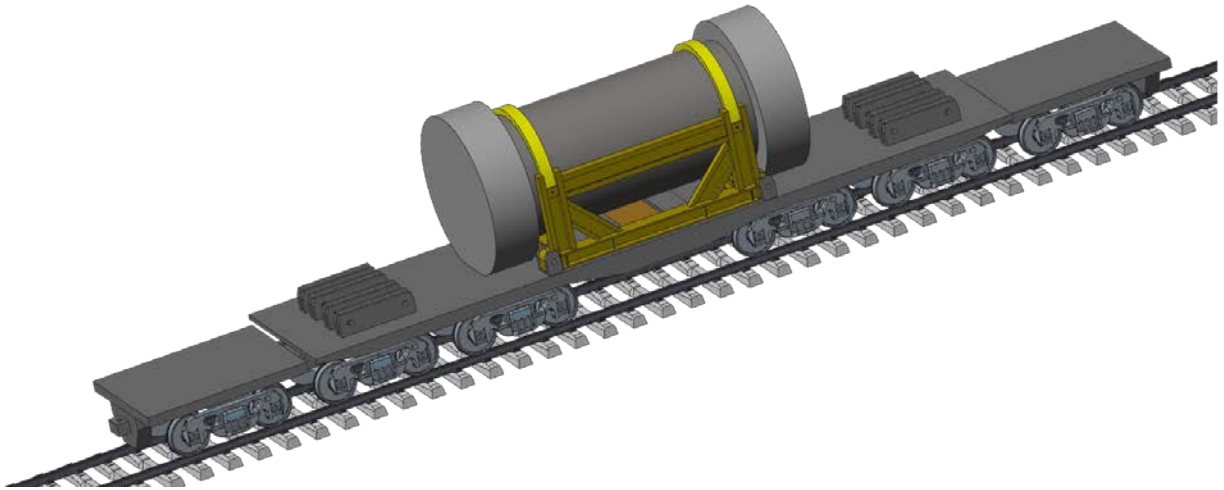
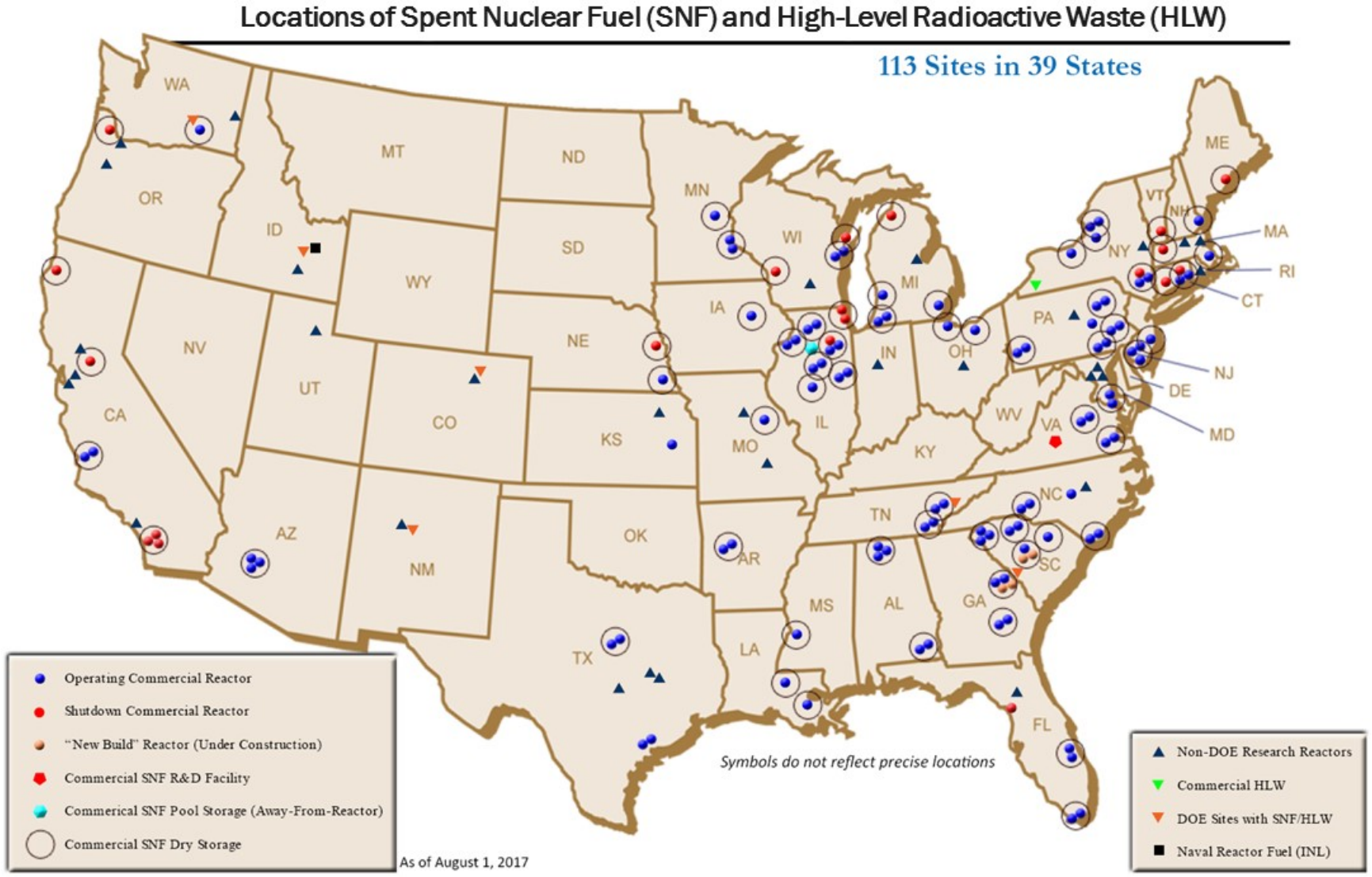
This technical presentation reflects illustrative analyses based on research of various concepts. No inferences should be drawn from this presentation regarding future actions by DOE.



Contents

- Need for Integrated Waste Management system analysis
- Integrated system analysis tool set
- Site-level data and constraints
- System-level analysis and insights
- Summary

Planning for transportation of SNF and HLW at the national level requires a systematic approach



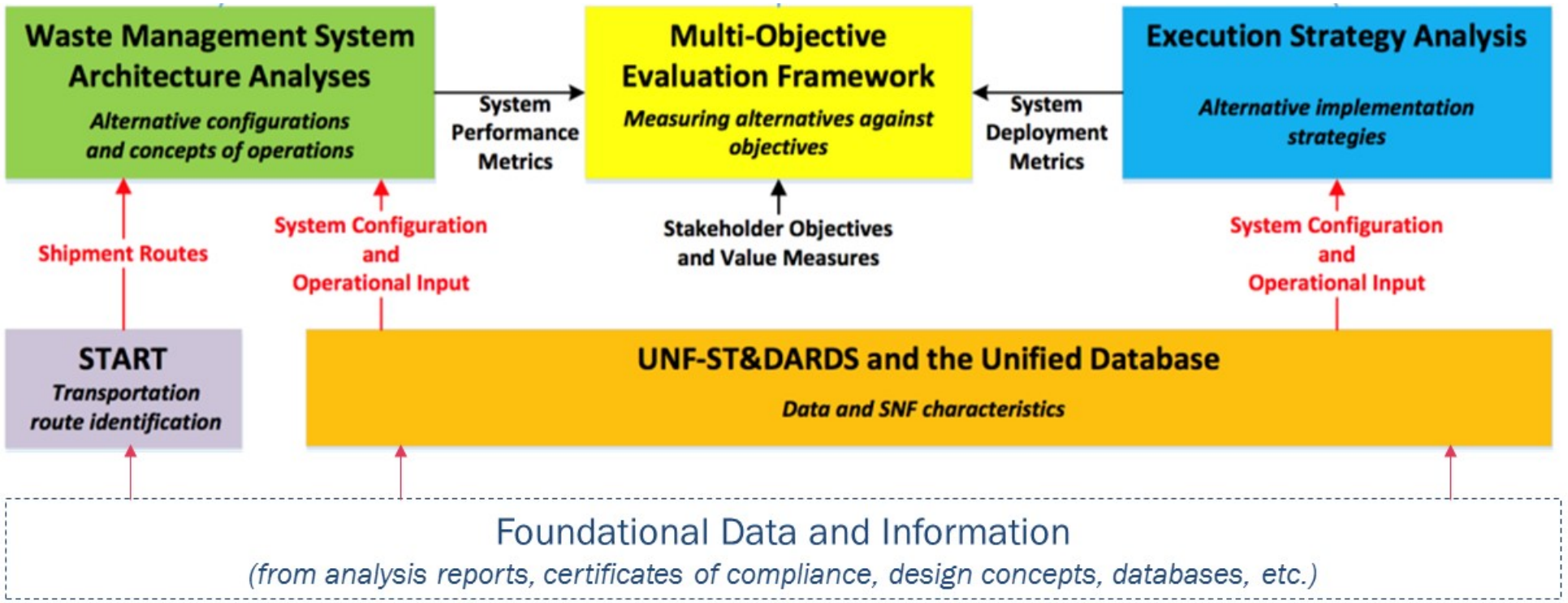
Integrated Waste Management System Analysis

