

SOFTWARE FOR TRACKING CONTAINERIZED WASTE FROM CRADLE TO GRAVE

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ABSTRACT

Accurate and efficient management of hazardous waste is not only a regulatory requirement but good management practice as well. Local, state, and federal requirements for managing waste include a multitude of reports and paperwork to verify and validate the characterization, location, and status of each waste container. Without the aid of a computerized system, this task would be daunting. Even if the data were organized efficiently, the ability to provide characterization or inventory reports at a moment's notice would be next to impossible. The Integrated Waste Tracking System (IWTS) developed at the Idaho National Engineering and Environmental Laboratory (INEEL) is a computerized database system designed for waste management personnel to document, report, and track containerized waste from cradle to grave. IWTS consists of a sophisticated yet intuitive workstation client and a robust and fully scaleable database server to provide a full spectrum of waste characterization information. IWTS can track waste from initial generation through processing and disposal, provide a series of reports to verify inventory, dynamically evaluate operational limits at the time a transaction is made, summarize waste generation, and produce shipping documentation, including the EPA Hazardous Waste Manifest. In addition to inventory specific reports, summary level reports that utilize the same data are created on the Intranet, thus providing up-to-the minute information for a broader range of users (e.g. management and emergency planners). IWTS has extended the workstation client through the use of hand-held tools to assist waste handling personnel with inventory and routine tasks. With over a million records on the system, IWTS has provided the INEEL with waste tracking, characterization, and inventory for over two years. IWTS is the INEEL's tool for more efficient and accurate management of its waste.

WASTE MANAGEMENT ISSUES

Managing waste is governed by volumes of regulations and requirements, many of which require regular reports to federal and state regulators, as well as to internal company auditors or management. These tasks alone demand a significant amount of time and resources.

Table I, Waste Management Matrix, briefly lists those regulatory items that affect waste management activities. (1)

I. Waste Management Matrix

Regulatory Drivers	RCRA – Anybody who generates, transports, stores, and/or treats hazardous waste TSCA – Treatment or Disposal of specific chemicals DOT – Transportation of hazardous material on public roadways CERCLA – Cleanup activities at designated sites DOE – Radioactively contaminated waste FFCA – Federal facilities required to comply with certain regulations
Characterization	Waste Types: LLW, MLLW, Hazardous, Special-Case, Recyclable, Industrial Containers Tank systems Land Disposal Restrictions Pollution Prevention
Inventory	Satellite Accumulation Areas Temporary Storage (90-day) Areas TSD Facilities Weekly Inspections of storage areas
Compliance	Detailed chemical and physical analysis of the facility Emergency preparedness Contingency Plan Record of the description, quantity, location, treatment or disposal of the waste Biennial Reports
Cost Savings	Reporting Efficiency Standard, Centralized Data Civil and Criminal violations
Shipping	Uniform Hazardous Waste Manifest Exception reporting

Anyone who has waded through the sea of regulations governing hazardous waste is fully aware of the time and energy required for compliance. Waste generators have to determine whether or not their waste is hazardous through process analysis and/or sampling. Once characterization is completed, the data must be stored in an easily retrievable system. Storage facilities need to keep a close eye on their permit limits and segregation requirements, hence, determining current inventory and calculating changes becomes a routine task. Shippers of hazardous waste must pay particular attention to labeling and manifesting requirements. Preparing and tracking the shipping documentation requires complete and accurate records.

Although each person involved in managing waste has their own specific responsibilities, much of the data utilized by them is the same. The problem is devising a scheme to compile the data once and use it in multiple places, giving each person access to the data while maintaining accuracy and accountability for the data.

The answer is a comprehensive and flexible computerized waste tracking system.

COMPUTERIZED WASTE TRACKING SYSTEM

The biggest issue faced when deciding on a computerized waste tracking system is defining the requirements or specifications for the system. A careful examination of the process used to manage waste needs to be thoroughly described and, each corresponding regulatory or management driver identified. Any existing forms or standardized paperwork used in the process needs to be gathered and reviewed, and operational or regulatory limits need to be included in design specifications.

