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Transportation and System Analysis Collaborations in Support of a Federal Consolidated Interim Storage Facility

March 2024

Robby Anthony Joseph, Harish Gadey, Brian Craig, Lucas Vander Wal, Mark Abkowitz, Robert Claypool, Riley Cumberland, Caitlin Condon, Miriam Juckett, Steve Maheras, Gordon M Petersen

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Transportation and Systems Analysis Collaborations in Support of a Federal Consolidated Interim Storage Facility

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This is a technical presentation that does not take into account contractual limitations or obligations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (Standard Contract) (10 CFR Part 961).

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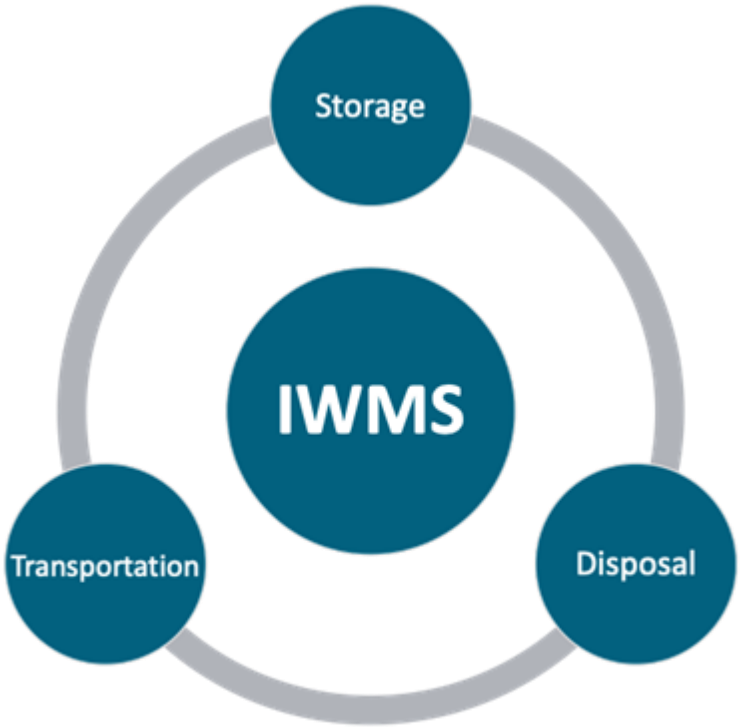
The Integrated Waste Management System (IWMS) program is planning for future transportation, storage, and eventual disposal of the nation's spent nuclear fuel (SNF)

- A federal Consolidated Interim Storage Facility (CISF) requires various tasks that must be completed before SNF can be accepted at the facility
- The IWMS relies on the cross-cutting interactions between areas such as transportation, storage, and disposal
  - Our team is working closely to integrate these areas to develop a cohesive IWMS program
- The team identified several tasks to understand the interdependencies of these areas



The three major systems integral to an overarching IWMS

Outline

- Background:
  - Systems Analysis
  - Next Generation System Analysis Model (NGSAM)
  - Stakeholder Tool for Assessing Radioactive Transportation (START)
- Integration
- Conclusions

