THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE HAS DEVELOPED A MEANS TO SAFELY AND ECONOMICALLY ACHIEVE WASTE MINIMIZATION GOALS

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ABSTRACT

Challenges continue in the closing of the Rocky Flats Environmental Technology Site (RFETS). The waste packaging and disposal of oversized-large pieces of contaminated production equipment, concrete structures/vaults, steel tanks, and building debris is an area of waste minimization opportunity. Past practices to size reduce the equipment into pieces small enough to fit into approved, standard waste containers continues to be a safety risk to the D&D worker, as well as a costly and time consuming approach. Size reducing can be very expensive, and exposes workers to high-risk tasks, including significant industrial, chemical, and radiological hazards. RFETS has developed a waste package that meets the definition of a Strong Tight IP-1 package using a Polyurea coating for shipping large contaminated objects. This system has saved the project approximately $1.2M in FY03. These cost and schedule savings are significant.

INTRODUCTION

The Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado is a DOE Closure Site performing decommissioning tasks, demolition of over 400 structural facilities, and site restoration. All facilities will be removed at the completion of this project with the site being restored to a natural environmental state. To date, approximately 120 structures have been removed. The facilities range in size from staff and administration buildings to large Plutonium (Pu), Uranium (U), and Beryllium (Be) processing and or manufacturing and recovery facilities. These facilities contain several large, contaminated production pieces of equipment that need to be packaged and shipped to disposal sites. Kaiser-Hill L.L.C. is contracted with the safe removal and minimization goals for the packaging and shipment of all waste items.

Waste packaging of oversized tanks, vaults – both concrete and steel, and equipment presents enormous challenges with respect to safety, cost and scheduling. No standard method for size reduction of contaminated equipment exists. Each item of concern has required an engineered approach, which increases cost, extends schedules, and exposes workers to safety risks. Over-sized objects are not amenable to standard size cargo containers. A packaging system customized for any sized object is safer and more cost effective. One piece of equipment removed from building 865 weighed 360 thousand pounds and was packaged as a single item. Two others pieces of equipment whose total weight exceeded 420 thousand pounds were also packaged as single waste items. A sprayable polyurea coating for use as a strong-tight package for both SCO I and SCO II waste has been developed.

Safety and health hazards associated with these tasks has been greatly minimized. The Department of Transportation (DOT) and the Nevada Test Site (NTS) has approved the use of this Polyurea Plastic Packaging system and to date 14 items have been delivered for burial at NTS.

The packaging process starts with a structural base of the footprint of the object to be packaged. The base has a border, which is coated to a minimum thickness of 250 mils. The waste object is then set into the prepared base and secured. The item is then shrink-wrapped and the shrink-wrap is stapled to the base. The plastic wrap is then heated with a heat gun to produce a tight form fitting composite package.

Adhesive metal depth gauge buttons are placed onto the plastic surface at specified positions to be used as thickness gauge buttons. The constant measuring of the sprayed material is to ensure proper thickness of the material and for quality control. A "Strong Tight Package Vent Assembly" is installed and secured with special shrink-wrap tape. The polyurea material is then sprayed uniformly onto the package. The thickness of the coating can be measured at any time by pressing a calibrated Elcometer Electronic Thickness Gauge to the metal depth gauge buttons. Quality control of the total process is controlled through use of the Integrated Work Control Process (IWCP) and waste inspection criteria.

This paper will review the progress RFETS has made in waste packaging, increasing worker safety, and the impact this new packaging system has made in meeting and exceeding the waste minimization goals. The use of a customized system is needed to safely dispose of non-routine waste items that several sites are encountering during Decommissioning activities. The use of Polyurea materials and Shrink-wrap as a strong tight package eliminates size reduction tasks, supports waste minimization goals, and decommissioning schedules are being accelerated at RFETS. This approach can be utilized throughout the industry, and the improvements to cost, schedule, safety, and reducing contamination risks to personnel associated with size reduction will also be presented.

BACKGROUND

The waste is generated in many forms and varying sizes. All facilities and supporting infrastructure will be removed at completion of this project and the site premises will be restored to a natural environmental site. The facilities range in size from staff and administration buildings, to very large Plutonium (Pu), Uranium (U), and/or Beryllium (Be) processing, machining/fabrication and recovery facilities. The Pu and Be buildings contain several hundred large contaminated pieces of production equipment. The site is also responsible for the disposition of thousands of cubic feet of contaminated concrete and asphalt. The six major projects at RFETS are tasked with the safe removal and waste packaging for shipment of contaminated items generated during decommissioning activities.

