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THE USE OF POLYMERIC BARRIER SYSTEM (PBS) FOR CONTROL OF CONTAMINATION DURING D&D OPERATIONS AND SHIPPING OF RADIOLOGICAL WASTE

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ABSTRACT

Bartlett Nuclear Inc's "Polymeric Barrier System (PBS)"

Description: The Polymeric Barrier System (PBS) is a non-toxic, water-based solution which forms an impermeable barrier between hazardous or contaminated materials and the environment.

Applications:

a. The application of PBS to any surface to lock down loose contamination and prevent leaching of contaminates after decontamination efforts.

b. PBS is also used to control environmental contamination and soil erosion - providing a far superior alternative to the traditional approach of plastic sheeting or tarpaulins.

c. Easily applied in the field, PBS is ideal for minimizing the dispersion of contaminated materials, covering contaminated soil or construction debris, protecting equipment, stabilizing burial trench soil, confining spills and coating asbestos materials.

d. PBS is commonly used to stabilize large plant components, concrete, valves, and other problematic radwaste items prior to shipment.

Examples:

PBS has been successfully used at the Idaho Cleanup Project specifically on the demolition of Test Area North facilities. PBS was used to lock down loose surface contamination in a myriad of circumstances. Large and small scale application of PBS precluded the decontamination of areas of loose surface contamination. PBS was used on large and small overhead components, expanses of metal and concrete surfaces and in "permitted confined spaces" such as tunnels and trenches.

The color coding of PBS allowed the segregation of contaminated components to be picked from building debris and disposed of in accordance with local procedures.

External coating of large components such as tanks and 10 ft x 10 ft pieces of metal debris minimized the time and effort required to prepare and ship radioactive waste to both on and offsite disposal facilities.

This overall approach significantly reduced both cost to the company and risk to our employees.

Features & Benefits:

Applies quickly with industrial airless sprayer, paint roller, or brush - rental available
One gallon covers approximately 50 square feet at 25 mils
Dries in 8 to 24 hours
Low-cost solution
Available in 5 or 55-gallon quantities

INTRODUCTION

The feasibility of using a water based Polymeric Barrier System (PBS) for site specific control of contamination was demonstrated by pilot scale field tests at the Feed Materials Production Center (FMPC) and the Savannah River Site (SRS) during the fall of 1989. Test sections consisting of a wide variety of substrates were selected to demonstrate the use of PBS for specific applications of concern at each site. Using a spray application system, all substrates were covered with a continuous polymeric coating which after curing, isolated the test sections from the external environment.

BACKGROUND

In early 1989, the University of Cincinnati submitted proposals to Westinghouse Materials Company of Ohio (WMCO), the site management contractor for the FMPC and to Westinghouse Savannah River Company (WSRC), the site management contractor for the SRS, to perform a demonstration of the feasibility of using Polymeric Barrier System (PBS) for site specific interim control of hazardous substances. Proposed demonstrations at the FMPC & SRP included:

1. Equipment contamination containment coatings for materials of concern at each site
2. Renewability/Repairability of a year old FMPC test site
3. Particulate run-off control at the FMPC
4. Soil cover and trench stabilization agent at the SRS

Test sections ranged in size from 1 to 150 square feet and included a wide variety of substrates.

The Polymeric Barrier System (PBS) was to be applied to the test sections by spray field tests (Reference 3). After curing, the applied PBS was expected to cover each test section with a durable, continuous polymeric coating that would isolate the test section from the external environment and prevent its further dispersion by wind, rain or other environmental forces.

The proposals specified the test integrity and durability after the application of the PBS material. The following sections describe the work performed under the terms of the project agreements, including a description of the feasibility demonstration field test, the field test results, and the conclusions drawn from those results.

FMPC SITE DEMONSTRATION

Three site-specific applications of the Polymeric Barriers System (PBS) were demonstrated at the FMPC site in Fernald, Ohio. In September 1989, a field test was conducted at the site of the September 1988 demonstration to assess the repairability/renewability of the PBS material after one year of environmental exposure. Next, an equipment contamination control demonstration was conducted on six typical contaminated substrates in the FMPC decontamination area. Finally, the third site demonstration was conducted to determine the efficiency of the PBS for the control of contaminated soil run-off.

The PBS materials and spray application system necessary for the conduct of the demonstrations were transported by the University of Cincinnati (UC) project team to the FMPC sites. The selection of the test sites and applications were made by mutual agreement of the UC project team and Senior Staff Engineers at Westinghouse Material Company of Ohio (WNCO), who led the FMPC effort.

