D&D WASTE TRACKING AT THE ROCKY FLATS SITE

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ABSTRACT

The Rocky Flats Site (RFETS) is in the midst of an multi-year decommissioning project (1995-2006) to dismantle and demolish four major plutonium facilities, four major uranium facilities, and over 400 additional facilities of different types. The project is currently generating large quantities of transuranic, low-level, mixed, hazardous, and sanitary wastes at varying rates from each facility. The paper describes a waste tracking system which has been implemented at the Site, why waste tracking is essential to the success of the project, how project management tools have been applied to waste tracking and how these tools can improve the management of the project. Lessons learned from setting up the tracking system are also presented.

As the Site completed the decommissioning of its first plutonium facility, it was apparent that standard waste tracking methods were inadequate and misleading. Tracking of just the original estimated waste and actual waste generation variables over time did not adequately present what was occurring during decommissioning. An approach was needed to compare actual waste generation to the waste estimate on an on-going basis, allow prediction of future waste generation, separate productivity and schedule impacts on generation rates, and provide information to management in a format to support site decisions.

The approach to track project decommissioning waste generation draws heavily on methods used for project cost control. The keys to its implementation include the use of existing data sources, the need for tracking increments smaller than the facility level, application of earned value and resolution of issues that arise as data collected for cost control purposes is applied for waste management, and the project estimate at complete. Once the initial data is assembled, additional analyses to improve projections are also possible.

The actual use of this technique in a major decommissioning project demonstrates that decommissioning waste can be analyzed and tracked similarly to project costs once the different systems are understood, and that such tracking can yield meaningful data to support management decisions. Since waste management and disposal comprises a significant percentage of overall project costs and substantial infrastructure for decommissioning projects, the approaches employed should prove useful to individuals involved in waste management for multi-year projects.

INTRODUCTION AND PROBLEM

Decommissioning at the Rocky Flats site continues as four major plutonium facilities are currently in various stages of dismantlement and several support facilities have been closed awaiting demolition. Successful closure is dependent upon the integration of several interrelated activities, one of which is waste management. Waste management requires understanding the total quantity of waste generated from each project, as well as site wide, to ensure disposition resources are available for disposal of the waste. These resources include cost-competitive disposal sites capable of accepting the total volume of each waste type; waste container contracts competitively bid on the total number of various containers needed, and transportation contractors able to deliver the waste to the disposal facilities.

In addition to understanding the total quantity of waste generated, it is necessary to know the volume of waste generated during Decontamination and Decommissioning (D&D) of the buildings. This is needed to budget for waste shipping, disposal, and container procurement, as well as ensuring adequate on-site storage to balance waste generation and waste shipping rates. Additionally, personnel and equipment scheduling for waste certification, Non-Destructive Assay (NDA) (personnel and counters), on-site transportation and waste paperwork preparation depends entirely on the time-phasing of waste generation.

The baseline waste estimates were prepared using actual waste data from the decommissioning of the first plutonium facility, Building 779, as described previously (1). The waste estimates were generated by waste type – Transuranic (TRU), Transuranic Mixed (TRUM), Low Level (LLW), and Low Level Mixed (LLMW) - and by activity. As the project schedule was set up by activity, the estimated waste volumes were then allocated across the project schedule. Applying actual D&D waste data from Building 779 has been shown to be an effective method of estimating the waste for the other buildings (2). However, it assumes that D&D of other buildings will be performed in the same general manner as Building 779. Therefore, the waste estimate and Baseline waste schedule can not account for improvements made to D&D methods, or building specific areas where more waste will be generated.

Waste tracking in Building 779 was performed by tracking the cumulative actual waste generation against the waste estimate. This makes it possible at any point in time know how much waste has been generated to date, compared to the estimate. The problem with this method is that it does not take into account whether the project is on schedule or if activities have been moved around to accommodate project execution. Specifically in the case of Building 779, the actual transuranic and low level waste generation were tracking extremely well with the waste schedule through the first three-quarters of the project. Unfortunately, the project was behind schedule from a waste standpoint, and areas of the building where poor waste estimates were made had not yet been decommissioned. By the end of the project, the actual waste generation was 60% higher than estimated for the transuranic waste and 180% higher than estimated for the low level waste.

Though the actual waste generated from a project will be what ends up at the shipping dock at the end of the day, not understanding the potential quantity of total waste generated as well as waste generation by quarter results in unnecessary cost impacts. If the waste generation estimates are perfect, then waste management resource planning will require only those funds and personnel to be successful, without diverting funds from other site closure activities. However, the waste generation estimates are just that, "estimates," which are based upon past site performance, and planned schedules. As new D&D methods are developed which decrease the quantity of waste generated, and as projects are delayed or surpass the baseline schedule, the actual waste generated will differ from the baseline estimate. This results in the site having inadequate resources to dispose of waste offsite, or excess resources which could have been used for other site closure activities.

Some of these impacts can be avoided by tracking the D&D waste improvements, problems, and the effect of schedule, which are quantified and used to project future waste generation.

THE PROJECT COST CONTROL MODEL

The waste tracking problems encountered in Building 779 can be directly compared to classical project cost control problems. If the actual cost of the project is tracked against only the estimated cost over time, it is difficult to separate increases in cost from accelerated schedule, or lower costs from delayed schedule. For example, it may appear that the cost of a project is proceeding as expected and the project will complete on budget and on-time. This may be a true assessment, however it is possible that activities within the project are behind schedule and the cost is higher than expected. Another example may show the actual cost lower than the estimated cost indicating that the project will complete under budget. In this case it is very possible that the project is drastically behind schedule and the cost is actually overruning.