The size reduction and waste packaging of equipment, concrete, and asphalt presents enormous challenges with respect to safety, cost and scheduling. No standard method for size reduction of contaminated items exists. Each item requires a uniquely engineered approach, which increases cost, extends schedules, and exposes workers to safety risks. Oversized objects are not amenable to standard size shipping containers. The manufacture and procurement of a specially constructed container for each oversized object is time-consuming and expensive. After several months of size reduction of a large piece of equipment, the technical leads for the Building 883 project investigated the potential use of a sprayable Polyurea coating for use as a strong-tight package.

Two oversized Be and Radiological contaminated production furnaces were selected as a pilot project utilizing this approach.

Fig. 1 Oversized be and radiological contaminated production furnace

The demonstration using Polyurea Plastic as a Strong Tight Package was successful. The aggressive size reduction efforts were eliminated for these two furnaces. Safety and health hazards associated with these tasks were minimized. Technical reviews of this method of packaging have resulted in the Department of Transportation (DOT) and the Nevada Test Site (NTS) approving the use of Polyurea Plastic for packaging of low level waste (LLW) being shipped to the NTS. There have been several successful shipments to the NTS of this type of packages.

The use of heat shrink used to ship large industrial equipment was considered, but was lacking in structural integrity required for over the road shipment of contaminated waste. Polyurea Plastic has properties lacking in the heat shrink. If the two methods were used jointly, the results would offer a 100% continuous covering that is extremely strong, virtually puncture and tear resistant, and lightweight. The outer, quickly curing sprayed Polyurea coating has provided the structural integrity needed, while the initial plastic wrap has functioned as a continuous surface to accept the sprayable InstaCote™ SE Polyurea coating.

THE CHALLENGE

Normally, large Surface Contaminated Objects (SCO) and waste must be packaged into some kind of custom metal box or wood crate, or size reduced to fit into a cargo container or standard waste container. Size reduction has required considerable manpower, is a high risk D&D activity to the worker, and an extended schedule to accomplish. Size reduction does not support the concept of As Low As Reasonably Achievable exposure to radioactive contamination (ALARA) if other methods are available to reduce or eliminate this exposure.

The safe and efficient size reduction and waste packaging of large pieces of production equipment from plutonium and beryllium processing facilities at Rocky Flats is the challenge. A challenge to the safety of our workers and a challenge to reduce cost and improve on the schedule. Size reduction and packaging of large pieces of equipment and concrete structures has taken several months to complete at significant costs and with high safety risks. There is no standard method of size reduction of contaminated items. Existing practices require unique engineering approaches that increase costs and extend the schedule. The construction of special containers in the past has proven to be an expensive solution. A totally enclosed unique container fabricated on site is preferable because this approach minimizes size reduction tasks.

Size reduction creates additional soft waste. Cutting and or sawing methods require an air-controlled enclosure with HEPA filtration. Tents or a Permacon type structure are required to control the airborne contaminants arising from these cutting activities, and cutting is a high-risk activity and should be avoided where possible.

Meeting waste minimization goals for the site has become more difficult due to the number of large items and the volumes needed to place oversized waste. Reducing the number of packages shipped eliminates the additional administrative costs for waste certification, waste accounting, waste tracking and travelers and the number of over the road shipments. Plus the other admin costs not mentioned.

For example, compare 1 trip for an item that weighs 240 thousand pounds and is around 8 feet by 8 feet by 20 feet, (1280 CF), to size reducing this item to be placed into cargo c0ntainers. Each cargo can handle 40 thousand pounds, but practically only about 30-35 thousand pounds get loaded into each cargo due to space. The project now has the administrative costs to manage 7-9 additional cargo units, (10,240CF) schedule 7-9 additional trips to the depository site, plus the burial costs of 10,240 CF.

Extensive resources, manpower, and time are required to comply with the free release survey process for radiological and beryllium contaminated equipment and debris. Decontamination of the equipment is not a viable option due to the numerous inaccessible areas contained in the manufacturing and processing equipment, which cannot be totally decontaminated. Attempting to spray encapsulate on the machine surface directly has not been effective due to these inaccessible areas. Wrapping the machine surface in plastic sheeting would require all seams to be taped. Tape adheres poorly to most plastic sheeting and protection obtained with the sheeting is limited to the strength of the thin plastic sheeting.