- DOE's Office of Nuclear Energy has been sponsoring the development of an analytical toolset for applying systems analysis, systems engineering, and decision analysis principles to the evaluation of various potential integrated waste management (IWM) system architectures

- IWM system architecture analyses are being conducted on a variety of research topics and scenarios associated with future deployment of a comprehensive system for managing nuclear waste

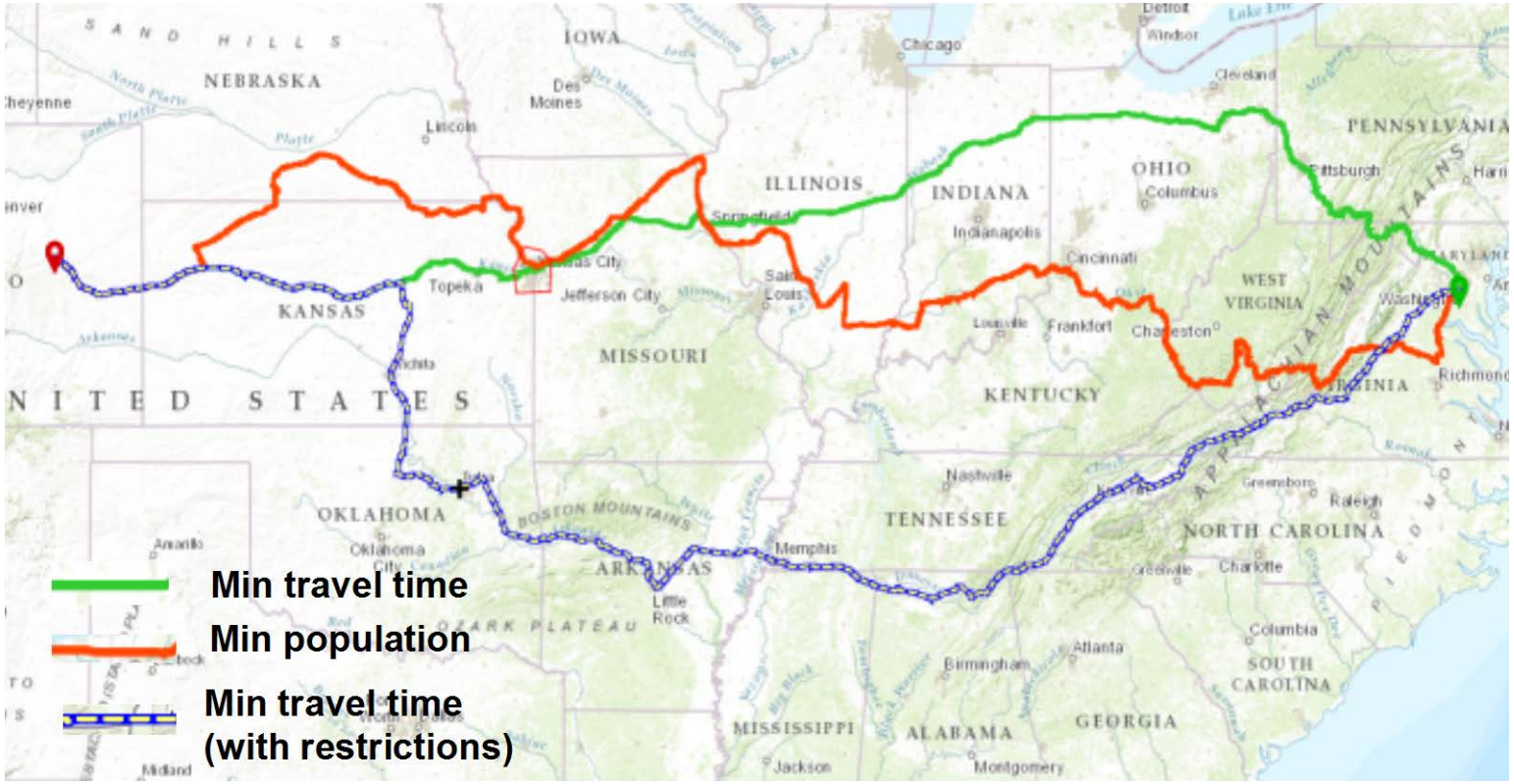
- Considers various aspects of the back-end of the nuclear fuel cycle (i.e., transportation, storage, and disposal)

IWM's goal is to provide a solid basis for future decisions related to deploying a spent fuel management strategy



START = Stakeholder Tool for Assessing Radioactive Transportation
UNF-ST&DARDS = Used Nuclear Fuel – Storage, Transportation & Disposal Analysis and Resource Data System

Integration of START and System Analysis Tools



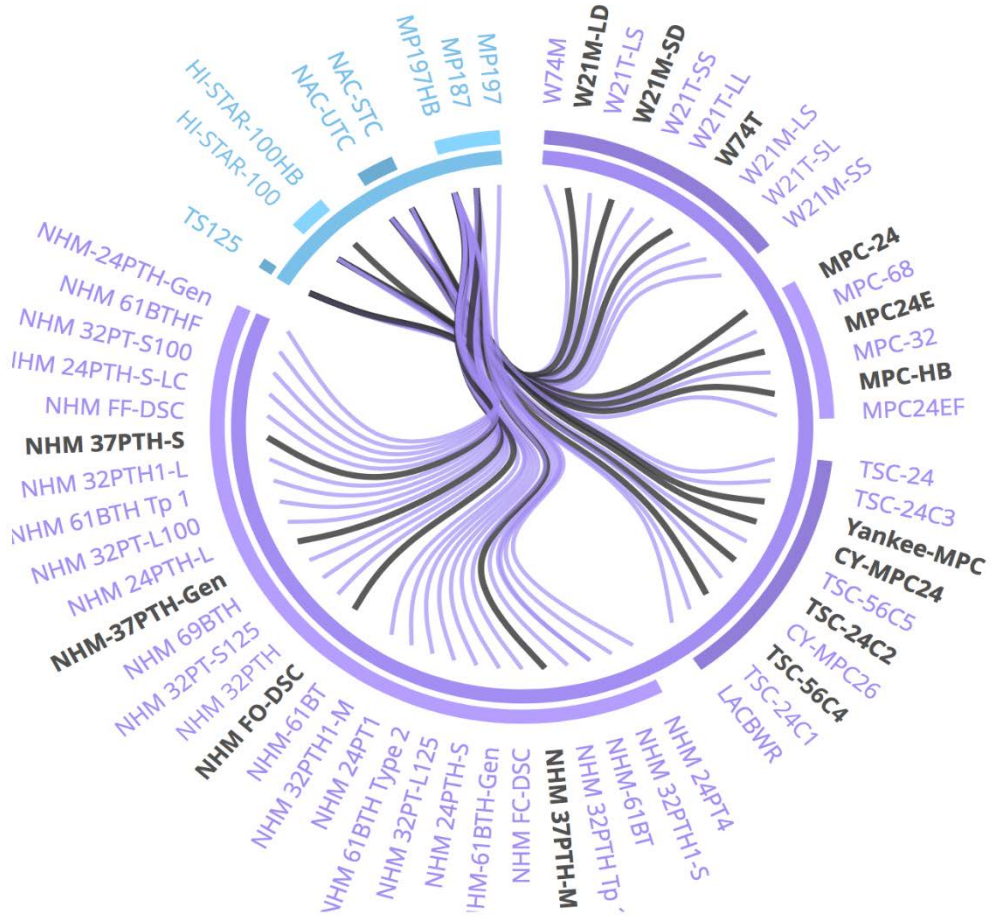
Example START Routes

Example routes are for illustrative purposes only and do not reflect a selected destination site

