Automated Solutions for Identification of Abnormalities within Waste Streams - 9229

B. Slater, H. Bruemmer, G. Smylie
Insei Software Engineering Services
2235 E. 25th St., Idaho Falls, ID 83404

ABSTRACT

Management and analysis of data within the waste management world is a vital, yet time consuming activity. In the past, data submitted for waste stream characterization and container certification required human review and approval. While human review can identify data points that fall outside accepted parameters, identification of statistical outliers and anomalies requires a comprehensive comparison against historical data points. A full statistical review of submitted data cannot be adequately performed without technical assistance. This paper will detail the development of the Statistical Tracking Tool (STT) developed for the Waste Isolation Pilot Plant's Waste Data System (WDS) and other automated optimization tools designed to greatly reduce time devoted processing nuclear waste shipments. The tools within the WDS provide technical assistance for analyzing data within waste streams prior to characterization and certification approval and assisting in the building of overpacks and payloads for shipment and disposal. The identification of potentially problematic data sets will prevent erroneous waste shipments avoiding regulatory fines, wasted man hours, and work stoppages. Further analysis will be given to additional techniques and principles that can be applied to a wider range of data adding to the efficacy and value of the Statistical Tracking Tool.

INTRODUCTION

Proper and effective management of data relating to waste has become an increasingly important topic within the nuclear waste industry. The burden placed on individuals to identify, process, and categorize waste data has likewise grown and become a time consuming task. Associated with these tasks is the responsibility to single out and interpret irregularities within data sets. Such activities are designed to comply with federal, state, and local regulations and assist in recognizing potential scenarios that might cause deviation from standard business processes. In essence, it is the responsibility of the data reviewer to detect any potential problem with data sets and resolve the problem before the risk issue comes to full realization. No human process is infallible, especially when dealing with large, complex data sets that are coupled with a multifaceted set of regulations. To ensure that potential data risks are properly handled, automated tools are required that accomplish the work of a human reviewer in a fraction of the time and with guaranteed results.

The intent of this paper is to document tools that have been developed for usage with the Waste Isolation Pilot Plant (WIPP) sponsored Waste Data System (WDS) project. The WDS system will be the primary instrument for the tracking shipments of TRU-waste within the DOE complex. The WDS is the evolved replacement for the WIPP Waste Information System that had been in use since the opening of the WIPP facility. The duties of the WDS include the tracking of characterization, certification, overpack, payload, shipment, and WIPP emplacement data. In the past, the functionality of WWIS was geared towards the

gathering and storage of data. The intention of the WDS is to expand on the base functionality and provide a new fundamental concept of adding intelligent tools to assist in the usage and evaluation of the data stored within the system.

LIST OF ACRONYMS

CH-TRU	Contact Handled Transuranic
OCA	Overpack Creation Assistant
PCA	Payload Creation Assistant
RH- TRU	Remote Handled Transuranic
STT	Statistical Tracking Tool
TCO	Transportation Certification Official
TRAMPAC	Trupact Authorized Methods for Payload Control
WCO	Waste Certification Official
WDS	Waste Data System
WIPP	Waste Isolation Pilot Plant
WWIS	WIPP Waste Information System

NEED FOR AUTOMATION

Manual Processes

The WDS tracks vast amounts of TRU waste shipment data dating back to the initial waste shipments received by the WIPP. In the prior system to the WDS, characterization and certification data required human review and approval. This action was performed in two principal steps. The first step was the data was gathered and submitted by an authorized Waste Certification Officer (WCO) for the shipping facility. It is the duty of the WCO to validate that the data is accurate, complete, and meets all applicable internal and external policies and procedures. In conjunction with these actions, the WCO also performs and initial verification that the waste will meet all required transportation and emplacement requirements as specified by the WIPP facility.

Once the data has been approved by the WCO, it is formally submitted to a WIPP Data Administrator for approval. The primary goal of the Data administrator is to review the individual payload waste container submissions, validate the compliance of the records, and approve the payload waste container for shipment to WIPP.

An individual payload waste container record can potentially contain thousands of data points, many of which are highly critical to the shipment approval process. Data points relating to transportation requirements are of particular importance, as they are used in a series of calculations to determine flammability rates and subsequent limits. Within the provided data, many dependencies occur that will determine the specific conditions under which payload waste container can be successfully and safely shipped. To authorize shipment, a complex set of calculations must be applied to determine the flammability potential for any given waste container during transit as determined by the TRAMPAC regulations.

