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Next Generation System Analysis Model: Recently Added Features and Future Plans

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SUMMARY

To better enable informed decision-making regarding the back-end of the nuclear fuel cycle, the Integrated Waste Management System (IWMS) program within the U.S. Department of Energy, Office of Nuclear Energy (DOE-NE) has been sponsoring the development and application of system analysis tools capable of analyzing various system options for the management of spent nuclear fuel (SNF) and high-level radioactive waste (HLW).With these tools, IWMS architecture analyses are being conducted to support the future deployment of a comprehensive nuclear waste management system that considers all major back-end aspects of the nuclear fuel cycle (i.e., transportation, storage, and disposal).[1]

The Next Generation System Analysis Model (NGSAM) is an agent-based simulation software tool expressly designed to be capable of modeling features within various IWMS architectures. NGSAM imports data from Oak Ridge National Laboratory (ORNL)'s unified database (e.g., historic assembly information, thermal profiles for assembly heat, and at-reactor dry storage loadings) to ensure that each simulation initializes with a realistic representation of the state of commercial SNF in the U.S.

Recent major enhancements implemented into NGSAM in the period since NGSAM was last presented at the WM2019 conference include:

- Tracking of railroad escort car acquisition and buffer car acquisition
- The addition of heavy haul truck (HHT) and barge routes for some sites, as well as support for user-defined inter-modal routes
- Updates to the logic that checks the transportation cask thermal limit maps prior to package transport
- An allocation method that predicts when reactor sites would pack assemblies from their spent fuel pools for dry storage, and prioritizes shipments directly from the pools of those reactor sites in the preceding periods (before the predicted loadings to dry storage), thus reducing the number of

[1] This is a technical paper 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). For example, under the provisions of the Standard Contract, spent nuclear fuel in multi-assembly canisters is not an acceptable waste form, absent a mutually agreed to contract amendment. To the extent discussions or recommendations in this paper conflict with the provisions of the Standard Contract, the Standard Contract governs the obligations of the parties, and this paper in no manner supersedes, overrides, or amends the Standard Contract. This paper reflects technical work which could support future decision making by DOE. No inferences should be drawn from this paper regarding future actions by DOE, which are limited both by the terms of the Standard Contract and Congressional appropriations for the Department to fulfill its obligations under the Nuclear Waste Policy Act including licensing and construction of a spent nuclear fuel repository.

casks loaded into dry storage at reactor sites
- The addition of "reactor site family" operational limits to restrict the number of loads of SNF taken from the pool and from dry storage at a given reactor site each year
- Added support for multiple canister loading map options and packages with multiple compatible transportation overpacks
- Updates to the handling of non-commercial SNF, including a new database that contains data to support the updates
- Updates to allow analysis of hypothetical scenarios which include repackaging at reactor sites, e.g., for possible comparative analysis with other scenarios
- Implementation of additional output reports, or modification of existing ones
- The ability to generate and implement user edits via the NGSAM website
- The ability to model loading SNF from pool storage at an interim storage facility (ISF) into dry storage at the ISF
- The ability to model consolidating SNF from different existing storage containers at a DOE site into the same DOE standard canister
- The ability to model transferring SNF casks from one transportation mode to another, e.g., from HHT to rail, referred to as transloading.

These new features have improved NGSAM capabilities and users' experience with the model.

Preliminary NGSAM requirements for modeling advanced reactor fuels, reprocessing, treatment, and conditioning were considered, and this paper describes them at a high level. Other nuclear fuel cycle system analysis tools developed under sponsorship of DOE-NE, like the VISION code developed at Idaho National Laboratory, might be better suited for initial high-level analysis of those technologies and advanced fuel cycles. As technologies are developed and system concepts evolve, NGSAM could provide value by providing more detailed modeling of transport, storage, and disposal of spent fuel and wastes from advanced reactors and advanced fuel cycles at the fuel element and waste container level.