In order to correctly communicate project performance, *Earned Value Analysis* has been developed to integrate scope, cost and schedule. The three key elements of Earned Value analysis are:

1. The Budgeted Cost of the Work Scheduled (BCWS), which is the cost estimate spread over the project schedule, the budget.
2. The Actual Cost of the Work Performed (ACWP), which is the dollars spent to date.
3. The Earned Value, or Budgeted Cost for the Work Performed (BCWP), is a percentage of the total budget equal to the percentage of work actually completed to date. Another way of saying this is the estimated cost for the work actually done.

These three measures can be compared to show whether or not the work is being completed as planned (3). For instance, if the actual cost, ACWP, is under budget, BCWS, is may be thought that the project is underrunning on costs. However, if the earned value, or BCWP, is lower than the actual costs, then the project is not only overrunning on cost but is behind schedule. Once the earned value analysis is complete a variance analysis can also be performed, to isolate the nonconforming areas in order to fix or accentuate the result.

At this point, you might be asking yourself, "Thanks for the refresher in cost control, but my life is waste, and what can this do for me?" Since the classical problems observed in both cost and waste control are similar, then the classical approach to cost control could be adapted to waste tracking. The waste tracking model would have three similar key elements:

1. The Estimated Waste for the Work Scheduled (EWWS), which is the waste estimate spread over the project schedule.
2. The Actual Waste generated for the Work Performed (AWWP), which is the waste generated to date.
3. The Earned Value, or Estimated Waste generated for the Work Performed (EWWP), is a percentage of the total waste estimate expected to be generated from the work actually completed to date. Another way of saying this is the estimated waste generation for the work actually done.

Since the waste tracking model is adapted from the existing cost earned value analysis it should be straightforward to apply. However, since it is waste and not cost, and is being applied to a D&D project, several factors had to be considered for its application.

APPLICATION OF THE MODEL

Successful application of the D&D waste tracking model demands the primary focus remain the D&D of the facility and not waste tracking. Keeping this in mind makes it easier to understand why a D&D foreman doesn't return your voice mail message:

> *"Hey Ed, I need several of your D&D workers to start keeping track of how much waste you're generating and for them to figure out what percent of the waste they've generated so we can figure out how much you would've generated based on the estimate. We need to do this as soon as possible so we will know if your project is generating too much waste."*

Based on the thoughts running through the typical foreman or project manager's mind, the model needs to be built on the following elements:

- Obtain project buy-in – So the project doesn't feel this is just another way for upper management to steal resources, saddle them with another useless requirement, and pummel them for being behind schedule, or making too much waste.

- Use existing resources – Instead of requesting additional data from the project, use existing sources of actual waste generation, project earned value and the estimated waste quantities.

- Collect data at the appropriate level – Requesting only the data that will be used. Otherwise the project will see it as no value added and credibility with the project will be lost.

Obtain Project Buy-In

For the project to buy-in to waste tracking, it is only necessary for the project manager and foremen to understand what they will get back. One of the goals of waste tracking is to give the project manager the ability to manage his waste generation similar to the way he can manage his costs and schedule. To manage the waste, the project manager and foremen need good projections of how much waste the project will generate, to make sure they have enough containers and waste support personnel, and that the waste gets moved quickly off the dock. More important, the waste management and disposal cost is a significant budget drain that must be managed, if not by the project, then for the overall site. We have found a key part of this control at Rocky Flats is a dynamic waste projection through site closure shown on a quarterly basis. This projection takes into account waste management improvements and schedule variations.

To give the project manager this level of control requires development of the following tools and data:

- Waste earned value analysis for the overall project
- Actual-to-estimate comparisons for discrete project increments
- Container packing weight trends
- Container use trends
- Low level versus Low level mixed volume ratio
- Container Projections

Use Existing Resources

Rocky Flats has several systems and databases in place from which the project D&D data can be obtained, and the system was structured around using them.

Waste and Environmental Management System (WEMS)

WEMS is the site database for RCRA compliance and waste management. WEMS is a mature program which provides a great deal of information about each waste container, including the actual waste generation data by container, including waste type, IDC, container type, container volume and container net weight and fill date. Based on the fill date, the waste generated by waste type by quarter can be calculated yielding the AWWP.

Baseline Estimating Software Tool (BEST)

BEST is the site database for the estimate. The Baseline waste estimate data is available as part of the estimate and is in the RFETS BEST system for each project by work activity from the third quarter fiscal year 2000 to project completion. This provides the data for the EWWS. The work activities are then grouped as larger activities called Sets. A Set is simply a grouping of adjacent or logically connected gloveboxes, tanks, contaminated areas, or other decommissioning scope that will be managed as a major project activity.

Earned Value by Quarter

The earned value is the percent of the work complete for each project Set for each quarter. Each project reports the earned value on a monthly basis to the Project Management Reporting System (PMRS) where it is compared against the estimate to generate cost and schedule variances for the project. The earned value data from PMRS can be applied to waste as long as the execution phase (where waste would be generated) is separated from the planning phase (where no waste is generated). The earned value is multiplied by the EWWS to obtain the EWWP.

Property Database

The property database tracks the removal and disposition of all major pieces of equipment at RFETS. The database provides the property number and description and the container or where the property has been placed. This is can be used to track major pieces of equipment like gloveboxes and tanks, and provide refinements to the waste tracking.