Potential for Error

As with any business process, the potential for human error is ever present. Due to the number of data submissions and the volume that must be reviewed by hand, the likelihood is high that errors in data submittal and subsequent validation will occur. While computer assisted data entry and submittal can greatly reduce the potential for risk, it does not entirely remove the risk from occurring. Unless the system is performing validations on the data itself, taking into consideration the manner in which the data will be used, the efforts for automated validation will be insufficient. Simple validations can catch data entry errors, but another level of sophistication is needed to evaluate corollaries within the data that when combined can produced irregularities or be of concern when combined with other waste which is being processed.

Automation Efficiencies

As previously stated, the sheer volume of data that is made available to users through data systems can be nearly insurmountable. A single user lacks the ability and time necessary to analyze a complete set of historical data. Comparisons can be made to hundreds or thousands of similar waste containers to identify anomalies, but practicality prevents the human user from performing such actions. As in the case of the Data Administrator for the WDS, a single waste stream can contain thousands of payload waste containers, each with its own extensive data set. Such activities are best left to automated tools that can examine thousands of records and perform calculations within seconds. While the naked eyes cannot easily discern between subtle fluctuations in data points, automated tools can almost instantly perform an analysis of a wide range of data, delivering exact and comprehensive results.

STATISTICAL TRACKING TOOL

The designers and administrators of the WDS recognized the fact that the WDS repository contained a wealth of historical information that could put to practical use when evaluating newly submitted data to the WDS. The WDS contains detailed information regarding individual waste drums dating back to shipments that first came to WIPP in March of 1999. By the end of 2008, the WDS tracked data relating to nearly 200,000 waste drums. With each drum record, relations exists to waste stream profiles, gas sample results, TRAMPAC evaluations, and other critical data fields.

To take advantage of this vast data set, the designers of the WDS planned and built the Statistical Tracking Tool (STT). The STT began as means to properly catalogue and display historical data relating to particular payload waste containers. The initial idea was to allow the data reviewer to easily access all pertinent data relating to the waste drum that would assist in determining compliance with regulations. While the WDS designers did provide quick and efficient access to the information relating to payload waste containers, initially it did not take into consideration the greater population of containers of which the container was a part.

To make full usage of the data available to the STT it was determined that a single waste container would be viewed in comparison to similar containers to identify any potential deviations from the general population. The first step in properly segregating the data populations was to decide upon how the data would be grouped and if the granularity in the group distribution was an effective means of defining relationships. Potential grouping candidate considerations included a combination of drum types,

TRUCON codes, Shipping Categories, and generating sources. The final decision was made to use the Waste Stream Profile as the determining factor for examining historical data sets. The Waste Stream Profile provides both the granularity and the breadth of data required to perform statistical comparisons of waste drums. In addition, waste within in a waste stream is in a uniform enough distribution that analysis and comparison can be made between a single payload waste container and the general population.

Data Tracking Points

The first iteration of the STT limits the data within the waste stream that is to be catalogued and reviewed by Data Administrators. Data points that have been relevant to risk events in the past were chosen as the first set of points to be tracked by the system. As result the following data points are being tracked by the STT:

- Decay Heat
- Hydrogen Samples
- Methane Samples
- Gross Weight
- Total Dose Rate
- Total Flammable VOCs
- Flammable Gas Generation Rate

For each data point the min, max, mean are calculated a recorded in the WDS database.

When a waste payload container is submitted for approval by a Data Administrator, the Data Administrator has the option to visually inspect the above data points in comparison to the rest of the waste stream. An example graphic from the WDS demonstrating this capability is show below in Figure 1.

