Waste Processing Using WCATS with its Underlying Task-Based Architecture – 14662

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ABSTRACT

The Waste Compliance and Tracking System (WCATS) team at Los Alamos National Laboratory (LANL) has developed an effective waste processing framework that dramatically increases the simplicity of managing radioactive and hazardous waste while ensuring compliance with state and federal regulations. This meta-data driven framework compliments a task based architecture in which unit operations are defined using advanced work-flow concepts called work paths.

As an example, an end-user can define a new waste storage building along with certain compliance limits using volumetric, nuclear material, and other pre-identified algorithms. Processing operations such as repackaging, over-packing or treatment units can also be defined instantly with setup rules for input and output containers (e.g., TRU isotope limits). Finally, the end-user can define a work path that visually identifies the unit operations required (e.g., define waste item, radioassay container, transfer container to building 100, or consolidate waste items). In little time, facilities can be defined, placed into operation, and their work flow monitored.

The framework allows unit operations to leverage numerous validation and compliance procedures using operational defined limits that can change frequently. Work paths act as a guide for the waste, ensuring the proper steps are taken for all waste, and are able to be monitored by users. This framework has allowed better operations management when dealing with compliance, inventory, and processing operations

A FRAMEWORK OF UNIT OPERATIONS & TASKS

Every waste management facility is configured differently because the waste processing, storage, disposal, and permit or safety requirements are different. In a matter of minutes, a WCATS user, can configure a facility using metadata to the specifications of the facility owner. The process starts by defining the facility, and its fundamental unit operations. The system supports five fundamental types of unit operations, or “service units” using the application’s terminology:

- Treatment or processing
- Storage
- Disposal
- Characterization, and

- Administrative.

The five types of unit operations cover the range of operational activities you find at waste management facilities. For example, a waste storage building would be defined as "storage" service unit, and an incinerator would be defined as a "treatment" service unit. TABLE I provides additional examples of each service unit type.

TABLE I. Types of service units with examples

Treatment & Processing	Storage	Disposal	Characterization	Administrative
• Cementation • Incineration • Segregation • Sizing • Over-packing	• Building • Outdoor pad • LT 90-day area	• Disposal pit • Disposal shaft • Land application • Injection well	• Radioassay • Radiological survey • Visual inspection • Total metals analysis	• Facility surveillance • QA review • Disposition request • Facility inspection

With facilities and service units defined to match the actual waste operations, the end-user can start processing, moving, and disposing of waste. This is accomplished via the application's "task-based" architecture which implements the concept of a transaction by associating a task record with a specific service unit and an associated list of waste containers or waste items. For example, a task associated with waste storage building "XYZ" will transfer the associated container(s) into building "XYZ". A task-based transaction accomplishes work, such as a cementation run, a container radioassay, a shipment, and so forth, based on the type of unit operation. The following task profile (Fig. 1), shows a packaging operation for radioactive waste items.