Project Working Schedule

The project working schedule describes the most current plan for executing the work. While the earned value analysis is tracked against the Baseline Waste estimate, EWWS, project execution will follow the project's working schedule. In order to develop the best projection possible, the working schedule will be used with the estimated waste remaining for each activity to develop the projection.

Collect Data at the Appropriate Level

In any analysis, the temptation is to collect as much data as possible and then determine what is really useful. Unfortunately, requesting a detailed level of information will brand you as both unsympathetic to the goals of the project as well as an ivory tower data weenie.

Fortunately, Sets at RFETS are typically structured around the D&D of similar equipment types, so that actual Set data can be combined with the waste estimate to obtain data at a lower level. Therefore, monitoring waste at lower than the Set level would not yield significantly better data, while requiring additional personnel to monitor and track each piece of equipment as it was removed and package. Therefore, the lowest practical level for waste tracking is by the Set, which can be tracked with existing resources.

Alternatively, the project may request the tracking to be done at a higher level, like the overall building or total project. As the D&D of a building can take several years, this makes the validity of the waste tracking entirely dependent upon the earned value. Waste tracking at the Set level separates the completed Sets, where the total waste generation is now an actual, from the Sets in-progress, where the total waste is a function of the earned value. Waste tracking by Set also provides data to the project manager on how well actual waste generation is tracking by Set is to the estimate, and yields indicators at a low enough level to identify potential problems for the project manager to take corrective action as early as possible.

In summary, the goal in applying the waste tracking model is to provide each project with waste data which can significantly effect the success of the project. And by obtaining project buy-in you will get a return call to your voicemail message:

> *"Hey Ed, I've finished the latest waste tracking for your project and would like to review it with you before it goes final. Based on the actual waste data from WEMS, the baseline schedule from BEST and the earned value data from PMRS, you are generating right on estimate but are behind schedule. Based on the working schedule you'll still be generating at a slower rate than the baseline so you may want to divert some waste disposal budget to execution, and reduce your container requirements."*

MECHANICS OF THE TRACKING SYSTEM

Having identified clear goals for the waste tracking system and access to adequate existing data sources, the mechanics of assembling the system began. While the choice of software provides the brain for the system, generation of the actual waste over time, estimated waste for the work performed and projection data is the heart of the earned value analysis and the backbone to all other additional analysis.

Software Selection

In general, converting the raw container and estimate data into the format necessary for an earned value analysis is straightforward. However, it is a significant data handling exercise. Though much of the data is available in Excel spreadsheets, the multiple data sources as well as the need for extensive data sorting on a quarterly basis, makes a relational database such as Microsoft (MS) Access ideally suited for waste tracking. MS Access makes it possible to relate the various data sources together and establish predefined queries. Thus, on quarterly basis the new data is pasted into an Access table, and the needed queries and reports and generated at the push of a button. Finally, as MS Access has limited graphing capabilities, the results are copied to an Excel spreadsheet and the graphs generated.

Development of the Actual Waste Generation Curve – AWWP

Comparison of the actual data by Set to the estimate by Set requires additional data not typically available in WEMS. Within WEMS, each container has a discrete number and is identified by waste type, Item Description Code (IDC), container type, container volume and net weight. For some containers the Set (or Sets in many cases) from which the waste was generated is identified on the waste traveler. In order to attach all of the containers to specific Sets, the waste travelers for crates, halfcrates, standard wasteboxes and cargo containers were reviewed, and a separate table attaching container numbers to Set numbers was generated.

To account for those containers having waste from multiple Sets, the number of Sets in each box was determined and the volume and weight of that box was divided equally between those Sets. Within Access this was done in multiple steps, to determine the number of Sets per container. Finally, for each container, the container volume (or net weight) was divided by the number of Sets contained, and the volumes were totaled across the Set for each waste type. An additional sort criteria collects the volume totals by quarter.

Development of Earned Value Curve - EWWP

The earned value curve is generated by multiplying the project percent complete for each Set (execution phase only) by the estimated waste for each Set, and then summing the total quantity of waste "earned." This assumes that the percent complete for each Set is equal to the percent of waste generated per Set, or simply stated, "when the Set is 50% complete, 50% of the waste is generated."

One method to correct this would be to send personnel into the building on a quarterly basis to visually determine what percent of the waste had been generated based on how much equipment had been removed compared to what was left. Due to the time consuming nature and inherent inaccuracies of this method, an analysis was performed on several completed Sets where the actual waste percent complete could be calculated and compared to the Set earned value for the same time frame. This clearly indicated that waste generation lags the Set execution. To account for this, a correction factor has been applied to ensure the EWWP accurately reflects the waste earned value.

Development of the Projection Line

The Projection line is can be one of the most useful tools resulting from the entire waste tracking analysis. The projection line can indicate to the project manager and waste management group how much waste will be generated in subsequent quarters, giving them accurate planning data. When the projection line is extended to the completion of the project it provides the Estimate At Complete (EAC). Generating an EAC in this way can avoid the rebaselining observed in many projects.

The projection line in its simplest form, takes all the Sets which have not been started and spreads them across the schedule. For all of the Sets in progress, the actual waste generated to date is combined with the percent complete to calculate the waste remaining by Set. The waste to be generated by Set by quarter is summed to obtain the projected waste generation by quarter.