For a waste management system, a computerized system should do the following:

- Provide Waste Stream characterization
- Provide Container specific characterization
- Support multiple waste types
- Log waste collection activities
- Provide a flexible facility model definition for multiple facilities
- Evaluate impacts to facilities before a transaction occurs
- Track waste movement between locations
- Track processed/treated waste into secondary waste streams
- Track waste disposal activities
- Track hazardous identities through processes
- Track cost for shipping, storage, treatment, or disposal
- Log storage retention time
- Generate inventory reports
- Generate activity reports for shipments, processes, and disposal
- Generate shipping documentation
- Generate waste genealogy trees
- Evaluate and enforce facility specific operational limits
- Provide libraries for facility specific waste stream information
- Support inventory tools for operational areas
- Allow expansion for additional reports and/or functionality
- Be multi-user capable and enterprise ready
- Be ergonomic and intuitive
- Be Year 2000 Compliant.

Once all aspects of the process are laid out, focus should then be given to the critical steps that can be streamlined, automated, or consolidated. If starting from scratch, it is best to keep the scope of the requirements narrow while focusing on the one or two aspects of the overall process that will provide the most benefit. Trying to capture the entire range of business aspects will create chaos causing the project to fail. It's best to start small, deploy in phases, and continually look at improvements as the system gets used.

Switching from a paper system to a computerized system requires careful deployment. As such, all end users must be considered. The level of access to the data needs to be defined, because its efficiency is an important tool for performing their responsibilities. Their computer skills and access to capable computers must be considered. Organizational or company culture changes must be factored into the phases of deployment to ensure acceptance. Defining the ownership of the system once it is operational will ensure any defects in the system will be effectively and expeditiously corrected.

The Integrated Waste Tracking System (IWTS) project has taken the philosophy of first meeting the needs and requirements of the end users, and addressing regulatory drivers of the system second. Many legacy systems that focused on regulatory compliance rather than user needs have not been well accepted by the

users nor maintained by an accountable organization. The quality of the data quickly became a concern requiring additional cross-checking and verification. A system that helps end users perform their job responsibilities faster and easier equates to consistent and quality data.

One major issue in developing site-specific software of this magnitude is providing a feature-rich product within schedule and available resources. The software management triangle (2) offers a good perspective on software management. The three elements of the triangle are resources, time, and features. The idea behind the triangle is to manage each element realizing that a change to one element affects the others. The ideal system should balance all three elements equally by identifying enough features within available resources and time to complete the system.

The development cycle for the current version of IWTS took standard project management practices and the software management triangle to compile the design requirements, configuration management plan, resource loading, and a projected delivery schedule. One of the first cuts to the project was resources. To keep the project in stasis, features also had to be cut. The result was an earlier projected release date. Throughout the development cycle, the feature baseline was constantly challenged. End users and management asked for more features. When the resource and time elements were factored in, the feature was usually eliminated. Those features, however, were documented and categorized for future upgrades. Planning for future upgrades means the software can grow with the organization and ensures it receives proper maintenance.

Resources

Resources not only include a budget but also manpower, computers, and a stable development environment. The development team should comprise a project manager, developers, and quality assurance specialists. The project manager oversees the schedule and design requirements and keeps the team focused on completing the requirements. Generally, at least two developers are needed to do the actual programming. Keep in mind that excessive numbers of developers do not necessarily mean the system will be done faster. As such, development teams should consist of an adequate number that fits the time and features for the system. Quality assurance provides the documentation and testing to ensure the software functions properly.

Time

Time is the number of days, from start to finish, required to develop a system. Most estimates from developers are optimistic. It is advisable to add an additional time buffer to account for unforeseen problems or extensive technical hurdles. Other factors that affect time are based on the choice of development tools. If the developers are familiar with the development tools then most of the time spent will be in productive work. Any new development tools or utilities will require extra time to learn the product.