The Unified Database contains SNF and related systems characteristics

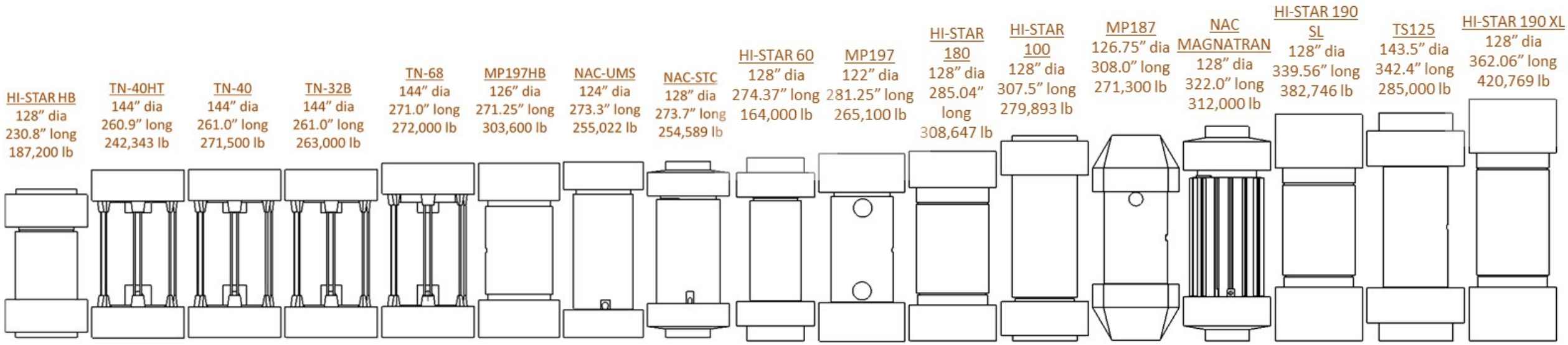
- Fuel geometry, dimensions, and materials
- Reactor irradiation histories (e.g. reactor cycle length, specific power)
- Cask system data, including certificate of compliance (CoC) requirements
- Site attributes e.g., facility, reactor, pool, Independent Spent Fuel Storage Installation (ISFSI)
- Economic attributes (e.g., transportation infrastructure, ISFSI, and facility estimated costs)
- Transportation infrastructure attributes (e.g., rail, heavy haul, legal weight truck, and barge related data, and transfer times between these transportation modes)
- Potential future facility attributes

Various canisters (grouped by vendors) and their designated transportation cask



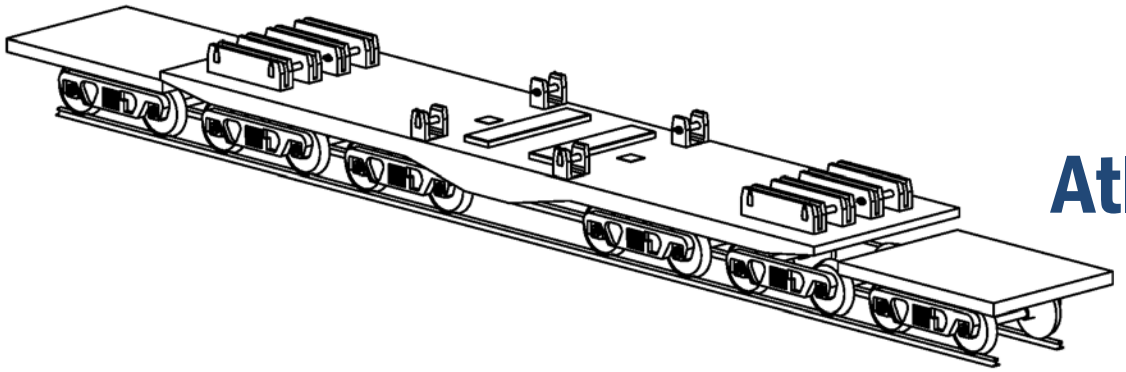
NUHOMS is shortened as NHM

Transportation cask attribute data are collected in the Unified Database



*The TN-32B and MAGNATRAN casks are not yet certified for transport

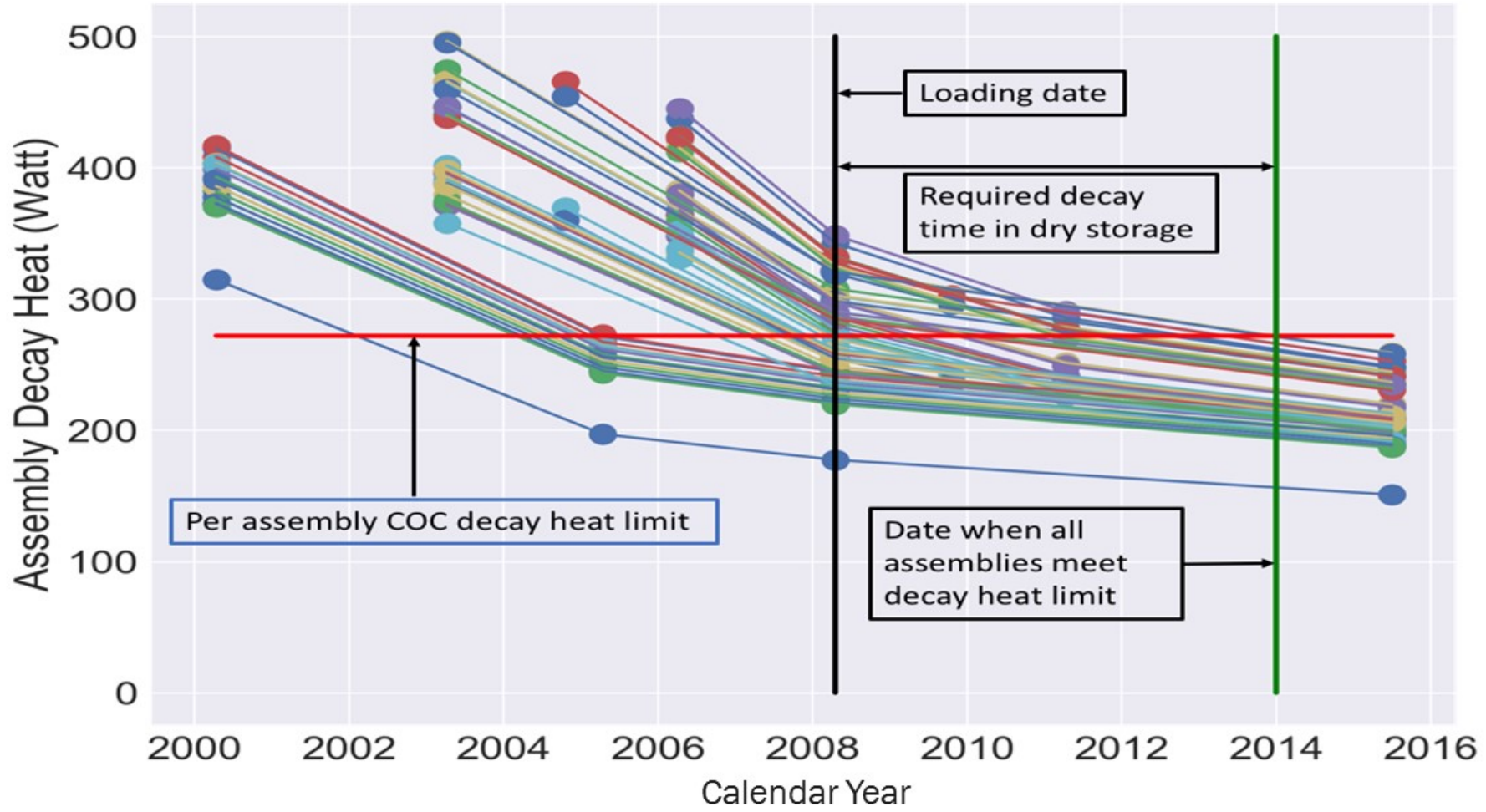
Various Transportation Casks for Rail Transport