FMPC Repairability/Renewability Demonstrations

On September 7, 1989, a field test was conducted to demonstrate the repairability and renewability of PBS materials after one year environmental exposure. The original site of the September 1988, technology feasibility test (Reference 3) was utilized for this demonstration. The 1988 test section with a surface area of 57 square feet was originally constructed using material excavated from the FMPC site.

PBS was originally applied to the test section in September 1988 and left undisturbed for one year prior to the repairability/renewability test. The year-old material was intact and was flexible enough to permit foot traffic on its surface. Grass and weeds which had grown around the perimeter were removed. A volume of 3.3 gallons of PBS was spray-applied to the test section over the year old coating. The new barrier was given a contrasting pigmentation so that the original coating could be distinguished from the old material applied (see Figures 1 and 2).

Figures 1 and 2. Repairability/Renewability Demonstration Photos

MPC Equipment Contamination Control

The use of PBS for equipment contamination control was demonstrated at the Decontamination Facility of the FMPC on September 19, 1989. A total of six separate substrates were used in the test. These substrates included a greased fifth wheel, fork truck, fork truck tires, a rusted uranium melting pot and a section of transite (asbestos cement board). The PBS, which was easily applied to all substrates, set in under ten (10) minutes. Visual inspection and photographs taken in September, 1989 showed no degradation of the PBS. Table 1.1 provides coverage and cost data for each item

Table 1.1 Coverage and Cost Data for PBS Contaminated Equipment Containment Demonstration

Substrate	Pounds Applied	Total Material Application Cost
20" Truck Tire	2.25	$5.63
Greased 5th Wheel	3.30	$8.25
Transite (Asbestos Cement Board)	1.50	$3.75
Fork Truck (Moving Parts)	3.70	$9.25
Fork Truck Tines	4.25	$10.63
Uranium Melting Pot	5.50	$13.75

Controlled Water Run-off Tests

Controlled water run-off tests were initiated in October 1989, at the FMPC in order to provide initial estimates on the ability of PBS to reduce the generation of Uranium (U) and total suspended solids (TSS) in natural rain run-off water.

Soil from the FMRC site containing 115 +6 ppm of Uranium was placed in the upper half of four 2 ft. x 2 ft. test basins. All of the basins were inclined by 100 so that run-off water could be readily collected. The soil in three of the basins was coated with different amounts of PBS. The fourth basin was left uncoated to serve as control basin. The amount of PBS material per square foot of basin soil surface is tabulated in Table 1.2.

The basins were left in a controlled area exposed to the natural outdoor environment. Shortly after three rainfall events, water was collected from each basin and analyzed for TSS, U content, and pH. The results of each set of run-off analyses are also shown in Table 1.2, in addition to an analysis of the "as collected" natural rainwater.

The analytical results show that after the first rainfall event, the thinnest PBS layer (on soil sample 2, ~ 0.5 lb/ft2 or 2,400 g/m2) reduced the TSS level in the run-off from the untreated control sample. Doubling the thickness of the PBS material reduced the TSS run-off level by 97% (Sample 3). An additional layer of PBS (Sample 4) was deemed ineffective in bringing about any further reduction in the TSS level. TSS reduction for the PBS-treated samples after subsequent rainfalls ranged from 77% to 91%. Treated soil run-off water uranium content also decreased with respect to control sample run-off. However, the reduction was not dramatic or as consistent as the TSS reduction. This may indicate that some of the Uranium in the soil was in a water-soluble form and incorporated into the PBS at the time of its application to the soil surface. Further analysis would be necessary to determine if this is actually the case.

The pH of the run-off was generally the same as the precipitation (slightly acidic with one exception). After the initial precipitation, the run-off water in the reference basin was slightly basic, indicating that the rainwater permeated and was partially neutralized by the soil.

The visual appearance of the test basins provides the best indication of TSS reduction, showing obvious erosion. The visibility through the pool of run-off water of the wood grains in the floor of the basin with the thinnest coat attests to the clarity of the run-off water. As of December 1989, the soil with the thinnest layer showed no deterioration in the integrity of the PBS barrier.