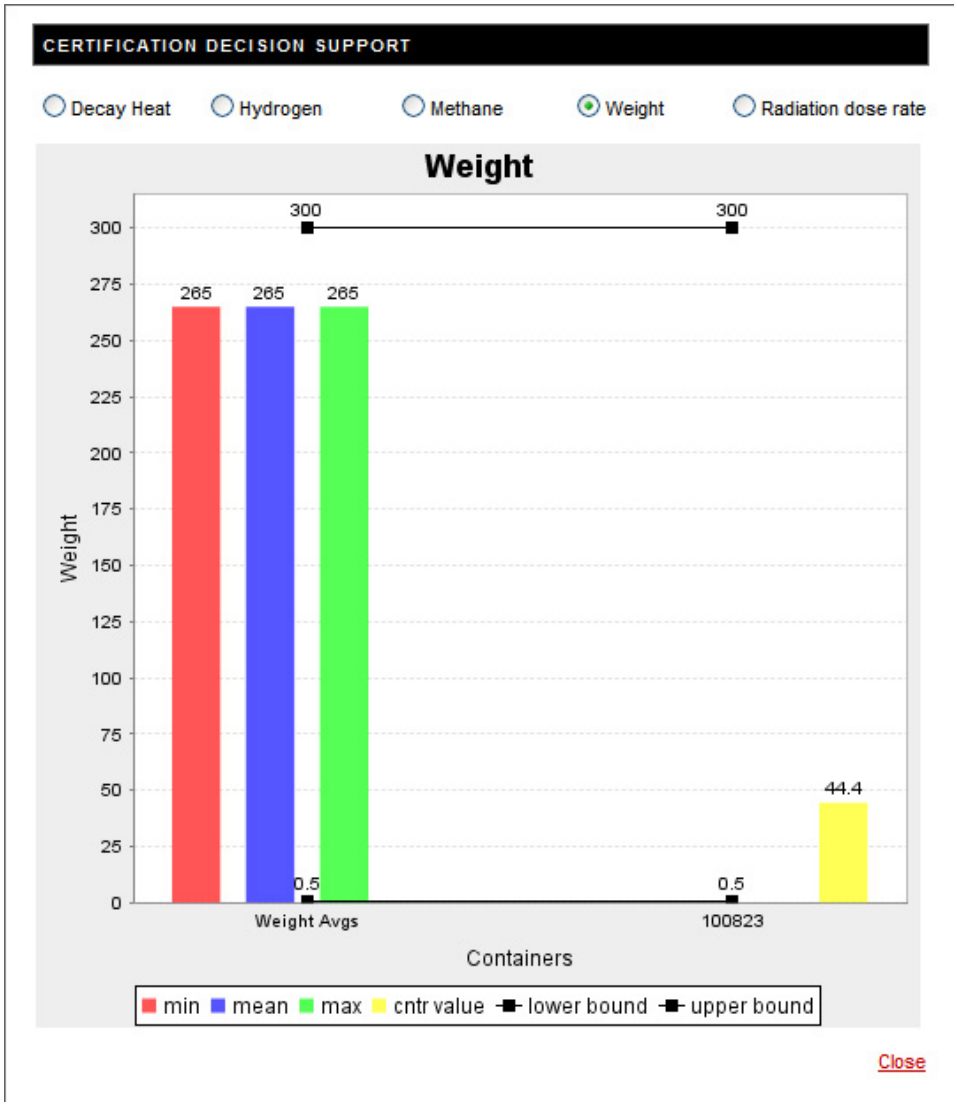

Fig. 1 – Weight Comparison Graph for Waste Stream in relation to payload waste container 100823.

Another feature of the STT is the ability to set boundary limitations for notification of a statistical anomaly. The Data Administrator has the ability to set notification boundary values for when a data point falls outside the specified boundary range, the system automatically provides a notification to the Data Administrator. The Figure 1 graphic demonstrates the displaying of the boundary limits in conjunction with the other data points relative to the payload waste container.

The visual displaying of data across the entire waste stream can alert the Data Administrator to data points that meet boundary conditions but differ greatly from the population. While the posted value might be within boundary conditions, the calculated difference from the normal population could alert the Data Administrator of a potential data entry problem. In a hypothetical situation, a waste drum weight of standard waste box could be submitted of 10 kgs. While this value falls well below the set upper limits for weight control, the small weight value in comparison to the rest of the waste stream would indicate that the weight value was not properly recorded or that the data set for the waste container is incomplete.

In this case, further investigation into the correctness and completeness of the reported waste container would be warranted.

Table 1 details the initial boundary values that are being utilized by the system. Any change to the system is tracked as records can be modified and expired. For each modification, a reason must be specified to provide historical traceability for changes to the system.