Features

The features should be adequate to satisfy the requirements of the system. Too few features can make the system non-beneficial; conversely too many features can make the system too complex to use or deploy. Starting with less features and planning for routine upgrades gets the system running quickly and gives users motivation to provide design input. Features specified by the end users result in a product that is accepted and utilized.

THE SOLUTION

IWTS is the computerized database system chosen by the INEEL to provide a controlled and centralized repository for waste characterization data and to track waste from cradle to grave. IWTS was designed with end user input and requirements from waste generators and waste operations personnel. The philosophy behind the development team was to give those essential waste management personnel a flexible tool to perform their work more efficiently and to better meet management reporting and accountability needs. A

centralized system needed to be realized for this theory to succeed. Once integrated, all site-wide reporting would originate from one source, thus providing the consistency lacking in other legacy systems.

IWTS was first conceived as a simple data system to help many organizations provide inventory data for the Federal Facilities Compliance Act (FFCA). As the data grew and user input was gathered, the vision for future versions was realized and planned. The first major release of the system consolidated certain data and eliminated multiple entry points for the same information. Version 2 piloted technological concepts of deployment to multiple, geographically-remote facilities and automated certain operational tasks. Version 2 was designed to be modeled into the different facility activities, yet provide consistent reports. This version was deployed across the INEEL in a single year, thus eliminating redundant systems and providing a single repository for all waste management personnel to enter and retrieve data. Version 3 of IWTS (Figure 1) expanded the previous release by making it faster and easier. IWTS has also gone through extensive verification and validation testing to ensure data integrity. Having achieved its Year 2000 compliance, it is ready to serve the INEEL for years to come.

The screenshot displays the Integrated Waste Tracking System (IWTS) interface. The main window is titled 'Material and Waste Characterization Profile'. It features a menu bar with 'File', 'Edit', 'View', 'Tools', 'Window', and 'Help'. Below the menu bar is a toolbar with various icons. The interface is divided into several sections:

- Containers Profile:** A section at the top left with a 'Shipment Task' button.
- Manifest Search:** A section below 'Containers Profile' with a search bar.
- Material and Waste Characterization Profile:** The main data entry area, which includes:
 - Profile Information:** Fields for 'Material Profile No.' (MP-2), 'Profile Date' (1/1/60 01:00:00), 'Name of Waste or Material' (ICPP Analytical Lab Waste), 'INEEL Site Treatment Plan ID' (INEL-2), 'Generating Unit' (ANLAB), and 'Material or Waste Type and Action' (MLLW: CH, to be incinerated at WERF).
 - Status Switch:** Radio buttons for 'Active' (selected), 'Inactive (available in past not present)', and 'Cancelled (not available in past or present)'.
 - Record Lock Parameters:** Fields for 'Record Lock Parameters' (7/16/96 15:45:12) and 'Insert Parameters' (7/16/96 14:44:05), both with a 'greenk' status.
- Navigation and Controls:** Buttons for 'Define', 'Approvals', 'Process', 'Spec. Char.', 'Char. Req.', 'Gen. Active', 'Gen. Inactive', 'Layers', 'Physical Char.', 'Chem. Char.', 'Composition', 'Incin. Prop.', 'Comments', and 'Edit Log'. There are also 'Active', 'Inactive', and 'Cancelled' status buttons.

A small text box at the bottom right of the main form provides instructions: 'Inactivation allows a record to remain selectable for historical profiles prior to the inactivation date. The inactivation date defaults to the date/time of inactivation, but can be changed to a user defined date/time. A cancelled record will not be selectable by past, present, or future records. After a record is cancelled, a historical profile may continue to reference it, but any attempt to update the reference will require a new selection.'