Table 3.2 Analysis of Soil Run-Off Water

Sample Description	Sample 1 Control Soil	Sample 2 Treated Soil	Sample 3 Treated Soil	Sample 4 Treated Soil	Sample 5 Rainwater
Basin Surface Area (ft^2)	8.70	8.07	8.08	8.70	N/A
Basin Geometry (in^3)	44.75x28x50	44.75x26x3.50	44.75x26x3.50	44.75x26x3.50	N/A
PBS Treatment of Soil Surface (lbs/ft^2)	0.00	.49	1.00	1.39	N/A
Initial U Content of Soil (mg/L)	109.00	123.00	115.00	—	N/A
Run-off, 10/16/89	0.45	0.25	0.24	0.14	0.44
Water U, 10/18/89	—	0.35	0.32	0.27	0.12
Content, 11/9/89	0.41	0.65	0.37	0.32	<0.10
pH of 10/16/89	8.00	7.70	6.50	5.90	6.30
Run-off, 10/18/89	—	7.00	6.90	7.00	6.50
Water 11/9/89	6.80	6.90	6.90	6.80	7.00
TBS, 10/16/89	112.00	43.00	3.00	5.00	—
Run-off, 10/18/89	—	24.00	3.00	12.00	30.00
Water, 11/9/89 (mg/L)	22.00	2.00	5.00	201.00	—

SRS SITE DEMONSTRATION

In early November 1989, two site-specific applications of the Polymeric Barrier System (PBS) were demonstrated at the Savannah River Site (SRS) near Aiken, South Carolina. During the week of October 30 through November 3, PBS was demonstrated for use as a cover for soil excavated from simulated burial trench and as an equipment contamination containment coating.

The PBS materials and spray application system necessary for the demonstrations were transported by the UC project team to the SRS.

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Soil and Trench Stabilization Demonstration

In October 1989, after normal SRS check-in procedures, the UC project team was escorted to the site to observe construction of the test section. A 152 sq. ft. test section was constructed by SRS personnel using large-scale trench excavation equipment from the SRS burial ground.

The soil from the excavation was piled adjacent to the south edge of the trench in an approximately conical pile 2.5 ft. high and 10 ft. in diameter. The test section consisted of the conical pile, the south and west walls of the excavation, and the surface soil between the two. A rain fly was used overnight to prevent rain water collection in the trench.

PBS was applied in three coats to the test section. The weather conditions were typical for a fall day in the southeastern United States; scattered clouds and intermittent sunshine. The air temperature during the demonstration was between 75º and 79ºF.

A total of 75.4 lbs was applied. When the field team returned to the test-site one day later, the thin film applied the previous day was set and covered with a heavy dew. After the dew evaporated, two additional "finishing" coats were applied to the test section. The first coat was applied at noon and the second in the late afternoon. A total of 32.5 lbs. of additional material was applied to the test section.

Table 2.1 shows a detailed tabulation of the amounts applied in the two-day period. The durability and efficacy of the PBS material was confirmed by an inspection of the test section in March 1990, by SRS staff personnel. Although the PBS material shows some evidence of weathering, it remained functional and maintained its integrity. In particular, it was successful in stabilizing the trench walls to which it was applied.

Table 2.1 Summary of Weight of Applied Material
Savannah River Site Field Test 10-31 to 11-1

Date	Time of Applications	Pounds Applied
10-31	First coat, 10:58 - 11:07 a.m.	5.5
10-31	Second coat, 11:10 - 11:16 a.m.	10.5
10-31	Touch-up, 11:17 - 11:18 a.m.	1.0
10-31	Third coat, 2:42 - 2:52 p.m.	47.5
10-31	***TOTAL*** Application	74.5 lbs.
11-1	Touch coat, 11:55 - 12:03 p.m.	19.5
11-1	Touch coat, 3:18 - 3:28 p.m.	13.0
11-1	***TOTAL*** Application	32.5 lbs.

Equipment Contamination Control Demonstration

Six pieces of scrap material were coated with PBS material and, although not contaminated with any radioactive materials, the scrap specimens were typical of the contaminated waste produced by routine SRS operations. Two specimens were made of lead, one was a plastic (PVC) cylinder, and the other three were stainless steel scrap (type unknown).

The six test specimens were arranged in hanging positions and entirely covered with PBS material in two application sessions of about 10 minutes in duration. The first session was a 12:05 p.m.; the second was three hours later. Because of the small size of the specimen, there was significant overspray, but approximately 6 lbs. of PBS material was deposited on the specimens.