Acknowledgements

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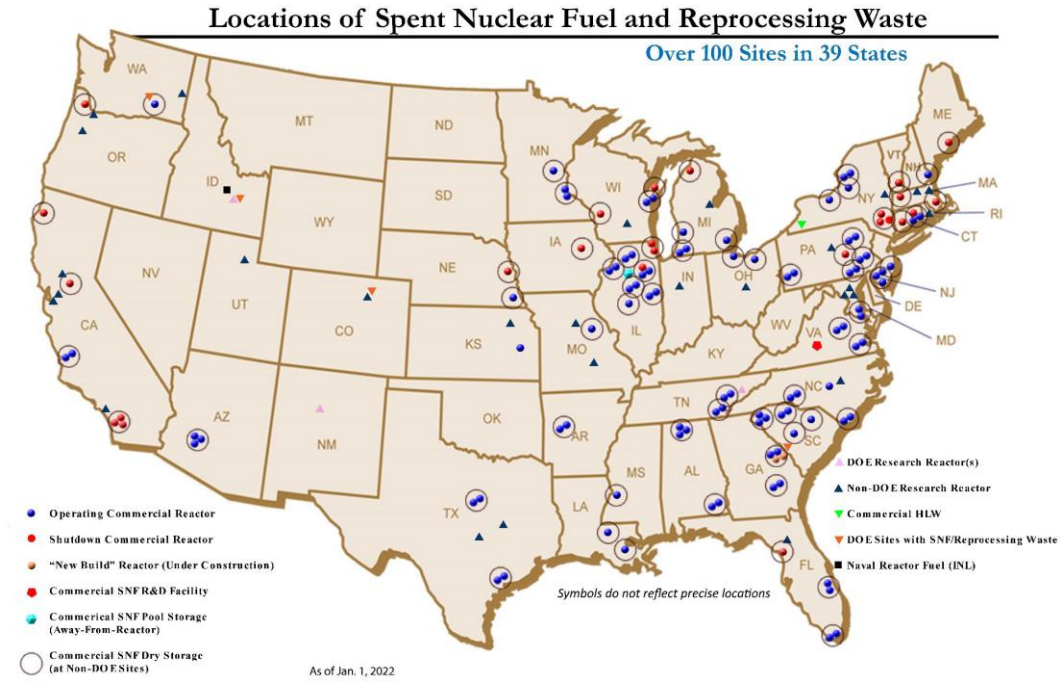
- Multi-laboratory, muti-organizational, multi-disciplinary collaboration team
  - Argonne National Laboratory (ANL): **Brian Craig, Lucas Vander Wal**
  - Idaho National Laboratory (INL): **Robby Joseph, Gordon Petersen**
  - Kanini: **Robert Claypool**
  - Oak Ridge National Laboratory (ORNL): **Riley Cumberland**
  - Pacific Northwest National Laboratory (PNNL): **Harish Gadey, Caitlin Condon, Miriam Juckett, Steve Maheras**
  - Vanderbilt University: **Mark Abkowitz**

These collaborations can support the development of a federal consolidated interim storage facility in the United States

- Federal consolidated interim storage:
  - Is an important component of a waste management system
  - Allows for the removal of SNF from existing reactor sites
  - Provides useful research opportunities
  - Builds trust and confidence with stakeholders
  - Begins to address taxpayers' liability

