

PROCESS SIMULATION AS APPLIED TO TRANSURANIC WASTE MANAGEMENT

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ABSTRACT

The Carlsbad Area Office of the Department of Energy has successfully developed a computer model to optimize transuranic (TRU) waste management strategies. The National TRU Waste Systems Model (NTWSM) components represent the physical infrastructure needed to support the TRU waste management system as well as the diverse regulatory issues and stakeholder concerns. TRU waste is currently stored at more than 20 Department of Energy (DOE) sites across the nation. The goal is to eliminate temporary storage of TRU waste across the DOE Complex and achieve environmentally sound permanent disposal at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.

Achieving permanent disposal at the WIPP necessitates the distribution of resources across the DOE complex. The WIPP facility, transporters, and corridors (transportation routes) are resources that must be shared among the more than 20 sites such that all interested parties meet necessary goals and regulatory requirements. Coordinating sites shipping demands, regulatory agreements and stakeholder needs became a priority as the opening date of the WIPP neared.

The National TRU Waste Systems Model (NTWSM) was developed as a tool to be used by the DOE to optimize shared disposal resources across the DOE Complex. The NTWSM consists of 13 sub-models. Ten of the sub-models represent the 10 largest TRU waste storage sites. The remaining storage sites are represented in one sub-model. The two remaining sub-models represent transportation and the WIPP. The site sub-models are based on TRU waste movement from generation and/or storage through processes such as characterization, repackaging, treatment, and loading for shipment. The site sub-models then send information about the waste to the transportation sub-model that it is then sent to the WIPP sub-model.

The NTWSM logic is based discrete event queue theory. Because waste processing is integrated with WIPP and transportation information, the NTWSM allows the DOE to determine how various events could impact its ability to dispose of TRU waste. The NTWSM is modified with changes in existing and future site infrastructure needs for certifying waste, meeting site regulatory agreements and public expectations. The NTWSM is also reconfigured to represent different scenarios based on possible funding levels, national priorities, and distribution of resources devoted to waste management.

INTRODUCTION

The National Transuranic Waste System Model (the Model) is a computer simulation designed to evaluate the preparation and flow of TRU waste from generator sites throughout the Department of Energy (the Department) complex to the Waste Isolation Pilot Plant (WIPP) facility for disposal. The Model uses process simulation software to predict waste outputs of waste management operations as a function of time over the life of the WIPP.

Process simulation modeling is a tool used by many industries, both private and public, to evaluate complex systems. For example a manufacturing plant might use process simulation to determine the possible effects of increasing the rate of production: will there be adequate resources (labor pool, raw goods, transportation capability); can the new production rate be sustained for an indefinite period of time without adding additional infrastructure. Process simulation modeling is also used by various military branches to ensure adequate supplies are delivered in a timely manner. The Department currently uses this technique as the basis for its *National TRU Waste Management Plan Rev.1* (DOE, 1997).

In the interest of national defense, it has been the policy of the United States since the 1940s to develop and manufacture nuclear weapons. However, during the last ten years priorities have shifted away from increased stockpiling of weapons to waste management and environmental restoration. Historically, the Department claimed exemption from Resource Conservation and Recovery Act (RCRA) land disposal restrictions for listed wastes. However the enactment of the Federal Facility Compliance Act (FFCA) in 1992 effectively removed the exemption, and the Department now must comply with RCRA requirements. As a condition of the FFCA, the Department was required to develop site treatment plans presenting the methods it would use to achieve RCRA compliance for mixed wastes. Mixed wastes are those wastes that are contaminated with RCRA listed chemicals or compounds. Each site was required to submit a specific plan for the treatment of its mixed (RCRA) waste to the EPA or delegated regulator for approval. As a result of site treatment plan development and subsequent regulator approval, many of these sites now have enforceable milestones which are independent of other TRU waste generator/storage sites.

Transuranic waste is stored/generated at 23 sites across the nation (Figure 1). The Department recognized the need for integrated planning of TRU waste activities during the development of these *Site Treatment Plans*. Although the FFCA did not mandate that waste disposal options be specified, the Department recognized disposal as a necessary part of waste management. Department sites that either generate or store TRU waste identified the Waste Isolation Pilot Plant (WIPP) as the disposal mechanism for TRU waste in their *Site Treatment Plans*. However, planning efforts were not all inclusive. While each site made plans to dispose of defense TRU waste in a manner that achieved site goals and met State requirements, a systematic evaluation of Department shared resources was not performed. The Department has developed a model of its transuranic waste disposal system in response to this need.