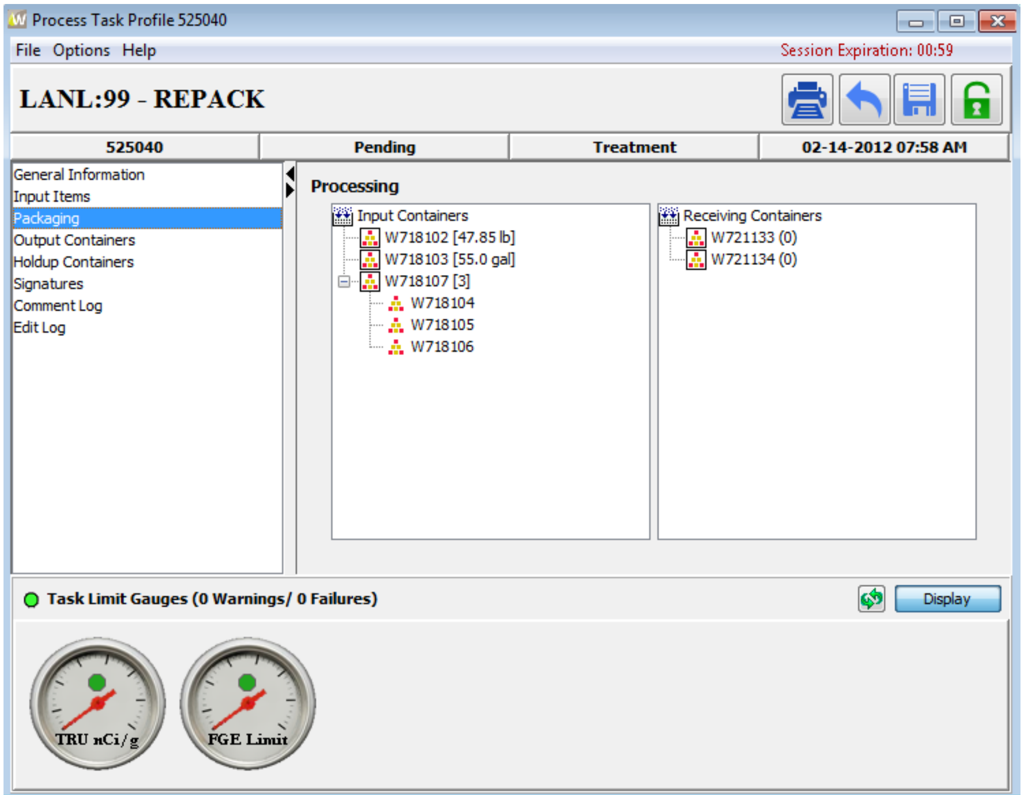

Fig 1. Task profile user interface for packaging waste items.

MANAGING WORK FLOW

A large waste management facility, similar to LANL's Technical Area 54, can accommodate thousands of waste containers, each with different characteristics, different processing and characterization requirements, and different history of operations. It can be a challenge to efficiently manage work flow, and this is where the concept of a "work path" is introduced. A work path is a sequence of operations that should or must be performed in order to disposition waste. For example, a transuranic waste item generated at LANL might require three operations, such as "visual inspection", "radioassay", and "packaging", performed in that specific order. The three unit operations represent a work path (see Fig. 2) graphically built by the end-user to automatically direct the sequence of operations. When an operation is complete (e.g., visual inspection), the application will automatically direct the waste item or container to the next operation (e.g., radioassay) and send notifications to the appropriate personnel. Work paths keep waste moving from operation to operation, ensures that critical steps are not skipped, and prevents waste for entering the wrong unit operation.

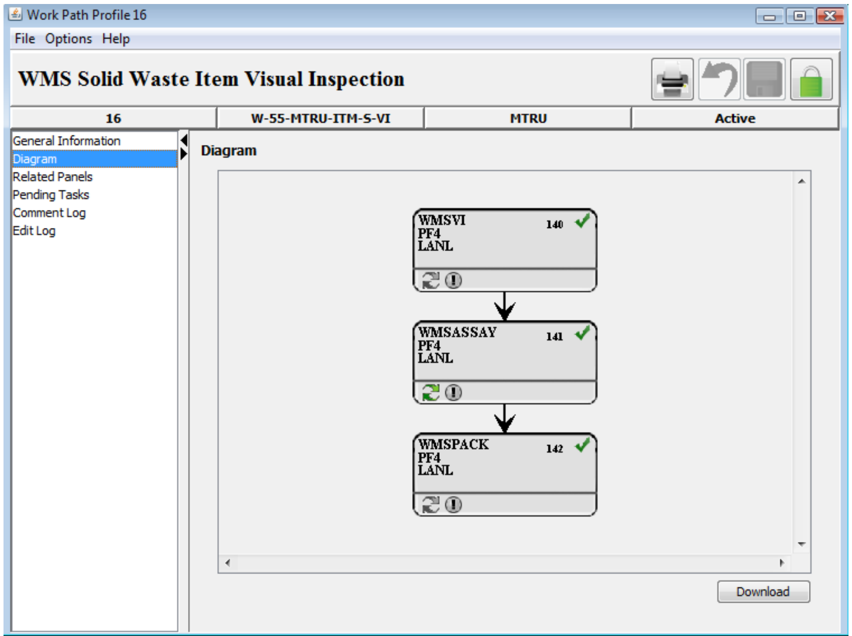

Fig 2. User-defined work path defines a sequence of operations (e.g., radioassay, and packaging).