Atlas Railcar

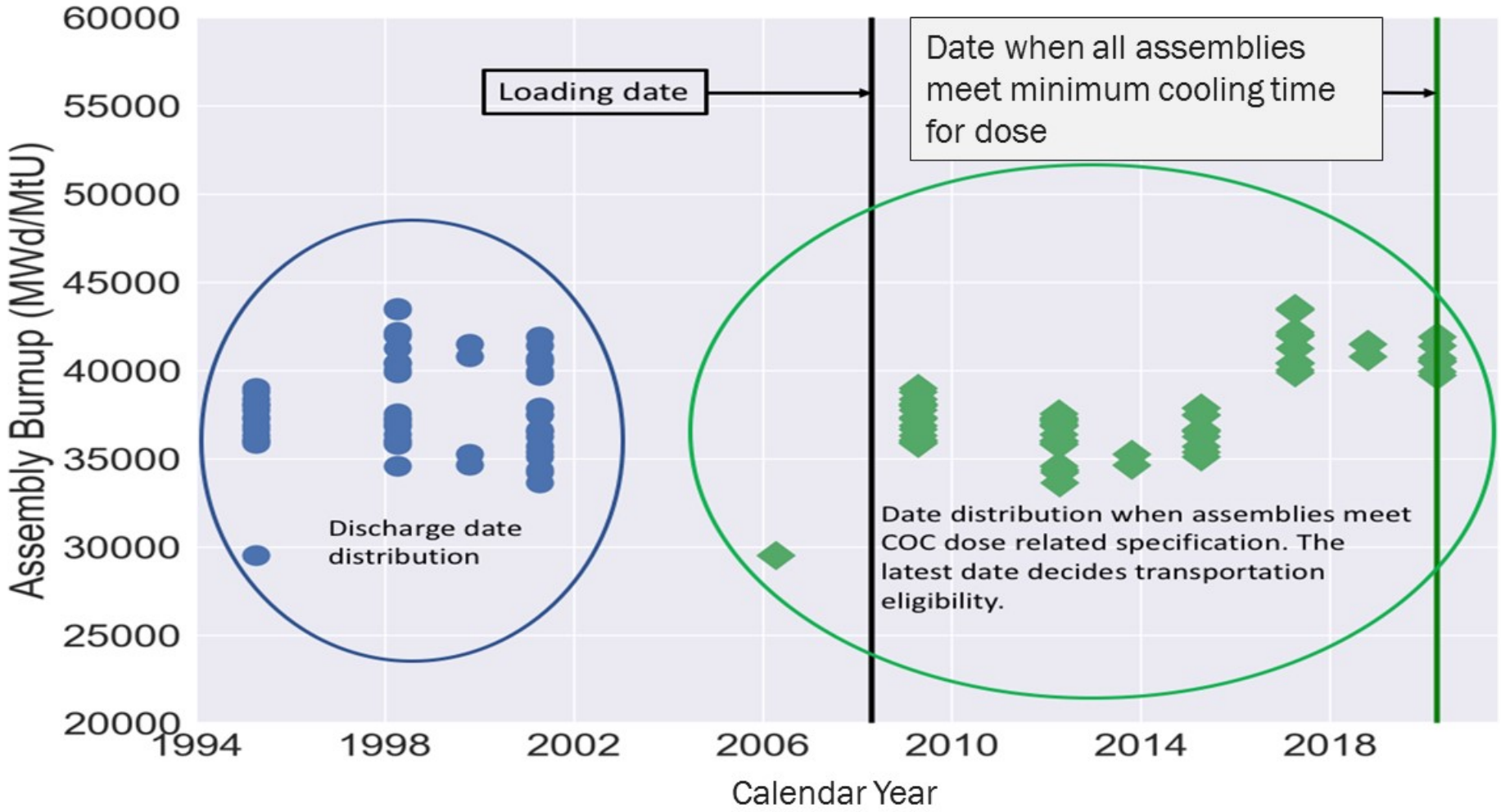
Site-Level Constraints: UDB checks against transportation CoC limits can be used to determine dates when SNF could be shipped

Assembly Decay Heat Example



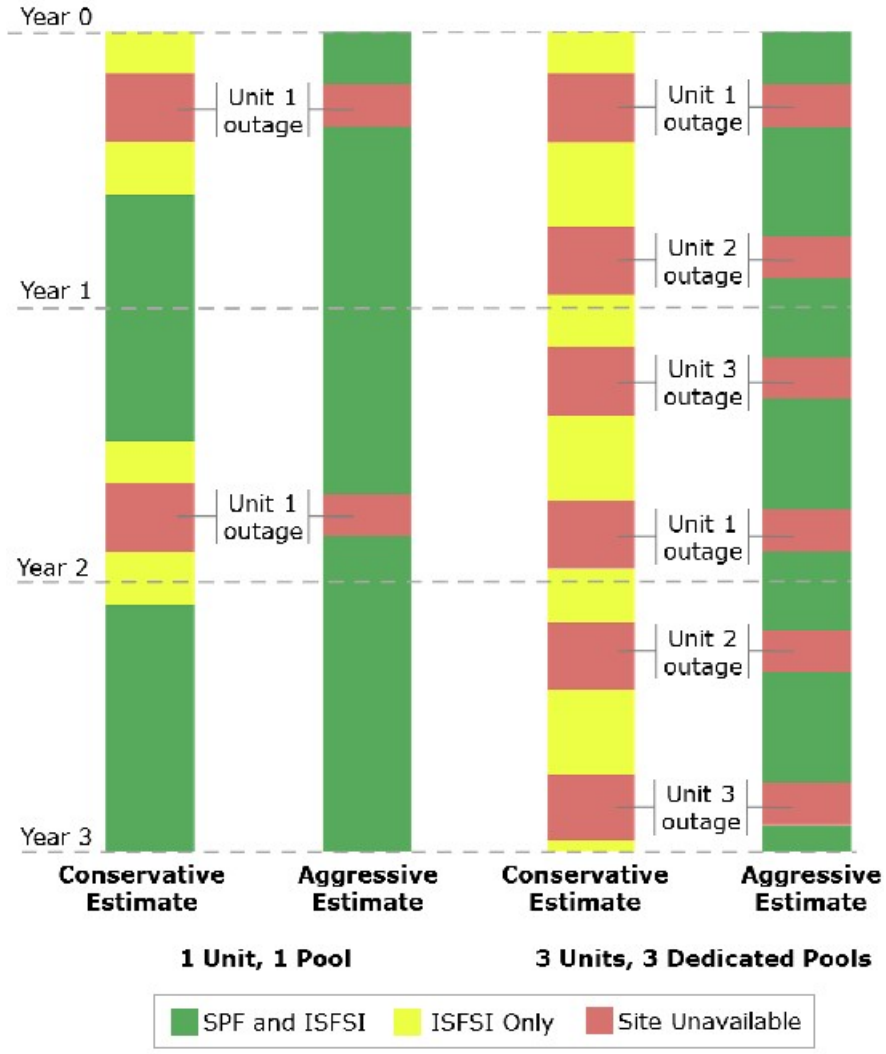
Site-Level Constraints: UDB checks against transportation CoC limits can be used to determine dates when SNF could be shipped

Assembly Minimum Cooling Time Example (Dose Related)



Site-Level Constraints: Refueling outages and pool configurations can constrain ability to prepare SNF for shipment

Reactor Type	No. of operating reactors	Refueling Cycle (months)	Spent Fuel Pool Configurations	No. Sites in family
PWR	1	18	1 Dedicated	10
PWR	1	24	1 Dedicated	1
PWR	1	24	2 Dedicated to single unit	1
PWR	1	18	4 Dedicated to single unit	1
PWR	2	18	1 Shared	9
PWR	2	24	1 Shared	1
PWR	2	18	2 Dedicated	12
PWR	2	24	2 Dedicated	1
PWR	3	18	3 Dedicated	1
PWR	3	24	1 Shared, 1 Dedicated	1
BWR	1	24	1 Dedicated	11
BWR	2	24	2 Dedicated	9
BWR	3	24	3 Dedicated	1
Shutdown Sites				13