Figure 1. Integrated Waste Tracking System (IWTS)

Design

The core design behind IWTS allows it to be deployed at multiple facilities yet maintain a consistent data structure and user interface across each location. The heart of the database is a database engine, Sybase SQL Anywhere, that can run on multiple operating systems through standard Structured Query Language

(SQL) protocols. Its small footprint allows the engine to run on enterprise servers as well as desktop or laptop computers. Where network connectivity becomes an issue, (e.g., where facilities do not have direct network access), the database can be configured to run on a local computer and replicate data bi-directionally through a modem on a scheduled or non-routine frequency. (3)

For special cases where ad hoc queries or reports are needed, the database engine allows full Open Database Connectivity (ODBC) compatibility. This feature has allowed IWTS data to be migrated to the intranet to provide up-to-the-minute information for management. Other ODBC applications have been extended from IWTS to assist the main application. The handheld inventory tools provide operations personnel with instant container and inventory information through the use scanning of container barcodes. Other modules on the handheld tools have been designed to expedite waste handling tasks and data entry while maintaining data integrity consistent with the client user interface.

Being ODBC compliant, the IWTS data has been used to expand the capabilities for tracking disposal of the Low Level Waste backlog, quarterly Site Treatment Plan updates, pollution prevention activities, and data warehousing for site-wide reports. Historically, much of the data provided to these other systems required weeks or months of research. Now the data can be reviewed and updated in minutes with the assurance that the data is accurate.

The client user interface is also a robust entity to the entire system. It was compiled on one of the industries premier development tools, Powerbuilder. IWTS provides links to the various system modules, drag and drop capabilities to enhance data entry tasks, and an intuitive interface. Numerous reports are available to give waste management personnel valuable information for their waste. Table 2, IWTS Reports, lists most of the reports available from IWTS.

Table 2. IWTS Reports

Characterization	Material and Waste Characterization Profile Container Profile Job or Task Profile EPA Uniform Hazardous Waste Manifest Shipping Certification Job or Task Costs
Inventory	Area Container Inventory Fissile Nuclide Inventory by Container Waste Generation by Area Waste Processed by Area Waste Disposed by Area Area Limit Compliance based on Facility Model Proposed Inventory Load or Campaign List
Reference	Facility Models Radionuclide List EPA Codes List with treatment subcategory Controlled Material List User/Contact Reference Table Contract Price List

LOOKING INTO THE FUTURE

The success of any software product centers on its flexibility and adaptability to changes. Version 3 has evolved IWTS from a desktop system to a client-server enterprise system. Its inherent architecture and functionality has increased with each version allowing it to be used by multiple organizations with varying requirements yet, providing consistent data for reporting purposes. As the INEEL moves toward streamlined waste management practices and policies, IWTS will need to evolve to support that vision.

IWTS will be redesigned to support pre-process waste determinations. Generators will be able to define a process and identify the product streams from that process. The waste streams, if any, will be further characterized and reviewed. Waste containers will then be tied back to the generating process.

The IWTS handheld inventory tools will also continue to expand, providing greater access to the data in operational areas. Laptop computer data access points are being expanded to give remote locations full access to the data. The barcode scanning tools can also be integrated into process control equipment to monitor waste handling and treatment on a real-time basis.

IWTS contains over two years worth of site-wide waste data. As such, the EPA biennial report can be electronically compiled with little additional effort. In addition, the EPA's electronic data interchange for hazardous waste manifests can be handled through IWTS, thus eliminating the paper handling process that currently exists.

IWTS could be configured to allow offsite generators to input their waste data at a remote location. Their data can then be exchanged between their local system and the IWTS main system, thus eliminating the redundancy of data entry and reducing data transcription errors. Updates and corrections can be made and documented electronically providing an audit trail to be reviewed instantly by both parties.

IWTS solves many of the reporting requirements and answers many of the questions posed by waste management specialists. As the features and functionality of IWTS continues to expand, its adaptability to other industries will also expand.

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