At the conclusion of the application sessions, the specimens were completely enclosed in a continuous film of PBS material. After the PBS material dried, visual inspection confirmed that the material adhered to the specimens and that the integrity of the continuous film was not compromised (no visible cracks or spilling).

PROJECT HIGHLIGHT: RECENT USE OF PBS AT THE IDAHO CLEANUP PROJECT

Since early 2005, PBS has been successfully used at the Idaho Cleanup Project (ICP), specifically on the demolition of Test Area North (TAN) facilities. PBS was used to lock down loose surface contamination in a myriad of circumstances. Large and small scale application of PBS precluded the decontamination of areas of loose surface contamination. PBS was used on large and small overhead components, expanses of metal and concrete surfaces and in "permitted confined spaces" such as tunnels and trenches. The color coding of PBS allowed the segregation of contaminated components to be picked from building debris and disposed of in accordance with local procedures.

Idaho site engineers describe the use of PBS in Cubicle 13, "Radiological Engineering researched several other brands of fixatives and recommended the use of a Polymeric Barrier System (PBS). The PBS was applied to the floor and surfaces of the cubicle. The PBS was found to be highly effective. It withstood high traffic areas preventing leaching and contamination. The product was cost effective and had a quick drying time and was easily applied with a portable hand sprayer. PBS was used extensively in other areas of the facility to "lock" loose contamination" (Reference 4).

This overall approach significantly reduced both cost to the company and risk to the employees

Figure 3. PBS Spray Application

Figure 4. PBS-Coated Penetration Segments

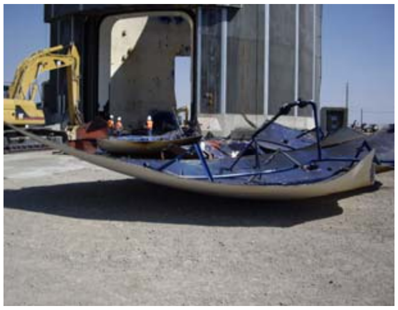

Figure 5. PBS Coating Section of Dome

Transportation & Shipping Applications

PBS can be used to stabilize large plant components, concrete, valves and other problematic radioactive waste items prior to shipment. External coating of large components such as tanks and 10 ft x 10 ft pieces of metal debris minimized the time and effort required to prepare and ship radioactive waste to both on and offsite disposal facilities. Upon correct application and inspection, PBS has been approved by the U.S. Department of Transportation (DOT) to ship radioactive waste, providing for use as a strong tight container.

At the Idaho site, low level waste was shipped from the TAN facility to the off-site Idaho CERCLA Disposal Facility Complex. The average radioactivity levels of the waste were 20,000 to 30,000 dpm and maximum levels were 100,000 to 150,000 dpm.

ADDITIONAL EXPERIENCE

PBS has been used at both commercial nuclear utilities and Department of Energy (DOE) facilities nationwide. Select commercial nuclear project locations include Pacific Gas & Electric's Humboldt Bay Power Plant and Sacramento Municipal Utility District's Rancho Seco Nuclear Generating Station. Select DOE facilities include BWXT/Y-12, Hanford, Idaho National Lab/Idaho Cleanup Project, Nevada Test Site, Oak Ridge National Lab, Rocky Flats Environmental Technology Site, Savannah River Site and the West Valley Demonstration Project.

Figure 6. PBS Coating on Steam Generator

CONCLUSIONS

Results of the field tests indicate that, for many applications, PBS is a superior alternative to plastic wrapping or tarpaulins for contamination and erosion control. PBS reduces the risk of tearing and avoids the generation of large amounts of additional waste. PBS applies quickly and easily with an industrial airless sprayer, paint roller, or brush and dries within 2-24 hours, depending on thickness of application and ambient conditions (i.e., humidity). PBS offers an inexpensive solution for contamination control and transport of radioactive waste, available in 5 or 55-gallon quantities, with one gallon covering approximately 50 square feet at 25 mils.

PBS is applied to any surface to lock down loose contamination, prevent contaminate leaching after decontamination efforts, and control environmental contamination and soil erosion. In the field, PBS is ideal for minimizing the dispersion of contaminated materials, covering contaminated soil or construction debris, protecting equipment, stabilizing burial trench soil, confining spills and coating asbestos materials. PBS is commonly used to stabilize large plant components, concrete, valves, and other problematic radioactive waste items prior to shipment and is DOT-approved for use in transport, providing for use as a strong tight container.

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