Work paths can be simple or complex, include parallel operations, repeatable operations, 1 of n operations, and so forth. Some waste types, such as those for transuranic waste, can include many steps with complex business rules (see Fig. 3).

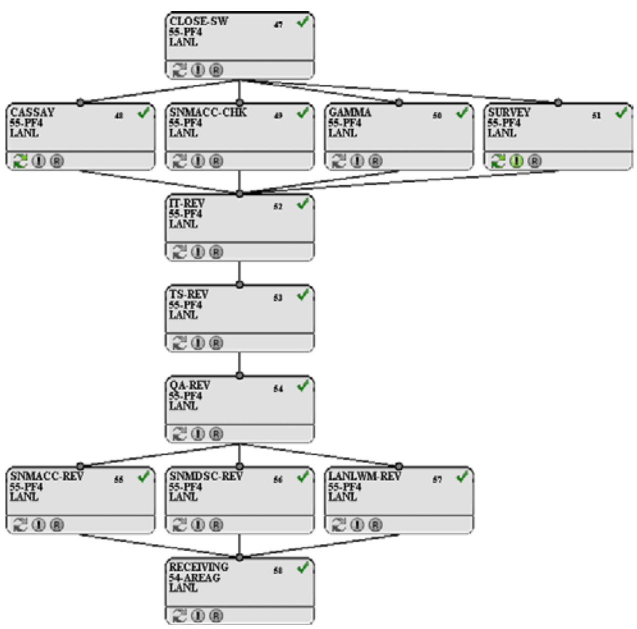

Fig. 3. Work paths can include many unit operations with complex business rules.

MANAGING INVENTORY COMPLIANCE

So far, we have discussed a flexible framework that allows an end-user to define their waste management facility, implement unit operations call “service units”, perform waste operations using task-based transactions, and implement “work paths” that direct work flow and automate logistics. There is one more important element of the application framework, and that involves the enforcement of inventory compliance rules. The implementation of these rules vary widely from one facility to another, so once again, metadata is used to apply them, as necessary. These algorithms range from simplistic to complex, including a range of common business rules implemented by regulatory permits and technical safety requirements, such as:

- Container and/or storage unit fissile gram equivalent (FGE) limits
- Container and/or storage unit Pu-239 equivalent activity limits
- Enforcement of U.S. DOE nuclear facility hazard categories (e.g., Category 2 or 3)
- Volume, mass, and container count inventory storage limits.

Additional inventory compliance algorithms, referred to as “task logic”, are easily added to the framework by a software developer, and made accessible to the end-user via metadata.

After the inventory compliance rules for a facility are specified, the application will trigger the appropriate evaluations as transactions are performed by the waste handler or operator. The “task logic” results are displayed (see Fig. 4), and subsequently archived to a transaction log.

