TRUSYSTEM - A COMPUTERIZED SYSTEM FOR THE MANAGEMENT OF DEFENSE TRANSURANIC WASTE

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ABSTRACT

The U. S. Department of Energy (DOE) is embarking on a program to dispose of defense transuranic waste in the Waste Isolation Pilot Plant (WIPP) near Carlsbad, NM. In order to ensure that WIPP receives the waste at the required rate, the careful management of a logistic system involving numerous DOE facilities and specialized waste transports is required. TRUSYSTEM is being used in the design and operation of this complex system. TRUSYSTEM consists of a computerized database (PRISM), a system simulation program (TRUSIM), and software for the monitoring and dispatching of waste transports (PHOENIX). This system designed to operate on the new generation of microcomputers, is being written in machine independent code (FORTRAN and "C"). It is easily maintained and can be moved between different types of computers. TRUSYSTEM resides entirely within computer memory. This provides the speed necessary for real-time operations.

INTRODUCTION

The U. S. Department of Energy (DOE) has been generating and storing defense program related transuranic waste (TRU) at numerous sites throughout the United States. The amount of waste stored, rates of generating new waste, and the properties of this waste vary greatly from one site to another. Likewise, the time at which facilities will be available to process these wastes for shipment to the Waste Isolation Pilot Plant (WIPP) and the rates at which the waste will be processed vary between the sites.

For WIPP to operate efficiently and to ensure that program goals for the disposal of waste are achieved, it is necessary for WIPP to receive the proper amount of waste at a uniform rate. This requires the careful management of the complex logistic system and quick access to complete and accurate information about the logistic system. With these objectives in mind the Joint Integration Office (JIO) developed TRUSYSTEM, a comprehensive system of a computer database and models to assist in the analyses and operation of DOE's TRU logistic system.

TRUSYSTEM OBJECTIVES

The programmatic objectives of TRUSYSTEM are:

- provide for the analyses of the total TRU logistic system as it affects waste shipments to WIPP

- provide the information necessary for broad management decisions and for day-to-day operations

- ensure flexibility and long-term utility of TRUSYSTEM. Since the WIPP program will span several decades, TRUSYSTEM should be adaptable to changing program needs and computer technology

The technical objectives for TRUSYSTEM are:

- COMPLETENESS - the system should be able to treat all aspects of the logistic system which impact the shipment of waste to WIPP

- ROBUSTNESS - the codes should be rugged enough to allow accommodation of new logistic problems without the fear of unforeseen limitations or "bugs"

- PORTABILITY - the system should be easy to move from one computer to another in order to take advantage of changes in computer technology

- SPEED - the system should be fast enough to allow extensive sensitivity analyses (multiple executions to find the sensitivity to the changes in various parameters) and to provide real-time (simultaneous) status for the logistic system

TRUSYSTEM TECHNICAL APPROACH

TRUSYSTEM consists of three major software programs:

- the database which contains all of the logistic system data and parameters (amounts of waste, travel times between sites, time required to load a transport, etc.)

- transport tracking software which determines the progress and status of waste transports

- a simulation model which uses the database and tracking information to analyze the performance of the logistic system

The approach to hardware selection and software development is:

- to use microcomputers

The growth in the power of microcomputers will keep pace with the increasing need for computing power as the software moves from development, through the demonstration phase, to full system operation.

- to use standard computer languages (FORTRAN and "C")

Much of the software is unique and had to be written from scratch. By foregoing the use of any "canned" software and writing the entire code in standard computer languages, TRUSYSTEM can be moved from one computer to another. This also ensures our ability to maintain the code over the long term.

- that TRUSYSTEM will reside entirely within computer memory

By writing the software so that the entire code and all data is placed into computer memory, very fast execution is achieved. Also, by having the entire TRUSYSTEM in computer memory, the use of unreliable mass storage devices (such as hard disks) is minimized.

- that images of TRUSYSTEM's data will be maintained on laser optical disks

Because TRUSYSTEM resides entirely within computer memory, it is a simple matter to create images of TRUSYSTEM's data on a storage device, such as laser optical disks. If there is a hardware or software failure, restarting TRUSYSTEM is as simple as inserting a disk into a second computer.

TRUSYSTEM DATA BASE - PRISM

PRISM is database software developed by JIO which requires a minimum of computer hardware, provides fast execution, and is robust. The most important features of PRISM are the optimization of data storage and ease of altering the definition of the data structure. The key to the data structure is the use of a six-level hierarchy for defining the data. A typical use of this structure is:

(1) SITE	the site at which waste is located (e.g., Rocky Flats Plant)
(2) LOCATION	the location within the site (e.g., stored, newly generated)
(3) TYPE	the type of waste (e.g., Contact Handled, Special Case)
(4) PROCESS	processing required to prepare the waste for shipment (e.g., none required, solidification)
(5) CONTAINER	the type of container for the waste (e.g., 1 gallon pail, 55 gallon drum)
(6) ATTRIBUTE	the quantitative measure (e.g., number of containers, Pu-Curies per container)

The above description of the data structure is for a container of waste. The same scheme can be used to describe other parts of the logistic system such as a TRUPACT (transuranic package transporter), its location, its contents, its status, etc. At the user's option, one or more of the six levels of hierarchy can be left empty. Such a data structure allows hundreds of thousands of data to be maintained within a microcomputer's memory.

An interesting feature of PRISM is that it creates an English lexicon based on words which are assigned specific functions. This lexicon can be altered at any time and several words can be used for the same function; for example, +, add, and plus all have the same meaning.

