A Comprehensive Solution for Managing TRU & LLW From Generation to Final Disposition – 13205

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ABSTRACT

A LANL multi-disciplinary team faced the challenge of building and delivering a waste information system capable of managing radioactive, hazardous, and industrial waste from cradle to grave. The result is the Waste Compliance and Tracking System (WCATS) a flexible, adaptive system that has allowed LANL to consolidate its legacy applications into one system, and leverage the advantages of managing all waste types within a single scalable enterprise application.

Key functionality required for robust waste operations, include: waste characterization, waste identification, transportation, inventory management, waste processing, and disposal. In order to maintain data quality, field operations such as waste identification, surveillance checklists, wall-to-wall inventory assessments, waste transfers, shipment pickup and receipt, and simple consolidation operations are captured by the operator or technician using mobile computers. Work flow is managed via end-user defined work paths, to ensure that unit operations are performed in the correct order. Regulatory compliance reports and algorithms are provided to support typical U.S. EPA, DOT, NRC, and DOE requirements, including the EPA hazardous waste manifest, NRC LLW manifest, DOE nuclear material at risk, RCRA TSDF inventory rules, and so forth.

The WCATS application has allowed LANL to migrate and consolidate its disparate legacy applications. The design and implementation is generalized so that facility owners can customize the user interface, setup facilities and unit operations (i.e., treatment, storage, disposal, characterization, and administrative), define inventory compliance rules, and establish custom work flow requirements.

THE PROBLEM – LEGACY DATABASES WITH LIMITED OR NO INTEGRATION

When your business needs an IT solution for payroll, procurement, or project management, there are many off the shelf software solutions. Should your business generate radioactive waste, or manage a permitted treatment, storage, and disposal facility for radioactive waste, there are few if any good off the shelf solutions. More than one desperate manager has put their faith in software engineers to develop a custom solution. These efforts are costly and high risk.

An integrated application that incorporates all the requirements necessary to manage radioactive, hazardous, and industrial waste at a major facility would be a daunting effort. As a result, it's common practice for management to divide and conquer large tasks. That's where the problem can begin, they might build one application to support waste stream characterization, another to manage low level waste container inventories, and another to manage the generation and certification of transuranic waste, and so forth. In the early days of waste management, while the primary focus was waste storage, this disparate set of software solutions was workable. When the priority shifted to treatment and disposal, the weakness of these solutions became painfully apparent. For example, consider a scenario where LLW is managed in one system, TRU waste in another. Then imagine a TRU waste repackaging operation that generates both TRU and LLW, and consider the issues surrounding waste inventory assessments, hazardous constituent tracking, source-term calculations, nuclear material at risk (MAR) calculations, and so forth. In this case, when we consider waste processing, we are forced to build solutions that interface with multiple legacy databases, resulting in high software engineering costs, complex rework scenarios, data quality issues, and the potential for unexpected regulatory compliance problems.

In recent history, Los Alamos National Laboratory (LANL) faced the challenge of replacing its five legacy database applications with a new integrated system. The result is the Waste Compliance and Tracking System (WCATS). A flexible enterprise class software application design and implemented by a team of software engineers and waste management subject matter experts.

THE REQUIREMENTS

In order to meet the needs of a full-scale treatment, storage, and disposal facility, a waste management application must address a range of operational, regulatory, work flow management, and enterprise application requirements.

Support for TSDF Operations

An integrated application must support the fundamental transactions associated with waste operations including:

- Waste stream characterization
- Waste identification and containerization
- Waste movement including both intra-facility transfers and inter-facility shipments
- Waste treatment and processing, including a range of capabilities from simplistic packaging operations to more complex operations that transform waste into new forms (e.g., cementation), and
- Waste disposal.

These core capabilities are required to properly manage waste; the bread and butter requirements for a robust waste management system.

Support for Regulations

LANL is a federal facility, where environmental compliance, safety, and security are a priority for waste management. The significant regulatory drivers that affect waste operations, and potentially affect the application design are:

- U.S. EPA RCRA regulations for hazardous waste
- U.S. DOT regulations for shipping hazardous materials
- U.S. NRC regulations for shipping and disposing of radioactive waste, and the
- U.S. DOE regulations for operating nuclear facilities.