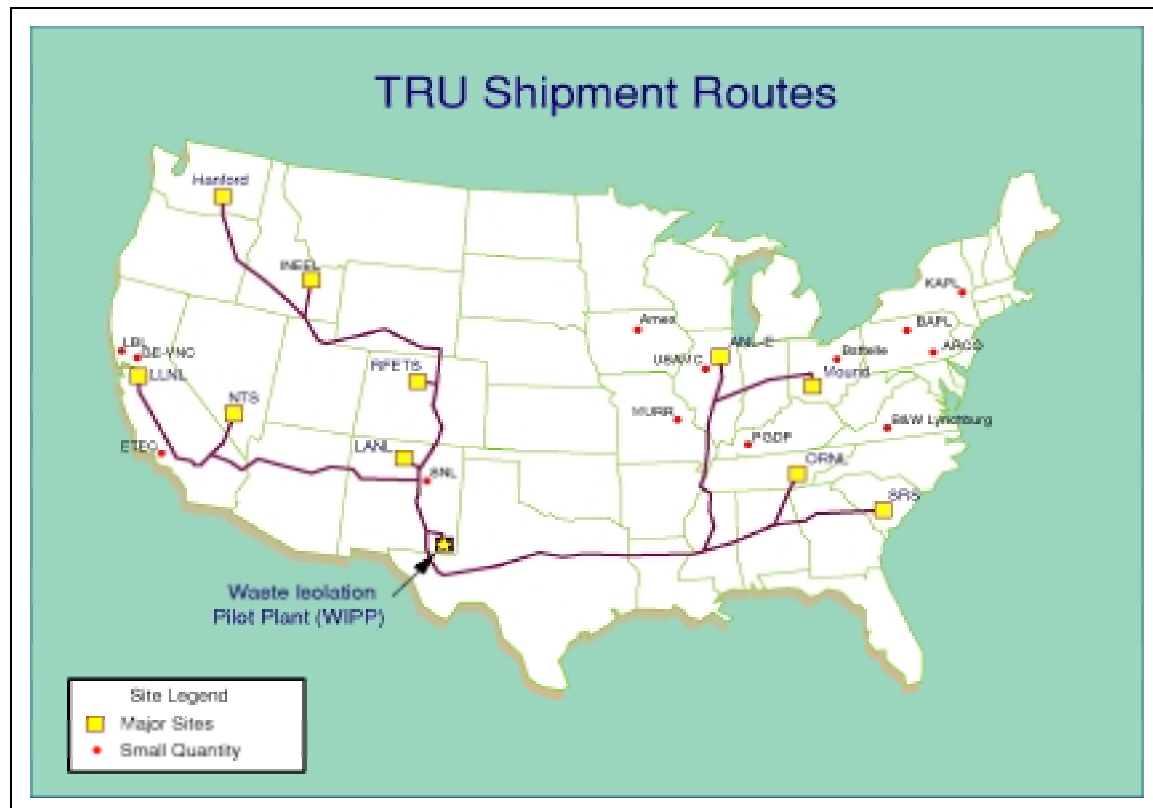


Figure 1: Location of TRU Waste Generator/Storage Sites and Planned Major Shipping Corridors (DOE, 1997)

THE NATIONAL TRU WASTE SYSTEM MODEL

The Model was developed as a tool for use in evaluating and optimizing the TRU waste system. The Model, in essence, is a network of time-delay functions acting on waste units to represent processing elements such as retrieval, characterization, repackaging, treatment, and transportation. Because waste management operations vary from site to site, the Model was developed as a series of small models representing the generator sites, the WIPP facility, and the transportation system. Each model, in turn, consists of a series of building blocks, each representing a facility, function, or activity of the site's waste management operations. Figure 2 represents all the models and displays the interaction that is used by the National TRU Waste System Model. Figure 3 shows a portion of the model for LANL, while Figure 4 represents logic for moving containers of waste through a facility at the LANL.