Table I. Initial Boundary Notification Values

Data Element	Lower Bound	Upper Bound	Expiration	Reason
Decay Heat	.001	1.5	N/A	N/A
Hydrogen	0.5	9000	N/A	N/A
Gross Weight	0.5	300	N/A	N/A
Total Dose Rate	0.5	90	N/A	N/A
Flammable Gas Generation Rate	1E-16	0.025	N/A	N/A
Total Flammable VOCs	0.5	10000	N/A	N/A
Methane	0.5	600	N/A	N/A

At set intervals, the STT, as a part of the WDS, executes a process to scan all data points relating to active waste streams being utilized within the WDS. Currently, the STT updates all data points on active waste streams once every 24 hours. If required, the interval between executions can be modified as deemed necessary. The lower limit of containers required to report statistical data is set at a minimum of 50 containers. If an active waste stream falls below this threshold, the system continues to gather data, but it is not made available to the user.

OVERPACK/PAYLOAD ASSISTANTS

A natural extension to the STT within the WDS is the Overpack and Payload Creation Assistants. A time consuming activity for waste shippers is the manual creation of overpacks and payloads. Creating the proper combination of payload waste containers can be an intensive process as different combinations of waste have a “community” effect on the global properties of the shipments.

A single container with seemingly benign properties can easily cause an entire shipment to fail payload transportation checks. Transportation Certification Officials (TCOs) have the large task of selecting payload waste containers from small to large populations that can properly co-exist within a payload shipment vessel. Until all payload waste containers have been designated for inclusion in a single payload, the checks cannot be properly enacted for shipment approval.

The role of the Overpack and Payload Assistants is to efficiently automate this entire process. A population of candidate containers can be submitted to the Assistants for consideration in creation of an overpack or payload. The Assistants are then able to access the historical statistical data to pre-group payload waste containers that are very likely to successfully pass ensuing TRAMPAC evaluations.

The Assistants are able to build potential overpack and payload plans in a matter of seconds that would take days for a TCO assembly by hand. The TCO is then able to focus on the submission and approval process. Within the WDS, the Assistants also provide additional tools that allow the TCOs to specify options the automated creation of overpack and payloads. TCOs can manually select specific containers or payloads to for forcibly included or exclude from potential configurations. These options give TCOs the flexibility to deal with difficult to manage waste drums. Included is the ability to manage the number of potentially dunnage containers to include in an overpack and payload.

FUTURE CONSIDERATIONS

The WDS is only tapping into the potential for profiling containers and waste streams. Currently the system is only providing notifications to Data Administrators to assist in the manual decision process of approving data. As stated previously, such a process still presents risk for error and can be highly inefficient as the resources required to review individual payload waste containers can be exhaustive and time consuming.

Future iterations of the STT will improve upon the capability of the software to not only provide decision support, but the ability to provide decision recommendations and eventually take corrective action when risk issues arise. Currently the STT only identifies data points that fall outside set boundary conditions. Subsequent versions of the STT will provide a finer statistical approach to decision support. Data points will be examined against population and judged against set deviations within the distribution of values. Items that fall outside the set standard deviation points will be flagged and controlled for action.

Not only does the WDS contain historical data regarding the properties of payload waste containers, but the WDS contains information that details the conditions under which the same payload waste containers were placed in aggregate payloads and subsequent shipments to the WIPP facility. Using the same data, the STT would have the ability to recognize and flag payload waste containers that exhibit characteristics of waste containers that have historically been difficult to ship under regulatory requirements.

Using the historical data, the STT will be able to build payloads and shipments that have the ability to include traditionally difficult to ship waste and ease the burden on repackaging scenarios or excessive dunnage container usage in payloads.

A secondary function is the complete automation of waste shipment approval process. With necessary guidelines and restrictions encoded into the system, the STT will have the ability to automatically process and approve waste shipments without human interaction. Instead of waiting for responses dependent upon a business schedules, waste shippers could get instantaneous feedback and approval on proposed waste shipments. Data Administrator resources could then be focused on more meaningful tasks that require human intervention and considerations.

CONCLUSION

In the future the waste management industry will face many challenges in efficiently and correctly shipping waste. The proper usage of automated tools will enhance the ability to recognize potential risk

events and automate the handling of events. The automated tools will lead to increased compliance, cost savings, and the ability to meet project schedules.