The complexity of these regulations necessitates the implementation of an IT solution in order to efficiently operate a facility and ensure compliant operations. When managing waste, the application must provide tools to build DOT shipping descriptions, print and manage the EPA uniform hazardous waste manifest, calculate DOT and NRC waste parameters, configure and print the NRC LLW manifest, enforce inventory limits imposed by permits, and evaluate DOE material-at-risk (MAR) limits for nuclear source-terms stored at the facility.

Flexible Workflow

Things change, and historically, waste information systems have been "hard-coded" so that changes are costly. Waste management personnel requested a flexible application that can more readily adapt to changing requirements, in particular, the application must support:

- User-defined workflow to control the sequence of operations
- User-defined signature definitions for treatment, storage, and disposal transactions
- User-defined facilities and unit operations
- User-defined inventory and limit compliance rules
- User-defined user groups with customizable user authorization schemes, and
- User-defined checklist reviews for inspections, surveillance activities, and quality control reviews.

New processes, new procedures, and new regulations are part of the waste management routine. These workflow requirements exist to ensure the application can be quickly and efficiently adapted to meet those needs.

Support for External Interfaces

Finally, when hosting an enterprise application, it's necessary to incorporate features that keep maintenance costs low for application administrators. This is accomplished by providing interfaces to other corporate information systems, such as:

- Employee information for identify end-users and keeping their contact information current.
- Financial information for billing waste generators
- Chemical inventory data for the identification and disposal of unused/unspent chemicals
- End-user training and qualification data to ensure compliant operations
- Laboratory Information Management System (LIMS) data for sample and analytical results
- Enterprise services for end-user access and authentication.

Each interface works to reduce the duplication of end-user data entry or reduce the work load of the application administrator. Application availability is a high priority to waste operations, and to the extent possible, each interface is implemented in a manner that ensures the availability of the waste information system despite temporary outages of the third-party system.

THE EVOLUTION OF APPLICATIONS IN THE COMPLEX

There may not be many off-the-shelf software solutions for waste management, but there are numerous legacy application that have been designed and implemented throughout the U.S. DOE complex. Understanding how these database applications evolved over time, and understanding the strengths and weaknesses of those applications, provides some constructive insight to the design of a modern integrated application.

There are essentially three generations of applications. The first generation was container centric. These applications provided useful information about the container and its contents, including container type, volume, weight, and related information about the waste matrix and contaminants. The container centric applications were relatively simple in design and acceptable for a number of years, until the Federal Facilities Compliance Act for hazardous waste was passed in 1992. This initiated the second generation of applications which included a focus on the point of waste generation, identification of waste streams, and the concept of a hazardous waste determination. As a result, second generation applications added another subsystem to the database design, often referred to as the "waste stream", "waste profile", "material profile", etc. The waste stream was meant to be defined and characterized before the first container of waste was generated, allowing reviewers to classify the waste based on process knowledge or analytical results for radiological and chemical contaminants. It was also used as

a planning tool to estimate generation rates and consider treatment/disposal options. For a few years, the second generation database applications appeared robust and suitable for radioactive waste. At the time, most radioactive waste remained in storage, and there were few options for managing mixed waste types (i.e., MLLW and MTRU waste). As the focus shifted to waste treatment and disposal, the second generation database applications proved woefully inadequate. In particular, it was extremely difficult to track waste as it moved through complex multi-step treatment operations, such repackaging, sizing, incineration, and the processing of secondary waste streams from those processes such as ash, contaminated personal protective equipment (PPE), and so forth. Tracking and accounting for radionuclide source-terms through multiple process steps was arduous if not impossible, and following the hazardous constituent contaminants through processing operations was a challenge too. These issues ushered in the third and most sophisticated generation of database applications, where three tightly integrated subsystems (Figure 1) were required; the (1) container, (2) waste stream, and (3) TSD tasks. This third subsystem formalizes the operational transactions for treatment, storage, and disposal, and provides the necessary three legs to the proverbial stool for a robust waste management application. The challenge is integrating these three subsystems in a manner that provides a flexible application that can manage all waste types from the simplistic to the complex.

The solution for LANL is WCATS a third generation waste management application including all three essential subsystems.