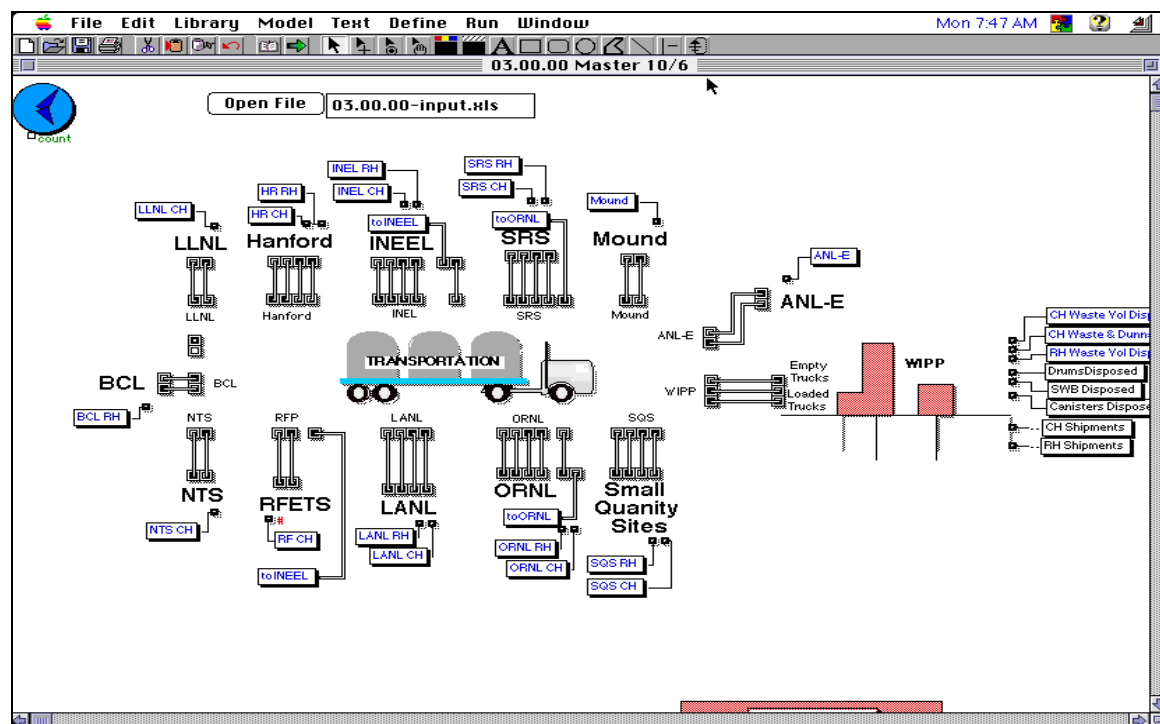


Figure 2: The National TRU Waste Complex Integrated Through Transportation

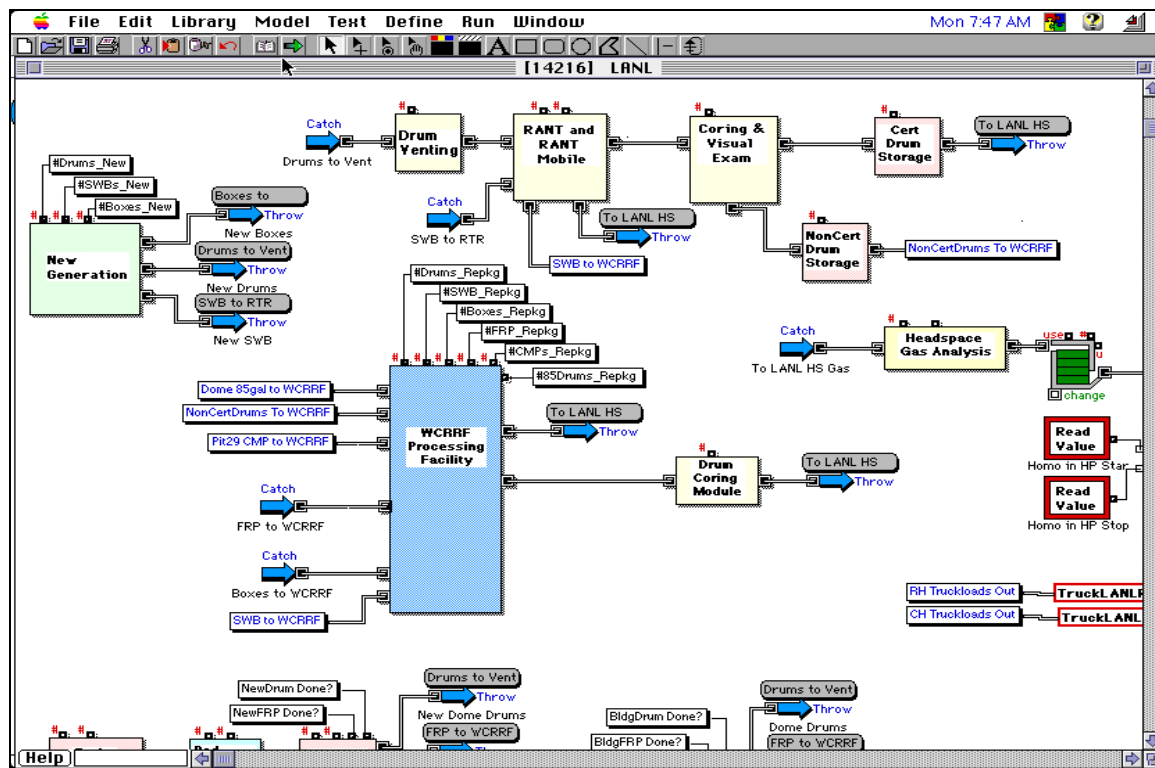


Figure 3: LANL TRU Waste System

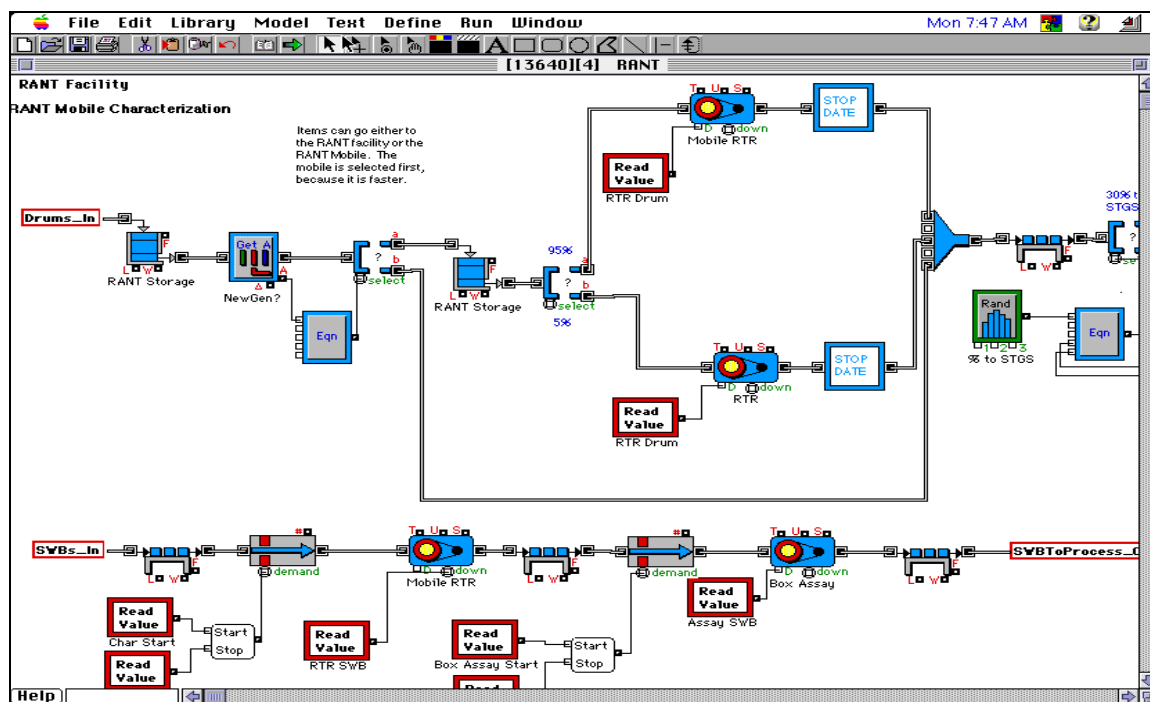


Figure 4: Process Logic

Process Flow diagrams were developed for the ten largest generator/storage sites, WIPP, and transportation. A single flow diagram represents the remaining (small quantity) TRU waste generator/storage sites. Process flow diagrams of each site were created with the main purpose of giving the information providers and those building the Model a common “language” with which to communicate. The flow diagrams are then used to code the Model. Results are analyzed based on performance measures and presented to sites and stakeholders. Optimization occurs as the site capabilities and goals are aligned to effectively use WIPP and transportation resources.