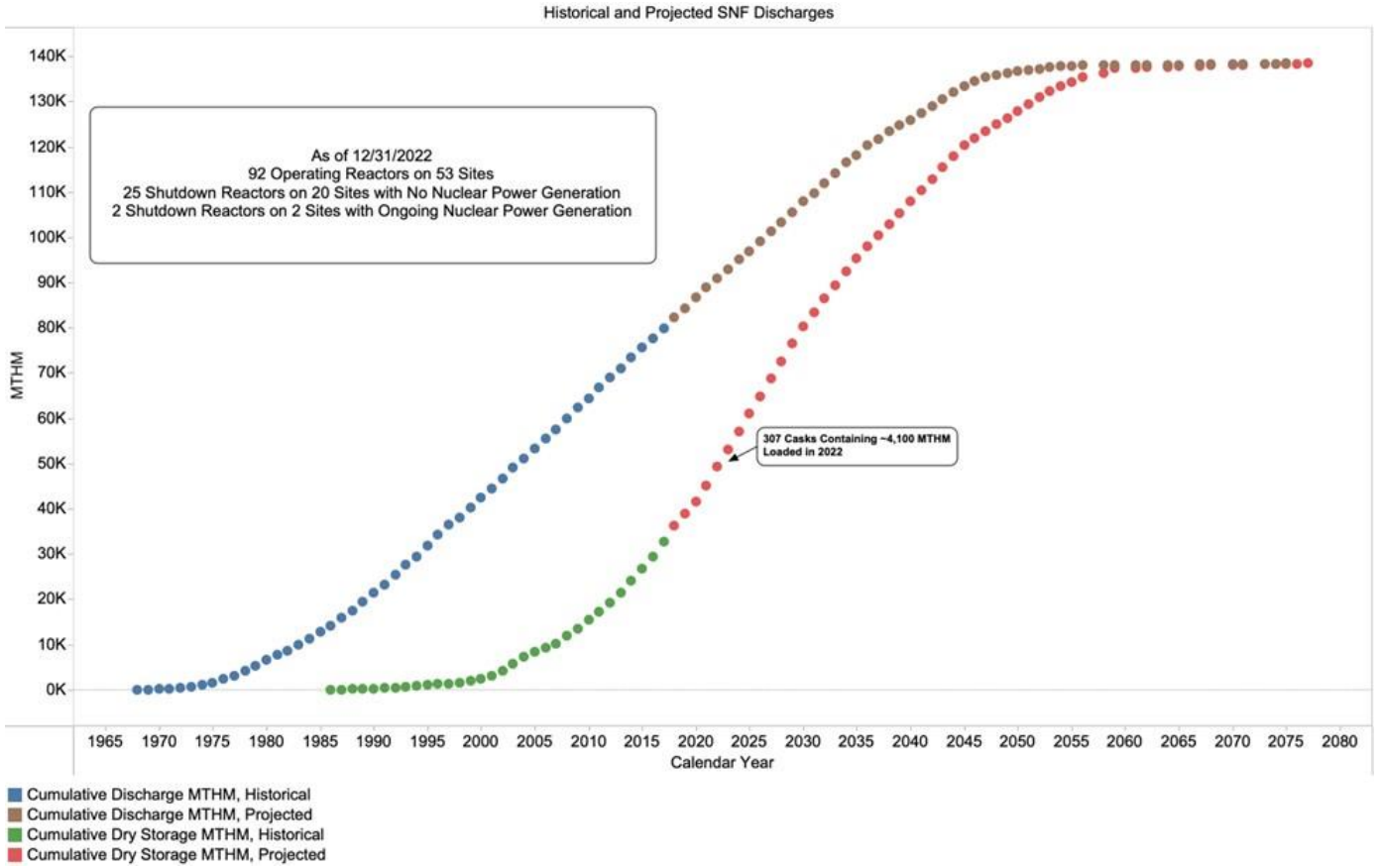


Nearly all existing commercial SNF is stored at the reactor sites where the waste was generated.

Of the over 70 commercial nuclear power reactors sites with SNF, about one quarter have ceased reactor operations.

Why system integration? The existing U.S. light-water reactor fleet has and continues to generate SNF that must be managed

- Approximately 90,000 metric tons of heavy metal (MTHM) of SNF discharged and in interim storage at reactor sites
- About 2,000 MTHM discharged per year
- Over 4,000 dry storage canisters (over 45,000 MTHM)
- A few hundred dry storage canisters are added each year
- Projected growth to almost 140,000 MTHM by 2060



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Conduct system engineering and analysis to support future deployment of nuclear waste management system

- IWMS program is sponsoring development of system analysis tools for analyzing system options for SNF and high-level radioactive waste (HLW) management
- Analyses to support future deployment of a comprehensive nuclear waste management system that considers the major back-end aspects of the nuclear fuel cycle (i.e., transportation, storage, and disposal)
- System analyses typically use these modeling and simulation tools to investigate the implications of:
  - Acceptance rates
  - Receipt logic
  - Facility capacities
  - Use of standardized canisters
  - Facility start dates

System analysis is used to compare numerous alternatives to answer “what if” questions

Implications of various strategies investigated including SNF removal strategies, number and locations of CISFs and mined geologic repositories (MGR), repackaging, packaging, storage, transportation, aging, and disposal canisters (STADs), and bare fuel transport.