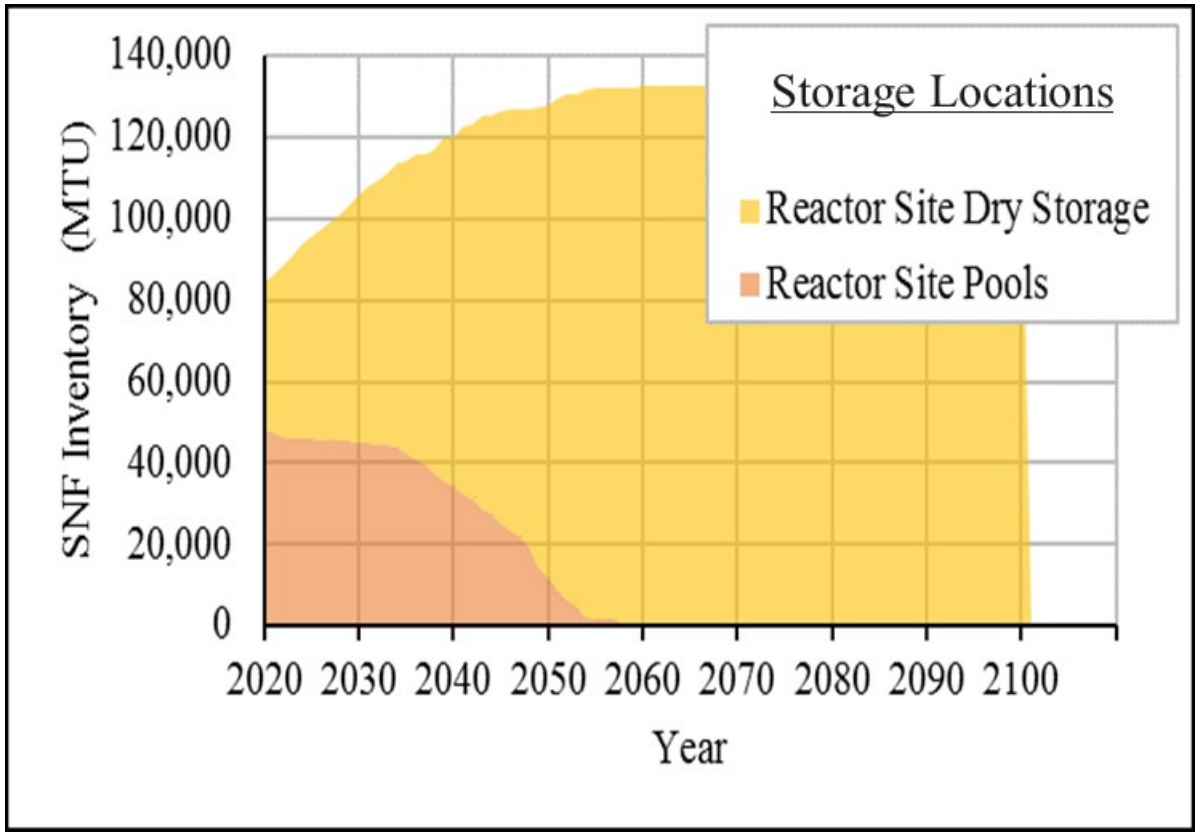
System-Level Analysis: Different approaches for transporting SNF from the commercial reactor fleet have been analyzed

- In various types of packages:
  - Re-usable non-canistered transportation casks
  - Dual-purpose canisters
  - Triple-purpose canisters, i.e. standardized transportation, aging, and disposal canisters (STADs)
  - Combinations of the above
- At different transportation rates, e.g.
  - ~3,000 MTHM/year or 225 casks/year
  - ~4,500 MTHM/year or 337 casks/year
  - ~6,000 MTHM/year or 450 casks/year
- With various shipment priority algorithms, e.g.
  - Allocations based on Oldest Fuel First (OFF)
  - Sites that shutdown prior to 2020, then OFF (OFFsd)
  - Shutdown Priority Ranking for Initiation of Transport (SPRINT) - prioritizes sites in the order they have shutdown or are scheduled to be shutdown

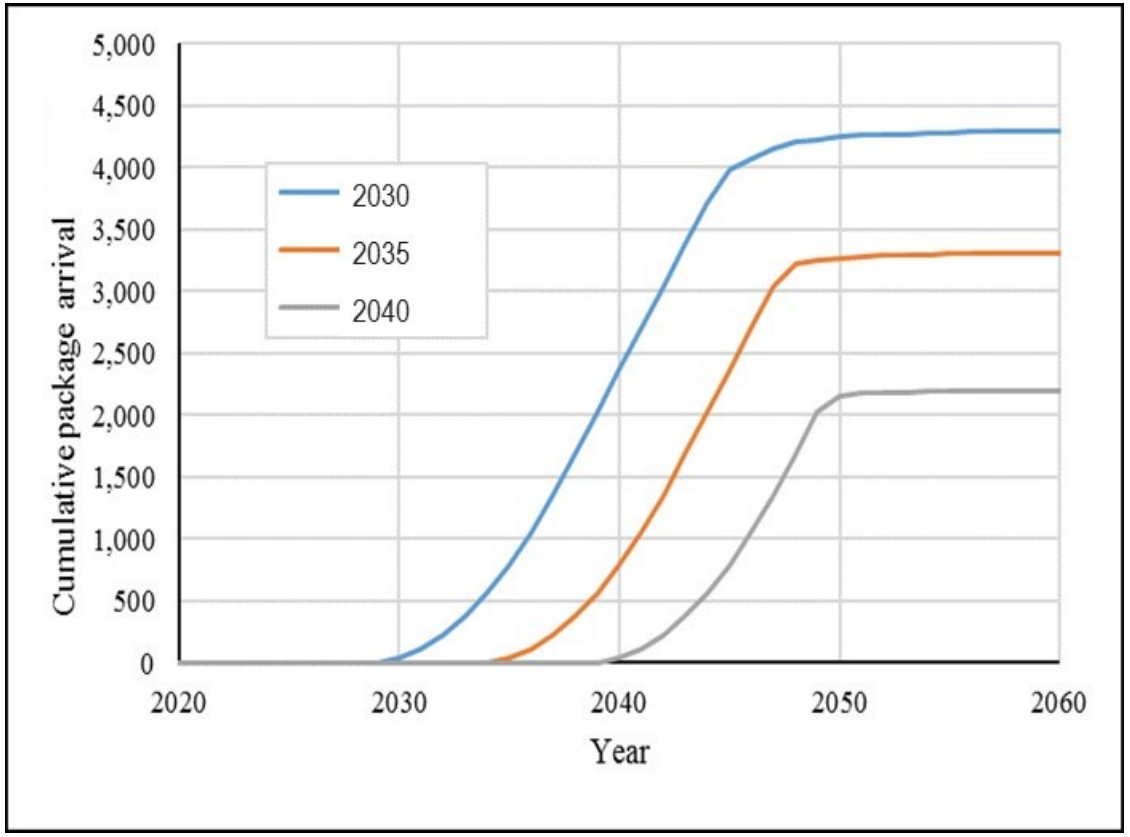
Reactor Sites with All Reactors Shutdown by 2020

	Year of first discharge on site	Year of last discharge on site	Amount of SNF on site (MTU)	Total packages [actual or assumed in simulation]	GTCC casks [loaded or estimated)]
Humboldt Bay	1971	1976	28.94	6	1
La Crosse	1972	1987	37.97	5	0
Rancho Seco	1977	1989	228.38	22	1
Yankee Rowe	1972	1991	127.13	16	1
Trojan	1978	1992	359.55	34	0
Haddam Neck	1970	1996	413.53	43	3
Maine Yankee	1974	1996	542.26	64	4
Big Rock Point	1974	1997	57.92	8	1
Zion	1976	1997	1019.41	65	4
Crystal River	1978	2009	582.23	44	2
San Onofre	1970	2012	1608.82	128	5
Kewaunee	1976	2013	518.70	46	2
Vermont Yankee	1973	2014	703.66	60	2
Fort Calhoun	1975	2016	465.35	42	2
Pilgrim	1973	2019	725.95	62	2
Oyster Creek	1971	2019	831.91	64	2

Analysis of non-canistered SNF transportation cask scenarios reveals closing window to ship from pools, primarily between 2035-2055