A typical generator site model includes all of the aspects of TRU waste operations: generation, storage, separation of low-level and transuranic waste streams, characterization, treatment (includes repackaging) and loading of waste for shipment. The site models process information about volume remaining on site (on a container basis), volume shipped, and utilization of TRU waste storage capacity (is capacity being reached).

The transportation model consists of resource pools for transporters (tractor and trailer sets) and resources for three different payload containers types. In addition, the transportation model includes mileage between sites, delays related to transportation through municipalities, and competition for resources. The transportation model also records information regarding utilization of the fleet.

The WIPP disposal model consists of accepting the trucks loaded with waste, unloading the waste and returning the trucks and payload containers to a resource pool for further use. The WIPP model maintains a cumulative total of volume disposed, number of drums, standard waste boxes, and canisters disposed of, and volume disposed by site for both contact handled and remote handled TRU waste.

BASELINE MODEL

Creation of the Model is somewhat analogous to that of building blocks. As with building blocks, a model needs a base or foundation from which everything else is constructed. The base for the Model consists of information from site personnel, *Site Treatment Plans* and the *Transuranic Baseline Inventory Report Rev.3* (BIR) (DOE, 1997). Site personnel provided the information on current TRU waste capabilities, while waste volume information was derived from the BIR. The purpose was to gain an understanding of the TRU system as it existed at the time of model development.

The original or “Baseline Model”, was coded directly from process flow diagrams, which were first approved by the appropriate site personnel. These individual site models were integrated through the WIPP and transportation models, the two major resources all TRU sites must share. The results indicated few sites were able to characterize or ship waste, thereby leaving much waste at the generator sites at the close of the WIPP. The integrated results provided a clear statement of the existing capabilities of the TRU waste system and established that change and investment were necessary in order to meet the requirements of the FFCA.

The Site Treatment Plans documented independent generator/storage sites plans to achieve compliance. Building from the Baseline Model, planning information from the Site Treatment

Plans was integrated. The results indicated that all sites would meet regulatory agreements, however, some TRU waste remained after the planned close of the WIPP. In addition, WIPP resources were underutilized in the early years.

IMPROVEMENTS THROUGH SYSTEMS INTEGRATION

Based on the Site Treatment Plan iteration of the Model development, the Department began to integrate the TRU waste system. Initially redundancies, bottlenecks and inefficiencies within the system were identified. A systematic approach was then used to create alternative solutions to these problems. Some of the alternatives are listed below:

- Accelerating schedules for procuring equipment, thereby accelerating shipment start date
- Coordination of shipping schedules
- Using mobile equipment for characterization and repackaging to assist sites without sufficient resources for TRU waste processing
- Sending waste from smaller sites to larger sites for treatment and characterization

As a result of discussions with sites and stakeholders, an optimized version of the Model was used to create the *National TRU Waste Management Plan Rev 1* (DOE, 1997). Some founding assumptions include:

- WIPP opening date May 1998
- Receipt of a RCRA permit May 1998

Because WIPP's opening date and receipt of a RCRA permit have been further delayed, and because priorities have shifted yet again in terms of funding levels available to accomplish Department goals there will be a subsequent revision to the Management Plan (Rev.1) when WIPP opening and schedule becomes better defined. Until then, the Model is updated a minimum of 3 times per year by the TRU Waste Steering Committee, so that the Department can assess the impacts of the delay on regulatory milestones at the generator sites.

FUTURE USES FOR THE NATIONAL TRU WASTE SYSTEM MODEL

The National TRU Waste System Model is a tool used by the Department to evaluate potential changes in existing or planned infrastructure, funding levels, national priorities, or distribution of resources, thereby allowing the Department to assess options to minimize the impacts such changes on the TRU waste system. As the Department moves into the operational phase of WIPP, it becomes more and more important to concentrate on near-term activities in addition to long-term planning. The Model is flexible to the point that it could be modified for use in shipping schedule contingency planning. This will require further collaboration with generator/storage sites as well WIPP.

The flexibility of the modeling technique allows this tool to be adapted to most any situation, certainly to other waste programs within the Department. The benefits of developing a system model are the ability to analyze individual components while they are still in the planning stage and to determine the relationship of components which must interact. Problem areas can be

identified prior to implementation, saving time and money. Inefficiencies in the system can also be evaluated. For systems that are already being implemented, a system model is beneficial for contingency planning. This type of tool is also helpful in determining the impacts of modifications and shifting priorities of the system.

REFERENCES

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