Because of the importance of the projection additional elements have been added. Instead of allocating the waste remaining based on the Baseline schedule, it is spread by quarter based on the most current working schedule. This enables the projection to represent the actual work to be performed, and the resulting waste generation as closely as possible. Also, trends are followed to quantify improvements in waste packing, and packing factors are applied at the Set level to modify the estimated quantity of waste remaining. Similarly, as the projects are implementing decontamination methods, converting gloveboxes from transuranic waste to low level waste, factors are also being developed to downgrade remaining Set glovebox waste from transuranic to low level.

Additional Analyses

The generation of a good projection for waste generation can be combined with trend analysis to yield additional management data. For instance, trends in the percent of low level waste which is also hazardous can be combined with the overall low level waste projection to estimate how much low level mixed waste may be expected over subsequent quarters. Similarly, trends in container use for different waste types can be combined with the waste projection to estimate the number of containers which will be generated in subsequent quarters.

RESULTS

The analysis of the data results first in the generation of the earned value analysis, providing project status from a waste standpoint. The earned value analysis is dependent upon the waste earned value which is compared to the project, or cost, earned value. Additional analyses may include the packing efficiency, the relative quantity of low level mixed waste, and container usage. These additional analyses can then be used to project what containers will be needed and generated by the building.

Earned Value Analysis

The primary waste tracking curves generated from the data are the earned value analysis curves shown in Figure 1 for the Rocky Flats Building 771 TRU and LLW. The TRU Waste Tracking graph (Figure 1(a)) shows that for the quarter beginning July of 2001 the Earned value (EWWP - 759 m^3) is slightly higher than the Actual waste generation (AWWP - 709 m^3) and both are significantly lower than the Estimate Waste (EWWS - 944 m^3). This continues an ongoing trend observed since the estimate was rebaselined in May 2000. Therefore, the TRU waste schedule variance is the difference between the EWWS and EWWP or 185 m^3. Expressed in time, the project is approximately 1-½ quarters behind from a waste generation perspective. Comparing the EWWS and EWWP curves for the last 3 quarters indicates the schedule variance is remaining consistently at approximately 1-½ quarters behind.

The TRU waste estimate variance (analogous to the cost variance) is the difference between the AWWP and the EWWP or –50 m^3. This indicates that the project is currently generating less waste than estimated. Comparing the AWWP to the EWWP for the last 3 quarters indicates that the actual waste generation had been exceeding the estimate until this most recent quarter. The difference is certainly within statistical error the method, but could also indicate waste improvements recently implemented.

The Projected TRU waste curve has a much steeper slope than the previous quarters' AWWP curve. This confirms that the project working schedule is aimed at placing the project back on schedule within the next two quarters. While this may be aggressive, the slope of the projected line is similar to the slope of the earned value line for the last quarter.

The Low Level Waste Tracking graph (Figure 1(b)) shows that for the quarter beginning July of 2001, the Earned value (EWWP – 4,681 m^3) is significantly higher than both the Actual waste generation (AWWP – 3,047 m^3) and the Estimate Waste (EWWS – 3,993 m^3). Therefore, the low level schedule variance is the difference between the EWWS and EWWP or -688 m^3. Expressed in time, the project is approximately ½ quarter ahead of schedule from a waste generation perspective. Comparing the EWWS and EWWP curves for the last 3 quarters indicates the previous positive schedule variance (behind schedule) was caught up from being approximately 2 quarters behind.

The low level waste estimate variance is the difference between the AWWP and the EWWP or -1,634 m^3. This indicates that the project is currently generation less waste than estimated. Comparing the AWWP to the EWWP for the last 3 quarters indicates that the actual waste generation had been exceeding or matching the estimate until this most recent quarter. The difference could certainly indicate waste improvements recently implemented.

The Projected low level waste curve has a much steeper slope than the previous quarters' AWWP curve. This also confirms that the project working schedule is aimed at placing the project back on schedule within the next two quarters. While this may be aggressive, the slope of the low level projected line is also similar to the slope of the earned value line for the last quarter.