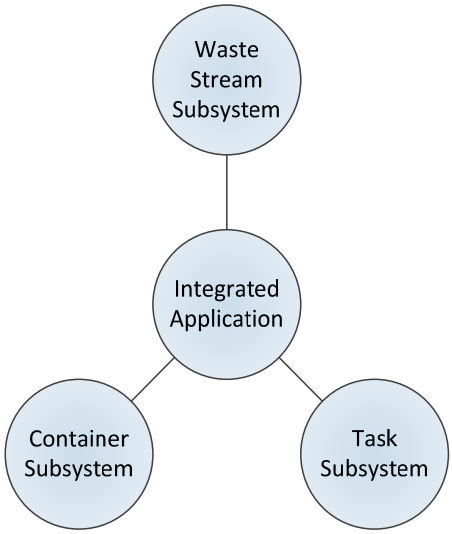

Figure 1. Third generation integrated applications incorporate waste stream, container, and task subsystems.

WASTE STREAM CHARACTERIZATION

Best practice and environmental policy requires that a generator plan for and characterize their waste streams prior to generating waste. This is accomplished via the WCATS user interface

using the "waste stream profile". At LANL, this same subsystem is used to define all types of waste, including radioactive, hazardous, industrial, chemical, and solid waste streams. The range of information gathered for a profile includes (see sample waste stream in Figure 2):

- General information about the process, generating location, and personnel
- Annual generation rate, including estimate for out years
- Waste composition
- Specific activity of radionuclide contaminants
- Concentration of chemical contaminants
- Assignment of U.S. EPA codes and underlying hazardous constituents (UHCs)
- Charge codes for billing waste processing and disposal costs
- Attachment of supporting documentation (e.g., material safety data sheet [MSDS])
- Electronic signatures for review and approval
- Annual review, certification, and extension of the waste stream profile.

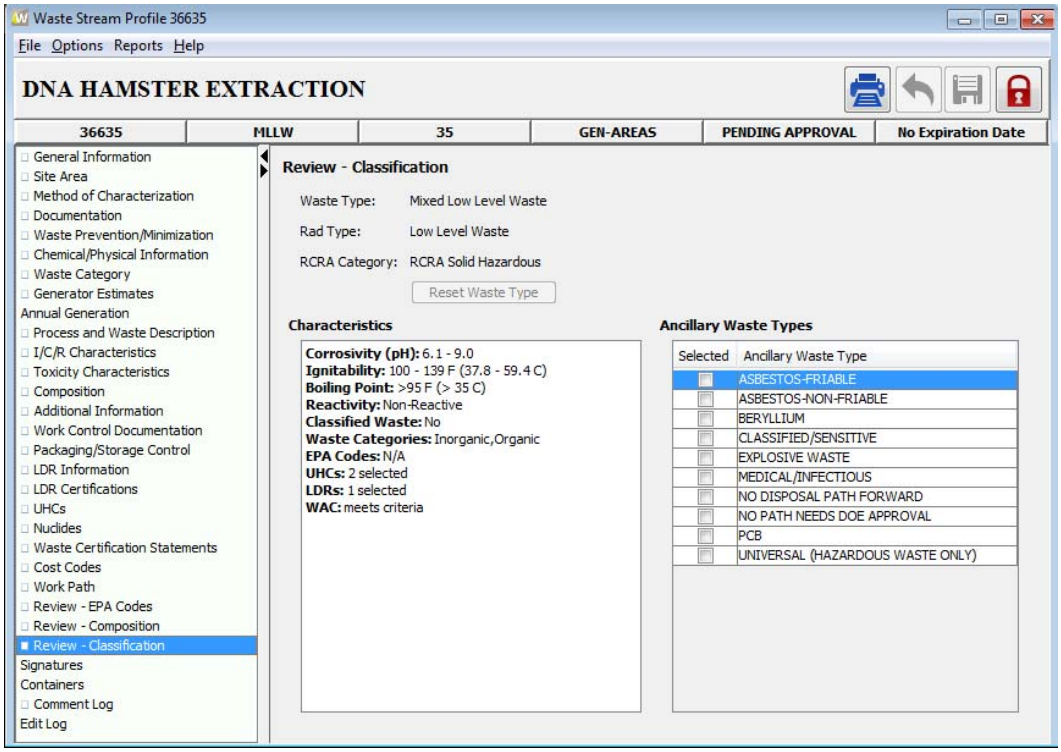

Figure 2. Waste stream profile, showing navigation panel (left) and classification panel (right)

The online submittal, review, and approval process has significantly reduced the average turnaround time for new profiles from approximately 40 days (a paper process) to approximately

5 days. Every waste type can have a custom review and approval process, automatically routing the profile for approval based on a signature definition. For example, PCB contaminated waste, TRU waste, LLW, asbestos contaminated waste, and so forth, may have different review and approval requirements. Each waste type definition is customizable by an application administrator, using metadata to configure the user interface, signature definitions, and validation rules (e.g., hazardous waste requires EPA codes, or LLW requires cost codes for billing, etc.).