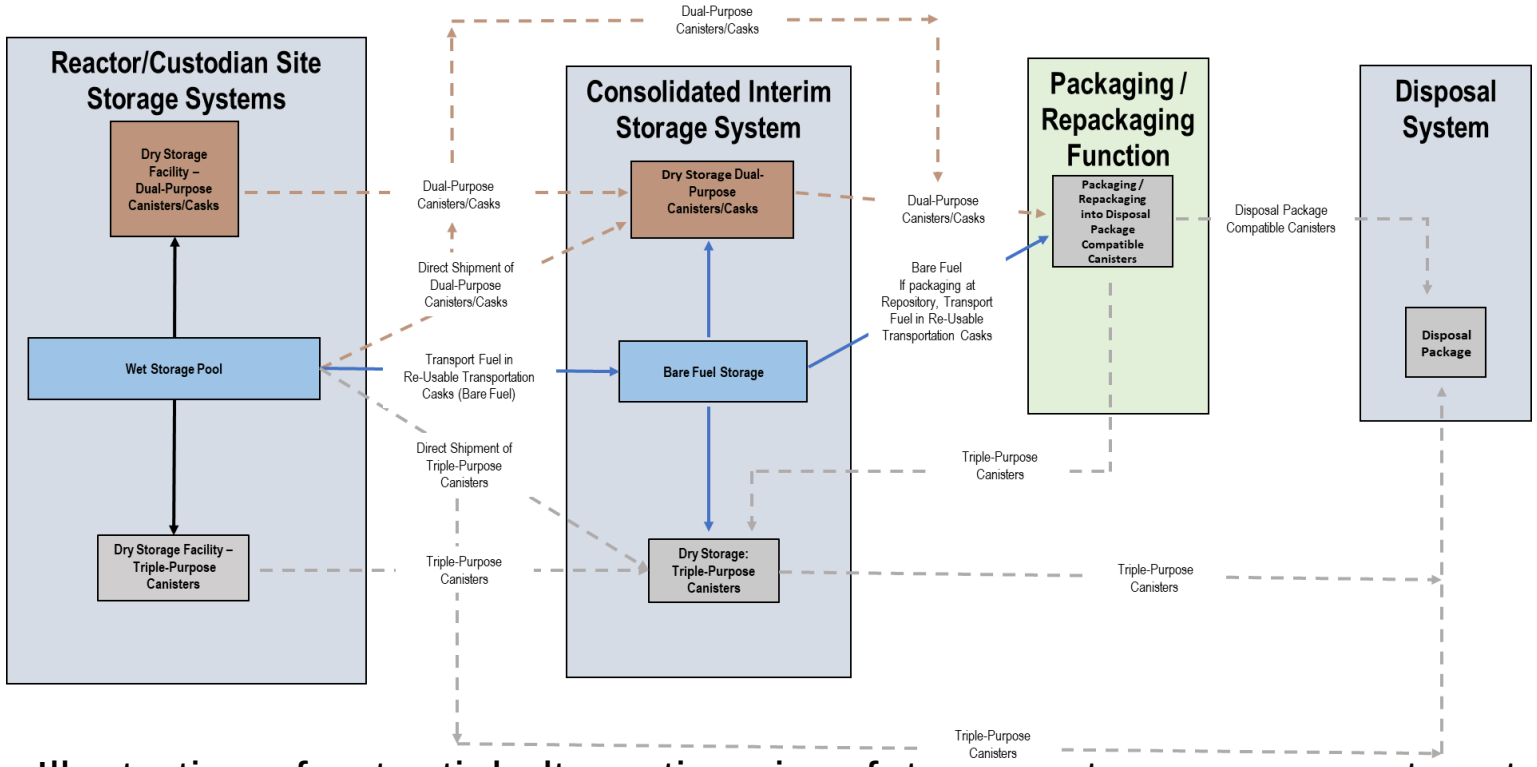
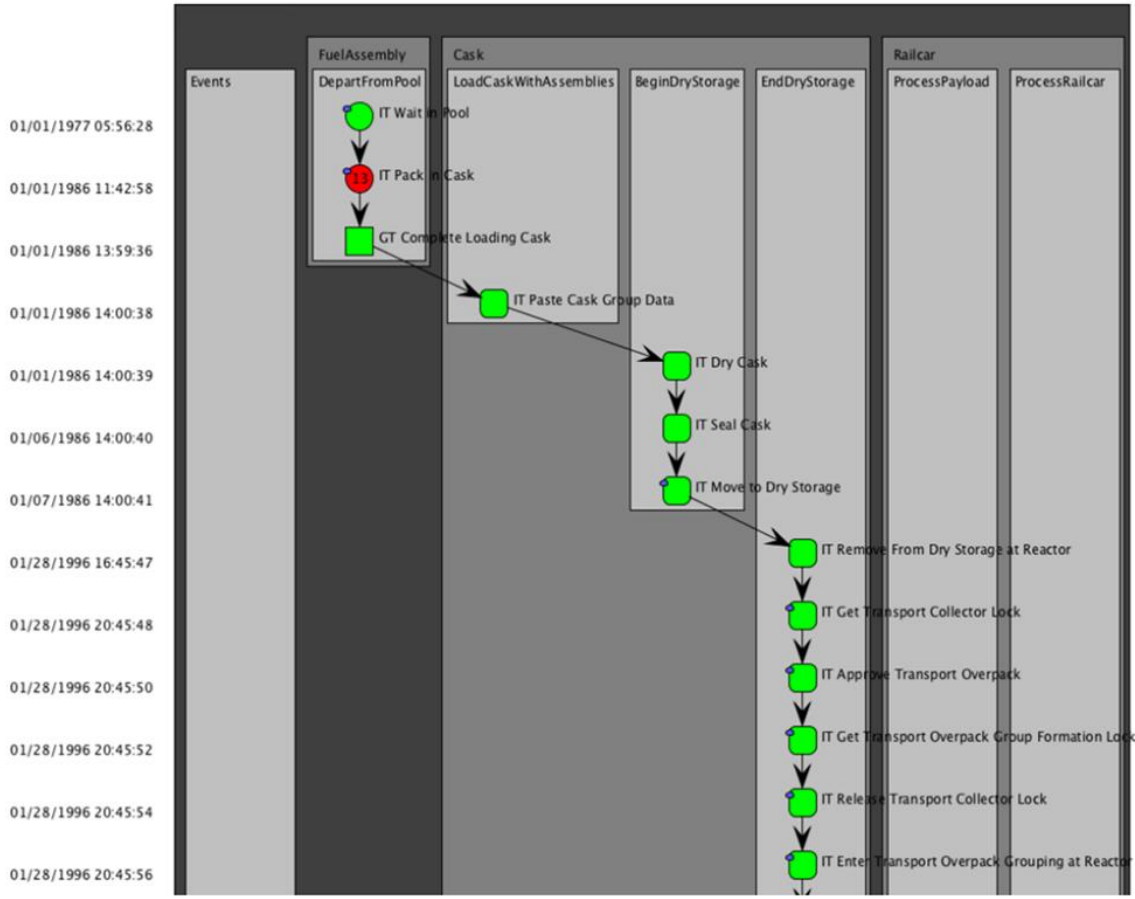