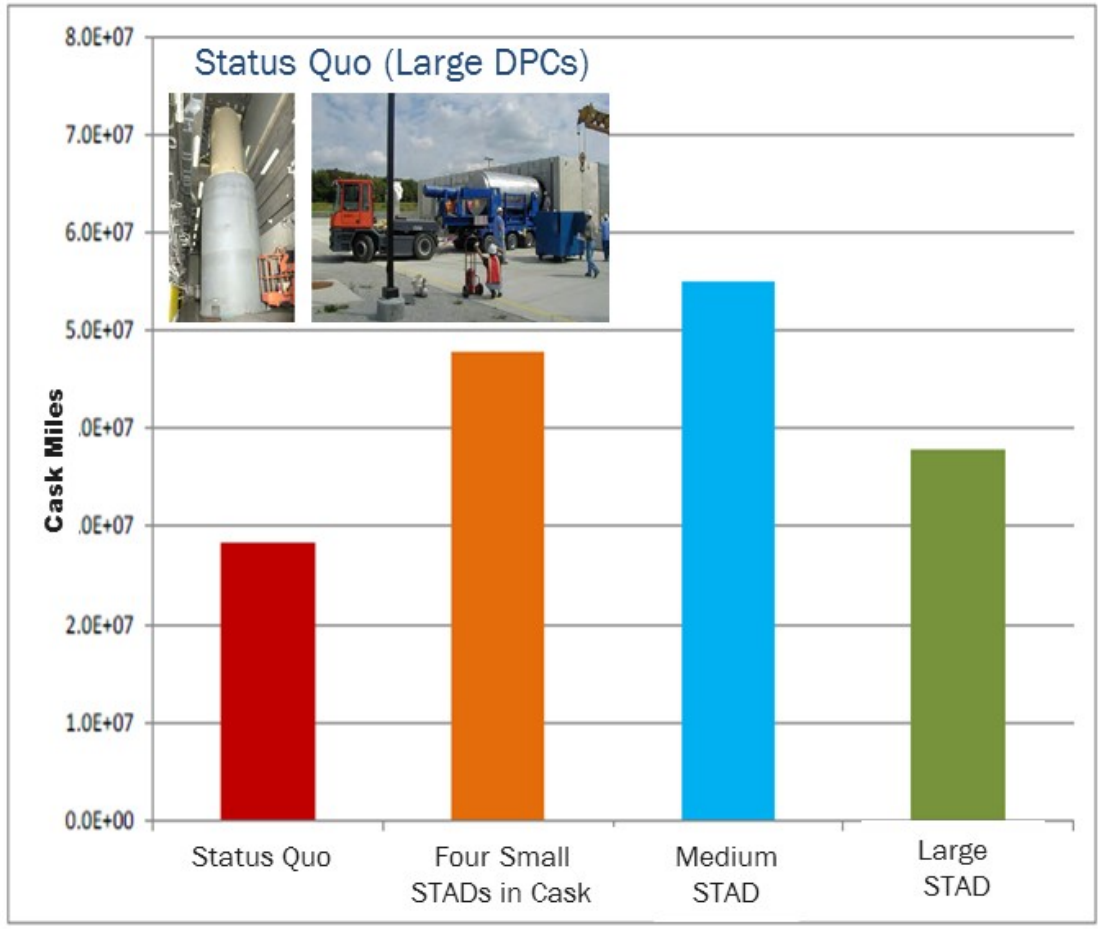


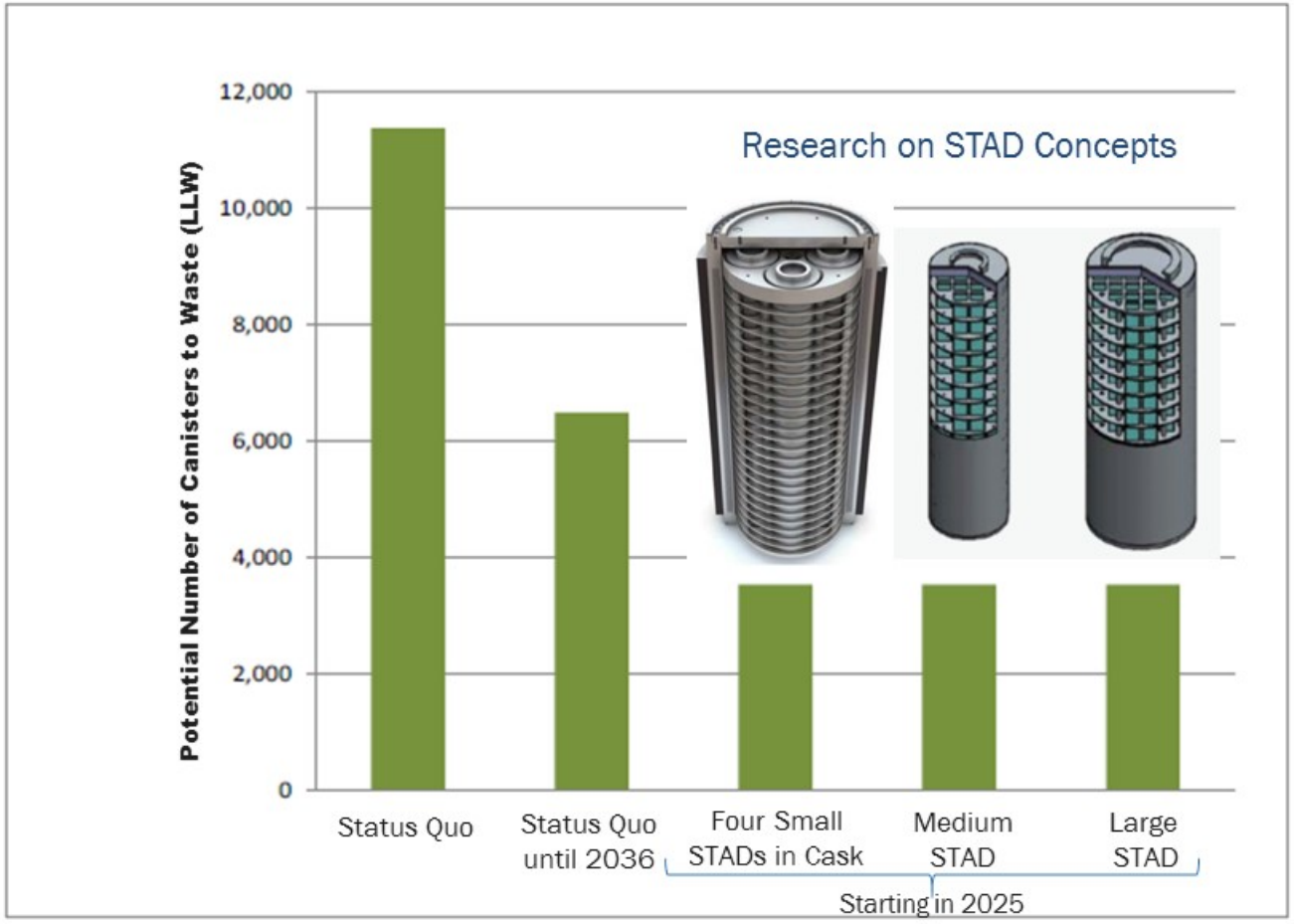
Emptying of reactor pools into dry storage (assumes no transport to receipt facilities)



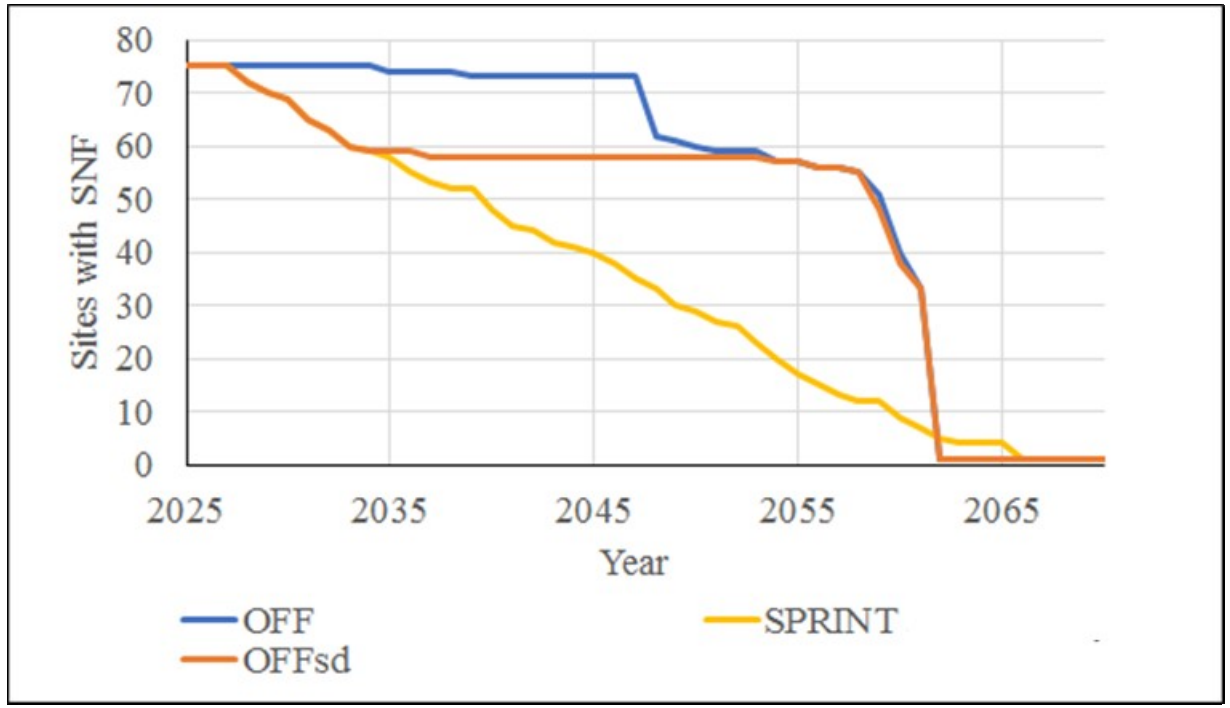
The cumulative number of non-canistered SNF packages that can be transported diminishes with later receipt dates