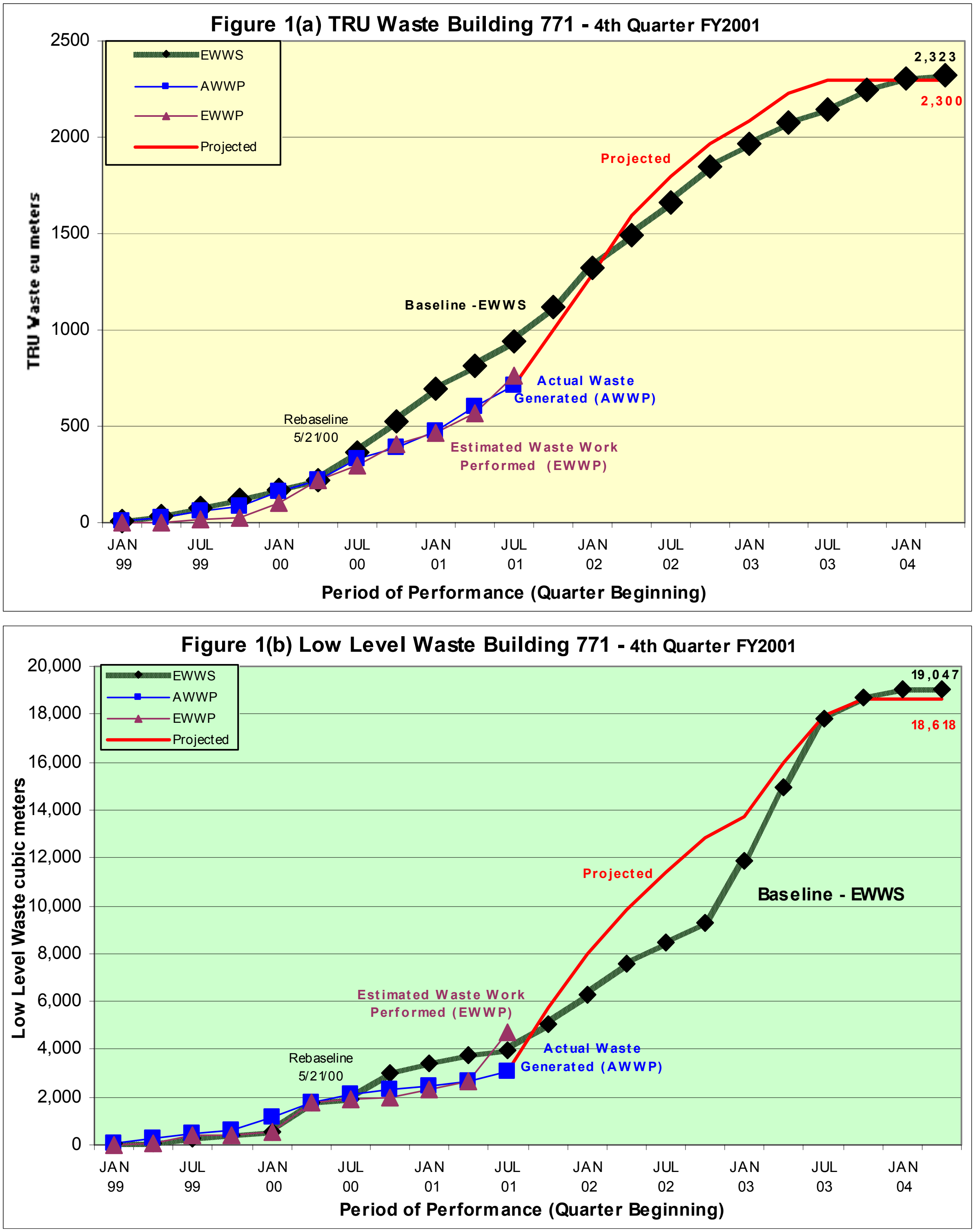

Fig. 1. Building 771 Waste Earned Value Analysis

Waste Earned Value

For completed Sets, both the cost estimate and actual cost data, and the waste estimate and actual waste data are at 100%. For Sets that are incomplete, we were concerned that we were overstating the expected waste (EWWP) by making it the same as the earned value obtained from PMRS. As discussed previously, the determination of earned value is from the project earned value based on D&D task execution. As this is used in the cost analysis, we have termed this as the "Cost Earned Value" as the task execution can be directly related to the cost earned. We were concerned that this "cost earned value" or the portion of the estimated cost that had been accomplished would not be equal to the portion of the estimated waste that had been generated. Put another way, when the work was half done, would half of the waste be generated? In order to develop a relationship between the cost earned value and the percentage of how much waste has been generated, or the "waste earned value," we analyzed data from completed Sets. Once a Set is complete the percentage of waste generated during the execution of that Set can be directly calculated and compared to the cost earned value. This is shown in Figure 2.

For the TRU waste (Figure 2(a)), there is significant data spread as might be expected from unaltered data. However, it is clear that most of the points are less than what an identity function would yield, where the waste earned value equals the cost earned value. The application of a polynomial yields a curve representing what experience would suggest. At the beginning of the task, little or no waste is generated as D&D begins. Once the task is well underway, the slope of the polynomial is near identity indicating the change in the cost earned value is similar to the change in the waste earned value. Finally, when the task is completed, the waste earned value is still 15% from completion, indicating there are still containers which are not yet completed, whether they are not full, awaiting more waste, or not yet closed awaiting final inspection. The time lag for the waste earned value to reach 100% varies from 2 to 4 weeks.

The low level cost earned value versus waste earned value (Figure 2(b)) is more scattered due to the more prevalent use of larger containers. The curve does indicate that the waste earned value is more closely represented by the cost earned value.

The data from this analysis were applied to the EWWP curves in the earned value analysis shown in Figure 1.

Waste Packing Efficiency

A primary assumption of the waste estimate is that the work will be performed in a similar manner as Building 779. One issue with this is how well the waste is being packaged. A straightforward method of drawing a comparison is to track the weight of each container type. This was further sub-divided into "hard waste" – metal and debris, and "soft waste" – paper and plastic, to avoid differences in the relative quantity of hard or soft waste, which have very different weights, from confounding the packaging analysis. The three container types holding the greatest volume of waste are the Standard Waste Box (SWB), the Full Crate or Metal Crate (Crate), and the Sealand container (Cargo). Drums were not tracked as they contain less than 5% of the total volume generated, though the number of drums is significant.

The average container weights from Building 771 are shown in Figure 3 with the maximum and minimum container weight for each quarter. By comparison, the hard waste SWB average weight in Building 779 was 1,262 compared to a current Building 771SWB average weight of 1,328 pounds. This is an increase of 5%. Graphs of the soft waste are similar in design, and not shown.

Container weights are also important to watch from a trend standpoint, as a steadily decreasing container weights can lead to increases in the overall waste generation values. Finally, cubic meters of waste, although it is how the waste is contracted for disposal, is a derived quantity. What really exists and has to be managed is containers.