Another challenge was to generate a waste package to comply with all waste regulatory requirements to support the Waste Acceptance Criteria (WAC) at the NTS, and the DOT in transporting hazardous materials.

THE SOLUTION

A proposal in early 2002 to coat equipment with a Polyurea spray proved to be effective in meeting the definition of a Strong-Tight Industrial Package. This allowed the equipment to be transported to a waste receiver site intact on a flatbed trailer. Some extremely large pieces of equipment at Rocky Flats will still require size reduction to meet road size limitations. But the use of Polyurea spray coating to provide the packaging of a majority of the large pieces of equipment at Rocky Flats is expected to significantly reduce worker exposure to hazards and pare down project costs and schedule.

The Kaiser-Hill project team proposed using a Polyurea spray coating on two large oversized contaminated Pacific furnaces. The process was expected to reduce the risk to the D&D workers by eliminating hazardous size reduction tasks, and exposure to airborne contaminants, both radiological and beryllium.

The proposal was to use a plastic shrink-wrap material, then reinforce this covering with 0.25 inches of the Polyurea blend. The shrink-wrap that is used is a plastic sheeting composed of repeating, identical base units – a monomer and a hydrocarbon. It was anticipated that when the package was completed, the result would be a 100% continuous covering that is puncture/tear resistant, and lightweight. The plastic shrink-wrap provides the continuous substrate surface to accept the sprayed Polyurea material.

The packaging process starts with constructing a bottom pan in the size and shape (footprint) of the object to be sprayed. The plastic sheeting can be attached to a wood frame base. The heat shrink on the base is heated using a propane heat gun creating a continuous plastic cover. The package is then inspected to ensure total coverage without any holes. The base footprint is the size of the item to be encased. The completed platform is placed on a structural platform, usually an 8' X 20' base.

Fig. 2 Base constructed to accept the footprint of the waste item

The heat shrink pan is placed onto a structural platform. The bottom pan can have a four-inch lip and the pan bottom is coated to a thickness of 250 mils minimum of the Polyurea material. The walls and top of the sides are also coated to the minimal thickness. The object to be packaged is set into the prepared pan and chained down to the metal platform. A DOT knowledgeable inspector inspects chaining.

Fig. 3 Completed base ready to accept the waste item

Methods for moving and handling the object prior and post application depend on the facility. The application can be performed either indoors or out. The constraints are relative to temperature for the workers and the weather conditions that would influence spraying.

Fig. 4 Extrusion press loaded into prepared base and secured. Ready for shrink wrap.

Shrink-wrap is sized and made to cover object. The shrink-wrap is mated to the pan by securing a stapled batten at the pan lip. The shrink-wrap is heated with the propane-fueled heat gun to produce a smooth contour. Any heat damage to the shrink-wrap plastic or loose corners can be smoothed out using wide shrink-wrap tape. Care should be taken to insure that chain/plastic pass-through areas are taped well.

The next step is to place adhesive metal depth gauge buttons onto plastic surface at work package specified positions. Next, we install a "Strong Tight Package Vent Assembly", a filter, on any vertical surface and secure with special shrink-wrap tape. Then a two-inch mask is placed over the vent filter disc with double tape on the backside.

Fig. 5 Shrink-wrapped piece of equipment with thickness measurement buttons

The InstaCote™ SE Polyurea material is then applied as a spray over the entire wrapped area of the item. For superior performance, the workers spray the object four to six times utilizing a crosshatch type pattern until the required thickness is achieved. A light, thin initial coat over the entire surface will render a superior product. Continue to apply Polyurea to the specified thickness. Care should be taken to get complete overlay where the shrink-wrap is secured under the stapled batten. Care must also be taken to insure that the chain/plastic pass-through areas are adequately sprayed.

Fig. 6. Spraying InstaCote™ SE on prepared package

The Waste Inspector ensures that the "Strong Tight Package Vent Assembly" is sprayed properly. The thickness of the coating can be measured at any time by pressing a calibrated Elcometer Electronic Thickness Gauge to the metal depth gauge buttons. The package is ready for quality inspection when proper thickness at all button locations is obtained. A worker then removes the covering from the filter. The measured thickness of InstaCote^{TM} Se at all of the button positions, as specified in the work-package is recorded on the log sheets in the work package.

Fig. 7 Package complete, and ready for shipment.

Quality control of the total process is controlled through use of the Integrated Work Control Process (IWCP) and waste inspection criteria. Below are some examples of inspection points.