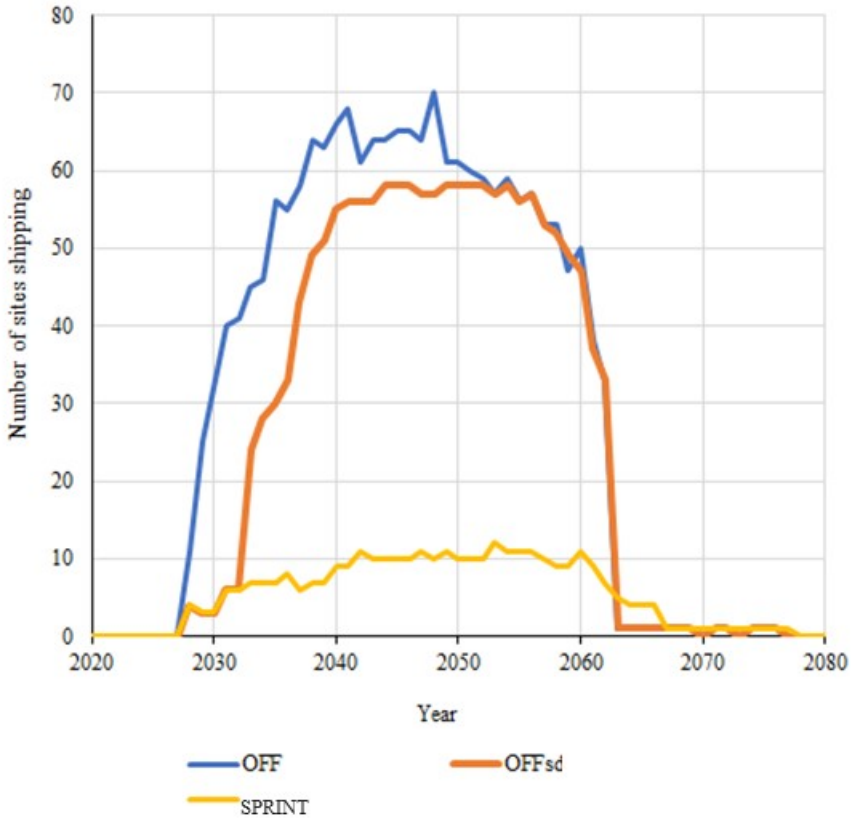
System analysis allows inter-dependencies to be assessed and can be used to guide further research



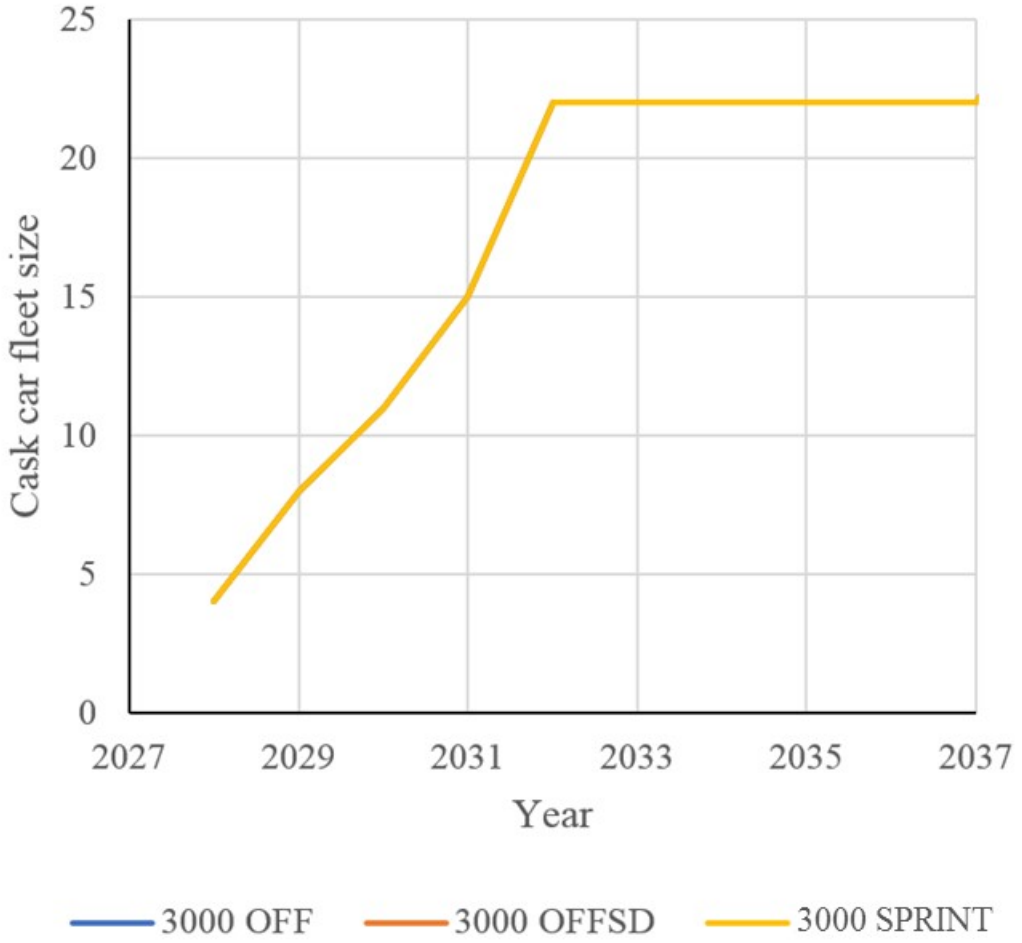


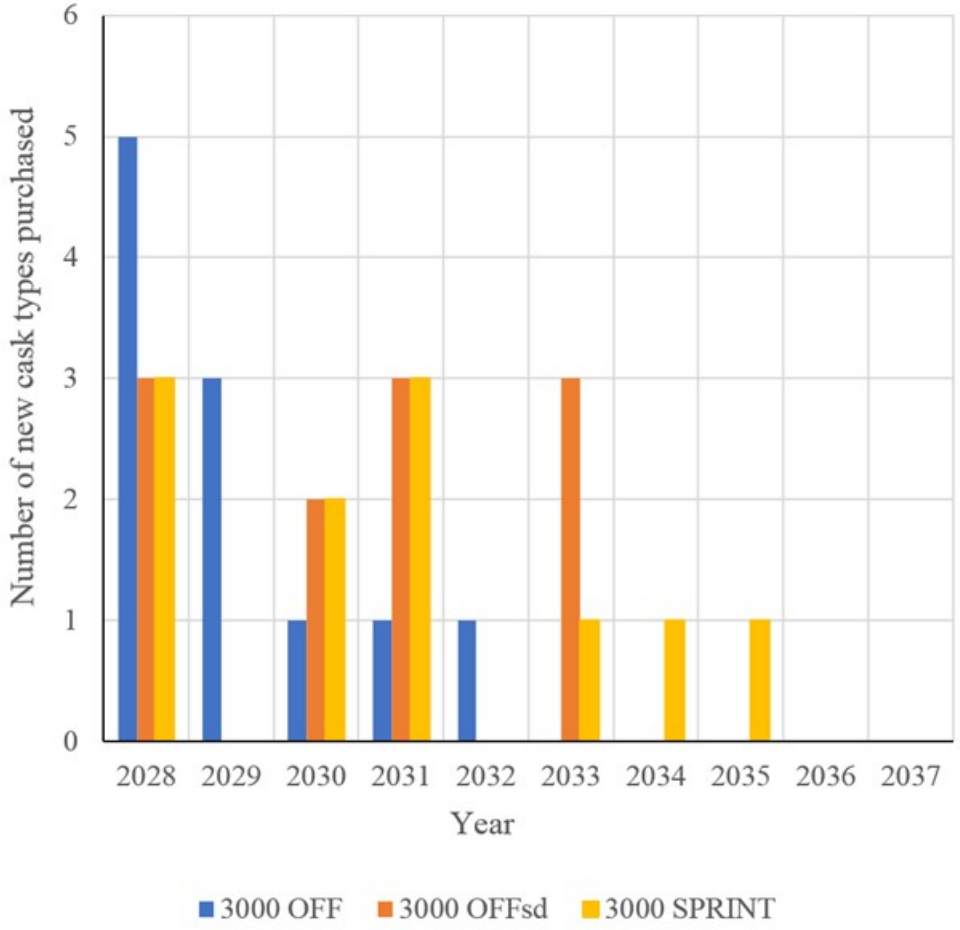
Analysis shows shipment priority logic impacts rate at which U.S. sites can be cleared of commercial SNF and number of sites shipping per year