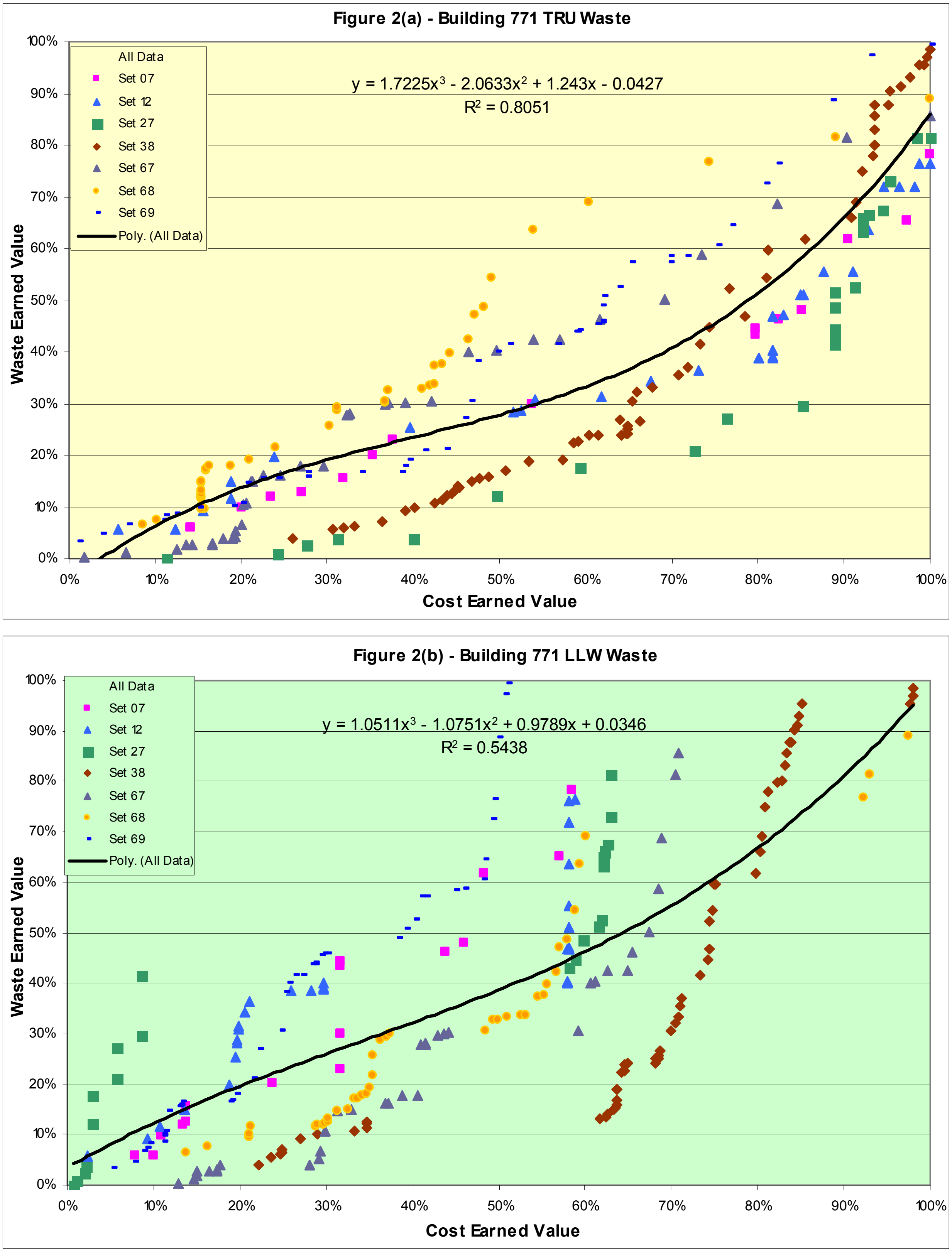

Fig. 2. Building 771 Cost Earned Value versus Waste Earned Value

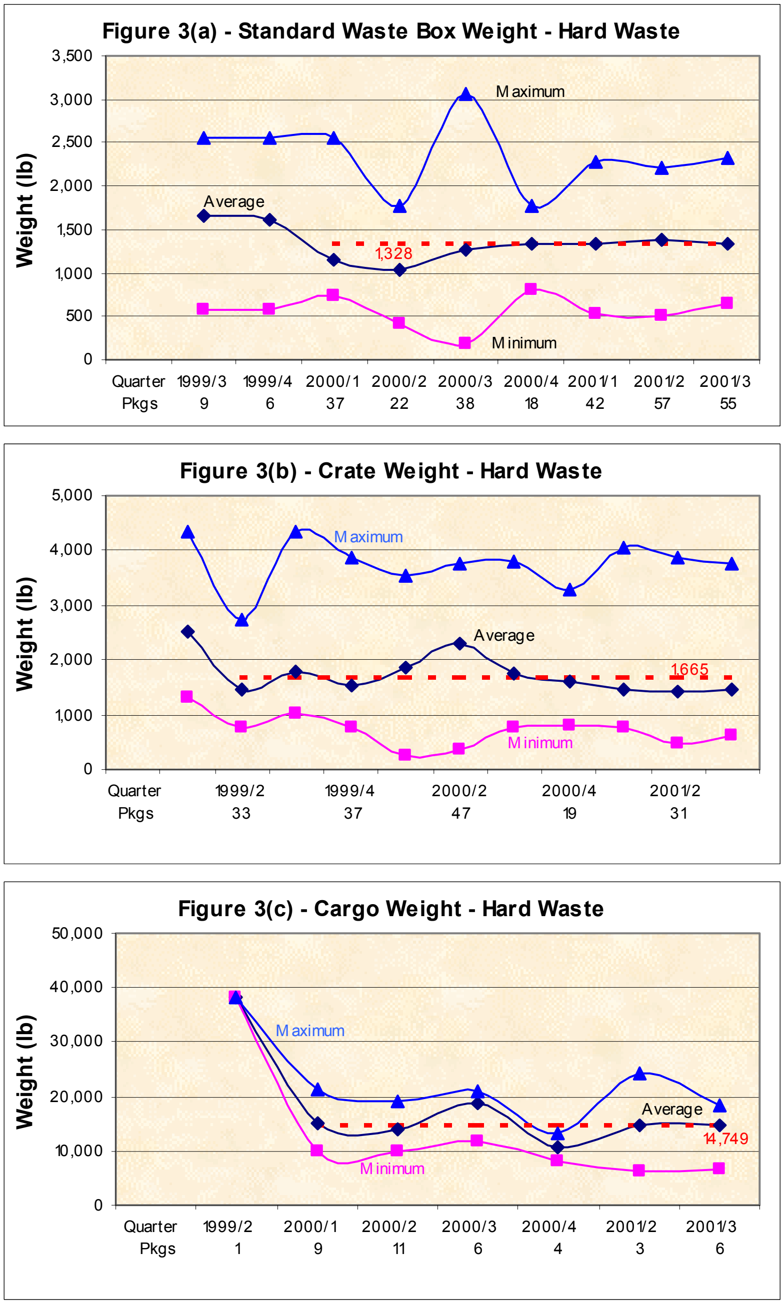

Fig. 3. Container Weights

Container Use

Another useful piece of information is knowing which containers are being used for the various waste types. These are shown in three graphs in Figure 4, on a percentage of the waste volume. For instance, on an average 92.3% of the low level mixed waste by volume, is placed in fullcrates, and 6.3% is placed in drums. These are trends which are relatively consistent over the last 8 quarters. For the low level waste, there is some variation between the use of cargos and fullcrates, specifically in the first quarter of 2001. However, the trend over the last 6 quarters indicates that 58.8% of the low level waste by volume goes into cargos, 36.7% goes into fullcrates, and 2.8% goes into drums. The TRU waste trend over the last 7 quarters indicates 83.4% of the TRU waste by volume goes into SWBs, and 16.6% goes into drums. Though the last two quarters of 2000 show the greatest variation, they are included for another quarter and reevaluated based on 4 quarters of data.