CONTAINER AND ITEM IDENTIFICATION

With an approved waste stream profile, the generator is authorized to generate waste using the "container profile". Based on waste type, the application captures information essential for managing the waste, including:

- General waste item/container properties, such as container type, size, and weight
- Waste stream profile assignment
- Radioassay results or calculated source-term
- Radiological survey results
- EPA codes and UHC
- DOT shipping description
- Assignment of charge codes for processing and disposal.

Waste items or containers can be identified using the desktop "container profile" application or via a mobile computer and portable barcode printer (Figure 3). Capturing accurate data requires putting transactions, like waste identification, in the hands of those performing the work, including those working in the field. In addition to waste identification, WCATS provides a suite of mobile applications focused on transactions that typically occur in the field (see list in Figure 4).

Figure 3. Mobile computer and field printer support field operations like waste identification.

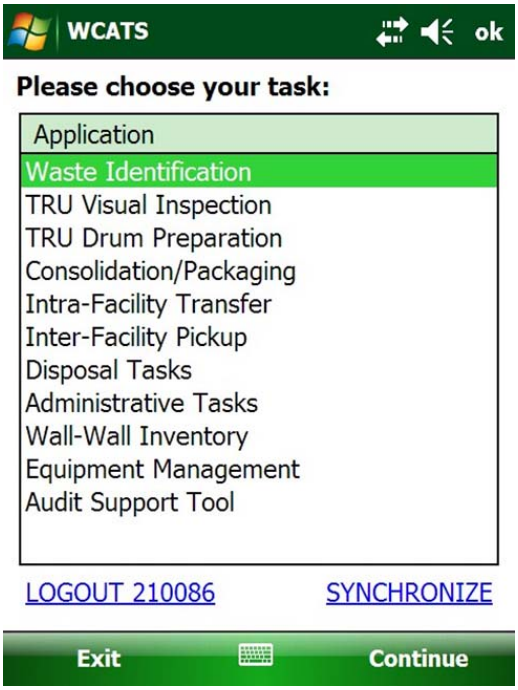

Figure 4. Mobile application selection screen for field operations.

OPERATIONAL TASKS

The generator is usually eager to disposition their waste to a treatment or disposal facility, and WCATS provides comprehensive support for treatment, storage, and disposal facilities via the "task profile". The task profile breaks operations down into five fundamental types (see examples in Figure 5): treatment/processing, transfer/shipping, disposal, administrative, and characterization.

Treatment	Storage	Disposal	Characterization	Administrative
•Cementation	•Area G Dome 229	•Area G Pit 29	•Radioassay	•CWDR
•Packaging	•PF4 Storage Pad	•Area L Shaft 24	•Radiological Survey	•QA Review
•Compaction	•PF4 Room 432		•Visual Inspection	•SS Review
•Sizing	•*ONYX Receiving*			•RCRA Inspection
	•*NTS Receiving*			

Figure 5. Five types of user-defined unit operations are supported by the task profile (examples shown)

Shipping and Transfer Tasks

Shipping and transfer tasks move waste between facilities or within a specified storage unit. A user can define companies, facilities, buildings, and grid locations (x, y, z), and then manage their waste within those locations. These operations can be performed from the desktop "task profile" or the corresponding mobile application, again, putting the transaction in the hands of those performing the work. For inter-facility shipments, a full suite of regulatory documents are supported including the U.S. EPA's uniform hazardous waste manifest and the U.S. NRC LLW manifest.

Disposal Tasks

Disposal tasks move waste to what is typically a permanent resting spot, such a subsurface pit or shaft. The end-user can define new disposal units, and appropriate grid locations (x, y, z) to represent the placement of the waste. Similar to shipping and transfer tasks, disposal tasks are support by a mobile application, putting the transaction in the hands of the facility operator.