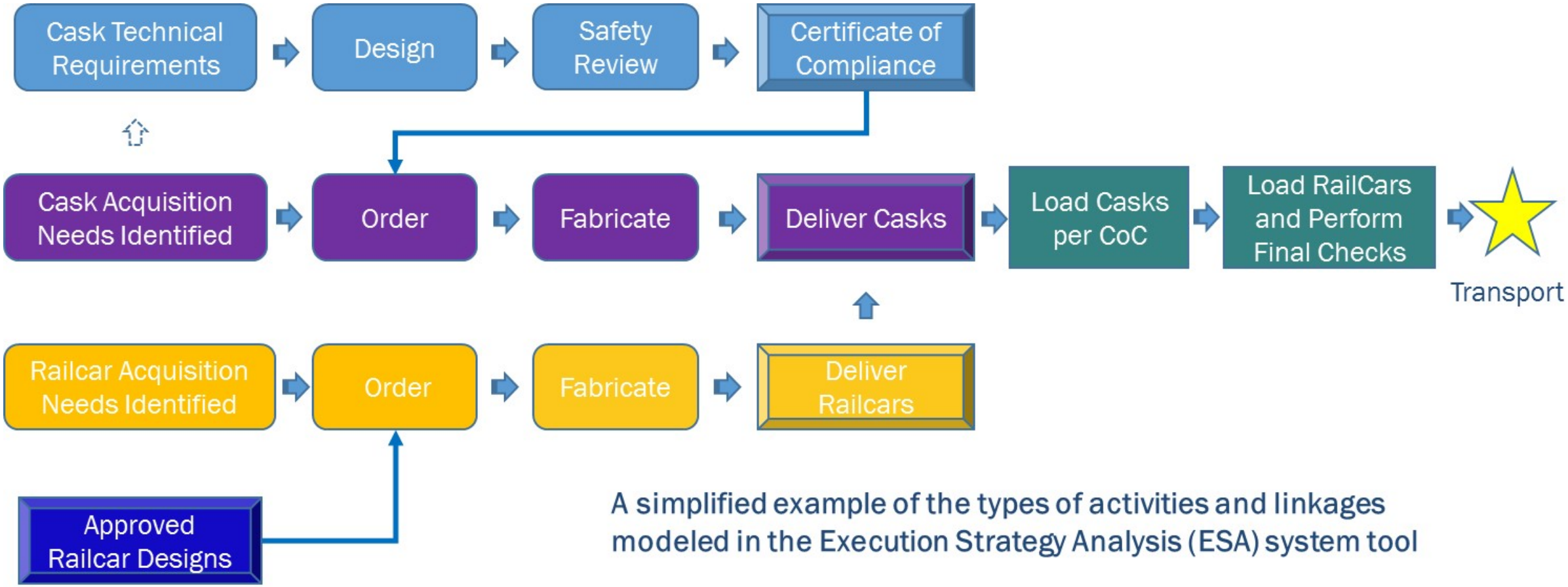


System analysis can inform when railcars and cask types are needed





Results from system architecture analysis may be used in execution strategy analysis to support planning for transportation hardware

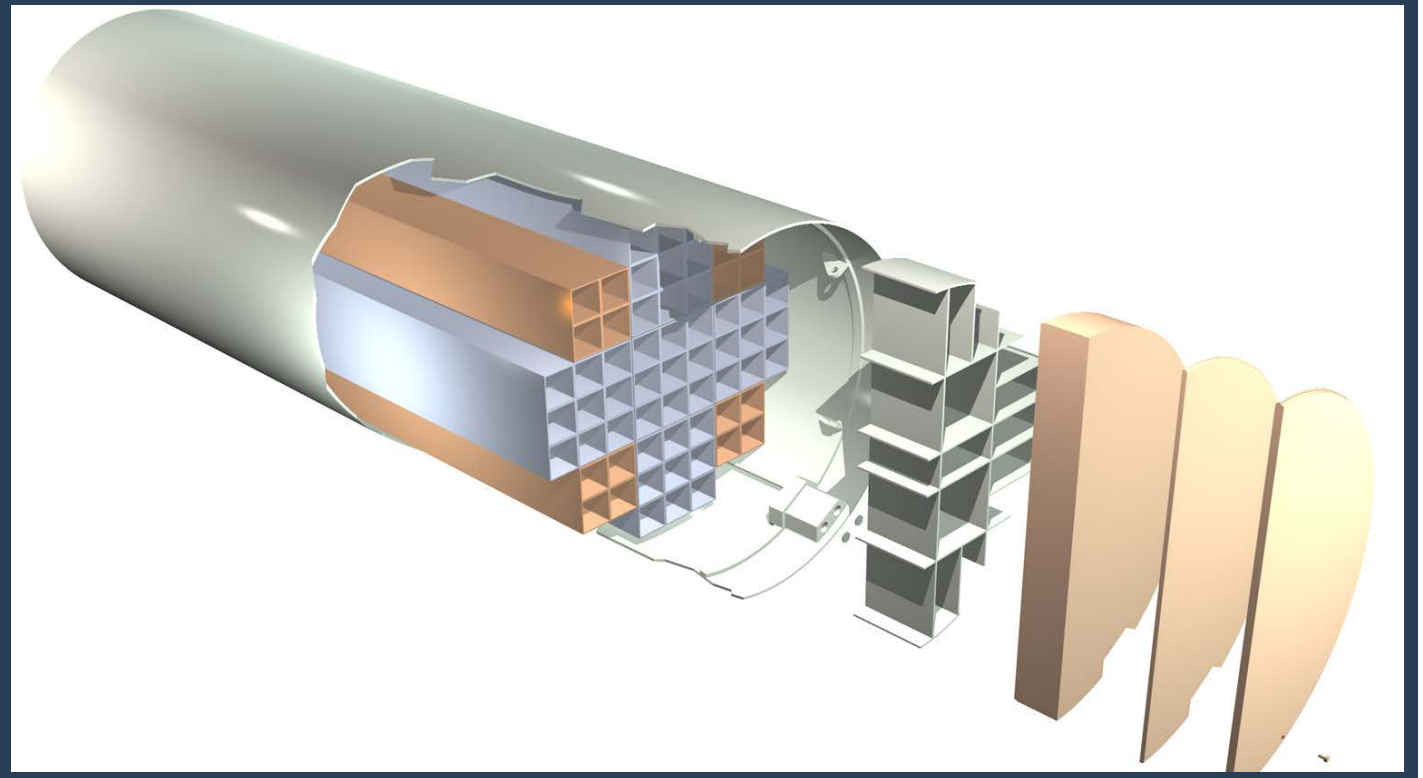


A simplified example of the types of activities and linkages modeled in the Execution Strategy Analysis (ESA) system tool

Integrated system analysis tools can provide insight into transportation planning activities

- A suite of analytical tools and supporting data are being used for integrated waste management system analysis
- These tools aid in understanding the interdependencies between various system elements, including transportation, and can be used to inform overall system planning and guide future research
- The current focus is on commercial SNF; however the tool set could be expanded to include DOE SNF and HLW packages in the future
- Research work is continuing to refine and enhance these system analysis tools and accompanying data

Questions?



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