Illustration of potential alternatives in a future waste management system

NGSAM models SNF from origin sites to disposition site(s) including transportation and interim storage

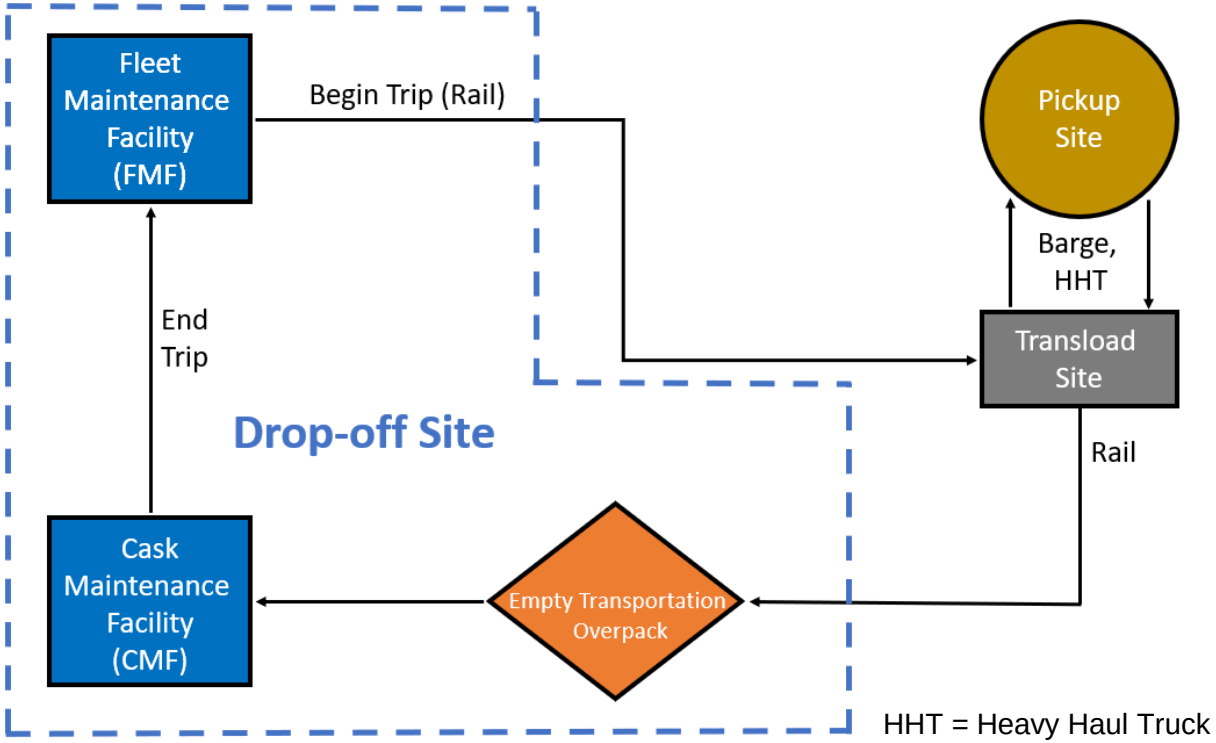
- NGSAM simulates the SNF backend
- NGSAM allows detailed customization for options such as:
  - Storage facilities (dry/wet)
  - Packaging options
  - Facility opening dates
- NGSAM can help answer questions related to:
  - Shared resources required (e.g., transportation assets)
  - CISFs and options
  - Multiple repositories scenarios
  - Throughputs and costs