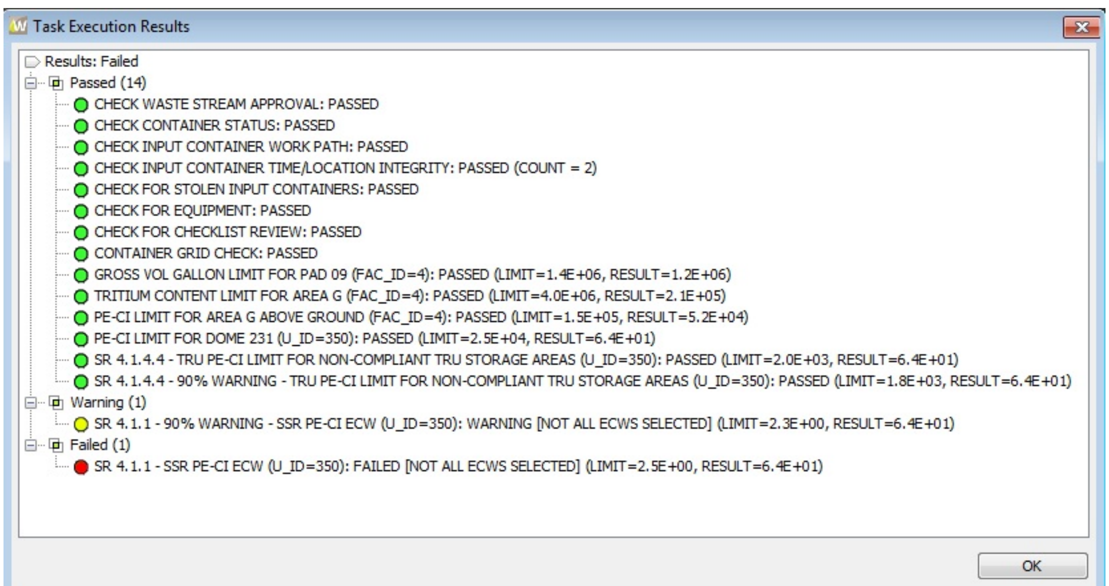

Fig 4. Task execution logic enforces facility inventory compliance rules.

IMPROVING OPERATIONS MANAGEMENT

With a waste management facility defined, unit operations established, work flow rules defined, and inventory compliance logic implemented, we are ready to start managing waste. However, many waste transactions are accomplished in the field, away from a workstation or desktop computer. Typical transactions like waste transfers, shipping, waste item definition, and waste consolidation occur in the field, accomplished by waste handlers and operators, working on their feet. Data quality is high when the end-user responsible for a transaction records it, so field force automation is essential. The WCATS application accomplishes this objective by implementing mobile devices (i.e., barcode scanners) and barcode printers that can be used in the field (see Fig. 5).

Fig. 5. Mobile computer and field printer support field operations like waste identification.

The mobile device implements an embedded relational database supporting full bi-directional replication capabilities, which implies the device can capture transactions even when a wireless (cellular or WiFi) signal is not available, and if necessary, it can synchronize data via an Ethernet connected cradle. Synchronization logic ensures that potential conflicts between field transactions and desktop client operations are handled appropriately, consistent with inventory and compliance rules.

Earlier, the subject of work flow was discussed, and one of the most advanced features of the system is the ability of logistics personnel to communicate work requests via work path assignments or direct requests to workers in the field. The worker can see what containers need to be moved, shipped, or staged for various unit operations. This allows everyone involved to see the big picture, and work together to improve the productivity of waste operations.

The suite of mobile applications include (a) waste identification, (b) item-based consolidation/packaging, (c) intra-facility waste transfers, (d) waste shipment pickup and receiving, (e) waste disposal, (f) wall-to-wall inventory assessment, and (g) an audit support application (see Fig. 6). The audit support application allows a user to scan any container in inventory and see detailed information about its radiological, hazardous, and location/task history.

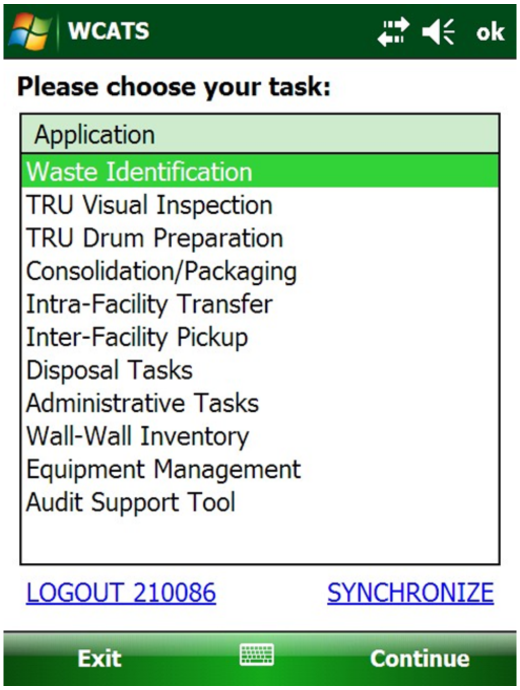

Fig. 6. Mobile application selection

CONCLUSION

The WCATS application provides a framework that's easily extended to support any radioactive waste management facility. Its metadata driven architecture avoids the pitfalls of legacy applications that were customized for a specific operation, and then unable to adapt to new requirements without costly software engineering resources. The end-user defines their facility, unit operations, work flow, and inventory compliance rules using "service units", "work paths", and "task logic". The metadata driven framework extends the application from the desktop to the field worker's mobile computing device.