Visual – Interface at pan and shrink-wrap (no holes, 100% continuity in cover/coating)

Visual – Chain/plastic pass-through areas are sprayed in completely (no holes, space or gaps. Coating should totally fill in chain loops.)

Visual – Strong Tight Package Vent Assembly is sprayed properly. Vent media should be clean and tape used to secure vent assembly should be totally covered.

Review – work package for coating thickness readings. If questionable, randomly check-coating thickness using an Elcometer Electronic Thickness Gauge, compare recorded thickness with determined thickness and readings should compare within +/- 10%.

In regards to creating an NTS compliant waste package, RFETS Material Stewardship department generated a revision to the Appendix B of the NTS waste profile. The revision identified the general waste stream information that our project was requesting to package waste, using a compliant container.

The other information provided to the reviewing and acceptance agencies was the physical properties of the waste form, the waste stream components, and how the final waste form will comply with the criteria as defined in the NTS WAC. Also needed was the Resource Conservation and Recovery Act (RCRA) chemical characterization information using process knowledge and actual sampling and analysis results. The radiological properties of the waste were defined and the radiological characterization process used was provided in determining each packages activity.

The profile approval process as described in the NTS WAC Revision 4 was completed. The National Nuclear Security Administration Nevada Operations Office (NNSA/NV) received and approved the shipment and disposal of the subject waste stream under the requirement of the NTS WAC, Revision 4, and the RFETS Waste Certification Program.

The use of Polyurea and shrink-wrap as a strong tight waste-shipping package has eliminated several size reduction efforts for the projects. This new process has reduced costs, improved worker safety by reducing the risk to personnel associated with size reduction, and has also improved project completion schedule.

In several instances, large contaminated tanks, vessels, concrete mixers, and other types of containers have been sent to the receptor site after having the opening sealed and sprayed with InstaCote. The package was approved as its own strong tight unit as long as the openings were fixed/sealed. This was accomplished using the Polyurea material, thereby saving the project all waste packaging costs per item.

MATERIALS

InstaCote™ SE is a polyurea coating that is sprayed on to accessible surfaces of a contaminated object, and is similar to the after market coating applied to pickup beds. The blend is a plural component polyurea product with nearly unlimited surface application. The polyurea material has an extremely quick cure time, it can be applied to most surfaces, it is unaffected by temperature changes, it is non-marring, and is highly resistant to toxic solvents. This coating cures within seconds, to become a tough, resilient barrier and permanently fixes the contamination. When properly applied, this polyurea material meets the specific requirements of 49 CFR 173.410, and the requirements of a silt proof non-specific built bin container as specified in 49 CFR 173.240 (c) (See Table I below).

Table I Polyurea Coating
Typical Physical Properties

	Wet		
Solids			
By Weight	100%		
By Volume	100%		
VOC	0.0 lbs./gal		
Coverage	Thickness	Area	Usage
	30 mil (1/32")	1 sq/ft	0.15 lbs
	60 mil (1/16")	1 sq/ft	0.32 lbs
	90 mil (3/32")	1 sq/ft	0.40 lbs
	120 mil (1/8")	1 sq/ft	0.58 lbs
	180 mil (3/16")	1 sq/ft	0.82 lbs
Weight/gallon	9 lbs combined		
Viscosity			
A Component (Isocyanate)	800-1200 s/cps @ 25^o C		
B Component (Amine polymer)	700-1000 s/cps @ 25^o C		
Cure Times	45 seconds		
Gel	2 seconds		
Tack Free	25 seconds		
Post Cure	24 hours		
Recoat	Within 2 hours		
Shelf Life	Indefinite		
Clean up solvent	Xylene, MEK, Isopropyl alcohol, Methyl Pryolidone		
Thinner	Never Recommended		
	Cured		
Stress/tensile strength	2500-2800 psi		
Elongation @ 25^o C (77^o F)	280%		
Hardness	54 Shore D		
100% Modulus	1700-1900 psi		
Tear Strength Ply	410 PLI		
Thermal Shock	-65^o F with no effect		
Impact notched	320 inches/flash pounds		

LESSONS LEARNED

The project team expected to encounter growing pains and problems/issues in developing a new compliant waste package. The team remained flexible and open-minded when issues arose, and solicited feedback from all team members when correcting problems. Listed are the problems and solutions in using and in generating a new LLW package.