Treatment and Processing Tasks

Processing tasks are used to package or transform waste based on unit operations defined by the end-user. These operations can range from simplistic repackaging or consolidation units to complex incineration or cementation units. Typically, treatment tasks have input containers (e.g.,

feed containers) and output containers (e.g., daughter containers). Waste can be transferred from input to output containers using various methods or combinations of methods including: item-based, weight-based, volume-based, or user specified volume percent (see item-based packaging task in Figure 6). Radionuclides, EPA codes, and UHCs are automatically partitioned from input to output containers according to the unit operations setup properties. Unit operation specific rules, such as output container source-term limits, weight limits, and so forth, can be implemented by the end-user with metadata. Simple waste repackaging, consolidation, or over-packing activities can be performed from the mobile application.

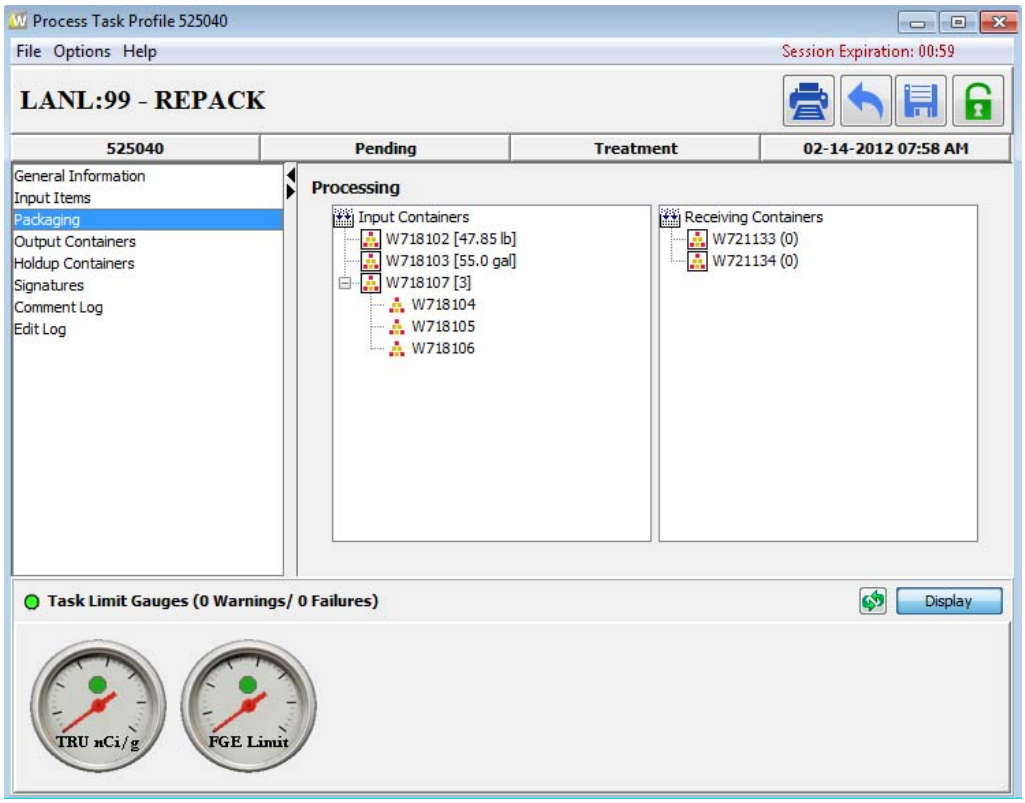

Figure 6. Processing task for packaging waste items from input to output containers.

Administrative Tasks

Administrative tasks do not move or transform waste; they implement checklist reviews, facility surveillance requirements, routine inspections, generator disposition requests, and so forth. Administrative unit operations are defined by the end-user, and may include a checklist review (i.e., a list of questions, with possible answers, and responses) and a custom signature definition for review or approval of the task. Administrative tasks can be accessed from the desktop application or via the mobile application.

Characterization Tasks

Characterization tasks are implemented for formal waste characterization activities, where stringent data quality or concurrence requirements apply (e.g., TRU waste characterization) such as non-destructive assay (NDA), non-destructive examination (NDE), or visual examination (VE). Characterization task are supported as an integral element of the container profile, allowing the capture of electronic signatures and the enforcement of validation rules.