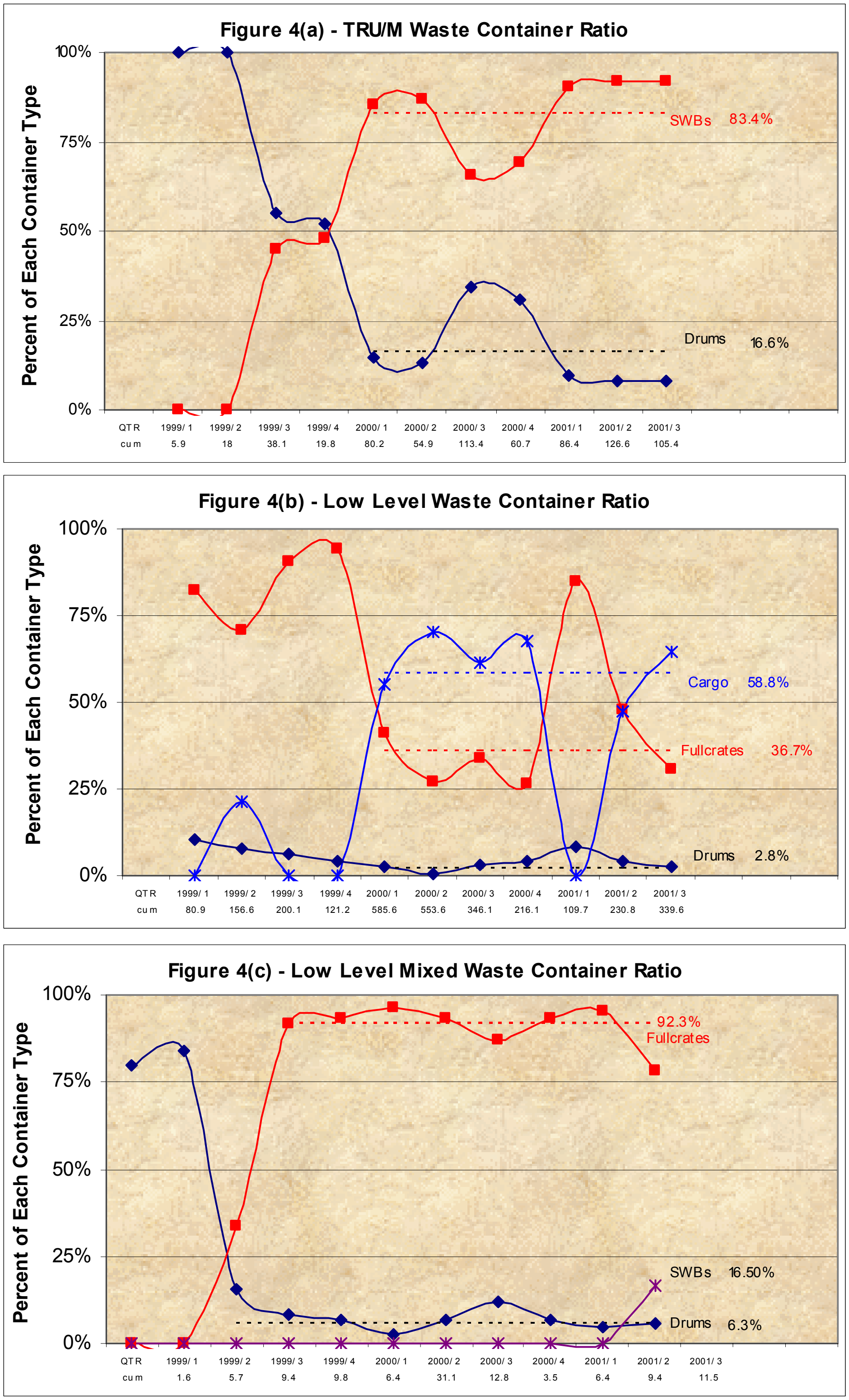

Fig. 4. Building 771 Waste Container Use

Low Level Mixed Waste

The waste estimate and tracking combines the low level and low level mixed waste as the low level mixed waste volume is relatively small compared to the total volume. However, from a tracking standpoint, it would be helpful to know how much low level mixed waste may be generated to plan the necessary resources accordingly. Analyzing the data as above shows relatively good trend for the last 6 quarters of 3.5% of the total low level waste generated is low level mixed waste. Based on this, the total level waste can be assumed to be 3.5% low level mixed waste, until the trend begins to show otherwise.

Container Projections

While it may seem trivial or reaching to establish trends for waste types and container usage, the goal is to be able to take the projected volume from the earned value analysis and apply it to a container projection. This data is very useful to plan the quantity and type of empty containers which will need to be ordered as well as the full containers requiring non-destructive assay, interim storage, and paperwork processing.

Based upon the projections in the earned value analysis, the percentage low level mixed waste of total low level waste, and the average percentage of each container type used, projected containers generated are shown in Table I.

Table I. Building 771 Container Projections

Quarter	TRU/M		LLW				LLM			
	SWBs	Drums	Cargos	Fullcrates	Drums	SWBs	Fullcrates	Drums	SWBs	Cargos
OCT 02	**128**	**231**	**41**	**298**	**341**	**20**	**27**	**28**	**1**	**0**
+/-	**17**	**154**	**17**	**167**	**291**	**30**	**2**	**18**	**3**	**0**
JAN 02	127	229	35	253	289	17	23	24	1	0
APR 02	134	242	29	208	238	14	19	19	1	0
JUL 02	87	157	24	173	197	11	16	16	1	0
OCT 03	74	134	22	161	184	11	15	15	1	0
JAN 03	54	97	14	102	116	7	9	9	0	0
APR 03	64	115	34	246	281	16	22	23	1	0
JUL 03	28	51	31	227	259	15	21	21	1	0
OCT 04	2	3	10	71	81	5	6	7	0	0

Based on the data variations observed a single standard deviation was calculated to represent the possible spread around the projection. This is shown in the third row, labeled "+/-." The variation becomes more pronounced for smaller containers, such as drums.

LESSONS LEARNED

In the course of tracking waste on the Building 779 and Building 771 D&D projects several items became apparent.

- Direct tracking of actual waste generated versus the estimated does not accurately represent the current status of the waste generated. This is primarily due to schedule variance but may also be attributed to efficiencies or additional requirements placed on waste packaging.
- The use of existing resources is essential in data gathering. D&D foreman are focused on the tasks directly related to removing equipment and preparing the structure for demolition. The quantity of waste generated is viewed as a by-product of the work and tracking the generation will divert much needed personnel.
- Project buy-in is essential and can be obtained by showing the information which can be obtained and by minimizing the use of D&D personnel in obtaining the data.
- Minimizing the extension of the projection line early in project will prevent unrealistic waste generation expectations. Early in the project waste generation and waste earned value data may indicate a much lower estimate at complete than the original estimate. It must be remembered that the projection is only a projection

and the elements generating it must be understood in order to use the most reasonable projection or estimate available.

EXTENSION OF THE MODEL

The waste tracking model is currently being applied to the D&D of three plutonium buildings on site. Its application to Building 371 is also underway which will include not only D&D activities but also, material and residue operations. This may require modification of the model in order to accurately represent the activities within the building, but when complete will be provide an overall view of waste generation within the building.

Similarly, the waste tracking model will be applied to the non-plutonium processing facilities and remaining structures. As these facilities had significantly different missions, different equipment and waste metrics and methods of tracking will need to be developed.

Once waste tracking models are completed for Building 371 and the non-plutonium facilities, the individual analysis for these projects will be rolled up into a site wide earned value and container projection analysis. This will provide waste management with the data needed to plan waste movement, personnel, NDA, on-site storage, and disposal activities and budget.

Also, the three plutonium facilities are succeeding in new methods of decontaminating TRU gloveboxes to low level surface contaminated objects. This can significantly decrease the quantity of TRU waste generated while providing only a moderate percent increase in the low level waste generation. Determination of the success of decontamination and generation of factors to be applied to the model is currently underway.

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