Detailed report on the history of an assembly through a portion of the waste management system

Collaborations are necessary to provide accurate information to the NGSAM team to aid in developing accurate models

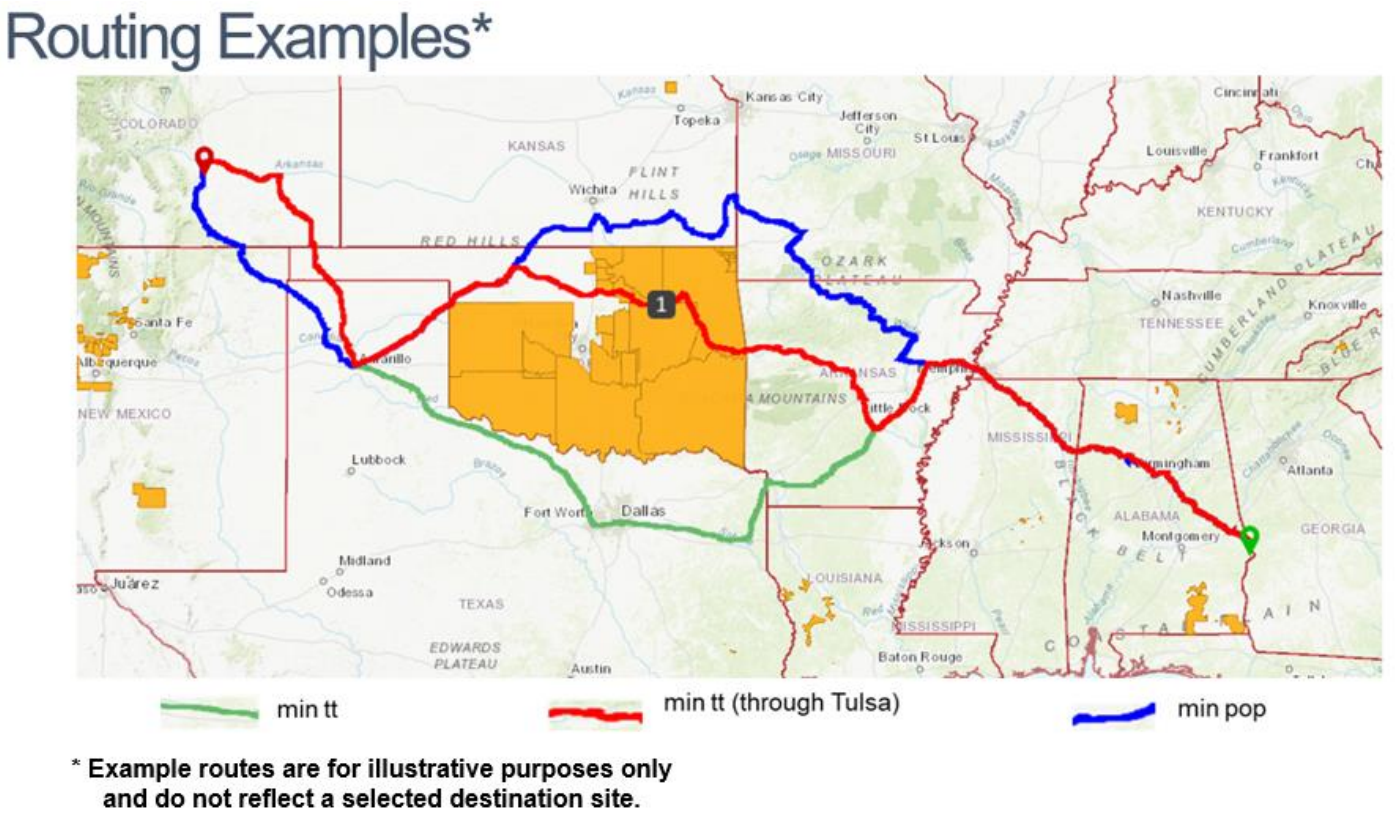
- System analysts, transportation subject-matter experts, and the NGSAM team work together to ensure potential IWMS activities are accurately modeled
- The figure shows an example process flow diagram that was produced to ensure the potential steps were modeled