"Waste streams", "containers", and "tasks" complete the essential three legs of the waste management information system stool. There are a several more capabilities required by a busy TSDF operation, including workflow and equipment management.

WORK FLOW MANAGEMENT

When dealing with large volumes of waste, numerous unit operations, and a large workforce, managing workflow can become a challenge. WCATS implements the "work path" concept, allowing waste management personnel to visually define a sequence of operations (Figure 7), and then assign that workflow (i.e., "work path") to a container or waste item, and then let the system route the waste from operation to operation. This improves workforce efficiency and reduces the possibility of costly operational or regulatory mistakes.

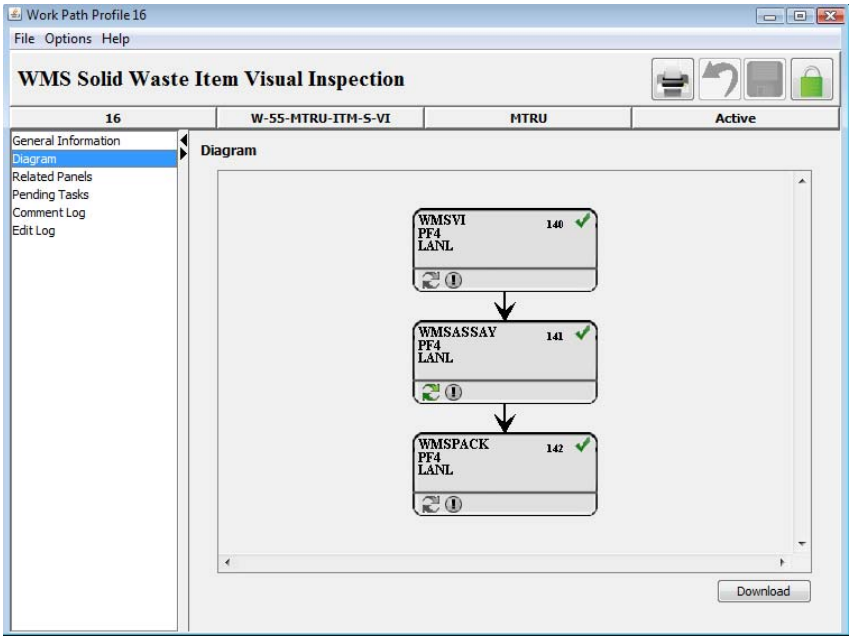

Figure 7. User-defined work path defines a sequence of operations (e.g., visual inspection, radioassay, packaging).

EQUIPMENT MANAGEMENT

Tools are utilized while processing, handling, and characterizing waste, including everything from simple torque wrenchs, scales, and pH probes to complex ventilation systems, NDA, and NDE machines. The inspection, calibration, and maintenance of this equipment is essential for compliant and safe operations. The "equipment" subsystem allows the end-user to define equipment, establish requirements (e.g., maintenance schedule), and record service events (e.g., changed engine oil on mm/dd/yyyy, calibrated torque wrench on mm/dd/yyyy). Unit operations can be setup to specify equipment needs, and then confirm that those operations are completed with properly maintained equipment.

CONCLUSION

LANL was faced with the challenge of building a new enterprise class waste management information system to consolidate five legacy database applications. From the beginning, there was an understanding that managing waste is a unique business; our end game is the treatment or disposal of waste, essentially destroying the evidence of our work. Our product is data, quality records that demonstrate waste was managed and dispositioned in compliance with environmental regulations.

WCATS was designed, developed, and deployed in a phased approach, allowing time to migrate information from each legacy application, and train end-users on the new system. This new system incorporates the essential features of an integrated waste management application, including subsystems for "waste streams", "containers", and the full range of operational "tasks", including treatment, storage, disposal, characterization, and administrative operations. To fully round-out the needs of LANL's customer base, the application includes workflow management capabilities via the "work path" concept, and supports the calibration, inspection, maintenance, and integration of equipment and tools necessary to run a compliant operation.

Finally, managing all waste streams, including radioactive, hazardous, and industrial waste types, within one robust application has allowed LANL to reduce its IT costs for application administrators, customer service representatives, and system/database administrators. The number of personnel required to maintain LANL's waste information systems have declined rapidly from approximately 20 to 8 people. The last legacy application is scheduled for data migration and decommissioning in March of 2013.