Problem

Ensure that a minimum of 0.25 inches of coverage is applied consistently on all surfaces of the package. The pressure of the sprayed material causes the coating to flow away – spread out – at the impact area.

Solution

A cross-hatching – multiple coverage spray technique was developed to provide the minimal thickness of 0.25 inches.

Problem

Potential expansion of the sealed package during transport to the disposal site.

Solution

Installation of a HEPA filter in the wall of the package and protecting the filter face during application.

Problem

Ensure structural integrity is maintained between the base and the upper section of the package.

Solution

Provide more surface area for overlapping of the sprayed material. The wood battens that attach the heat shrink sheeting to the base were modified.

Problem

Inconsistent operations, quality control, and proper cleanup/maintenance of the equipment.

Solution

An Integrated Work Control planning package was developed. Sections within the package outlined the requirements to be followed during operations to ensure compliance to the established directions. The IWCP package contains a pre-requisite section, a section detailing work tasks, and a post operations section. The package outlines the checklists needed for the correct start-up steps, the operation sequencing, and the cleanup tasks. Signatures are required to verify each task is completed prior to continued operation.

Table II identifies several of the larger items that have been packaged.

Table II RFETS completed InstaCote waste packages

Package Dimensions			Wt (lbs)
Super Compactor			
length	15.3	ft	
width	8.0	ft	91,753
height	8.0	ft	
Sutton Extrusion Press			
length	25.0	ft	
width	9.0	ft	349,360
height	10.0	ft	
Erie Anvil Block B865			
length	20.0	ft	
width	10.5	ft	250,189
height	8.8	ft	
Erie Anvil B865 Hammer			
length	20.0	ft	
width	11.6	ft	176,077
height	4.0	ft	
Erie Ram			
length	25.0	ft	
width	7.5	ft	47,315
height	5.5	ft	

Package Dimensions			Wt (lbs)
Super Compactor			
length	25.0	ft t	
width	8.0	ft	22,762
height	2.6	ft	
Concrete Vault T40 #1			
length	12.6	ft	
width	8.8	ft	34,656
height	7.7	ft	
Iso Press Yoke B865 Cold			
length	15.6	ft	
width	7.5	ft	61,558
height	3.0	ft	
Iso Press Yoke B865			
length	15.6	ft	
width	7.5	ft	40,498
height	3.0	ft	
A Mill Lindberg Furnace			
length	11.5	ft	
width	8.0	ft	19,237
height	9.0	ft	

CONCLUSION / SUMMARY

A critical safety challenge facing the D & D work crews at Rocky Flats is the disposal of extremely large pieces of production and processing equipment contaminated with radioactive and/or hazardous materials. Past practices have been to size reduce the equipment into manageable sizes that will fit into the approved standard waste containers. Size reducing the contaminated equipment poses a safety risk (exposing workers to significant industrial, chemical, and radiological hazards) and is labor intensive. Cost and schedule are also impacted.

When applied correctly, the polyurea material packaging system serves as a strong tight container for over the road transport of oversized LLW. The Spray-On-Container system forms a penetration resistant cover that meets the DOT regulations, the WAC for the NTS, and meets the definition of a Strong Tight IP-1 package. This system is easy to modify to provide waste disposal solutions for a long list of LLW.

The demonstration using polyurea plastic was successful. Aggressive size reduction efforts were eliminated for both furnaces. Nearly all safety and health hazards associated with size reducing and packaging were also eliminated. Cost savings for the two furnaces exceeded $30,000.

Kaiser-Hill determined that the product provided the best possible chemistry to address the projects radiological and industrial airborne contaminants concerns. The advantage of using a spray material to build a strong tight package for oversized items has improved worker safety, reduced D&D costs, recovered schedule, and increased waste packaging versatility.

Reducing the number of waste packages introduced into the waste accounting and handling system saves money in several fields of work as discussed. A person can identify their own tasks associated with waste processing and all the variable tasks and costs associated in managing 1 package from generation to the disposal site. The project here at RFETS considered the Total project costs and the safety and schedule impact by simplifying waste packaging.

To date, the use at RFETS in preparing these type of packages has realized total cost saving of over $2.0M. This is the first known use of a polyurea spray as an industrial package for low level radioactive and hazardous equipment in the DOE complex. The process is expected to save millions of dollars in the closure of Rocky Flats.

REFERENCES

1 DOE 49 CFR 173.24 (a) (b)

2 DOE 49 CFR 173.410