A potential process flow diagram in system simulations for loaded SNF cask railcars with a transload leg (if required) assuming the drop site, CMF, and FMF are collocated

START is a web-based transportation decision support tool

- START provides visualization and analysis of geospatial data relevant to planning and operating large-scale SNF and HLW transportation operations
- START includes several data layers that characterize populations, land use, and emergency response assets in proximity to potential shipment routes



START routing example for minimum time and population routing

Cross-collaborations help support the IWM mission

- Two example collaborations were detailed in the paper and the next two slides:
  - Travel time and sensitivities
  - Development and data integration initiatives

Travel time from an origin to a destination plays an important role in the turnaround time analysis of a transportation shipment

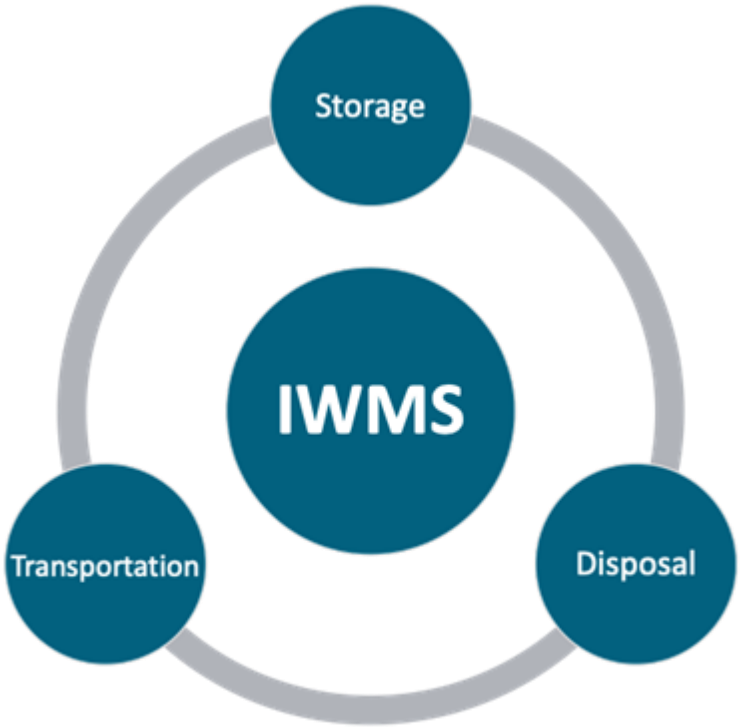
- Currently, START and NGSAM both use fixed travel time
  - Travel time is expected to be a distribution with buffer times rather than a fixed value
  - Uncertainties are planned to be integrated in both the START reported values as well as in NGSAM
- Buffer time can include transload site staging and preparation time activities
  - As well as infrequent incidents, such as off-normal events and accidents that increase the travel time
- Currently, data is reported only in the form of travel time when a route is run from an origin to a destination
  - However, there is potentially a need to report time both in terms of travel time as well as actual time since there might be some activities that do not require active travel but nevertheless accrue time, such as transload operations, inspection activities, crew change, etc.

START and NGSAM have two independent development teams

- Recent efforts have allowed developers from each team to gain access to the development environments for both tools
  - Efforts underway to directly access the application programming interface (API) for START
  - Could allow users in NGSAM to directly run routes in START using the NGSAM interface
  - Custom user-defined route import options were recently enabled in NGSAM
- The extensive data produced by START not currently stored for potential future analysis
  - Efforts ongoing to understand what is needed to enable the storage of all START-generated data in the Unified Database (UDB)
  - NGSAM tool also imports data from the UDB

The IWM program is planning for future transportation, storage, and eventual disposal of the nation's SNF

- A CISF requires various tasks that must be completed before SNF can be accepted at the facility
- The IWMS relies on the cross-cutting interactions between areas such as transportation, storage, and disposal
  - Efforts have been made to closely integrate these areas to develop a cohesive IWMS program
- Several tasks have been recently identified to better understand the interdependencies of these areas



The three major systems integral to an overarching IWMS

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Questions?

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