TRUSYSTEM TRANSPORT TRACKING SYSTEM - PHOENIX

PHOENIX is a highly specialized software package developed by JIO and is designed to monitor the geographic position and status of waste transports. This software, along with geographical positioning and communication hardware, forms the TRUPACT Monitoring and Dispatching System (TMADS). (A more detailed discussion of TMADS is provided at this conference in a paper entitled TRUPACT MONITORING AND DISPATCHING SYSTEM by Tappen, J.J; Driscoll, K. L.; Adam, J. A.; Olive, R. L.)

The primary function of PHOENIX is to provide TRUSYSTEM with information on the progress and status of waste transports, such as TRUPACTs. PHOENIX can serve other functions, such as determining whether a TRUPACT is following the approved route and is maintaining the expected speed. It can automatically detect abnormal conditions such as unscheduled stops, loss of communications, or distress messages from the vehicle driver. It can also provide automatic notification to DOE regional offices and state and local governments when a waste transport approaches their area of responsibility.

PHOENIX displays maps with transport identification, location, direction, and speed on high resolution color monitors. More detailed information, such as the exact distance and direction from the nearest bench mark (e.g., intersection of two highways), is displayed on the operator's console. PHOENIX also generates historical records and allows "instant replays" of past events.

The key to PHOENIX is the use of maps generated from coordinates (longitudes and latitudes) rather than the usual digital maps. The use of coordinate-based maps has several important advantages:

- The system is intelligent and does not require constant operator attention. Alarms will be sounded when an abnormal condition exists and the operator's attention is required. This eliminates operator fatigue

and allows the operator to perform other functions without the risk of missing important information.

- The maps are generated from data contained in computer memory rather than being called from mass storage devices as is the case with digital maps. This greatly increases the execution speed. The reliability of the system is also greatly increased since mass storage devices, which are the predominant source of microcomputer failure, are not required for map generation.

- Because coordinate-based maps can be updated with a minimum of information, inexpensive computers can serve as subscriber stations (remote terminals) and the time required to transmit the update data is small (less than a tenth of a second using ordinary telephone lines).

- The map data is automatically updated using the most accurate positioning data. This provides resolution and detail not normally found in digital maps. It also allows for the automatic drawing of roads if a vehicle should deviate from roads contained in the existing map base (e.g., the vehicle takes a detour).

The minimum data required by PHOENIX is the vehicle identification and longitude and latitude. To use the full capabilities of PHOENIX, two-way communications with the vehicle operator via a simple keyboard and digital display are required along with responses from sensors such as accelerometers.

TRUSYSTEM SIMULATION MODEL - TRUSIM

The cornerstone of TRUSYSTEM is TRUSIM which is the system simulation model. It uses the information provided by the data base (PRISM) and the transport tracking software (PHOENIX) to forecast the performance of the TRU logistic system. (The first generation TRUSIM was developed by E. A. Kern and the second generation was developed by H. S. Vaccaro, both of Los Alamos National Laboratory.) TRUSIM has two modes of operation:

Analytical	TRUSIM is used to answer hypothetical, or "what-if" questions. Questions such as, "What happens if WIPP operates six days a week rather than five?"
Operational	TRUSIM is used to answer such questions as "If TRUPACT #9 is scheduled to arrive at WIPP for unloading at 0915 13 Mar 1989, when will it be available to be re-dispatched and to which site should it be dispatched?"

To support such detailed calculations each individual component of the logistic system is defined in detail. For example, each container (e.g., TRUPACT) and vehicle (tractor) has the following attributes:

- date entered the system, date leaving the system
- mean time to failure, mean time to repair
- miles traveled, miles to next maintenance
- allowed routes, allowed destinations
- allowed load in terms of types of waste, weight, volume, and curies
- hours utilized, hours idle

Similar lists of attributes are maintained for all components of the logistic system. These attributes can be changed as a function of time. As an example, the amount and type of waste being processed at a facility, such as SWEPP, can be changed to accommodate a scheduled shut down for maintenance, a random failure, or a change in production rates.

To make simulations of the logistic system realistic, the simulations are based on one-hour increments of time. This time period can be increased or decreased if experience shows that this is appropriate.

Because it is not possible to predict what the future configuration of the TRU logistic system will be, TRUSIM is entirely generic. There are very few built-in parameters or assumptions. As a result, the model can be used to model other waste logistic systems or any other distribution and supply network.

The features and operation of a simulation model can be subtle. To ensure the reliability of TRUSIM, JIO has had it independently validated by Gilbert A. Hastings, S. M. Stoller Corporation. The methods of validation included comparisons with hand calculations, comparisons with the results from other models (e.g., earlier generations of TRUSIM), and extensive executions of the current TRUSIM to check for reasonableness, self-consistency, and reliability.

SUMMARY

The U. S. Department of Energy's Defense Transuranic Waste logistic system is diverse and complex. To assist in the analyses and management of the system, the Joint Integration Office has developed an integrated system of software to assist in the analyses and management of this logistic system. The software, TRUSYSTEM, consists of a database (PRISM), transport tracking software (PHOENIX), and a logistic system simulation model(TRUSIM). The database and transport tracking software provide the current status of the logistic system, while the simulation model provides the capability to predict the future performance of the logistic system. The use of TRUSYSTEM in analyses of the logistic system aids in today's management decisions. In the future it will assist in the day-to-day operations of the logistic system.

Important features of TRUSYSTEM are that it is comprehensive, fast, reliable, and it runs on microcomputers. By using microcomputers the hardware costs are modest and the ability to use new computer technology as it developed is ensured. Because TRUSYSTEM is written in standard computer

languages, it is highly portable (easily moved from one computer to another) and easy to maintain. The generic nature of TRUSYSTEM and its portability will ensure that it will be readily adaptable to the changes in the TRU logistic system over the decades during which waste will be shipped to WIPP.

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